



# Achieving lower speeds: the toolkit

MAYOR OF LONDON



TRANSPORT  
FOR LONDON  
EVERY JOURNEY MATTERS

# Contents

<b>04</b> About the toolkit	<b>34</b> Section 2: Vertical treatments
<b>06</b> How to use this toolkit	<b>44</b> Section 3: Horizontal treatments
<b>08</b> The case for lower speeds	<b>50</b> Section 4: Narrowing the carriageway
<b>14</b> Lower speeds in London	<b>64</b> Section 5: Rethinking the street function
<b>16</b> Implementing and monitoring lower speeds	<b>74</b> Conclusion
<b>18</b> Section I: Signing and road markings	<b>78</b> References

Reducing vehicle speeds has been proven to reduce both the likelihood of a collision occurring and the severity of the outcome.

The Mayor of London, Sadiq Khan, has made a clear commitment to road danger reduction and slower vehicle speeds by adopting Vision Zero for London.

The speed reduction measures outlined in this toolkit can be used by anyone seeking to make our streets safer, healthier and more attractive for walking and cycling. It is also aimed at those responsible for implementing specific speed reduction programmes on the Transport for London (TfL) Road Network and local roads managed by the London boroughs.



Designing streets as places to spend time, rather than pass through, helps to create a low speed environment

## About the toolkit

The toolkit is structured around five different types of speed reduction measures.

The cost and level of intervention for each escalates throughout the toolkit, from light-touch interventions such as the changes to signage and road markings outlined in section 1, through to the more transformational measures involving road space reallocation set out in sections 4 and 5 of the toolkit.\*

While camera-based enforcement, behaviour change campaigns and new technology such as Intelligent Speed Assistance can also have a role to play in reducing speed, this document focuses on the range of physical measures that can be used to change the look and feel of existing streets. How a street looks and feels has a measurable effect on traffic speeds and is one of the most effective means of promoting compliance with the speed limit. If motorists perceive that they have priority and that the street has been designed primarily for vehicular traffic, then they will drive accordingly. It is therefore important that the role of streets as places to dwell and relax, and where there are things to see and do, should be considered when seeking to design streets with lower speeds.

The look and feel of a street and the number of people who spend time on it can be heavily influenced by factors such as land use, quality of building facades, presence of active frontages and the way buildings and trees frame the street. Opportunities to influence these factors are often found in the planning system as part of the development application process and master planning for new opportunity areas. However, the overall quality and character of a place can be improved on existing streets through a combination of the measures contained in this toolkit, especially those outlined in sections 4 and 5, which involve a reduction and reallocation of carriageway space.

This document is not intended to constitute a design guide, nor replace local or national design guidance. While it contains a number of peer-reviewed measures to achieve lower speeds, these measures used in the wrong context or the wrong location may not achieve these aims, or have other unanticipated consequences. It is suggested that accredited professionals are engaged through the design process to review proposed measures on a site-specific, case-by-case, basis.

\* Although road space reallocation doesn't always have to involve costly engineering measures, as demonstrated by the low-cost and temporary interventions described in sections 4.6, 5.1, 5.3 and 5.4

# How to use this toolkit

This toolkit is intended to be used as an options palette and does not seek to replace or review any technical literature or policies previously published on this subject.

The document demonstrates the proven effectiveness of speed reduction measures used in case studies from around the world. The speed reductions seen in case study examples are context-specific, and results may not necessarily be replicated. The document does not provide evidence on the subsequent impact on collision numbers as a result of speed reductions at these locations. It makes the assumption, based on previous research, that lowering traffic speeds will reduce the likelihood and severity of collisions occurring.<sup>1</sup> It is important though that any street-based interventions are carried out with a comprehensive monitoring framework in place to understand the effect on collisions, and other benefits (or unintended disadvantages).

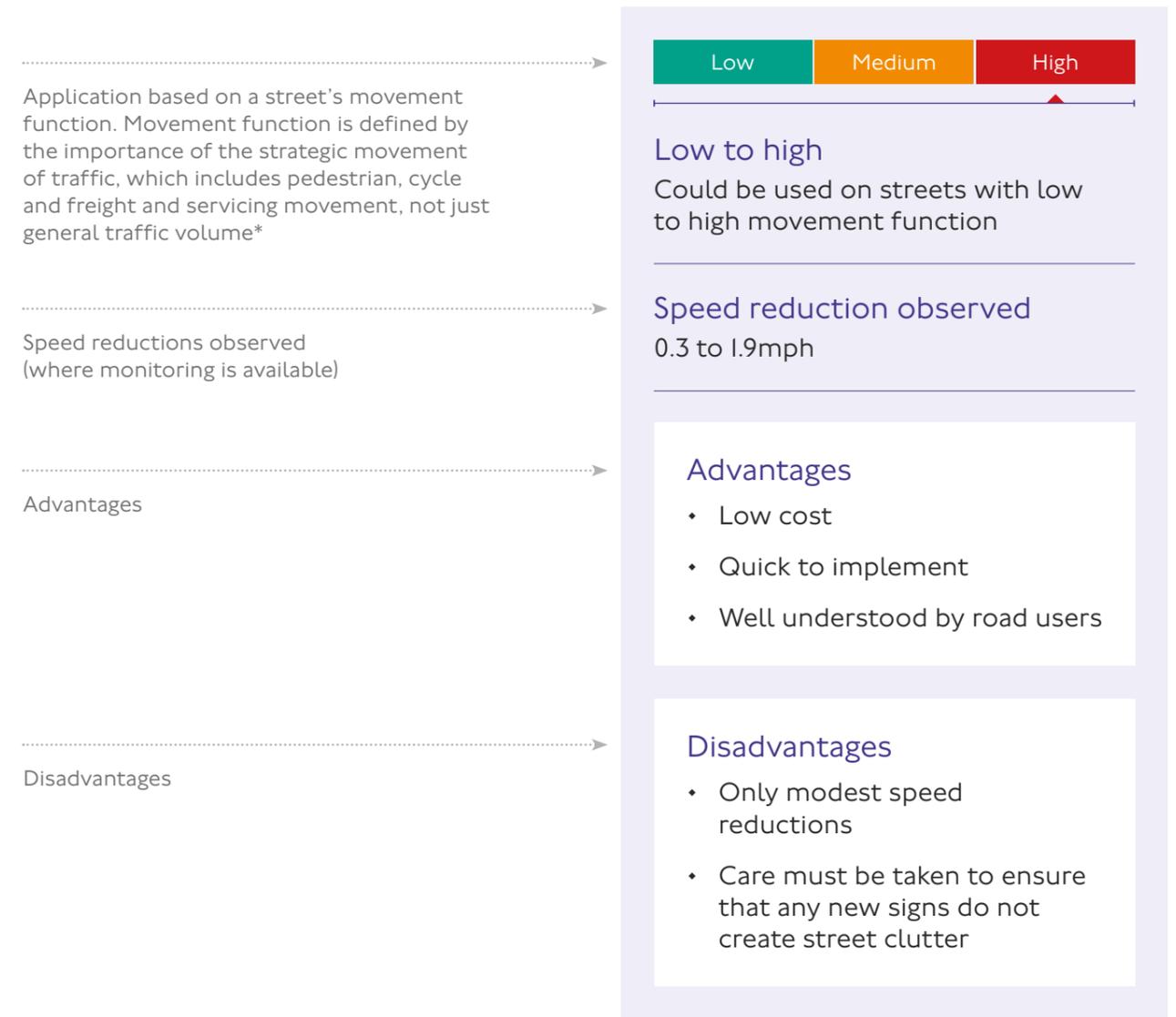
Some of the measures in this toolkit will be able to realise speed reductions by themselves, while most will achieve more effective results when used in combination with others. There is no 'one size fits all' approach to reducing vehicle speeds, and speed reduction measures should be chosen carefully, looking at the whole street, existing traffic volumes and speed, type of traffic, street functionality and stakeholder views.

Speed limits are generally self-enforcing through design, with recent research commissioned by the Department for Transport highlighting that the speed at which people drive is influenced more by

the look and feel of the road, than whether a 20 miles per hour (mph) or 30mph limit is in place.<sup>2</sup> The research found that signed-only 20mph speed limits had a small (~1mph) impact on average speed. Achieving lower speeds on busier streets with higher existing speeds is likely to require the use of multiple, physical engineering measures to alter the look and feel of the street.

For each of the measures in this toolkit, a summary table is provided to give an idea of the impact observed in the case studies available, its applicability to different types of streets based on existing movement function and any key advantages or disadvantages. The TfL Road Network broadly falls into the 'high movement' category, while streets managed by the London boroughs often consist of local routes with a low movement function as well as more strategic routes which, like the TfL Road Network, see large numbers of pedestrian, cycle, bus, freight and servicing movement. Therefore, distinguishing in this toolkit between those measures that are suitable for the TfL Road Network versus borough-controlled roads is not necessarily helpful as the two are not always different or unique. It is the role of the street designer to consider how the measures in this toolkit can be applied on a case-by-case basis, while taking into account the information in the summary table and any key considerations highlighted in the toolkit.

Figure 1: How to interpret the summary tables



\* **Low movement:** refers to local routes used for local access by people and deliveries  
**Medium movement:** refers to distributor routes that connect strategic routes with local points of access  
**High movement:** refers to strategic routes which play a key role for the city-wide movement of goods and people

# The case for lower speeds

Achieving lower speeds in London is vital for achieving our Vision Zero ambition to eliminate deaths and serious injuries from the transport network by 2041.

The Vision Zero approach recognises that people make mistakes, so our streets must accommodate human error and ensure impact energy levels are not sufficient to cause fatal or serious injury.

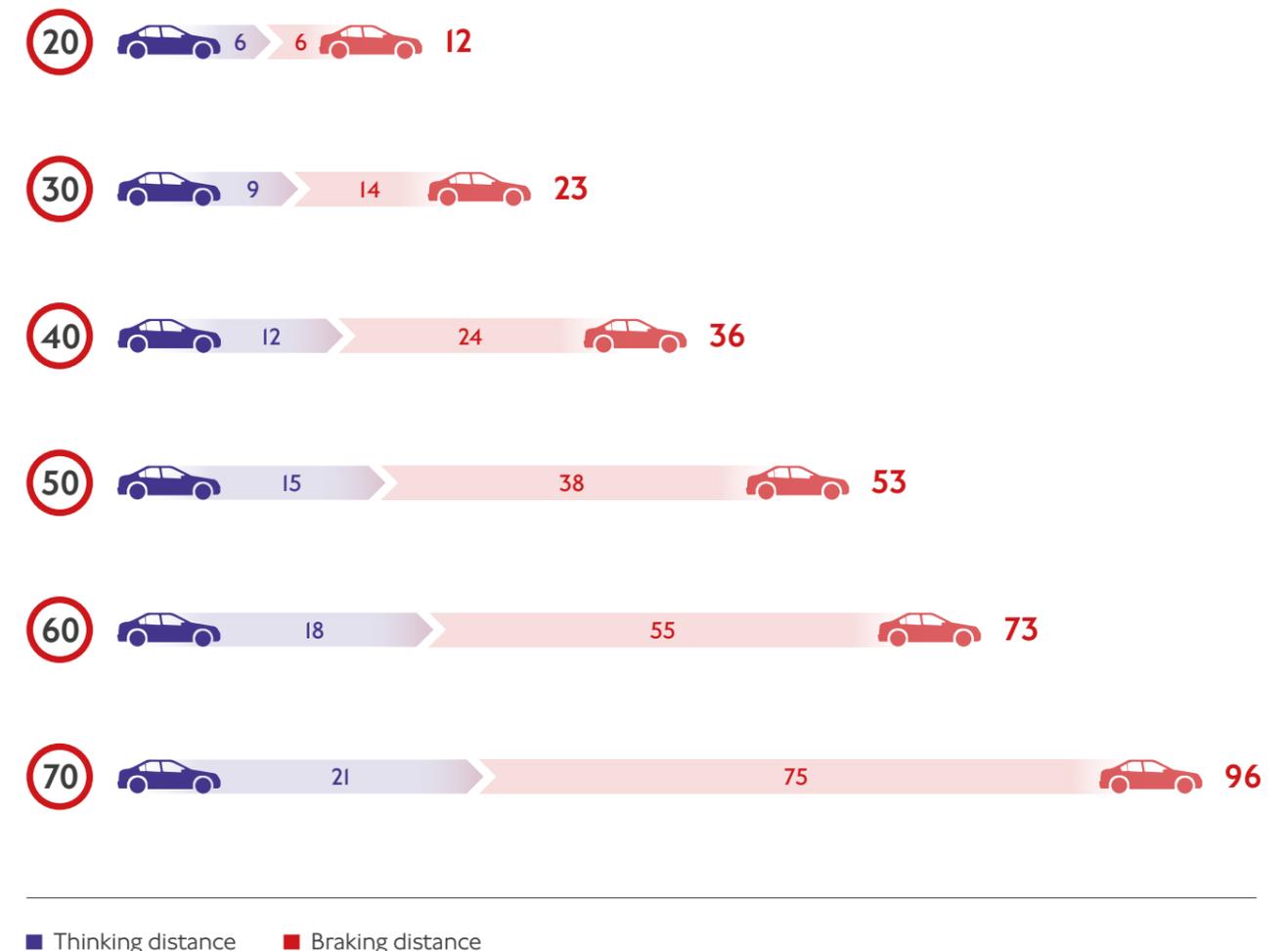
The severity of injury from a collision increases disproportionately as vehicle speed increases. If a person walking is hit by a vehicle travelling at 30mph they are more likely to be killed or seriously injured than if they were hit at 20mph.

As well as influencing the severity of a collision, the speed at which people are driving or riding impacts the likelihood of a collision occurring in the first place.

The faster a person is driving, the less time they have to react to avoid a collision. Based on a typical reaction time of 0.67 seconds, a car travelling at 20mph would be able to stop three car lengths sooner than a car travelling at 30mph, as illustrated in Figure 2.

This is why 20mph is widely regarded as a safe speed on roads with possible conflicts between motor vehicles and pedestrians, cyclists or other vulnerable road users. This view is backed by a number of international bodies, including the Organisation for Economic Cooperation and Development and the World Health Organization.

Figure 2: Typical stopping distances at different speeds as set out by the Department for Transport in 2015<sup>3</sup> (metres and miles per hour)



The distances shown are a general guide and based on an average sized car of four metres. The stopping distance will depend on a driver's attention (thinking distance), the road surface, the weather conditions and the condition of the vehicle.



Lowering traffic speeds makes streets more attractive for walking and cycling

Vision Zero is inextricably linked to the Healthy Streets Approach, which is the overarching framework for the Mayor's Transport Strategy. Slowing speeds contributes to many of the Healthy Streets Indicators shown in Figure 3, including People feel relaxed, People feel safe, Easy to cross, People choose to walk, cycle and use public transport, Pedestrians from all walks of life, Not too noisy and Clean air. The other Indicators can all be improved through measures to slow traffic such as using planting and seating to narrow the carriageway space.

The benefits of lower speeds are wide-ranging. Lowering traffic speeds reduces the dominance of motor vehicles and makes streets more attractive for walking, cycling and public transport trips, as illustrated in Figure 4. At present, too many people feel wary of making their journey on foot or by cycle. Fear of road danger, too much motorised traffic and vehicles travelling too fast are key deterrents to walking and cycling. Nearly a fifth of Londoners feel that too much traffic, and traffic travelling too fast, are major barriers to walking,<sup>4</sup> and more than half say that fear of being in a collision is a major barrier to them cycling.<sup>5</sup> Creating lower-speed environments that help people feel safe to travel more by walking and cycling will lead to health benefits as people are able to be more physically active.

Reduced car dependency and lower speeds help create better environments for people, with less air and noise pollution and improved traffic flow. The introduction of lower speed limits has sometimes raised concerns about impact on journey times and air quality. Yet many of these criticisms are unfounded when the evidence is reviewed, with a number of studies now confirming that journey times, for instance, are maintained or improved due to a more consistent traffic flow.<sup>6</sup> Imperial College London's evaluation of the impact of the introduction of 20mph speed limits on behalf of the City of London suggested the limits had no net negative impact on exhaust emissions, but results indicated clear benefits to driving style and associated particulate emissions. The research found that vehicles moved more smoothly, with fewer accelerations and decelerations, than in 30mph zones, reducing particulate emissions from tyre- and brake-wear.<sup>7</sup> Further evidence of the impact of vehicle speed on emissions and health is set out in TfL's Speed, emissions & health evidence summary.<sup>8</sup>

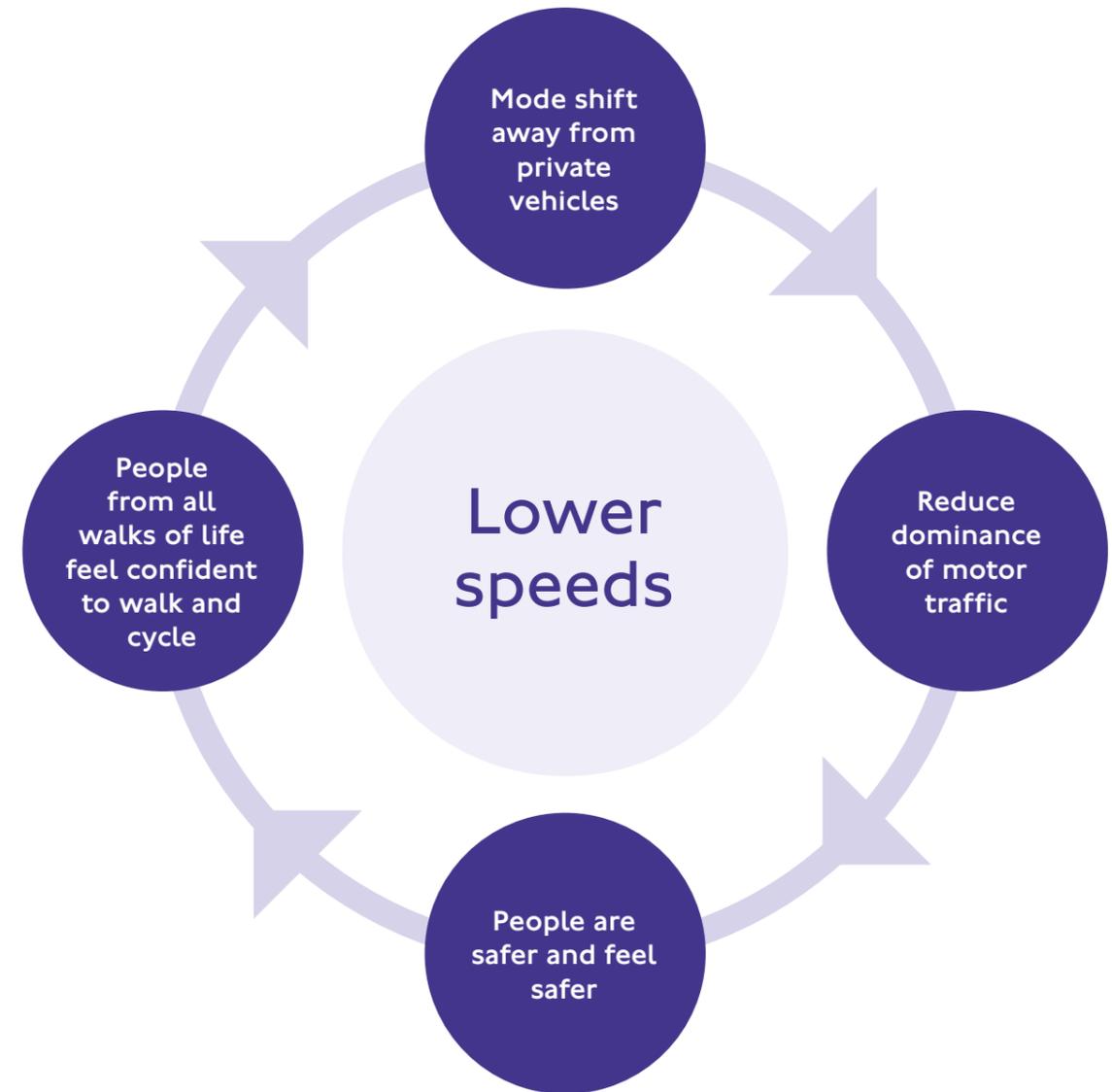
Figure 3: The 10 Healthy Street Indicators



Source: Lucy Saunders

Lowering speeds can contribute to each of the ten Healthy Streets Indicators in some way

Figure 4: How lowering speeds supports mode shift towards active travel



By making our streets safer and feel safer, we will create streets where people want to walk, cycle and use public transport.

# Lower speeds in London

London has already taken action to reduce speeds, and more than a third (39 per cent) of streets in London now have a 20mph speed limit.

TfL and the boroughs are working to make streets in London more welcoming and safe for people travelling by cycle, on foot and by public transport, so speed limits and corresponding speeds need to adjust.

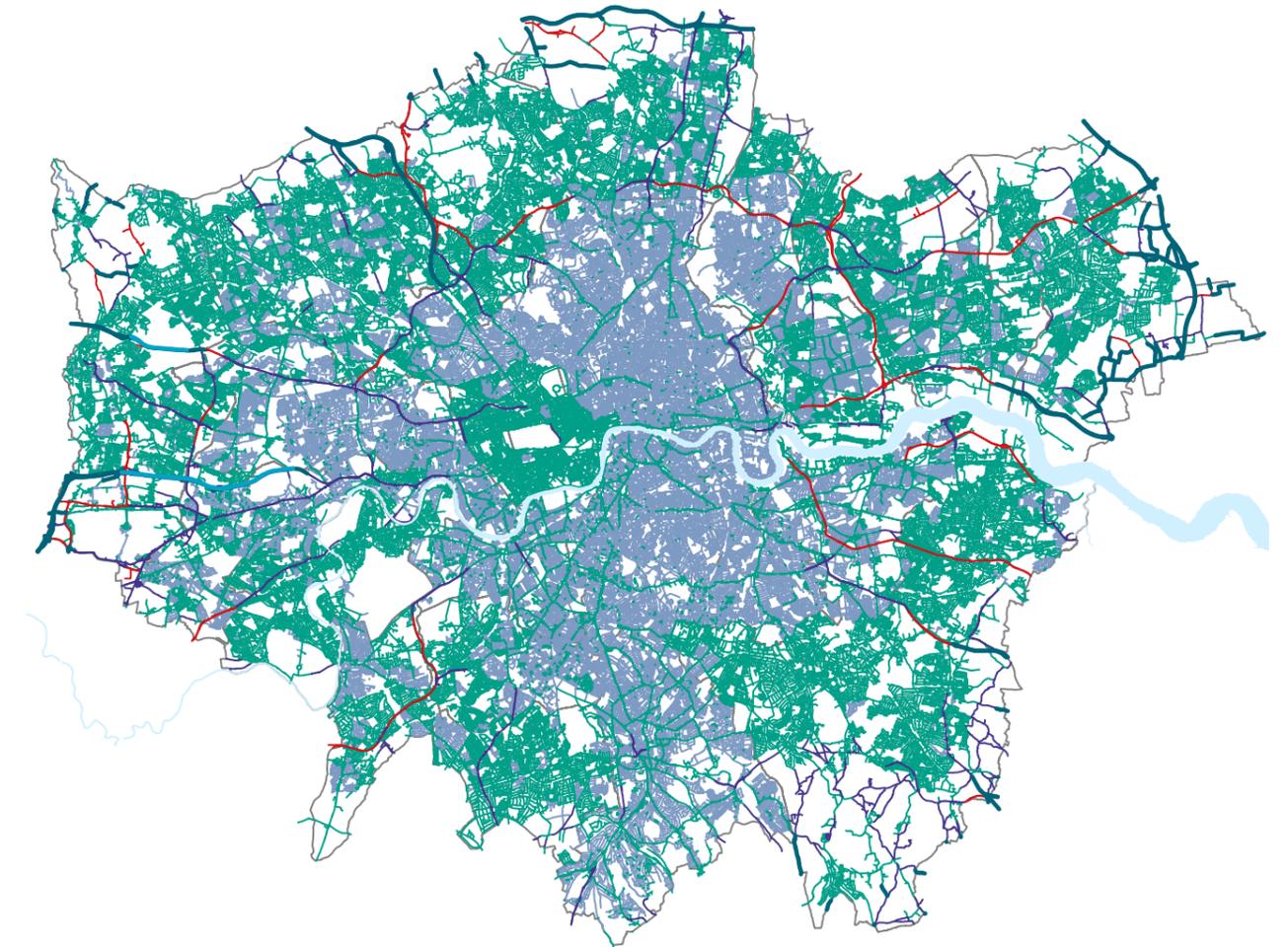
TfL has undertaken a risk-based analysis to identify locations where there is a case to lower speed limits on the TfL Road Network. This analysis considered:

- Current road danger (including numbers of fatal and serious collisions)
- Current and potential levels of walking and cycling
- Surrounding borough speed limits
- The function of the road, including whether it is a town centre
- The need to avoid displacing traffic from the TfL Road Network to local streets

From this analysis, a programme to lower speed limits on approximately 150km of the TfL Road Network has been proposed, as outlined in the recently published Vision Zero action plan<sup>9</sup> for London.

TfL would like to work with boroughs to apply the same risk-based approach used on the TfL Road Network to support similar changes in speed limits on strategic borough-managed roads to ensure speed limits across London's road network are clear and consistent and reduce road danger.

Figure 5: London digital speed limit map, July 2019



Key	
20mph	—
30mph	—
40mph	—
50mph	—
60mph	—
National speed limit	—

# Implementing and monitoring lower speeds

The 'Setting Local Speed Limits' circular<sup>10</sup> encourages local authorities to implement more 20mph limits in urban areas, to ensure greater safety for vulnerable road users.

The guidance states that, where the mean speed prior to implementation is at or below 24mph, a 20mph speed limit can be introduced using sign and road markings only. Above this, it is generally recognised that this will not be sufficient for the scheme to be self-enforcing or self-explaining, an issue that will create an unsustainable enforcement problem. In cases where the mean speed is above 24mph, additional speed reduction measures should be used.

Many boroughs in London use a 'blanket' approach to introducing 20mph limits on all their roads alongside a monitoring and evaluation programme to identify where further intervention might be needed to ensure compliance with a new speed limit. For example, after several years of delivering 20mph zones in response to casualty trends, the London Borough of Camden applied a blanket 20mph speed limit in 2013 to remaining streets using signage only. The borough uses monitoring and evaluation data to target staged interventions at locations with speeding issues to encourage compliance with its borough-wide 20mph speed limit (see case study).

As well as helping to identify where further speed control measures are needed, robust monitoring and evaluation data is essential alongside the introduction of new lower speed limits to understand the impact and effectiveness of different types of interventions. Monitoring a scheme's impact on speed, casualties and perceptions of the overall health of a street can help with demonstrating the benefits of lower speed limits to decision-makers and make the case for future lower speed interventions.

The Department for Transport's Traffic Advisory Leaflet 9/99<sup>11</sup> provides advice on how to accurately measure and monitor traffic speeds. In particular, it recommends that speed measurements are taken in dry weather conditions, at times when traffic is flowing freely. Looking at the 7pm-7am speeds, when free flow conditions are more likely, is one way of doing this.

Entering schemes on to the Traffic Accident Diary System allows for the number and severity of collisions and casualties before and after the introduction of measures to be monitored. Guidance for using the Healthy Streets survey<sup>12</sup> explains how changes in perceptions of the 10 Healthy Streets Indicators following an intervention can be tracked, using before and after surveys.

## Case study



## London Borough of Camden's staged intervention approach

Each year, traffic speed and volume surveys are carried out over a two-week period at 125 'core' locations, and the data used to create a prioritisation table of locations with the highest average speeds. Where a road has average night speeds greater than 24mph, stage one of the intervention programme, as described below, will be implemented. Should the average speed remain in excess of 24mph in the next round of surveys, the road is then flagged for stage two intervention. Should the average speed still remain greater than 24mph, the road moves up to stage three and then to stage four. The stages are:

**Stage one:** Enhance 20mph signage, by increasing the prominence of signage.

**Stage two:** Install mobile vehicle activated signs that warn drivers that they are exceeding the speed limit.

**Stage three:** Undertake 'Community Roadwatch'. This initiative gives local residents the opportunity to work side by side with their local police teams, and use speed detection equipment to identify speeding vehicles in their communities.

**Stage four:** As a final stage, infrastructure measures, such as traffic calming, are considered, especially at locations with a history of road casualties.



## Section I: Signing and road markings

- I.1 Signs and lines
- I.2 Vehicle activated signs
- I.3 Speed indicator devices and flashing beacons
- I.4 Virtual speed humps
- I.5 Centreline removal
- I.6 Varying surface treatments

Signing and road markings can be used in a variety of ways and will typically achieve small reductions in speed. A recent Department for Transport evaluation<sup>2</sup> of the effectiveness of 20mph (signed-only) speed limits found average speed reductions of approximately 1mph across 12 case study areas.

Although there was insufficient evidence to conclude that there had been a change in the number of collisions and casualties as part of this study, previous research has shown that small reductions in speed are still significant, as the severity and likelihood of a collision occurring increases with speed. Signing and road markings can also be used in combination with other measures outlined later in this document to maximise effectiveness. Signing and road markings must be used carefully to minimise visual clutter and avoid creating an environment that visually prioritises motorised vehicles.

# 1.1 Signs and lines

'Signs and lines' refers to schemes that are introduced using only signing and road markings. The extent of such schemes varies greatly across the UK and globally, from single streets to city-wide limits. Signed-only 20mph schemes are cheaper and quicker to implement than other measures, although they are compromised by a lower impact on speed reduction. A recent evaluation of the effectiveness of 20mph (signed-only) speed limits found average speed reductions of approximately 1mph across 12 case study schemes in England.<sup>2</sup> The table on page 23 shows mean speed reductions across a number of cases where 20mph speed limits have been introduced using signs and lines.

The Department for Transport suggests sign and road marking-only schemes are best suited to roads that have a mean 'before' speed of 24mph and under.<sup>10</sup> There are, however, a number of examples across London of boroughs introducing 20mph limits on all borough roads and then addressing those that prove to have average speeds in excess of the new speed limit by introducing additional measures.

The impact of any new signage on the streetscape must be considered with this type of intervention, particularly with regard to street clutter. TfL's Streetscape guidance<sup>13</sup> explains the importance of ensuring that people can comfortably move along footways unhindered by street clutter or inappropriately located obstacles.

Road markings vary in design but consist of painted lines, symbols or words on the carriageway (eg 20mph roundels). In the past, 'SLOW' road markings have been painted on the carriageway, telling motorists to slow down, but a 2015 evaluation by TfL was not able to prove that this particular type of road marking is effective at reducing speeds.<sup>14</sup>

Road markings must be carefully considered in conjunction with the character and function of the street, to ensure legibility and avoid visual clutter. Statutory requirements for the design and placement of road markings on the public highway are provided in the Department for Transport's Traffic Signs Regulations and General Directions,<sup>15</sup> and the Department for Transport's Traffic Signs Manual<sup>16</sup> gives advice on application.



A 20mph roundel on the carriageway



## Low to high

Could be used on streets with low to high movement function

## Speed reduction observed

0.3 to 1.9mph

### Advantages

- Low cost
- Quick to implement
- Well understood by road users

### Disadvantages

- Only modest speed reductions (and therefore existing vehicle speeds must be taken into account prior to implementation)
- No impact on those speeding deliberately
- Care must be taken to ensure that any new signs do not create street clutter

### Impact in practice: London

London is embracing lower speed limits, with 20mph speed limits in place on many stretches of our roads and all or almost all borough-managed streets in Camden, Hackney, Hammersmith and Fulham, Haringey, Islington, Lambeth, Lewisham, Southwark, Tower Hamlets and the City of London. Many other boroughs have already implemented 20mph limits on all non-arterial streets or are in the process of rolling out lower speed limits across their borough.

In 2014, the City of London introduced a 20mph speed limit on all of its streets, complemented by:

- Engineering schemes such as junction design improvements, courtesy crossings for pedestrians and filtered access to some streets to exclude through traffic
- An awareness campaign that included road shows, a press campaign, 20mph roundels on City of London refuse vehicles, and City of London Police engagement with motorists

- 20mph signs at entry and exit points to the City, with 131 20mph roundel markings applied to the carriageway
- Speed limit enforcement by the City of London Police

One year on in 2015, the measured mean speeds in the City of London were 1.5mph lower. A fall in speeds of 1mph has been shown to result in a fall in collision rates of approximately six per cent on urban main roads and residential roads with low mean speeds.

Over the last few years, TfL has been trialling 20mph speed limits on parts of its road network. Many of the trials, such as in Brixton town centre, used a combination of new signage, carriageway roundels, virtual road humps and lamp column banners. Physical engineering measures have been used with the aim of further reducing speeds, in locations including Earl's Court Road and Camden Street. Monitoring is under way to understand the impact of these schemes.

### Observed speed impacts – 20mph schemes

Study location and year	Mean speed reduction	Comment on data
Edinburgh, Scotland (2013) <sup>17</sup>	1.9mph	28 sites across one pilot area (~40miles)
Bristol, England (2011) <sup>18</sup>	0.9 to 1.4mph	Statistically significant result. £100k worth of pre/post monitoring carried out across two pilot areas
Bristol, England (2018) <sup>19</sup>	2.7mph	Statistically significant reductions in mean traffic speeds across the city
Oxford, England (2012) <sup>20</sup>	0.9mph	Pre and one year post monitoring at 130 sites
London Borough of Islington, England (2014) <sup>2</sup>	1mph	Borough-wide monitoring across all borough roads
City of London, England (2015) <sup>21</sup>	1mph on the TfL Road Network after one year and 1.5mph on the Corporation's roads after one year	Borough-wide monitoring including two TfL Road Network trial sites. Borough sites monitored across 46 sites
Graz, Austria (2014) <sup>6</sup>	0.31mph (lower reduction likely due to the scheme excluding 'strategic' roads)	City-wide monitoring of a number of criteria one year and 18 months after launch
London Borough of Southwark, England (2017) <sup>22</sup>	1.8mph	Speed impact measured across 86 sites
Calderdale, West Yorkshire, England (2018) <sup>23</sup>	1.9mph	Mean reduction in speed taken from 3.5million readings, with variations in some areas
London Borough of Hammersmith and Fulham, England (2017) <sup>24</sup>	0.31mph	85th percentile speed change at 100 locations surveyed in 2015 and 2017

## 1.2 Vehicle activated signs

Vehicle activated signs consist of an internally mounted radar that detects a vehicle's speed, and if this speed meets a set threshold, a message is displayed. They are a form of digital road sign commonly deployed for speed compliance reasons.

In practice, they have been found to be more effective than traditional signs, as their luminance provides a contrast that has more of an impact on motorists. Vehicle activated signs cannot take the place of fixed signs; rather they should be seen as supplementary and most effective when moved around to different areas where speeding is thought to occur.

Information displayed by a vehicle activated sign is triggered on an individual basis and is targeted to a specific motorist, as opposed to Variable Message Signs, which mainly provide information to motorists in general. Vehicle activated signs also benefit from public support and are relatively low cost. Further information about the use of vehicle activated signs is available in the Department for Transport's Traffic Advisory Leaflet 1/03.<sup>25</sup>

### Impact in practice: Southern UK<sup>26</sup>

The Transport Research Laboratory conducted an extensive study into vehicle activated signs, examining 60 sites across a mixture of A, B and C class roads in Britain. This study found that motorists' responses were the same even three years following implementation, with vehicle activated sign roundel sites seeing reductions of 1 to 14mph (the higher end included a speed limit change) and speed camera repeater signs achieving 1.3 to 4mph reductions.

This study also outlined the impact of a vehicle activated sign roundel deployed in combination with a speed limit change from 30 to 20mph. Reductions were seen for all sites, ranging between 4.4 and 7.5mph, with an average reduction in mean speeds of 6.2mph, yet all sites still exceeded the 20mph limit.



Credit: Westcotec Ltd

Vehicle activated sign roundel

Low Medium High

### Low to high

Could be used on streets with low to high movement function

### Speed reduction observed

Unknown

### Advantages

- Simple to understand
- Relatively low cost
- More effective than traditional signage
- Some vehicle activated signs can also provide real-time speed data for monitoring purposes

### Disadvantages

- Power supply required
- Ongoing cost of maintenance
- Fixed sites likely to be less effective than mobile
- Can be difficult to move

# 1.3 Speed indicator devices and flashing beacons

Speed indicator devices are an additional form of vehicle activated sign, which display a motorist's current speed (accompanied sometimes by a frowning face or message to slow down where applicable). They aim to raise a motorist's awareness of their own speed, positively reinforcing those travelling within the limit and warning those who are not.

These devices can achieve notable speed reductions. However, this is often due to a 'novelty effect', with their impact shown to significantly reduce over time and space. The rotation of speed indicator devices around different locations is suggested to overcome this fading impact, especially as there is no residual impact on speeds, with this ideally occurring every three weeks to maintain their effectiveness.

Flashing beacons are a form of signal and prescribed in Schedule 14 of the Traffic Signs Regulations and General Directions to provide warning of children likely to be crossing the road. They can be used near schools to act as a warning upon entry to a lower speed limit area through visual cues and the highlighting of speed limit signs. Impact is dependent on distance from the beacon. However, the speed reductions observed have been sustained over time.

The beacon activates for all motorists regardless of speed and can be turned on/off automatically or manually at specific times of the day, potentially when speeds are highest.



Flashing beacon



Speed indicator device showing speed and warning message



### Low to high

Could be used on streets with low to high movement function

### Speed reduction observed

0.2 to 2.6mph (speed indicator device)  
2.2 to 12.5mph (flashing beacon)

### Advantages

- Signs are relatively inexpensive
- Simple to understand

### Disadvantages

- Very short-term impact (speed indicator device only)
- Power supply required
- Speed indicator devices can be difficult to move, sometimes requiring a cherry picker to manoeuvre them, which in turn requires traffic management and skilled staff to remove or install them
- Ongoing maintenance cost

### Observed speed impacts

Author and study location	Mean speed reduction	Comment on data	Comments
Walter and Knowles (2008) <sup>27</sup> Speed indicator devices London	1.4mph for up to two weeks  During operation reductions varied between 0.6 to 2.6mph	Statistically significant until week three for 10 of the 11 sites	Impact reduced significantly over time (after one week) and distance (this begins to reduce 200m downstream and impact is negligible after 400m)
Poulter and McKenna (2005) <sup>28</sup> Speed indicator devices Kingston-upon-Thames	1.3mph after one week 0.2mph after three weeks	Both statistically significant results	
Hawkins (1993) <sup>29</sup> Yellow Flashing Beacons around signs Des Moines, Iowa, USA	2.9mph after one month 2.4mph after six months 2.2mph after one year	The results show the signs produced a statistically significant reduction in vehicle speeds	Location of 'school zone' sites may mean reductions are not solely attributable to beacons
Aggarwal and Mortensen (1993) <sup>30</sup> Flashing Beacons Vacaville, California, USA	6.5mph mean speed reduction  Reductions ranged from 2.8 to 12.5mph	Reductions were all statistically significant except for one, which saw a statistically insignificant increase of 0.3mph	Only one link, outside a school, studied. Measure also used in combination with signs

# 1.4 Virtual speed humps

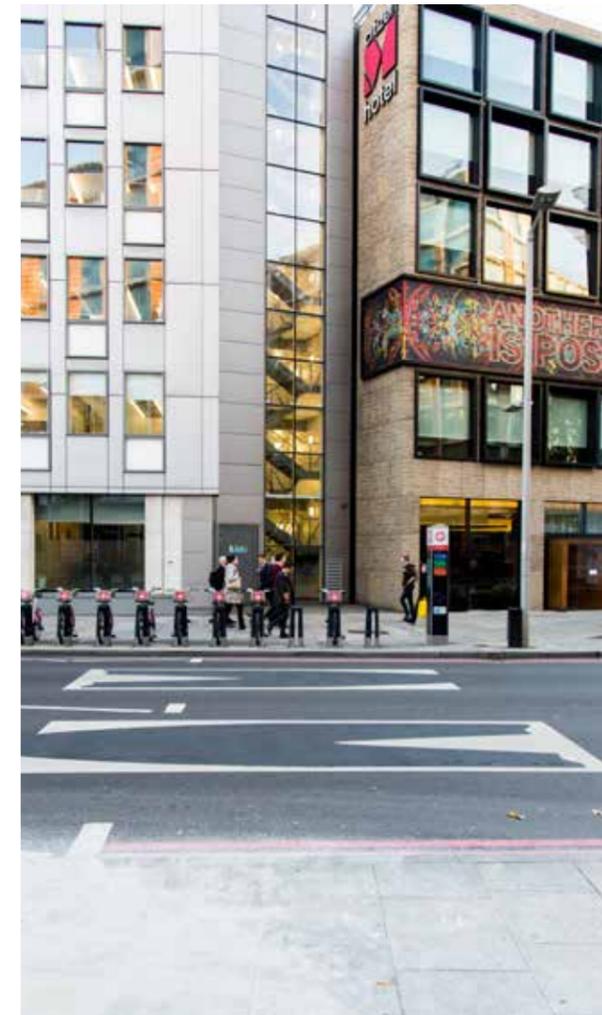
Virtual speed humps emulate vertical deflection measures without the need for engineering. These markings can be painted on the carriageway or created using specially designed mats, although care must be taken that they do not increase the skid risk for any road users.

These measures have a number of advantages compared to actual road humps: reduced cost, noise and time to implement. Questions still remain as to their impact over longer periods, and this suggests that they may not be as useful for commuter routes or where there is a high proportion of regular motorists in the area.

## Impact in practice: A17 London Borough of Newham, UK<sup>31</sup>

TfL trialled a variety of virtual speed humps in a 30mph residential area of North Woolwich in the London Borough of Newham. The markings were implemented within a three-hour period, overnight, at a cost of £935 per set.

Virtual road humps achieved an initial 4.4mph reduction in mean speeds after four months. However, the level of impact reduced over time as motorists became used to them. However, their impact was still significant after a year, with a reduction of approximately 1.7mph.



A virtual speed hump used in London, designed by Amayse



### Low to medium

Could be used on streets with low to medium movement function

### Speed reduction observed

0.23 to 1.7mph

### Advantages

- Very low cost
- Quick to implement
- No noise

### Disadvantages

- Impact declines over time
- The use of painted surfaces can increase differential skid resistance

## Observed speed impacts

Author and study location	Mean speed reduction	Comment on data
TfL (2015) <sup>31</sup> London Borough of Newham, London	Virtual box – 1.35mph Virtual triangles – 1.35mph Virtual humps – 1.7mph	Figures shown are after 12 months, with the figures for each direction combined and averaged
Blomberg et al (2012) <sup>32</sup> Philadelphia, USA	'An increase in the percentage of vehicles travelling at or below the speed limit and a decrease in the mean speed'	42 virtual speed humps on 25mph roads, monitored before and after for a total of five years. Citations, collisions and public perceptions also measured
Lalmahomed and Dikker (2001) <sup>33</sup> South Holland	0.23mph after both six weeks and six to nine months	Nine sites, mostly rural, monitored before and after. Conducted for speed, casualty impact and public support

# 1.5 Centreline removal

Centreline removal is achieved during planned resurfacing works by not reinstating the centrelines. It is supposed to work by reducing the confidence motorists have in allocation of road space, with this uncertainty leading to lower speeds. This measure provides immediate resource savings and longer-term maintenance savings by eliminating the need to re-paint as well as removing a skid risk for motorcyclists overtaking.

Centreline removal can be combined with lane narrowing, for example by reallocating space to cycle lanes. In non-separated conditions, research has found a correlation between overtaking speeds around cyclists and the absence of centreline markings.<sup>34</sup> This may be because the centreline presents a visual clue about where a driver should 'drive up to'. Its absence may cause the driver to consider their road position and travel at a careful speed.

Centreline removal should be avoided on streets with high traffic flows where there are likely to be motorists overtaking as there is a greater risk of drivers encroaching onto more of the opposing lane.

## Impact in practice: London<sup>35</sup>

TfL conducted trials of this measure on three 30mph routes on its roads and found significant reductions in speed, as shown in the table below.

The control site, which was monitored to ensure reductions were attributable to removal, saw speeds increase after resurfacing and the centreline being reinstated. A TRL study<sup>36</sup> has shown that speed increases following resurfacing can occur as motorists feel more confident that their vehicle will not be damaged by irregularities in the surface. This implies that the absolute reduction in speeds achieved by removing the centrelines is actually higher than measured for recorded data.

### Observed speed impacts

Site	Mean speed change (average to 95% confidence level)
Control Site – Wickham Road, Croydon	+4.5mph
A503 Seven Sisters Road, Haringey	-3.25mph
Wickham Road, Croydon	-2.95mph
A23 Brighton Road, Croydon	-1mph



Credit: Google Street View

A23 Brighton Road – Google Street View images of centreline removal – Before removal



Credit: Google Street View

A23 Brighton Road – Google Street View images of centreline removal – After removal

Low

Medium

### Low to medium

Could be used on streets with low to medium movement function

### Speed reduction observed

1 to 3.25mph

### Advantages

- Low cost
- Easy to implement when resurfacing
- Creates space for other users
- Minimal maintenance

### Disadvantages

- Site suitability must be carefully considered

# 1.6 Varying surface treatments

Varying surface treatments can allow for a more integrated approach to the design of public spaces and suggest an environment where priorities are different – less dominated by motorised traffic. Imprint surfaces are one way of achieving this effect, combining surface colour with paving texture, which highlight to the motorist that the area of roadway requires special consideration and should be approached carefully.

The use of coloured road surfaces, block paving and setts in the carriageway have been used previously in London to create varying surface treatments. However,

these measures have presented a range of challenges in terms of their maintenance, especially in high traffic areas or when utilities work has been required. TfL's Streetscape guidance<sup>13</sup> currently advises against the use of coloured road surfaces unless it is providing a safety or operational benefit to specified users and should only be implemented when other remedial measures have been deemed inappropriate.

Varying surface treatments are rarely used on their own. They are usually deployed in combination with other measures and as such their individual impacts are hard to quantify.

### Observed speed impacts

Author and study location	Mean speed reduction	Comment on data
Kennedy et al (2005) <sup>37</sup> Simulator trials	1.4 to 3.1mph	72 drivers took part in driver simulator trials, and findings were compared to control speeds
Kennedy and Wheeler (2001) <sup>38</sup> Buff road colour Norfolk, UK	East to west travel reduced by 4.4mph* West to east reduced by 2.4mph*	All reductions in mean speed were statistically significant

\* Figure is for all measures in combination (30>20mph limit change, road marking removal and coloured surface)



Imprint surface used on our road network with roundels at Camden Street



### Low to high

Could be used on streets with low to high movement function

### Speed reduction observed

1.4 to 4.4mph

### Advantages

- Provides visual delineation from the rest of the road
- Suggests an environment where priorities may be different eg less dominated by motorised traffic

### Disadvantages

- Maintenance requirements (and associated costs) should be considered as part of surface treatment selection



## Section 2: Vertical treatments

### 2.1 Road humps

### 2.2 Speed cushions

### 2.3 Raised tables

### 2.4 Gateways

Vertical treatments (sometimes referred to as vertical deflection) can have a dramatic impact on vehicle speeds but their introduction must be considered against their impact on other road users, particularly emergency vehicles, buses, motorcyclists and cyclists. Flat-top vertical treatments can support easier pedestrian access at crossings and speed reduction. However, vertical treatments can have a negative impact on those with visual impairments if the treatments meet the footway without the edge to the carriageway delineated by either a level difference of at least 60mm or tactile paving as set out in TfL's Streetscape guidance. In these cases, visually impaired people would not be able to identify whether they are in a 'safe zone' or in the carriageway.

Vertical treatments are most effective when combined with supporting measures. Legal requirements relating to vertical traffic calming features are set out in the Highways (Road Humps) Regulation 1999.<sup>39</sup> Advice on their use is given in the Department for Transport Local Transport Note 1/07: Traffic Calming.<sup>40</sup>

## 2.1 Road humps

Road humps extend across the entire carriageway, ensuring they affect all road users along the route. There are several varieties of road humps available, with flat, round or sinusoidal profiles. However, sinusoidal humps and humps with shallow ramps are preferred when considering cyclists, bus passengers and emergency services as the curvature is more comfortable. Chapter three of the London Cycling Design Standards<sup>41</sup> includes guidance for designing road humps with cyclists and other road users in mind. As outlined in the London Cycling Design Standards, sinusoidal humps and those with shallow ramps can also be used on bus routes, unlike round-top humps which are not acceptable due to the discomfort they would cause passengers.<sup>41</sup> However, TfL's technical advice note BP2/05<sup>42</sup> indicates that the cumulative effect of all traffic calming measures must be taken into account with regard to bus driver and bus passenger comfort.

Vertical traffic calming features such as road humps should be located away from turning or braking areas in order to accommodate motorcyclists. TfL's Urban Motorcycle Design Handbook<sup>43</sup> includes

further guidance on ensuring road humps are safe for motorcycles.

In some cities, dynamic road humps are used, which activate when oncoming motor vehicles travel towards them over a certain speed. Motor vehicles that are travelling at the speed limit or below therefore do not experience the discomfort of a speed hump. Dynamic road humps can be advantageous in their ability to accommodate emergency vehicles but often require a greater level of maintenance than non-dynamic speed humps. They are also not currently prescribed or permitted as part of the Road Hump Regulations 1999.<sup>39</sup>

Humps have consistently been shown to reduce mean speeds, both 'at-hump' and between humps, although this speed reduction is largely dictated by the distance between humps. As the gap between humps extends, motorists have time to increase speed before slowing for the next deflection. Despite this, Department for Transport studies have shown an average reduction of 21 per cent in mean vehicle speeds at each hump and significant drops in mean speeds when crossing the hump.<sup>40</sup>



Sinusoidal humps used in London

### Road hump spacing and corresponding speed reduction

		Department for Transport (2007) <sup>40</sup>						
		Spacing between humps (metres)						
Mean 'before' speed (mph)	20      40      60      80      100      120      140							
	'After' speed between humps (mph)*							
20	13	14	15	16	18	19	20	
25	15	16	17	18	20	21	22	
30	17	18	19	20	22	23	24	
35	19	20	21	22	24	25	26	

\* The corresponding 85th percentile speeds would be 4 to 5mph higher than the mean speeds

Low

Medium

### Low to medium

Could be used on streets with low to medium movement function

### Speed reduction observed

7 to 16mph between humps

### Advantages

- Compared to speed cushions (outlined in section 2.2), sinusoidal road humps are more effective and can better accommodate the needs of cyclists and motorcyclists
- Significant speed reductions when used widely

### Disadvantages

- Road humps must be carefully considered on bus routes
- Can increase vehicle accelerations and decelerations (although there is no clear evidence that speed humps have a net negative impact on air quality)
- Speed humps reduce overall noise by calming traffic but could increase noise and vibration in the immediate vicinity

## 2.2 Speed cushions

Speed cushions are not recommended for locations with significant cyclist flow, but are often introduced in preference to humps on routes used by buses and emergency vehicles. They allow buses and emergency vehicles to pass over them unhindered, with their wheels straddling the cushions rather than being ‘vertically deflected’, while cars and other vehicles with a narrow axle width must slow to pass over them.

As outlined in the London Cycling Design Standards, cushions can increase the risk of conflict between vehicle drivers and cyclists and motorcyclists as they may encourage vehicles to swerve from their path of travel to either try to avoid the cushions entirely or to attempt to minimise their level of deflection.<sup>41</sup> Cushions also often require cyclists and motorcyclists to alter their path to travel between cushions, further increasing the risk of conflict.

Where speed cushions are used, careful consideration must be given to their layout and placement in line with the London Cycling Design Standards,<sup>41</sup> Urban Motorcycle Design Handbook,<sup>43</sup> TfL’s Bus Priority Technical Note BP2/05<sup>42</sup> and Road Hump Regulations 1999.<sup>39</sup>

There are three main types of speed cushion layout:

- A series of single cushions combined with carriageway narrowing or hatch markings
- Pairs of cushions (allowing two-way working, suitable for higher-flow roads)
- Groups of cushions three abreast (also allowing two-way working), used on wider carriageways, avoiding the need to use road narrowing measures



Speed cushions on carriageway

### Observed speed impacts

Author and study location	Mean speed reduction	Comment on data
Deptment for Transport (1994) <sup>44</sup> – TAL04/94	Mean speed of 17 to 19mph when crossing narrow speed cushion (1.6m wide)	Monitored by TRL, commissioned by Department for Transport
Sheffield, UK/York, UK	Mean speed of 14mph when crossing wide speed cushion (1.8 to 1.9m wide)	
	‘Series of 3’ cushions were an average of 3mph lower than single speed cushions	

Low

Medium

### Low to medium

Could be used on streets with low to medium movement function

### Speed reduction observed

Variable

#### Advantages

- Greater impact on speed than horizontal treatments
- Less impact on buses and emergency vehicles than speed humps

#### Disadvantages

- Increased risk of conflict between vehicles and cyclists or motorcyclists (eg where cyclists or motorcyclists deviate from their path to avoid cushions)
- Wider cushions may be opposed by bus operators
- Less effective than speed bumps

## 2.3 Raised tables

Raised tables extend the full width of the carriageway between the kerb, and have a larger extended length than humps, creating a trapezoidal form. Generally, the surface is made of a different material than both the carriageway and footways. However, careful consideration must be given to the type of materials used with regard to maintenance and skid resistance. The challenges of maintaining coloured surfaces, block paving and setts in highly trafficked areas or where utility work may be required is outlined in section 1.6. The London Cycling Design Standards<sup>41</sup> and Urban Motorcycle Design Handbook<sup>43</sup> have further details about the impact of different surface treatments on skid resistance. Imprint surface treatments can be used in combination with raised tables to overcome many of these challenges around maintenance and skid resistance.

As with sinusoidal road humps, raised tables are acceptable in small numbers on bus routes at key locations when other measures are not possible. Raised tables are in fact advantageous if the plateau is sufficient to accommodate the full wheelbase of the bus (and so long as the position, height and gradient of the ramp is designed with bus passenger safety and comfort in mind, and with regard to TfL's Bus Priority Technical Note BP2/05).<sup>42</sup>

Raised tables can be used to create raised crossings or as treatments at junctions. Raised crossings and junctions can introduce some complications for visually impaired pedestrians if they include an un-delineated level surface. Tactile paving or a level difference of at least 60mm must be provided to delineate the carriageway so that visually impaired people on foot do not accidentally end up in the carriageway without realising where they are. TfL's Streetscape guidance<sup>13</sup> provides more detail about these accessibility requirements.

### Observed speed impacts

Author and study location	Speed reduction	Comment on data
Webster (1995) <sup>46</sup> Four UK locations	Mean speed reductions up to 11mph between tables	
Mao and Koorey (2010) <sup>47</sup> Christchurch, NZ	Between 17 and 18 per cent reduction in mean speeds. Speeds between tables increased slightly, relative to decrease while crossing table, but remained minimal	Three sites focused specifically on raised tables at different locations across Christchurch. Data is statistically significant
T. Makwaska and B. Turner, (2017) <sup>48</sup> Multiple sites in Australia	Raised tables lowered 85th percentile speed by 8kmh (4.97mph) at intersections, 7kmh (4.34mph) at Wombat (aka Zebra) crossings and 5kmh at midblock platforms	Statistically significant. Effectiveness of each application is dependent on the design, speed, environment and road function



Raised table used to create a crossing on Boyfield Street, London Borough of Southwark



Raised table at a junction on London's Cycle Quietway 1

Low Medium High

### Low to high

Could be used on streets with low to high movement function

### Speed reduction observed

17 to 18 per cent

### Advantages

- More effective than speed cushions and horizontal treatments
- Less impact on buses and emergency vehicles than humps
- Can improve crossing opportunities for pedestrians

### Disadvantages

- Raised crossings must provide delineation for pedestrians with visual impairments
- Slope gradient and impact on buses, cyclists, motorcyclists and emergency vehicles should be considered
- Maintenance requirements (and associated costs) of surface treatment should be considered alongside skid resistance

## 2.4 Gateways

Gateways are used to mark a change in the speed environment, commonly a transition between higher speed and lower speed. This measure is often seen at entries and exits to villages in more rural areas, but is increasingly prevalent on London streets as a way of distinguishing the entrance to urban streets with a higher place function, and alerting motorists to the need for a lower speed.

Gateways can be created using a mixture of measures such as pavement markings, signing, lane narrowing, traffic islands, street furniture or varying surface treatments and often a combination of them all. In London, they commonly include a raised entry treatment. Raised

entry treatments are tables that are located across side roads at their junctions with major roads. As outlined previously, vertical treatments can have a negative impact on those with visual impairments if they meet the footway without a level difference of 60mm or more. TfL's Streets toolkit<sup>49</sup> provides information on the physical design requirements for raised entry treatments at side roads.

While this traffic calming method leaves road users in no doubt of a change in environment, it also makes monitoring the impact of each gateway feature difficult to quantify, as they are rarely the same combination.



A Gateway in Bexleyheath's Town Centre

### Observed speed impacts

Author and study location	Mean speed reduction	Comment on data
Boulter (2000) <sup>50</sup> Gloucester, UK	1.4mph reduction in mean speed after one year and this reduction remained constant after two years	Neither change was statistically significant across any of eight links studied
Wheeler and Taylor (1999) <sup>51</sup> Rural sites across the UK	Inbound reductions of 3 to 13mph Outbound reductions of 2 to 12mph Within village reduction of 2 to 12mph	Results statistically significant for all but one site (in/outbound) All results statistically significant Of the nine villages studied, six reduced the speed limit along with implementing gateways

Low Medium High

### Low to high

Could be used on streets with low to high movement function

### Speed reduction observed

1.4 to 13mph

### Advantages

- Clear signal to road users of a change in environment
- Can improve streetscape and walking environment

### Disadvantages

- Gateways incorporating raised entry treatments must be carefully designed with the needs of those with visual impairments in mind



## Section 3: Horizontal treatments

### 3.1 Chicanes

### 3.2 Reduced corner radii

Realigning the carriageway in a way that requires vehicles to undertake a lateral shift or tight turn can help reduce speeds, as road users need to give way or slow down to complete the manoeuvre safely. Measures of this kind (sometimes referred to as 'horizontal deflection') have been shown to be less effective at reducing speeds than vertical treatments when used alone. However, horizontal treatments can be used in combination with other measures, increasing potential speed reductions.

# 3.1 Chicanes

Chicanes require cars to stop or slow down significantly to give way/negotiate with oncoming motor vehicles. They can be created using physical buildouts and islands, or via parking bays, allowing either single or two-way traffic depending on the deflection and space remaining. They are a proven speed reduction measure, and casualty reduction is also well evidenced, with Mountain et al (2005)<sup>52</sup> suggesting casualty reductions for chicanes are in the order of 29 per cent.

The spacing of chicanes and their impact on cyclists through forced manoeuvres and pinch-points are issues that should be considered with these speed reduction measures. However, inclusion of designs such as cycle bypasses can mitigate such issues. It is also important to remember that tight geometries can affect high-sided vehicles (eg, buses and HGVs), and so swept path analysis should be carried out.

Chicanes are often used in combination with other measures such as urban realm improvements, planting and footway widening to achieve enhanced benefits.



A chicane used to slow traffic on a London street

## Observed speed impacts

Author and study location	Location	Speed reduction	Comment on data
Sayer et al (1998) <sup>53</sup> UK wide	At chicane – one-way	12.3mph reduction in mean speeds	142 chicanes studied extensively
	At chicane – two-way	11.4mph reduction in mean speeds	
	Between chicanes – one-way	12mph reduction in mean speeds	
	Between chicanes – two-way	6mph reduction in mean speeds	
Marek and Walgren (1998) <sup>54</sup> Seattle, USA	At chicane	8 to 12mph reduction in 85th percentile speeds	Three sites studied extensively and results 'significant'
	Between chicanes	Up to 8mph reduction in 85th percentile speeds	

Low

Medium

## Low to medium

Could be used on streets with low to medium movement function

## Speed reduction observed

6 to 12mph

## Advantages

- Easy to combine with other measures
- Can be achieved through landscaping and urban realm improvements to achieve further benefits

## Disadvantages

- Tight geometries unsuitable for higher speed roads or bus routes
- Can create unsafe pinch-points for cyclists if not designed carefully

## 3.2 Reduced corner radii

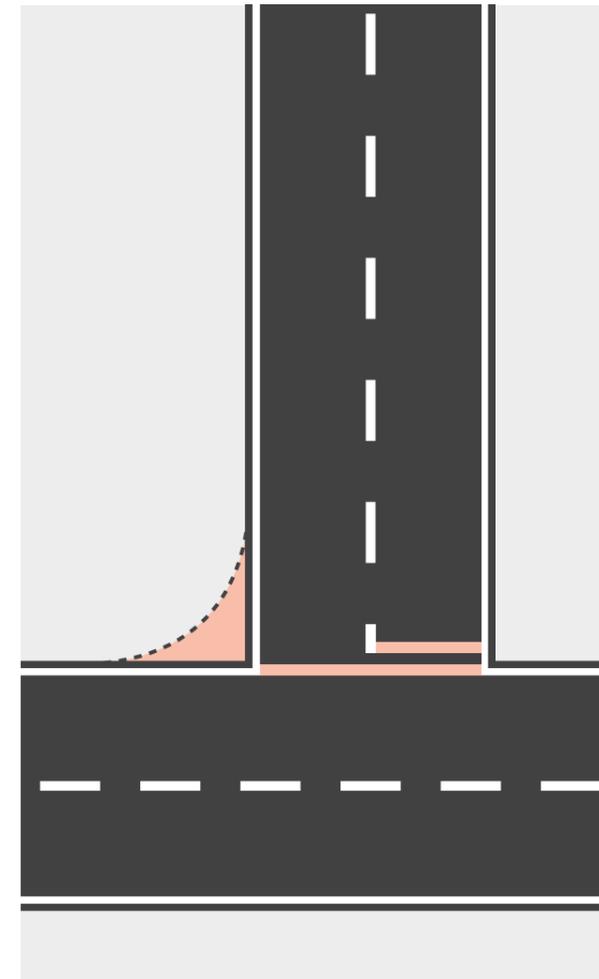
By reducing the radius of a corner, the turn becomes tighter for the motor vehicle, and motorists are forced to slow down to complete the turn successfully. This technique helps to reduce the risk to cyclists and pedestrians as traditional large corner radii create danger from fast-turning vehicles sweeping into the side road and cutting across cyclists and pedestrians.

Reduced corner radii results in shorter crossing distances and can help pedestrians to cross on their desire lines.

At some signalised junctions, stop lines may need to be moved back in the side road to support the safe turning of some larger vehicles.

### Roundabouts

Roundabouts with a tight turning radius and small dimensions are sometimes suggested as a speed reduction measure. The idea being that they can force a more exaggerated turning angle and motorists must therefore navigate the junction at substantially slower speeds than the rest of the road. However, roundabouts can make it difficult for pedestrians to cross the road, requiring deviation from their desired path and requiring alternative routes to negotiate the roundabout. There are many different types of roundabouts that exist and section 5.5 of TfL's London Cycling Design Standards<sup>41</sup> has further information about the challenges of designing safe roundabouts for people walking and cycling.



Reduced corner radii create a tighter turn for the motor vehicle requiring reduced speed

Low

Medium

### Low to medium

Could be used on streets with low to medium movement function

### Speed reduction observed

Monitoring not available

### Advantages

- Smaller corner radii expand the pedestrian area and reduces the distance of a pedestrian crossing
- Help to reduce the risk to cyclists and pedestrians as vehicles must slow down before turning

### Disadvantages

- Not suitable for higher speed roads



## Section 4:

# Narrowing the carriageway

4.1 Traffic islands and pedestrian refuges

4.2 Median strips

4.3 Loading bays, parking and 'parklets'

4.4 Trees and planters

4.5 Reallocating carriageway space for walking

4.6 Reallocating carriageway space for cycling

Narrowing the carriageway involves lane alterations (lane narrowing or removal) so that space is allotted to different road users and types of activity. This can be done through lining, or can be more formally implemented through infrastructure such as median strips, pavement build-outs and cycle lanes. Reallocation of carriageway space is a good option when looking to change the feel of the road and urban realm surrounding it, and for promoting a place function. It also provides further opportunities for walking and cycling trips while achieving the broader benefits of a lower-speed environment.

# 4.1 Traffic islands and pedestrian refuges

Traffic islands and pedestrian refuges employ the psychological logic of road narrowing and the breaking of sight lines to increase motorist concentration, and thereby deliver slower speeds. Expected reductions in speeds are estimated at between 1 and 3mph.<sup>21</sup>

Pedestrian refuges can be used to reduce crossing delay, permitting the safer movement of pedestrians, in addition to the physical separation of traffic by direction. Refuges can be made inclusive for visually impaired pedestrians using tactile paving where there is a single lane either side of the refuge. Where there are two lanes of traffic either side

of the refuge, tactile paving should not be provided at the kerbside as a visually impaired pedestrian may not be able to sense a second overtaking vehicle.

The implications of traffic islands and pedestrian refuges for cyclists and motorcyclists must be considered, as pinch-points can be created. Care must be taken in their design to ensure that they are not hazardous for motorcyclists who may be filtering through traffic. Further information about the design requirements for motorcyclists in London is available in TfL's Urban Motorcycle Design Handbook.<sup>43</sup>

## Observed speed impacts

Author and study location	Speed reduction	Comment on data
Boulter (2000) <sup>50</sup> Central islands Gloucester, UK	1.4mph reduction in mean speed after one year 1.6mph reduction in mean speed after two years	Neither change was statistically significant
Thompson et al (1990) <sup>55</sup> Pedestrian refuges Nottingham, UK	Statistically significant reductions in 85th percentile speeds at nine sites, and increases at four sites	32 sites extensively monitored before and after
Hillier et al (2016) <sup>56</sup> Multiple locations	Up to 5kmh (3.1mph)	Average based on study of 'road diets' where four-lane roads were reduced to roads with one lane in each direction, and a median turning lane or island in the centre



Pedestrian refuge on a London street

Low Medium High

## Low to high

Could be used on streets with low to high movement function

## Speed reduction observed

Up to 3.1mph

## Advantages

- Reduce severance
- Relatively low cost compared to formal crossings
- Simple to design

## Disadvantages

- Ongoing maintenance costs
- Potential to create pinch-points for cyclists and motorcyclists
- Need to be sufficiently wide for wheelchairs and pushchairs (and therefore dependent on carriageway capacity to implement)

## 4.2 Median strips

Median strips aim to slow traffic speeds through lane narrowing, alerting motorists to a change in road environment and encouraging them to slow down. As well as reducing vehicle speeds, using medians to reduce the carriageway provides informal crossing opportunities, thereby reducing severance created by a wide carriageway or heavy volumes of traffic.

A combination of flush and raised medians are increasingly being deployed on streets in London in combination with wider urban

realm improvements. Care must be taken with the design of flush medians as there is a risk of them being overrun by motorists turning right incorrectly/cutting the corner.

As with any measure, if medians are poorly designed (if they are too narrow, create pinch-points for cyclists or are deployed on inappropriate roads), they can actually detract from safety. TfL's Streetscape guidance<sup>13</sup> sets out the design standards and considerations for medians in London.

### Observed speed impacts

Author and study location	Mean speed reduction	Comment on data
Forbes and Gill (2000) <sup>57</sup> Raised median (with no lane width reduction) Ancaster, Canada	2.9mph reduction in mean speed (from 33.75 to 30.8mph)	Result was statistically significant
Dixon et al (2008) <sup>58</sup> U.S study of raised medians raised medians of varying forms (alone, with/without crossings and with gateways), simulator study	Mean speeds reduced by: • 3.4mph (median only) • 10.2mph (median + gateway) • 10.7mph (median without crosswalk) • 10.0mph (median with crosswalk)	Results were statistically significant



Median strip on Hornchurch High Street

Medium High

### Medium to high

Could be used on streets with medium to high movement function

### Speed reduction observed

2.9 to 10.7mph

### Advantages

- Makes crossing the street easier
- Can provide an opportunity to declutter the footway by locating street furniture on the median itself
- Most are traversable by emergency service vehicles

### Disadvantages

- If too narrow or poorly positioned, pedestrians may feel stranded in the carriageway
- Can create pinch-points for cyclists and motorcyclists if poorly designed
- Risk of being over run by vehicles
- Ongoing maintenance requirements of medians should be considered as part of the design process

## 4.3 Loading bays, parking and ‘parklets’

Lane reallocation for parking and loading can increase motorists’ awareness that vehicles will be pulling in and out of parking bays. This can slow vehicles by increasing motorists’ perceived level of risk, in addition to lowering speeds due to reduced carriageway width.

Parking can be provided on the diagonal or parallel to the footway, in the centre of the carriageway or on the outside of cycle lanes (see Royal College Street, section 4.6). However, too much parking and loading activity can create an unpleasant environment and space should not be taken from footways or cycle lanes. Consideration should also be given to the placement of on-street parking as it can lead to ‘dooring’ of cyclists and motorcyclists.

Using footway-level parking and loading pads that act as an extension to the footway can provide more footway capacity and a more comfortable environment for people walking. Providing cycle parking or ‘parklets’ instead of space for vehicular parking can help support active modes of travel and improve the place function of a street while visually narrowing the carriageway. A practical guide to using light-touch, low-cost features such as parklets to change the way a street looks and feels is provided in TfL’s Small Change, Big Impact report.<sup>59</sup>

### Observed speed impacts

Author and location study	Mean speed reduction	Comment on data
Chinn and Elliott (2002) <sup>60</sup> Simulation on English Roads	5mph (Parallel parked cars) 7mph (Right-angled parking)	Simulated assessment of driver behaviour and perceptions
Marshall (2008) <sup>61</sup> Six sites (three control) across New England, United States	2.3mph (average)	Result was true and statistically significant when all other factors (land-use, building setback, etc) were controlled for



Footway level parking and loading pads act as an extension to the footway. Changes in materials should be considered when using this type of treatment so that blind and partially sighted people can clearly differentiate between pads and the footway



Cycle parking on Paul Street, London Borough of Hackney



‘Fresh Air Square’ parklet, London Borough of Southwark

Low

Medium

### Low to medium

Could be used on streets with low to medium movement function

### Speed reduction observed

2.3 to 7mph

### Advantages

- Potential to improve place function and support active modes of travel
- Boost to local businesses

### Disadvantages

- Too much parking and loading activity can create an unpleasant environment
- Potential conflicts for cyclists and motorcyclists

## 4.4 Trees and planters

Trees and planters can be used to alter the layout of a road and reduce carriageway space (see 4.6, Old College Street case study), as well as improving the place function of a street, and motorist behaviour.

Free-standing carriageway planters were used as a quick and cost-effective design solution outside a school in Streatham, London as part of a Sustrans 'DIY Schools' project which aimed to improve safety and make the street better for the local community. As well as making the street greener and more pleasant, the planters helped to reduce traffic volumes and slow vehicles on the street. Traffic was found to be slower at drop-off time, with more cars travelling at 10-15mph and fewer at 20-25mph. Traffic volumes also dropped by 44 per cent compared to the year before the planters were installed.

Planters must be used on the carriageway rather than the footway to have the intended speed reduction effect and avoid narrowing the pavement. However, this will not always be possible on arterial routes and care should be taken not to obstruct sightlines, particularly on the approach to crossings. Planters are better suited to small plants with shallow root systems, as opposed to trees which will not be able to grow to their full potential in a planter. The potential for planters to accumulate litter should be considered as part of their design, placement and maintenance plan.

Carefully positioned trees can be used to reduce carriageway width as well as creating the perception of a narrower street, guiding sight lines and enhancing the

character of the area. Trees also often offer a wider range of environmental, economic, and social benefits (eg, improvements to air quality, drainage and mental wellbeing) compared to planters.

The Trees and Design Action Group has published guidance<sup>45</sup> highlighting examples in cities such as Bristol where trees have been effective in slowing speeds. The guidance describes the 'parallax effect' whereby tall features located very near to the carriageway and viewed from a travelling car seem to 'move' more quickly than other objects in the far background, reinforcing the motorist's impression of their own speed. When located on both sides of the street, trees can also create a sense of enclosure that discourages motorists from speeding.

### London's green ambition

The Mayor's Transport Strategy for London outlines a commitment to protecting tree canopy cover and sets a target of increasing the number of trees planted on our roads by one per cent each year between 2016 and 2025.

The context in which trees and planters are to be used requires careful consideration on a case-by-case basis. Trees and other planting should be implemented with specialist input and approval. TfL has a green infrastructure team which can be contacted for further help and advice at: [HighwaysTAA@tfl.gov.uk](mailto:HighwaysTAA@tfl.gov.uk)



Credit: Bristol City Design Group

Creation of a central reserve with trees along Whiteladies Road in Bristol as part of a bus priority scheme



Credit: Sustrans

Wooden planters installed outside a school in Streatham in London as part of a Sustrans 'DIY Schools' project

Low Medium High

### Low to high

Trees can be used on streets with low to high movement function (planters low to medium movement)

### Speed reduction observed

Monitoring not available

### Advantages

- Greenery provides character and improved public realm
- Can assist with actual and perceived narrowing of the carriageway
- Trees can provide shelter, improve air quality and biodiversity, and assist with sustainable urban drainage systems

### Disadvantages

- Maintenance requirements eg trimming, watering, leaf fall (and associated costs) should be considered as part of design and delivery
- Vegetation can cause problems if not maintained at the designed height or spread

## 4.5 Reallocating carriageway space for walking

Reallocating carriageway space for walking by widening footpaths can help encourage slower speeds by providing less carriageway space for motor vehicles and visually narrowing the vehicle pathway. As well as narrowing carriageways, footway widening and pedestrian activity help reinforce the message to motorists that it would be appropriate to travel at a lower speed. Trees, planters and street furniture such as seating can all be included within the expanded footway to further emphasise and encourage pedestrian use.



Hornchurch Town Centre in the London Borough of Havering, where a reduced carriageway width has allowed for wider footways and a central median to create a slower speed environment which is more welcoming to people walking and spending time on the street



Bonnington Square in the London Borough of Lambeth, where a reduced carriageway and extended footways provide space for outdoor seating

Low Medium High

### Low to high

Could be used on streets with low to high movement function

### Speed reduction observed

Monitoring not available

### Advantages

- Helps create a more comfortable environment for pedestrians
- Supports walking and cycling and improvements to the urban realm
- Can allow for a more equitable distribution of space
- Can be used in combination with other urban realm improvements

### Disadvantages

- Implementation is dependent on carriageway space

## 4.6 Reallocating carriageway space for cycling

Where lane narrowing or removal is feasible, space for cycling lanes as well as widened footways becomes an option. This new configuration not only reduces speeds and vehicle dominance, but also enhances safety and comfort for pedestrians and cyclists.

Reducing car use is an important part of the Healthy Streets Approach and Vision Zero in London. Reallocating carriageway space for cycling is essential for achieving this necessary shift from cars to walking and cycling use.

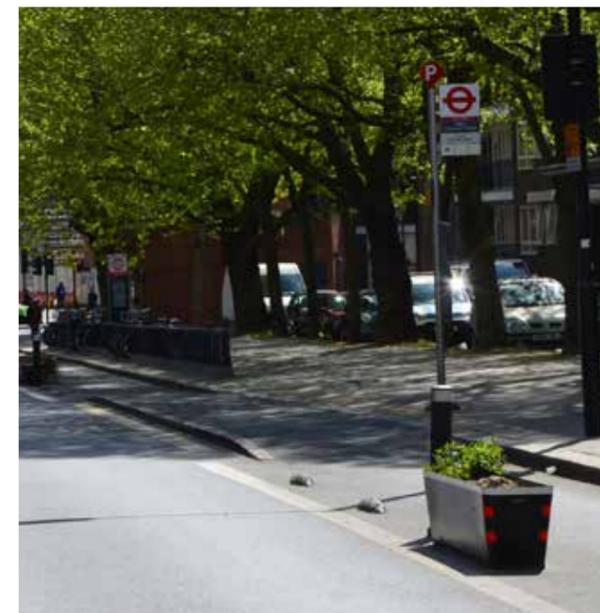
### Impact in practice: Royal College Street and Blackfriars Road

On Royal College Street in the London Borough of Camden, carriageway planters and car parking were used to create two lightly segregated cycle lanes running down either side of the street. These reduced the carriageway width, making it less comfortable for motorists to speed, and leading to a 21 per cent reduction in traffic speed when measured six months after the works were complete.

TfL data suggests that there has been a real and noticeable drop in spot speeds across the day on Blackfriars Road, most likely associated with behaviour due to a narrower carriageway created by the new segregated cycle lane. The new East-West and North-South Cycleways have been shown to carry, at peak times, nearly 50 per cent of the people using the road while taking up only 30 per cent of road space.



Lane removal on Blackfriars Road has allowed for a new segregated cycle way, improved public realm for pedestrians and a lower speed which is more welcoming to people walking and spending time on the street



Carriageway planters, armadillo speed bumps and car parking have been used to create a cycle path on Royal College

Low Medium High

### Low to high

Could be used on streets with low to high movement function

### Speed reduction observed

Monitoring not available

### Advantages

- Improved public realm
- Improved safety and comfort for pedestrians and cyclists
- Can be a more efficient use of carriageway space

### Disadvantages

- Implementation is dependent on carriageway capacity and existing vehicle speeds



## Section 5: Rethinking the street function

5.1 'Elastic' streets

5.2 New public spaces

5.3 Temporary or timed road closures

5.4 Low-traffic neighbourhoods

Many streets have the potential for a more diverse mix of active uses, but suffer from domination by motorised traffic. Rebalancing priorities so that people can use the space more flexibly can have positive effects for people walking and cycling, if it results in a calmer, low-speed environment and encourages more considerate behaviour.

## 5.1 'Elastic' streets

The concept of 'elastic' streets refers to low-cost, temporary measures that change the character of streets. This idea, although temporary, impacts upon the way road users utilise such a street and, if successful, ideas can be introduced permanently.

Temporarily placing street furniture on strategic parts of a street can change its character and use, and therefore reduce traffic speeds. The creation of 'parklets', as seen in cities all over the world, are a unique way to re-energise neighbourhoods while also supporting local businesses and encouraging walking and cycling. They help to reclaim streets and shift the balance away from motor vehicles.

While often combined with road closures, the presence of market stalls in or by the side of the road signals to motorists to slow down significantly, and to be alert to the presence of pedestrians.

Even when the market is not in use, market stalls road markings can still indicate the flexible use of the street to the motorist and reduce traffic speeds.

Low-cost, temporary materials can also be used to pilot a different road layout and help make the case for a permanent scheme. Sustainable transport charity Sustrans worked with the local community in the London Borough of Lambeth to develop a temporary traffic calming scheme outside a school on New Park Road, Brixton. Hay bales were used to create a prototype that would slow down vehicles and relieve concerns of local residents. Vehicle speeds were slowed by 70 per cent to an average of 9-11mph outside the school gate.



Credit: Bruce McVean

Parklet in Fitzrovia, London



Market stalls on Lower Marsh in London



Credit: Alex Slingsby

Prototype traffic calming using hay bales in Brixton in London

Low

Medium

### Low to medium

Could be used on streets with low to medium movement function

### Speed reduction observed

Monitoring not available

### Advantages

- Low cost and flexible
- Can help change a street's look and feel and thereby encourage slower speeds
- Can help build the case for a more permanent scheme

### Disadvantages

- Not appropriate for higher speed roads
- Any potential confusion for visually impaired pedestrians must be considered and mitigated against

## 5.2 New public spaces

With the realignment and reduction of carriageway widths there is an opportunity to create new public spaces and rethink the way a street is used. Where a street features more active uses, this can have a calming effect on traffic in the carriageway, breaking down perceptions of the space as dominated by the carriageway. This can be influenced by land use, for example, the opening hours and activities of shops and other businesses have an impact on the way the street environment is used. Benefits also include encouraging people to stay in a space, instead of just walking through it. This could be achieved in a variety of ways, including provision of places to sit, planting to offer shade and shelter or even special treatments, such as public art, lighting and water features and space for temporary stalls.



Byng Place, London Borough of Camden, where the designers have realigned the carriageway to create a civic space with active uses, having a calming effect on traffic



Great Queen Street, Covent Garden in London, where the designers reconfigured the road alignment to reduce traffic speed and create a new public open space in front of the historic Freemason's Hall

Low

Medium

### Low to medium

Could be used on streets with low to medium movement function

### Speed reduction observed

Monitoring not available

#### Advantages

- Can support social and cultural activities
- May support local economy and businesses
- Supports the Healthy Streets approach by creating 'places to stop and rest' and 'things to see and do'

#### Disadvantages

- Depending on the size and complexity of the space, significant capital expenditure may be required
- Interaction between different road users (particularly with pedestrians who have a visual impairment) should be considered in design

## 5.3 Temporary or timed road closures

Closing roads to traffic both prevents non-emergency vehicles from using streets, and provides increased road space for other road users. The road is not taken entirely out of use, with some local traffic usually remaining, but at reduced numbers compared to before the closure. This measure is recommended for residential roads when alternative routes are available.

A temporary change of use can also be used to give back all or part of the carriageway to the community and reduce or stop traffic running through a street at certain times. The change of use can be for markets on weekends or bank holidays, for 'Play Street' schemes, Christmas markets or other events. When the street reopens, motorists may associate pedestrian activities with the street and continue to drive slowly.



Credit: London Borough of Hackney

Hackney School Streets pilot scheme, where streets around schools become pedestrian and cycle only zones during school opening and closing times. Vehicles cannot enter the street between these times unless they have been given an exemption



Credit: Hackney Play Association

Hackney Play Streets, where residents close off their streets to through traffic for a few hours weekly or monthly, so that children can play outside more safely and neighbours come together, making streets friendlier for all

Low

Medium

Low to medium

Could be used on streets with low to medium movement function

Speed reduction observed

Monitoring not available

### Advantages

- More space for other road users
- Direct community benefit
- Emergency vehicles and some local traffic maintain access
- Low cost and flexible

### Disadvantages

- Relies on compliance from other road users
- Requires local community engagement to aid compliance and support

## 5.4 Low-traffic neighbourhoods (modal filtering)

'Low-traffic neighbourhoods' are groups of residential streets, bordered by main or 'distributor' roads, where through motor vehicle traffic is discouraged or removed. While residents in a low-traffic neighbourhood can still do all their journeys by car if they want or need to, it is harder or impossible to drive straight through from one main road to the next.

With through traffic gone, the streets in a low-traffic neighbourhood see dramatic reductions in motor traffic levels and often speeds too. Quieter, safer-feeling streets enable residents to switch to more healthy ways of getting around, particularly for short journeys.

There are many ways to obtain a low-traffic neighbourhood, but the best is arguably using 'modal filters' that stop motor traffic driving beyond a certain point, placed at strategic points around the neighbourhood. 'Modal filters' can be bollards or gate road closures that do not let any motor traffic through; or 'bus gates' to let some public transport through; or even width restrictions solely to keep out the biggest vehicles. Where filters go in, there is often some extra space around them for public realm improvements too – 'pocket parklets', tree planting, planters, seats etc.

London Cycling Campaign and Living Streets have joined forces to publish a Guide to Low Traffic Neighbourhoods<sup>62</sup> which lays out the pros and cons of different approaches. TfL's Streetscape guidance<sup>13</sup> provides detail about ensuring the appropriate placement of bollards or street furniture across the carriageway when using modal filters. The London Cycling Design Standards<sup>41</sup> outline the role of modal filters (often known as 'filtered permeability' when applied to cycling) in supporting the development of a cycle network.

### Impact in practice: Walthamstow 'mini-Holland'

Introduction of the original low traffic neighbourhood in Waltham Forest's mini-Holland saw motor traffic levels fall by over half inside the area and by 16 per cent including the main roads. Motor traffic levels went down by more than five per cent on the nearest main road when the second scheme was complete.



Modal filtering in Goldsmiths Row, London Borough of Hackney

Low

Medium

### Low to medium

Could be used on streets with low to medium movement function

### Speed reduction observed

Monitoring not available

### Advantages

- Active modes of travel become more comfortable and attractive, prompting mode shift

### Disadvantages

- Good communication and early engagement with residents is essential to build support and emphasise benefits
- Neighbouring areas must be considered during planning and design to avoid traffic displacement



## Conclusion

This toolkit includes a number of speed reduction measures that can be used when designing streets in London.

These measures can be used as part of any scheme, whether speed reduction is the primary objective or not.

It is important to be aware of the context of each proposed speed reduction measure and how it is to be used at a site. Many measures suggested in this toolkit have been highly successful at particular locations. This does not mean, however, that all measures will have beneficial impacts on all roads in every city. There is no 'one size fits all' approach to reducing vehicle speeds, and speed reduction measures should be chosen carefully, looking at the whole street and its context, existing traffic volumes and speed, type of traffic, street functionality and stakeholder views at each step. Accredited professionals should be engaged through the design process to review proposed measures on a site-specific, case-by-case basis.

It is essential to stress the need for effective measures for reducing speed. Strong leadership and innovation from designers, sponsors, and other involved stakeholders can help to guide the implementation of effective and well-planned speed reduction measures across London's road network.

An awareness of available measures and a desire to implement innovative and context-specific solutions to high speeds will help to shape London's streets, reducing road danger and encouraging walking, cycling and public transport use, as part of the Healthy Streets Approach.

There is no 'one size fits all' approach to reducing speed. The whole street and its context must be considered

# Summary of speed reduction measures

	Measure	Section of report	Observed speed reductions (mph)
Signing and road markings	Signs and lines	1.1	0.3 to 1.9mph
	Vehicle activated signs	1.2	Speed reductions for urban settings unknown
	Speed indicator devices and flashing beacons	1.3	0.2 to 2.6mph (speed indicator devices) 2.2 to 12.5mph (flashing beacon)
	Virtual speed humps	1.4	0.23 to 1.7mph
	Centreline removal	1.5	1 to 3.25mph
	Varying surface treatments	1.6	1.4 to 4.4mph
Vertical treatments	Road humps	2.1	7 to 16mph between humps
	Speed cushions	2.2	Speed reductions were variable
	Raised tables	2.3	17 to 18 per cent mean speed reduction
	Gateways	2.4	1.4 to 13mph
Horizontal treatments	Chicanes	3.1	6 to 12mph
	Reduced corner radii	3.2	Speed monitoring not available

	Measure	Section of report	Observed speed reductions (mph)
Reducing or reallocating the carriageway	Traffic islands and pedestrian refuges	4.1	Up to 3.1mph
	Median strips	4.2	2.9 to 10.7mph
	Loading bays, parking and 'parklets'	4.3	2.3 to 7mph
	Trees and planters	4.4	Speed monitoring not available
	Reallocating carriageway space for walking	4.5	Speed monitoring not available
	Reallocating carriageway space for cycling	4.6	Speed monitoring not available
Rethinking the function of the street	'Elastic' streets	5.1	Speed monitoring not available
	New public spaces	5.2	Speed monitoring not available
	Temporary or timed road closures	5.3	Speed monitoring not available
	Low-traffic neighbourhoods	5.4	Speed monitoring not available

# References

## How to use this toolkit

- 1 J. Hu and K. Klinich, Toward designing pedestrian-friendly vehicles, 2012. [www.researchgate.net/directory/publications](http://www.researchgate.net/directory/publications)
- 2 Atkins, AECOM, M. Maher, 20mph Research Study – Process and Impact Evaluation Headline Report, Commission by Department for Transport, 2018. [www.gov.uk/government/publications/20-mph-speed-limits-on-roads](http://www.gov.uk/government/publications/20-mph-speed-limits-on-roads)

## The case for lower speeds

- 3 Department for Transport, Rule 126, The Highway Code, 2015. [www.gov.uk/browse/driving/highway-code-road-safety](http://www.gov.uk/browse/driving/highway-code-road-safety)
- 4 Transport for London, Attitudes to Walking, 2017
- 5 Transport for London, Attitudes to Cycling, 2017
- 6 Steer Davies Gleave, Research into the impacts of 20mph speed limits and zones, SDG: London, 2014
- 7 Imperial College London, An evaluation of the estimated impacts on vehicle emissions of a 20mph speed restriction in central London, 2013
- 8 Transport for London, Speed, emissions & health, 2018. [www.tfl.gov.uk/corporate/about-tfl/corporate-and-social-responsibility/transport-and-health](http://www.tfl.gov.uk/corporate/about-tfl/corporate-and-social-responsibility/transport-and-health)

## Lower speeds in London

- 9 Transport for London, Vision Zero action plan, 2018. [www.tfl.gov.uk/corporate/about-tfl/the-mayors-transport-strategy](http://www.tfl.gov.uk/corporate/about-tfl/the-mayors-transport-strategy)

## Implementing and monitoring lower speeds

- 10 Department for Transport, Setting Local Speed Limits, Circular 01/2013, Department for Transport: London, 2013. [www.gov.uk/government/publications/setting-local-speed-limits](http://www.gov.uk/government/publications/setting-local-speed-limits)
- 11 Department for Transport, Traffic Advisory Leaflet 9/99. [www.gov.uk/government/publications/setting-local-speed-limits](http://www.gov.uk/government/publications/setting-local-speed-limits)
- 12 Transport for London, Healthy Streets surveys. [www.tfl.gov.uk/corporate/about-tfl/how-we-work/planning-for-the-future/healthy-streets](http://www.tfl.gov.uk/corporate/about-tfl/how-we-work/planning-for-the-future/healthy-streets)

## Section I: Signing and road markings

- 13 Transport for London, Streetscape guidance. [www.tfl.gov.uk/corporate/publications-and-reports/streets-toolkit](http://www.tfl.gov.uk/corporate/publications-and-reports/streets-toolkit)
- 14 Transport for London, Evaluation of the effect of slow markings on traffic speeds, Transport for London: London, 2015

- 15 Department for Transport, Traffic Signs Regulations and General Directions. [www.gov.uk/government/publications/traffic-signs-regulations-and-general-directions-2016-an-overview](http://www.gov.uk/government/publications/traffic-signs-regulations-and-general-directions-2016-an-overview)
- 16 Department for Transport, Traffic Signs Manual. [www.gov.uk/government/publications/traffic-signs-manual](http://www.gov.uk/government/publications/traffic-signs-manual)
- 17 City of Edinburgh Council, South Central Edinburgh 20mph Limit Pilot Evaluation, 2013
- 18 Bristol City Council, Monitoring report: 20mph speed limit pilot areas, Bristol City Council: Bristol, 2012
- 19 P. Pilkington, A. Bornioli, I. Bray, and E. Bird, The Bristol Twenty Miles Per Hour Limit Evaluation (BRITE) Study, Project Report, University of the West of England, 2018.
- 20 S. Toy, Delivering soft measures to support signs-only 20mph limits, University of the West of England: Bristol, 2012
- 21 City of London, 20mph speed limit, Director of the Department of the Built Environment, City of London: London, 2015
- 22 WSP Parsons Brinkerhoff, 20mph Speed Limits – Analysis of Impact of 20mph Limits, 2017
- 23 Calderdale Council, Report to Scrutiny Panel – Update report – 20mph speed limits in Calderdale, 2018
- 24 London Borough of Hammersmith & Fulham, 20mph Speed Limit, Speed Survey Results, Report of the Cabinet Member for Environment, Transport and Resident Services, 2017
- 25 Department for Transport, Traffic Advisory Leaflet 1/03. [www.gov.uk/government/collections/traffic-advisory-leaflets](http://www.gov.uk/government/collections/traffic-advisory-leaflets)
- 26 M.A. Winnett and A.H. Wheeler, Vehicle-activated signs – a large-scale evaluation, TRL Report 548, Transport Research Laboratory: Crowthorne, 2002
- 27 L.K. Walter and J. Knowles, Effectiveness of speed indicator devices on reducing vehicle speeds in London, Project Report PPR 314, Transport Research Laboratory: Crowthorne, 2008
- 28 D. Poulter and F. McKenna, Long-term SID report, University of Reading project report for RBK, 2005
- 29 N.R. Hawkins, Modified signs, flashing beacons and School Zone speeds, ITE Journal, 63, 1993, pp.41-44
- 30 G.C. Aggarwal and S.I. Mortensen, Do advance school flashers reduce speed?, ITE Journal, 63, 1993, pp. 24-30
- 31 Transport for London Internal Report, 2015
- 32 R.D. Blomberg, F.D. Thomas III and B.J. Marziani, Demonstration and evaluation of the Heed the Speed pedestrian safety program, Report No. DOT HS 811 515, National Highway Traffic Safety Administration: Washington, DC, 2012
- 33 M. Lalmahomed and E. Dikker, 3D Road marking: research results of the effects of 3-dimensional road marking, Organization for Traffic Safety, South Holland County, The Netherlands: De Bilt, 2001

- 34 S. Shackel, J. Parkin, Influence of road markings, lane widths and driver behaviour on proximity and speed of vehicles overtaking cyclists, 2014
- 35 Transport for London, Centreline removal trial, Transport for London: London, 2014
- 36 Cooper, Jordan and Young, The effect on traffic speeds of resurfacing a road, TRL, Berkshire, UK, 1980
- 37 J. Kennedy, R. Gorell, L. Crinson, A. Wheeler and M. Elliot, 'Psychological' traffic calming, TRL Report 641, Transport Research Laboratory, Crowthorne, 2005
- 38 J.V. Kennedy and A.H. Wheeler, Countryside traffic measures group: demonstration schemes, TRL Report 502, Transport Research Laboratory: Crowthorne, 2001

#### Section 2: Vertical treatments

- 39 Highways (Road Humps) Regulation 1999. [www.legislation.gov.uk/ukxi/1999/1025/contents/made](http://www.legislation.gov.uk/ukxi/1999/1025/contents/made)
- 40 Department for Transport, Local Transport Note 1/07: Traffic Calming, Department for Transport: London, 2007. [www.gov.uk/government/publications/traffic-calming-ltn-107](http://www.gov.uk/government/publications/traffic-calming-ltn-107)
- 41 Transport for London, London Cycling Design Standards. [www.tfl.gov.uk/corporate/publications-and-reports/streets-toolkit](http://www.tfl.gov.uk/corporate/publications-and-reports/streets-toolkit)
- 42 Transport for London, Traffic calming measures for bus routes: Bus Priority Team technical advice note BP2/05 September 2005
- 43 Transport for London, Urban Motorcycle Design Handbook
- 44 Department for Transport, Speed cushions, TAL 04/94, Department for Transport: London, 1994
- 45 Trees and Design Action Group, Trees in Hard Landscapes: A guide for Delivery, 2014. Online. Available at: <http://www.tdag.org.uk/trees-in-hard-landscapes.html>
- 46 D.C. Webster, Traffic calming – four schemes on distributor roads, TRL182, Transport Research Laboratory, Crowthorne, 1995
- 47 J. Mao and G. Koorey, Investigating and modelling the effects of traffic calming devices, Department of Civil & Natural Resources Engineering, University of Canterbury, Christchurch, New Zealand, 2010
- 48 T. Makwasha and B. Turner, Safety of raised platforms on urban roads, Journal of the Australian College of Road Safety – Volume 28 No. 2, 2017, pp. 20-78 Chapter/Section title Achieving lower speeds: the toolkit 79
- 49 Transport for London, Streets toolkit, design guidance documents. [tfl.gov.uk/corporate/publications-and-reports/streets-toolkit](http://tfl.gov.uk/corporate/publications-and-reports/streets-toolkit)
- 50 P.G. Boulter, The impacts of the Safer City Project on road traffic emissions in Gloucester: 1996–1998, TRL Report 444, Transport Research Laboratory: Crowthorne, 2001
- 51 A.H. Wheeler and M.C. Taylor, Traffic calming in villages on major roads: Final report, TRL Report 385, Transport Research Laboratory, Crowthorne, 1999

#### Section 3: Horizontal treatments

- 52 L. Mountain, W. Hirst, M. Maher, Are speed enforcement cameras more effective than other speed management measures? The impact of speed management schemes on 30mph roads, Accident analysis and prevention, 37, 2005, pp 742–754
- 53 I. Sayer, D. Parry, J. Barker, Traffic calming – an assessment of selected on-road chicane schemes, TRL313, Transport Research Laboratory, Crowthorne, 1998
- 54 J.C. Marek and S. Walgren, Mid-block speed control: chicanes and speed humps, NACTO: Washington, DC, 1998

#### Section 4: Narrowing the carriageway

- 55 S.J. Thompson, S. Heydon and C. Charnley, Pedestrian refuge schemes in Nottingham, Traffic Engineering and Control, 3, 1990, pp. 118–123
- 56 P. Hillier, T. Makwasha and B. Turner, Achieving Safe System Speeds on Urban Arterial Roads: Compendium of Good Practice. Austroads, Sydney, Australia, 2016. [www.austroads.com.au/publications](http://www.austroads.com.au/publications)
- 57 G. Forbes and T. Gill, Arterial speed calming: Mohawk Road case study, TRB Circular E-C019: Urban Street Symposium, 1-2, 2000, pp. 1-7
- 58 K. Dixon, H. Zhu, J. Ogle, J. Brooks, C. Hein, P. Aklluir and M. Crisler, Determining effective roadway design treatments for transitioning from rural areas to urban areas on state highways, Oregon Department of Transportation, 2008
- 59 Transport for London, Small Change, Big Impact: A practical guide to changing London's public spaces, Produced by Architecture 00 and Studio Weave as part of a commission by Transport for London, 2017. [www.tfl.gov.uk/corporate/about-tfl/how-we-work/planning-for-the-future/healthy-streets](http://www.tfl.gov.uk/corporate/about-tfl/how-we-work/planning-for-the-future/healthy-streets)
- 60 L. Chinn and M. Elliott, The effect of road appearance on perceived safe travel speed: Final Report PA3827/20, Transport Research Laboratory: Wokingham, 2002
- 61 W.E. Marshall, N.W. Garrick, G. Hansen, Reassessing on-street parking, Transportation Research Record 2046, 2008, pp. 45-52

#### Section 5: Rethinking the street function

- 62 Living Streets, A Guide to Low Traffic Neighbourhoods. [www.livingstreets.org.uk/get-involved/local-groups/london](http://www.livingstreets.org.uk/get-involved/local-groups/london)

## Further information and guidance

Visit [tfl.gov.uk](https://tfl.gov.uk) for more information  
and advice on lower speed limits

© Transport for London

September 2019

PUB19\_037