



Traffic calming measures for bus routes

Bus Priority Team technical advice note BP2/05
September 2005

Traffic calming measures for bus routes



Foreword

Transport for London (TfL) continues to introduce a variety of initiatives to make bus journeys reliable, quick and comfortable. Bus usage in London is growing at its fastest rate since 1946 and bus passenger numbers are at their highest since the 1960's. Each day over 6 million passenger trips are made on a network of 8,200 buses, running on roads which vary in terms of character and function.

Alongside the drive to enhance bus services is the on-going need to improve road safety. TfL supports a range of traffic calming measures to reduce the number and severity of accidents on both the Transport for London Road Network (TLRN) and borough roads. The introduction of well designed traffic calming measures on bus routes, such as speed cushions, can improve road safety while having little or no adverse effect on bus passengers and services.

This technical advice note replaces 'Traffic Calming Measures for Buses', which was published in 1999. Since then, a number of changes have affected the operation and delivery of bus services in London including the formation of TfL in 2000, under the control of the Mayor, and the replacement of London's bus fleet with

fully accessible low floor vehicles. Accordingly, the previous guidelines have been fully revised and enhanced to reflect these changes and developments in traffic calming techniques.

The main changes include the acceptance of 1700mm wide speed cushions on bus routes and new advice on traffic calming measures for articulated bus services. TfL has worked closely with London's local authorities to develop these guidelines, including a current trial of Vehicle Activated Signs (VAS) on a bus route to assess their impact on traffic speeds, without the use of vertical or horizontal carriageway deflections. This complements the road safety campaign aimed at educating people to drive responsibly.

TfL and London's local authorities continue to work together with bus operators to improve services and these guidelines make a valuable contribution to reconciling public transport and road safety. The London Technical Advisors Group (LoTAG) and The London Bus Operators Committee have endorsed these guidelines, recognising that London's streets can be made safer for all without unduly affecting public transport.

Peter Hendy, Managing Director
Surface Transport, Transport
for London

Gareth Davies, Chairman
LoTAG Transportation
Working Group

Barry Arnold, Chairman
London Bus Operators
Committee

Introduction

In recent years a number of new traffic calming measures and bus types have been introduced resulting in a need to update TfL's guidance for traffic calming on bus routes. The most notable development in bus type is the introduction of articulated buses, which has raised issues regarding their operation along roads where traffic calming measures exist.

These guidelines were produced taking into account the latest research regarding buses and traffic calming. Trials to determine suitable traffic calming on routes used by articulated buses were commissioned as part of this work.

It is increasingly important that traffic calming schemes are seen as a piece of urban design, so that they can make a positive contribution to the streetscene. Well designed and implemented traffic calming schemes can add dramatically to the quality of the public realm.

The purpose of these guidelines is to provide advice to highway authorities on how they can install new traffic calming measures without compromising road safety or inconveniencing bus passengers. In some cases the design of existing traffic calming schemes may no longer be compatible with bus operation and highway authorities are urged to consider amending such schemes to comply with these guidelines, in particular on routes operated by low-floor or articulated buses.

Where proposed traffic calming schemes do not follow these guidelines, particularly in terms of size and numbers of vertical measures, TfL's Road Safety Unit and Bus Priority Team will work closely with the highway authority to identify an acceptable solution. Accident data and analysis should be available to ensure that traffic calming schemes are properly justified.



Key points

- 1 Horizontal deflections are generally acceptable, except on routes where articulated buses operate.
- 2 Speed cushions are the preferred vertical measure on bus routes and are acceptable in small numbers when used as part of a combination of traffic calming measures.
- 3 Speed tables and raised junctions are acceptable in small numbers at key locations, preferably as part of a series of traffic calming measures.
- 4 Care should be taken to site parking at a sufficient distance from traffic calming measures to avoid hindering bus operation.
- 5 Round-top road humps are not acceptable on bus routes in London.
- 6 Trials are currently underway to assess the impact of Vehicle Activated Signs on traffic speeds along bus routes.
- 7 The cumulative effect of all traffic calming measures must be taken into account regarding increased discomfort to drivers and passengers.
- 8 The measures used should be suitable for the types of buses that use the route.
- 9 Appendix A provides a summary of the acceptability of traffic calming measures on bus routes.

Traffic calming measures for bus routes

1. Traffic calming and buses - special considerations

Traffic calming schemes raise a number of special issues for the operation of buses. The following considerations should be taken into account when traffic calming schemes are being designed and installed:

- buses have firmer suspension systems, similar to most other large vehicles carrying heavy loads
- buses are less manoeuvrable than cars
- bus operators have a duty of care to their passengers, particularly the elderly and disabled, who may be standing or moving around the bus
- bus operators must take into account the health and safety of all bus drivers. In some situations traffic calming can cause great discomfort, especially if the bus service has numerous vertical deflections
- traffic calming can lead to increased wear and tear to buses and where they are driven along a traffic calmed road many times a day this can lead to damage or increased maintenance costs
- bus services operate to a timetable, reliability is important if customer confidence is to be maintained; and
- traffic calming schemes should not cause excessively increased journey times to buses by requiring diversions or slowing down significantly more than other vehicles.



2. Road classifications associated with traffic calming

The design speed of traffic calming schemes can vary according to the type of road and the activities that take place along it. The Department for Transport (DfT) publishes Traffic Advisory Leaflets, which give advice on the effectiveness and use of various traffic calming measures in a variety of situations. These leaflets are referred to as appropriate and further details are given in the Bibliography at the end of this document.

The IHT have published a useful reference book (see Bibliography), which includes details of measures and schemes introduced and their impact on traffic speeds and accidents.

Local roads in residential areas

Where appropriate, a speed of about 20 mph is becoming the common target for local roads in residential areas. Sometimes this speed can be achieved by incorporating traffic calming measures into a designated 20 mph zone.

Alternatively, 20 mph speed limit signs and roundels can be used providing vehicle speeds are already at an appropriate level (see Traffic Advisory Leaflet 9/99 for more details).

In general, the buses which operate in these areas are 'local services' and they should be able to operate at 15 to 20 mph. It is advised that bus operators consider an operational speed of 15 mph or less when crossing traffic calming, such as speed tables, to minimise discomfort (see Traffic Advisory Leaflet 10/00).

Distributor roads

On 30 mph distributor roads, traffic calming aims to restrict speeds to within the speed limit and to deal with specific accident sites or lengths of road. Schemes with only horizontal deflections have been successful in some locations. The most serious problems for bus operations have occurred where excessive numbers of speed tables and cushions have been installed on important high frequency bus routes.

3. Traffic calming techniques

There is now a broad range of traffic calming techniques in use. This section considers each in turn and discusses their implication for bus passengers.

A) Visual appearance

Changing the road appearance is an important technique in altering a driver's behaviour on the road. Drivers can be encouraged to slow down by breaking up long lengths of wide road with visual measures such as road markings. These can be used to create an impression of a narrowing or a speed hump in the carriageway. Coloured or textured road surfacing and physical measures such as bollards, islands or tree planting can be used to change the character of the road. This can improve the highway environment for both road users and residents, but due consideration should be given to cyclists. Roads in new developments should be designed to incorporate this approach.

B) Speed cameras and variable signs

Cameras and new technology can provide alternatives to humps and other vertical deflections. In addition to the well-known 'Gatso' spot speed cameras, time-distance camera equipment is being developed. These time-distance cameras use number plate recognition at sites a known distance apart, allowing average speeds over lengths of road to be accurately measured. Vehicles exceeding the speed limit can then be identified.

TfL is currently working with time-distance camera suppliers to develop equipment suitable for use at the boundaries to residential areas to



Islands and Hatching

aid enforcement of 20mph zones. The equipment will be appropriate for reducing speeds on any linear stretch of road. Trials are planned in Camden and it is hoped the equipment will receive Home Office approval by Autumn 2006.

Vehicle Activated Signs (VAS) that warn speeding drivers, have also been effective at specific locations (see DfT Traffic Advisory Leaflet 1/03). The signs, which have no negative impact on bus services, are currently being trialled by TfL on a bus route to determine their effect on traffic speeds.

Traffic calming measures for bus routes



C) Access control measures

The use of residential areas by rat-running traffic can have a significant impact on the local environment. Measures, such as width restrictions, that restrict access to certain vehicles can minimise extraneous traffic volumes passing through an area. Bus services can be catered for in such schemes by installing bus gates or lanes, enforced by CCTV cameras to discourage access by other vehicles. Physical barriers, including rising bollards or arms, are not recommended as they can be mechanically unreliable and often struck by vehicles, causing operational problems for buses.

Making changes to traffic signal staging or timings is another way of discouraging through-traffic, or rat-running. This is not always appropriate on bus routes but where buses may be affected mitigation measures, such as short bus lanes, should be considered (see DfT Traffic Advisory Leaflets ITS 5/03 and ITS 6/03). Selective Vehicle Detection will also provide additional benefit for buses.

D) Priority changes

- Altered priority at junctions can benefit buses as they do not need to queue, although the junction's capacity can be severely reduced (see DfT Traffic Advisory Leaflet 6/01)
- Mini-roundabouts can slow traffic on all approaches provided there is sufficient flow on all arms. On bus routes, painted mini-roundabouts are considered preferable to those with raised central domes, which buses have to negotiate. Special consideration may need to be given if articulated buses have to turn at a raised mini-roundabout to minimise passenger discomfort.

E) Horizontal deflection devices

On bus routes, horizontal deflections (see DfT Traffic Advisory Leaflets 9/94 and 12/97) are generally preferred over vertical deflections as they do not produce upward jolts to bus passengers, but less pronounced sideways movements. TfL recognises however, that horizontal deflection measures alone are not always effective at reducing speeds.

Horizontal traffic calming measures can be incorporated into hard-landscaping projects to enhance the visual appearance of a scheme. The types of measures which can be combined in a scheme include:

- Chicanes that allow two-way flow but with reduced carriageway width. Care needs to be taken to ensure that parked vehicles do not impede buses. The trials conducted in June 2004, concluded that chicanes designed to allow the passage of an articulated bus would have little effect on the speed of most other vehicles. Therefore, chicanes are not recommended on articulated bus routes
- Large central islands can be used to create narrower carriageways (see Traffic Advisory Leaflet 7/95)
- Road markings such as cross-hatching and cycle lanes can be used to create a visual, but not physical, narrowing of the carriageway.
- Overrun areas can also be used to reinforce the appearance of horizontal deflections. Overrun areas are designed to help large vehicles negotiate narrowings, chicanes, roundabouts and tight corners particularly on narrow residential roads (see Traffic Advisory Leaflet 12/93)
- Pinch points can calm traffic speeds by requiring vehicles to give way to one another. One lane may have priority over vehicles travelling in the opposite direction. Consideration should be given to providing cycling facilities, such as a cycle by-pass.



Vehicle Activated Signs

All the above measures can successfully reduce vehicle speeds. They are generally acceptable on bus routes, although care needs to be taken to ensure that parking near chicanes and roundabouts does not impede buses and that the geometry of measures allows longer buses to pass.

F) Vertical deflection devices

On bus routes, vertical deflections of an appropriate type should only be considered where speeding and collision problems cannot be treated by the traffic calming measures already outlined above. The requirements for road humps are given in the road hump regulations (see Traffic Advisory Leaflet 7/96).

Traffic emissions immediately near a road hump can increase but overall emissions within a scheme can be reduced if traffic volumes decrease accordingly (see Traffic Advisory Leaflet 2/99). Vertical deflections can also delay emergency service vehicles particularly ambulances and fire appliances (see Traffic Advisory Leaflet 3/94).

The types of vertical deflection that can be accepted on bus routes are outlined on pages 8-11, together with guidance for their use.

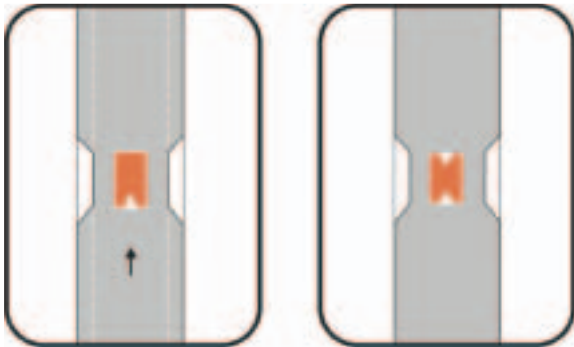
Traffic calming measures for bus routes

Speed cushions are the preferred vertical deflection measure used on bus routes, as they generally have less impact on buses than speed tables but slow vehicles to a desirable speed. Care must be taken to ensure that a bus can straddle the cushion correctly, particularly when there are adjacent parked vehicles. For articulated buses, it is important that there are no parked cars in the running lane, within 25 metres of the cushion. This is essential in preventing the bus having to go 'two wheels up' over cushions, which can be uncomfortable for bus passengers and cause delay.

Traffic Advisory Leaflets 4/94 and 1/98 recommend that the side slopes of speed cushions should not be greater than 1 in 4. This is generally acceptable to TfL and bus operators, although the double rear wheels do run over the edges. More rounded profiles can be used to reduce this effect on buses. On all bus routes cushions should be a maximum of 1700mm wide (including side slopes), 75mm high and have on/off gradients of 1 in 8 or shallower.

The spacing between the cushions in a series should be a minimum of 80m. Long series of cushions should be avoided as this will increase the likelihood of the bus being unable to align with all of the cushions. Ideally, a gap of 1.5m should be provided for cyclists between the edge of the cushion and the kerb.

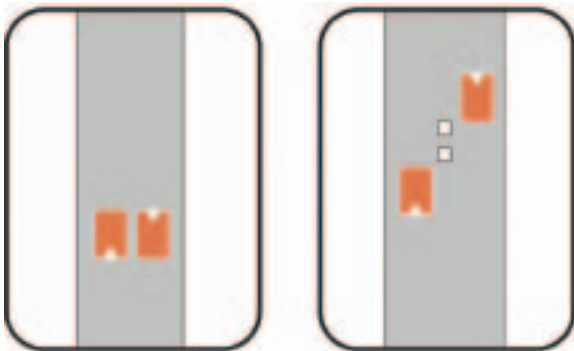




Single cushion

Single cushion

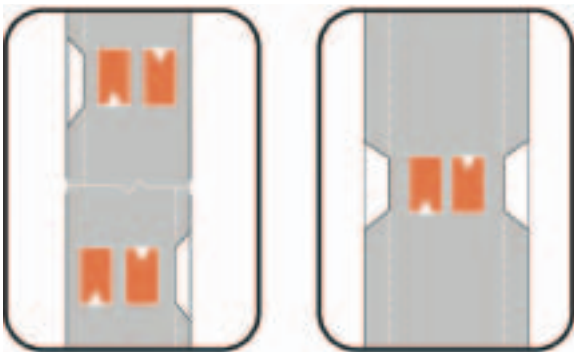
One cushion in the centre of the carriageway can be traversed successfully by buses. On one-way streets, this arrangement is almost always suitable.



Two-abreast cushions

Two-abreast cushions

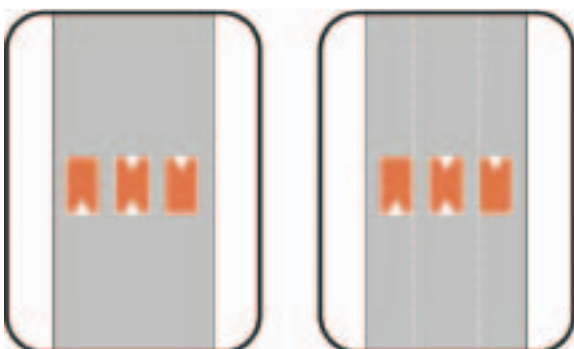
Layouts both with, and without central refuges are acceptable if there is adequate control over parking. Buses negotiating cushions can be hindered by vehicles parked too close to the cushions. In the case of articulated bus routes, parked vehicles in the running lane should be at least 25 metres from the cushions on both sides of the road.



Two-abreast cushions with build-outs

Two-abreast cushions with build-outs

Two-abreast cushions with build-outs is a layout that is suitable at many locations and, on bus routes, is preferred to three-abreast cushions. The kerb extensions can be replaced with cushions, producing three or four-abreast layouts. If parking is continuous throughout the day, the kerb extensions could be omitted but it is important that vehicles cannot drive through empty parking spaces to avoid traversing the speed cushions.



Three-abreast cushions

Three-abreast cushions

On many roads this layout is the simplest and cheapest to install. However, even with controlled parking on both sides of the road, buses frequently have to be driven down the centre of the road traversing the central cushion. This is only acceptable where traffic flows are fairly low in both directions, even at peak times of the day.

Traffic calming measures for bus routes

Speed tables are an extended flat-top hump with at least a 6 metre long plateau, plus ramps. They are designed to reduce discomfort to longer wheelbase vehicles, though they do require buses to slow down more than cars. Speed tables should generally only be used on bus routes at key locations, such as schools or shopping centres. There should not be a series of closely spaced speed tables. TfL and the bus operators would prefer no more than five speed tables on any bus route. Particular problems occur as the rear wheels of a bus leave the exit ramp. Heights of up to 75mm are acceptable, with entry and exit ramp gradients a maximum of 1 in 20. It has been found that 12.5 metre long plateau tables are slightly more comfortable for passengers on articulated buses than 6 metre long plateau tables though construction costs may be greater.

- In bus only streets, where it is sometimes desirable to use speed tables to delineate pedestrian crossing points and to moderate vehicle speeds, ramp gradients of between 1 in 20 and 1 in 30 are suitable
- In one-way streets, the exit ramps can be made less severe than the approach ramps to assist buses leaving the speed table.
- Some authorities have used widely spaced speed tables which have been acceptable on bus routes
- When speed tables are constructed on roads with steep inclines care should be taken with the design of the ramp gradients as grounding can occur (see Traffic Advisory Leaflet 2/96).



Raised junctions are similar to speed tables but cover an entire junction, with ramps on all approaches. They are usually flush with the footway providing a safer crossing point for pedestrians. They can calm two streets at once, without the loss of valuable parking space, and would be preferable to a series of speed tables on bus routes.

Rumble devices, including areas of coarse road surface texture, are generally acceptable at normal bus operating speeds. However, rumble strips can create unacceptable noise for residents particularly if there are lot of strips and a relatively high volume of traffic. Resonance can occur at slower speeds which encourages drivers to increase their speed in order to reduce the vibration in the vehicle (see Traffic Advisory Leaflet 11/93).

Round-top road humps are not acceptable on bus routes in London as passengers experience a double ‘thump’ when traversing the hump; one for each set of wheels.



4. Installing new traffic calming schemes

New scheme proposals, consultation and innovation

Traffic calming proposals affecting bus routes, access roads to bus garages and regular diversionary routes should be discussed with TfL and the bus operators early in their development, so that issues can be resolved and suitable scheme designs can be agreed. This consultation should cover the background to the scheme. Innovative designs should be used to achieve the required level of traffic calming without adversely affecting bus operation. Scheme development can often be assisted by first testing bus operation on the various layouts.

Traffic calming measures for bus routes



Discussions at the design stage will be followed by more formal consultation at Traffic Management Liaison Meetings and at the Traffic Regulation Order making stage. In some cases there can be a significant period of time between the initial consultation and the implementation stage. In these situations it is important to ensure that any changes, such as the introduction of articulated buses, are taken into account before the scheme is implemented.

Installation and maintenance

All traffic calming should be carefully designed and installed to prevent conflicts particularly with parking, access and grounding. Special care is needed at bus stops to ensure that access and egress is not compromised, and to reduce the risks to passengers who have just boarded or who are waiting to alight.

The quality of the construction and subsequent maintenance should be to a high standard to ensure the continuing effectiveness of the measures throughout their life.

Bibliography

Traffic Advisory Leaflets (available on www.dft.gov.uk):

3/93	Traffic calming special authorisations
11/93	Rumble devices
12/93	Overrun areas
13/93	Gateways
2/94	Entry treatments
3/94	Fire and ambulance services - Traffic calming: A code of practice
4/94	Speed cushions (see TAL 1/98)
7/94	'Thumps' thermoplastic road humps
9/94	Horizontal Deflections (see TAL 12/97)
7/95	Traffic islands for speed control
2/96	75 mm high road humps
7/96	Highways (Road humps) Regulations 1996
8/96	Road humps and ground-borne vibrations
4/97	Rising Bollards
12/97	Chicane schemes (see TAL 9/94)
1/98	Speed cushion schemes (see TAL 4/94)
2/99	Leigh Park area safety scheme, Havant, Hampshire
9/99	20 mph speed limits and zones
8/00	Bus priority in SCOOT
10/00	Road humps: discomfort, noise and ground-borne vibration
6/01	Bus priority
1/03	Vehicle activated signs
ITS 5/03	Public transport priority
ITS 6/03	Access control
2/05	Traffic calming bibliography

Health and Safety Guidance
(available on www.hse.gov.uk/vibration/index.htm)

London Cycle Design Standards, Transport for London,
May 2005
(available on www.tfl.gov.uk/cyclingdesignstandards)

Traffic Calming Techniques, The Institution of Highways
and Transportation, January 2005



Traffic calming measures for bus routes

Appendix A – Summary of measure types, bus operation, and acceptability

Type of measure	Bus operation	Acceptable numbers, dimensions, and spacing
Appearance and perception		
Change in road surface texture	Fully supported, although noise generated by some surface textures should be considered	As appropriate (using chippings of 14mm maximum size)
Coloured road surfacing	Fully supported	As appropriate
Street bollards, planters, trees, traffic islands, pedestrian refuges to narrow road	Generally appropriate, particularly when benefits to pedestrians accessing buses can be achieved	As appropriate. Spacing must allow for parking not to be obstructive
Speed measurement devices		
Vehicle activated signs	Fully supported	As required to improve safety
Safety cameras	Fully supported	As required to improve safety
Priority changes		
Altered priority	Fully supported although priority should be given to bus route if possible	As appropriate, with bus route given priority in the majority of cases
Mini-roundabouts	Generally supported although any raised central sections must allow buses to negotiate easily	Occasional rather than a series is preferred to avoid unnecessary side to side movements along a length of road. Cumulative effect may need to be considered.
Horizontal deflections		
Road markings	Fully supported	As appropriate
Kerb extensions including bus boarders	Usually supported, particularly at bus stops. Must allow room for buses to pass	Numbers as appropriate to road characteristics
Large central islands	Usually supported. particularly at bus stops. Must allow adequate room for buses to pass. Consideration of effect of adjacent parking essential	As appropriate

Type of measure	Bus operation	Acceptable numbers, dimensions, and spacing
Chicanes	Generally supported although room must be given to allow buses to manoeuvre. Must not be obstructed by parked vehicles. Should not be used on articulated bus routes	Supported in small numbers at key accident sites, although care has to be taken with dimensions to ensure that a smooth ride is maintained, particularly on double-deck buses
Pinch points	Generally supported, particularly on roads with low traffic flows where queues are not likely to develop in the opposite direction	Supported in small numbers at key accident sites although care has to be taken not to cause unnecessary delay to buses
Vertical deflections		
Speed tables	Acceptable where no other measures are suitable. Cumulative effect of all measures must be taken into account	Up to five speed tables acceptable on a route: Up to 75mm high, 1 in 20 maximum on/off gradient, 6000mm long flat top but 12500mm for articulated bus
Speed cushions	Acceptable where vertical measures are necessary. Cumulative effect on a bus route has to be taken into account. Cars must not be allowed to park within 25 metres of a cushion and care must be taken in the detailed design of layouts	Up to ten sets of cushions per direction acceptable with a minimum of 80m spacing preferred in a series. Cumulative effect of all measures should be considered on bus routes. Height max: 75mm. Width max: 1700mm including side slopes of 1 in 4 max. On/off gradient of 1 in 8 max
Rumble devices including 'Rippleprint'	Generally acceptable, although noise considerations have to be taken into account	Maximum height of 15mm but lower heights can be used when combined with other measures
Round-top humps	Not acceptable on London bus routes	

Further information

For further details or advice on the use of traffic calming measures on bus routes, contact:

Bus Priority Team

Transport for London
Windsor House, 42-50 Victoria Street
London, SW1H 0TL
Tel 0845 300 7000

Website: www.tfl.gov.uk