7 Movement

The key points from Chapter 7 are:

- MfS guidance is based on influencing vehicle speeds through the design of streets. This replaces past practice whereby street design had to meet safety factors arising from an assumption that vehicle speeds were not open to influence.
- MfS calls for the use of a full pallet of means of influencing vehicle speeds, and using these to make designs work, especially at junctions.
- Junctions should be designed based on balance of factors, rather than blanket adherence to rules. In particular, there are circumstances in which cross roads are desirable, and ways of designing them that are safe.
- MfS calls for first consideration to be given to the people on foot, and then in priority order those using cycles, public transport, and private motorised vehicles.

7.1 INTRODUCTION AND CONTEXT

7.1.1 Towns and cities exist for interaction. They depend upon movement systems – roads, streets, footpaths and public transport routes, and also upon the service utilities and drainage which make urban life possible.

Paternoster Square, London – a place for interaction

7.1.2 None of these systems exist in isolation. As well as being the means by which we get around and buildings are serviced, they are a crucial component of urban form and character. Just as much as architecture or landscape they help to determine whether places are good or bad. They should therefore be thought of and designed as an integral part of urban development.

7.1.3 For streets and places to be successful the connections must function well and look good. The success of street design will in large part be dependent on how well these two requirements are provided for.

7.1.4 Key objectives for the design of places:

- Making the connections work;
- Providing for movement choices;
- Creating a sense of place;
- Making routes safe routes for all users;
- Accommodating vehicles; and

- Encouraging appropriate driver behaviour.

7.2 KEY ELEMENTS

PLANNING FOR THINGS YOU CANNOT EASILY CHANGE

7.2.1 Certain elements in the design and layout of residential and mixed use streets are key because there will be very little flexibility to alter them once the development has taken place. These elements form part of the masterplanning and design coding stage and need to be decided before the detailed design work (for buildings, streets, landscape):

- Connections between new and existing streets and routes;
- Street network pattern;
- Hierarchy of places and streets;
- Block types and size and corresponding junction spacings;
- Land use and building type;
- Street widths;
- Speed attenuation concepts; and
- Parking concepts.

7.2.2 Having arrived at the basic form and structure, how can the detailed designs be worked up? The remainder of this chapter highlights the issues likely to be encountered, and ways of resolving them. There are also tips on avoiding unwanted consequences of particular design decisions.

7.3 THE MOVEMENT FRAMEWORK

(Reference: Places, Streets and Movement p32)

7.3.1 All forms of movement must be considered when designing streets and places, both locally and as linkages with other places. A key consideration for achieving sustainable development is whether and to what extent the designer can influence how people travel. Only by consciously addressing this issue at the design stage can people's dependence on car travel be reduced. Designers and engineers must respond to the wide range of policies aimed at making car ownership and use a matter of choice rather than habit or dependence. Local transport plans and movement strategies can directly inform the design process as part of the policy implementation process.

7.3.2 With this in mind, the movement framework for a new development should be based on:

- Priorities for movement: The order in which modes should be considered in the design process is:

    a. People on foot and those with disabilities.

    b. People on bicycles.

    c. Public transport vehicles and stops.

    d. Cars and other motorised vehicles.

- This hierarchy of modes should be adhered to in the design process – this may at times result in reduced vehicle capacity and increased vehicle delay so that other modes can be accommodated, however in a residential context this is unlikely to result in significant congestion.
- The relationship between movement and the form of development and the buildings that will help contain the streets.
- The links between new movement routes and existing routes and places.

Connecting new developments into the existing urban fabric is essential (p36, The Urban Design Compendium (English Partnerships and The Housing Corporation, 2000))

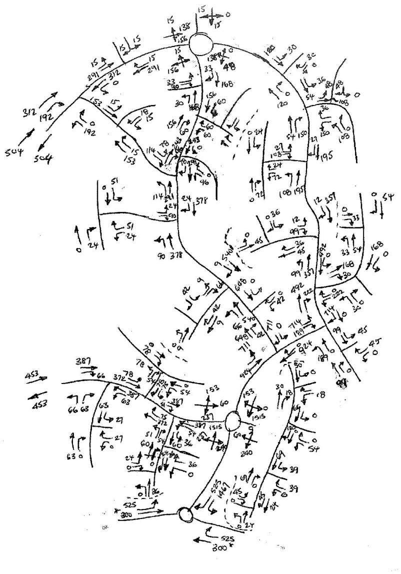
THE NEED FOR A CONNECTED NETWORK OF STREETS

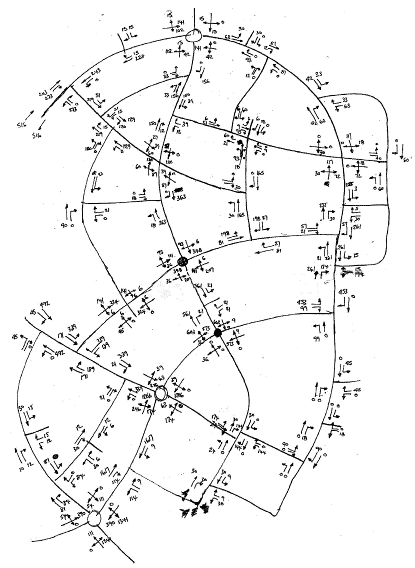
CONNECTED AND UNCONNECTED NETWORKS AND ROAD SAFETY

Connected or “permeable” networks have significant benefits in terms of encouraging walking and cycling and in making places more legible and easy to navigate. Such networks enable traffic to be more evenly spread across an area, in contrast to hierarchical networks which lead to some streets (distributors or collectors) being more heavily trafficked than others; so called “traffic bundling”. The concern is that permeable layouts may perform worse in road safety terms. This proposition arises because of an assumption that heavier traffic on fewer streets is easier to manage, and also that there will be a safety benefit in the streets (especially cul-de-sac) will less or little traffic.   .

In order to assess whether this is the case, a research analysis was carried out by TRL for Manual for Streets of two alternative layouts for the same site using the TRL software suite Safenet.

Safenet provides forecasts of collisions and casualty numbers and severity, based on traffic flows





and network geometry. In this case traffic forecasts were prepared for the site based on the existing layout and a modified network with much improved connectivity.   These forecasts assumed the same trip generation and distribution in both cases, thus ignoring the possibility that there would be more walking and cycling with the connected network.

The Safenet analysis took account of the fact that while the number of junctions in the connected network was greater, traffic flows at these junctions were lower due to the more even dispersion of traffic.

Conventional (existing) layout

Alternative permeable layout

The results of the analysis were:

	Forecast collisions per year		
Network type	**Links**	**Junctions**	**Total**
Existing conventional	1.08	0.70	1.78
Alternative permeable	0.92	0.76	1.69

(The actual number of collisions that took place at the site over the previous 5 years was 1 per year including damage only collisions (check**), which is considered to be in reasonable agreement with the Safenet figures)

The analysis suggests that there is no significant difference in collision risk with the more permeable layout. It seems that the increased number of junctions, and the risk that they represent, is offset by the lower flows resulting from greater dispersal of traffic. It therefore appears that, at least at the relatively low traffic flows in residential areas, it is possible to design connected networks without there being a significant adverse effect on road safety.

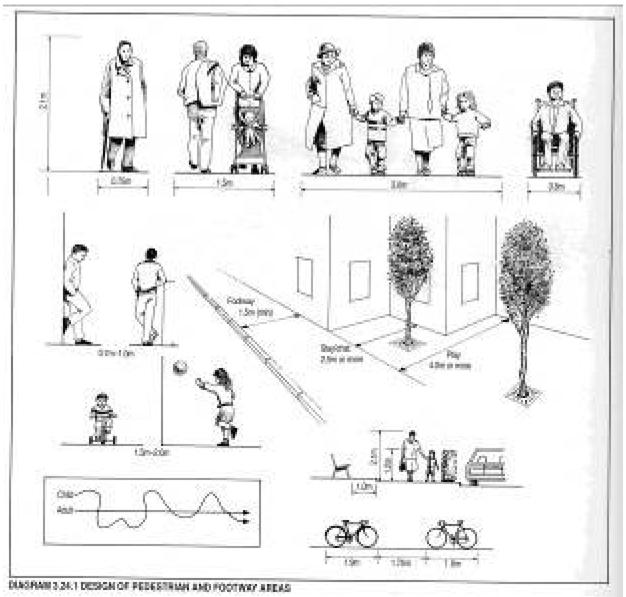
7.4 PEDESTRIANS

7.4.1 Creating a good environment and good facilities for walking is fundamental to successful development. Yet simple principles are often overlooked because designers are preoccupied with accommodating vehicles. Good sightlines and appropriate desire lines for pedestrians are two of the fundamental principles that need to be adhered to in order to generate more human scale streets.

Overlooked shared route for pedestrians and vehicles, Poundbury, Dorset

BASICS

7.4.2 The human dimension is the most important dimension. People may be alone or in groups. Footways should be good enough not just to enable people to pass along, but to make them feel good. There needs to be space to walk with others, and not to feel hemmed in by cars and buildings. Determining this “margin of quality” will have to be weighed against competing demands on land.



Diagrams to show human scale dimensions

7.4.3 People prefer to walk in straight lines. Deviations are not tolerated unless they are intuitively useful. Footways should therefore be straight and without deviations, including at junctions. Any departure from this must be justified. The propensity to walk is influenced not only by distance, but by the quality of the walking experience along the way. Twenty minutes along suburban streets can seem endless yet in the centre of Paris or London it passes without noticing. Sightlines and visibility are also key considerations for pedestrians especially in relation to issues concerned with personal security and comfort.

7.4.4 Pedestrian desire lines must be analysed and recognised and allowed for in the design of new places. Changes to existing layouts may be justified to make these desire lines more viable.

7.4.5 Pedestrian and cycle routes (streets) should, wherever possible, be part of a street that carries vehicles as people prefer to walk and cycle along streets where they can be seen by drivers, residents and other pedestrians. Routes for pedestrians and cyclists should be barrier free. If segregated footpaths/cycleways have to be provided, they need to be well connected and overlooked by houses and other buildings (excluding leisure routes).

Pedestrian desire lines have not been identified or catered for in the above example.

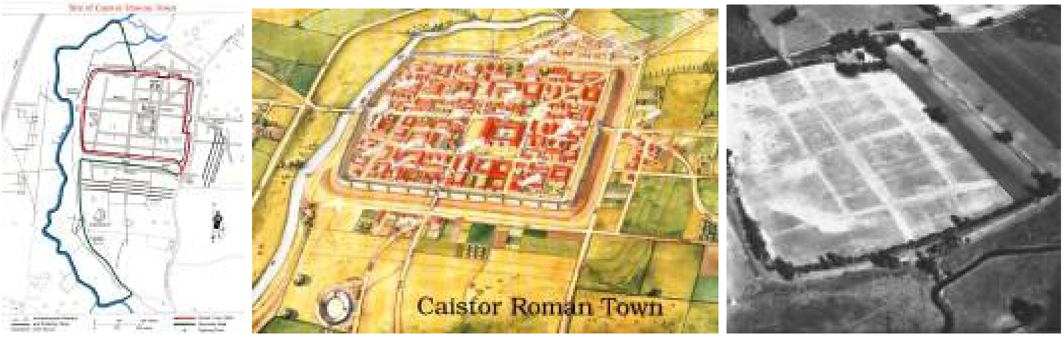
Pedestrian desire lines identified and catered for by diagonal pedestrian crossing in Balham (left) and at Poundbury (right)

WALKING SPEED AND BLOCK SIZE

7.4.6 An average walking speed of about 80 metres a minute, or 400 metres in five minutes, should be assumed. This figure is for average, able bodied persons and naturally will need to be adjusted according to whether the person in question has a mobility impairment, is young or elderly and where other factors such as topography or journey purpose will have a bearing on walking speed.

7.4.7 The figure of 400 metres does relate very well though to the 5 minute walk concept from Section 5.3 on walkable neighbourhoods. This is where average walking speed is useful as it means that the majority of people living within a well designed walkable neighbourhood will be within a five minute walk to their local facilities and hence will be more likely to walk to these rather than drive.

7.4.8 The layout of our towns and cities has historically related to pedestrian movement and the walkability of a place – this has led to block sizes of between around 80m and 120m – a figure that has been relatively constant for millennia (not surprisingly since the length of our legs has not really changed over this time period). *See the example below of Roman town with street layout, direct routes and block sizes.)*



Caistor Roman Town AD300 – the size of blocks in sustainable places has generally remained constant

THE FOOTWAY

7.4.9 Footways should be designed in relation to the environment within which they are set and the activities that will take place on that footway. There is no maximum dimension. In residential streets generally 2.0 – 3.0 metres in width is used which allows for services to be accommodated below.

7.4.10 Footway widths can be varied between different streets to take account of pedestrian volumes and composition. Streets where people walk in groups or near schools or shops for example, need wider footways.

7.4.11 The Pedestrian Environment Review System (TRL, 2006) gives guidance on the footway capacity that is adapted from work published by Fruin in 1971 (JJ Fruin, Pedestrian Planning and Design, 1971). It describes seven levels of service for pedestrians based on the relationship between footway width and flow:

Level of Service	Pedestrians/minute/M width
1	>82
2	66-81
3	49-65
4	33-48
5	22-32
6	15-22
7	<15

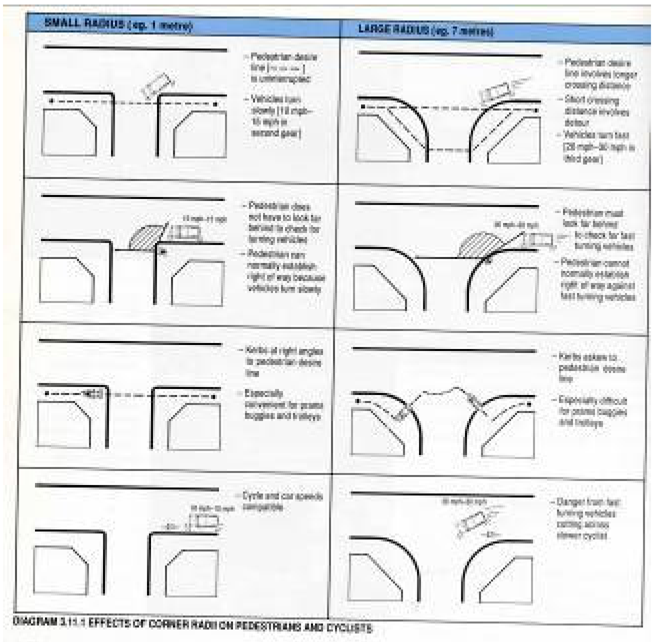
7.4.12 Regardless of flow, a preferred minimum of 2m should be provided.

7.4.13 When widths are specified, these should be considered in terms of the overall width and also the uninterrupted width for movement. Lighting columns, trees, utility equipment and street furniture should ideally be accommodated off the footway or in additional footway width (see Chapter 11 which looks at street furniture in more detail).

Lighting has been mounted on buildings at Poundbury in Dorset in order to minimise street clutter

CROSSING THE STREET

7.4.14 The principles for pedestrians crossing the street are set out in the diagram below. Pedestrian desire lines should always be respected. Smaller radii are preferable in order to facilitate these desire lines.



7.4.15 For the ease of pedestrian movement the footway should be kept at one level. Raised crossovers at junctions should be encouraged at locations where vehicle speeds are to be slowed and the ease of pedestrian movement promoted.

Pedestrian footway continues at one level, Islington (left) and Greenhithe (right)

Incorrectly located crossover – not on the desire line for pedestrians – the crossover should be nearer the junction in this case with a steeper ramp for vehicles to come up onto it in order to use the side street.

The use of a build out at junction allows for the pedestrian desire line to be respected.

CROSSING PLACES FOR PEOPLE ON FOOT AND WITH WHEELED AIDS

7.4.16 In streets with low traffic volumes, formal pedestrian crossings are not required. Crossing will be easiest in shared surface streets.

7.4.17 At junctions and at other specific locations (such as school or community building entrances) provision should be made so that people can cross "on the level". This can be achieved by:

- Raising the carriageway with ramps to footway level across the mouth of "T" junctions;

- Providing a full raised “table” with ramps at T junctions and cross roads”;
- Providing dropped kerbs at junctions and other locations; and
- “Grading” the carriageway so that it meets footway height where required without the provision of speed-reducing ramps (particularly appropriate on bus routes).

7.4.18 At locations where more dedicated crossing facilities or controlled crossings are required then the following can be considered:

- Zebra crossings
- Pelican crossings
- Toucan crossings
- Puffin crossings
- Pegasus crossings

Carriageway graded to provide level crossing area on pelican crossings, Queen Street, City of London.

Pegasus crossing

7.4.19 Dropped kerbs or raised carriageways are to be provided ease pedestrian movement and the movement of those who may be mobility impaired. They should be provided on the desire lines for pedestrians and this may include the radius to facilitate diagonal crossing. Tactile paving is not generally required in residential areas but if it is not to be used, the guidance needs of disabled people must be addressed by other means, such as detectable upstands et al. Early consultation with access groups in developing designs is essential to ensuring that the needs of all residents and street users are met.

7.4.20 Dropped kerb placed incorrectly. The couple in the photograph are not using the ramp facility (above)…and the reason! (below).

7.4.21 Dropped kerbing (as illustrated in the above example) is often placed incorrectly (i.e. not on the pedestrian desire line) due to large corner radii or a preconception that putting a dropped kerb on a radius is dangerous. Corner radii can be tight – down to 0.3m or even a squared-off kerb as large radii encourage speed, reduce the priority afforded to pedestrians by drivers, reduce pedestrian visibility and increase pedestrian inconvenience, risk and discomfort.

Dropped kerb provided on radius in order to facilitate pedestrian desire lines, Amsterdam.

7.4.22 With tighter radii the full street width can be used for turns by large vehicles in streets with low volumes of such vehicles. “Tracking” (see Chapter 8) should be used to determine minimum dimensions required. Decisions on carriageway width should take into account the need to keep corner radii small. The footway may also need to be constructed to carriageway standards in order to allow for larger vehicles that may overrun the corner radius.

7.4.23 Larger radii can be used without interrupting the pedestrian desire line if the footway is extended at the corner to enclose parking bays, and speeds are kept low with the carriageway ramped up to footway level. (See Crown Street case study and Rieselfeld photo below).

Verge and parking bay allow large radius without interrupting pedestrian desire line at junction (Rieselfeld, Freiburg)

Small radius for vehicle crossover, Rieselfeld, Freiburg

Subways and pedestrian bridges are strongly discouraged (except when there is the need to cross railways, water and significant topography etc.)

7.4.24 Central islands are not needed on most residential streets except for ornament or speed reduction. They provide little benefit to pedestrians where traffic is light.

7.4.25 Guard railing should not to be included in new schemes – any perceived requirements for it are to be designed out (see Chapter 11).

HEADROOM (DB32 3.72)

7.4.26 Headroom over footways should normally be at least 2.6m – with a minimum of 2.3 m for distances no more than 10 metres. Restricted headroom may extend up to a line 500mm away from the carriageway edge.

7.4.27 Trees should be selected whose spread does not interfere with these requirements.

7.4.28 Tapering obstructions can be particularly hazardous to white cane users and should be avoided or protected.

GRADIENTS (DB32 3.78)

- Ideally 5% maximum (the maximum gradient is to be determined according to site topography and individual circumstances).
- Cross fall maximum gradient of 2.5%. Changes and the transition of cross falls need to be considered in relation to pedestrian comfort – especially at pedestrian crossovers.
- Where vehicle crossovers are provided, these maximum gradients should not be exceeded - if necessary, vehicle ramps should be provided at kerb edges.
- Designers should attempt to achieve foot and cycleways as near to level as possible within the constraints of the site.

In some instances it may help to maintain level footways if the carriageway takes a different gradient.

SQUARES AND SHARED SURFACE STREETS

7.4.29 Shared spaces and streets promote locations where people can walk, rest and play without intimidation or domination by vehicles. Within squares and shared surface streets the 'tracking' or movement of vehicles must not be defined. The square is often defined by the buildings around it and any delineation within the square should relate to the buildings and not to the movement of vehicles.

SHARED SPACE

7.4.30 Shared Space is a term that summarises a particular approach to the design and management of streets and other public spaces. Although shared surfaces and Home Zones are now generally regarded as acceptable on the most lightly trafficked streets, the concept of Shared Space extends to busier places.

7.4.31 The underlying philosophy of Shared Space, as with shared surface streets, is that streets can function better where users negotiate priority and movement with one another, rather then obeying fixed rules that are set by some public authority. As with Home Zones and other shared surface schemes, this can work because the need to negotiate causes drivers to travel slowly, and others to watch out and make eye contact before proceeding. In order to achieve this, Shared Space involves the removal (or absence) of road markings, signage and physical limitations on movement such as kerbs and pedestrian guard railing.

7.4.32 Up until 2006 at least, most Shared Space schemes for busy areas were retrofit schemes.

7.4.33 Shared Space techniques have been developed in the Netherlands, in the Province of Friesland. The Kaden-Torenstraat junction in Drachten accommodates flows of up to 17,000 vehicles and 2,000 cyclists and pedestrians per day, with no priority other than two pedestrian crossings. Initial data suggest that this scheme has reduced collisions compared to the seven years prior to installation (when the junction was controlled by conventional traffic signals). Vehicle delays and queues have also been reduced.

Kaden-Toerenstraat, Drachten

7.4.34 The main shopping street through the market town of Haren carries some 7000 vehicles per day. In 2004 it was repaved as Shared Space, with all traffic signals and cycleways being removed. Pedestrians, cyclists and motor vehicles, including significant volumes of bus and HGV vehicles, now share the street.

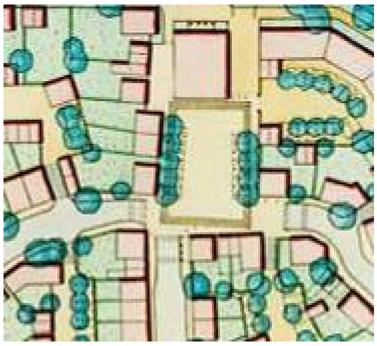
Haren main street after

7.4.35 Some existing streets in the UK already embody Shared Space principles and show that the principles can work in this country. Seven Dials in Covent Garden, London is a busy meeting point of seven streets where traffic negotiates a central feature which is also well used by pedestrians as a place to gather and sit.

Seven Dials, London – People and vehicles sharing the space

7.4.36 Shrewsbury High Street was repaved in the 1990s to create wider footways and a narrower carriageway. The scheme included a number of crossing points that are simply defined through a change of material. It has been found that many drivers give way to pedestrians using these ‘courtesy’ crossings, although there are no signs or markings enforcing this.

7.4.37 A number of schemes are now being developed across Europe under the EU-sponsored Shared Space research project, including a project in Ipswich. Further details of the programme is available at www.shared-space.org.



Square and plan (Duchy of Cornwall, Leon Krier), Poundbury, Dorset

Square, Newhall, Harlow

7.4.38 In shared space schemes a footway area that is protected from intrusion by vehicles can be provided if felt to be necessary. **see Cologne picture (TP to add)

7.4.39 Shared space should not be used where there is parking pressure and no parking control – in these situations space is taken over by vehicles, thus removing the intended advantage for people on foot.

7.4.40 Shared surfaces, where the street is not divided into a carriageway and footway, encourage drivers to travel more slowly due to the possibility of meeting pedestrians and cyclists using the whole of the space. Many shared surface streets are constructed from paviours rather than asphalt, which also emphasises the fact that they are different in nature from more conventional streets. Research by TRL for Manual for Streets (see Appendix ***) has shown that block paving reduces traffic speeds by around 2.5 to 4.5 mph, compared to asphalt.

Shared Surface Street, Beaulieu Park Case Study

7.4.41 If vehicle flows become too high, pedestrians will begin to feel uncomfortable in using the central portion of the street, and research carried out by TRL indicates that this tends to happen when vehicle flows exceed around 100 vehicles per hour (see box below). This traffic volume is consistent with current guidance on Home Zones, taken from practice in the Netherlands, which recommends an upper limit of 100 vehicles per hour on this type of street.

TRL research on shared surface streets

One study that was identified that could be interpreted to assess the effect of simplified streetscapes/shared space in London was the study of public transport in London Borough Pedestrian Priority Areas (PPAs) undertaken by TRL for the Bus Priority Team of TfL (York, 2003).

The information in the report appears to indicate that in PPAs there is a self limiting factor on pedestrians using the area also provided for vehicles (i.e. shared space) at around 100 vehicles per hour. Speed of vehicles also had a very strong influence on how pedestrians used the shared area. It would be reasonable to assume that these factors would also apply in other simplified/shared space schemes. Therefore in the London context shared space designs would be appropriate where vehicle speeds could be kept as low as possible and volumes were less than 100 vehicles per hour. However, it is not possible to draw hard and fast 'rules' to a single scheme."

“TRL research into the effectiveness of integration of public transport vehicles into shared space identified a threshold of 90-110 vehicles per hour, beyond which pedestrians treat the vehicle track as a 'road' to be crossed, rather than a space to inhabit.” (York, Public Transport in Pedestrian Priority Areas, Unpublished, 2003)

York, I. (2003). Public Transport in Pedestrian Priority Areas. TRL Unpublished report PR/T/136/03. Crowthorne: TRL Limited

7.4.42 Shared surfaces are one aspect of the ‘Shared Space’ design approach, which aims to influence road user (and particularly driver) behaviour by removing or minimising measures that seek to control and manage the space – such as road markings, separate carriageways and footways and traffic signals. Further discussion of Shared Space is contained in Chapter 11.

HOME ZONES

7.4.43   Home Zones are a particular form of shared space/shared surface street. Home zone is the UK term for the 'woonerf' street, pioneered in the Netherlands during the 1960s and 70s, and are streets where the emphasis is on the use of the space by the community for purposes other than movement – particularly children's play.

Informal play in home zones in Manchester and in the Netherlands

7.4.44   Home zones are strongly encouraged in both planning and transport policies for new developments and in existing streets – see Chapter 3 for details.

7.4.45   Home zones are distinguished from other shared surface streets by:

- Signed entry and exit points.

Home Zone Entry Sign

Home Zone Exit Sign

- Legal designation as a Home Zone.
- Orders which set the acceptable uses (Use Orders) and design speed (Speed Orders) for the street.
- The need for designation and orders to be preceded by formal consultation and other procedures (as with other Traffic Regulation Orders).

7.4.46   The Transport Act 2000 gives legal recognition to Home Zones and provides powers for local traffic authorities in England and Wales to designate home zones. However, this in itself does not change the legal use of the highway within Home Zones.

This is achieved through the passing of Use and Speed Orders, in accordance with the Regulations and Statutory Guidelines to be issued by Parliament in 2006.

7.4.47 The statutory requirements for designation and order making, together with the fact that many aspects of Home Zones can be provided in a shared space without designation as a Home Zone, means that developers and local authorities often implement 'home zone style' shared space schemes without designating them as Home Zones (see for example Chelmsford Beaulieu Park case study).

7.4.48 However, it is preferable for the designation procedures be followed, as this will help to engage local residents in determining the acceptable uses of 'their' streets and increasing their sense of ownership. The road signs will also signal to visitors the special nature of the streets.

7.4.49 In existing streets it is essential that the design of the home zone involves a significant amount of participation by local residents. In new build situations this is not easy to achieve, but the legal procedure does require that residents are consulted. Squaring this circle requires a partnership between the developer and the traffic authority, so that prospective residents are made aware of the proposed designation of the streets when choosing to live in the area, thus paving the way for the more formal consultation procedure by the traffic authority once the streets become public highway.

Local residents enjoying their street environment in the Netherlands.

7.4.50 Further guidance on the design of home zones is given in the IHIE document '*Home Zone Design Guidelines'* and on the website www.homezones.org.uk.

7.5 REQUIREMENTS FOR THOSE WHO ARE MOBILITY IMPAIRED

7.5.1 It is important to think of disability in the built environment not as an innate condition, but one that results from a failure to meet the needs of the individual.

7.5.2 Navigation of streets by people whose movement is physically impaired should inform every aspect of design. In general, design that is good for people with physical impairment is also good for other people. However, there are some issues where solutions may not be straightforward.

7.5.3 "Braille paving" or "bubble" paving" which provides a tactile message underfoot has been shown to help people whose sight is impaired to identify crossing places. However, such paving can be uncomfortable for wheelchair users and uncomfortable underfoot. Tactile paving can be extremely unsightly, especially when attempting to achieve a visual contrast.

7.5.4 Many countries do not use Braille paving, and instead rely on a small kerb upstand which is high enough to be detected by visually impaired people, but low enough to be negotiated in a self-propelled wheelchair. German research has demonstrated that a height of 15-20mm is optimum for this purpose.

7.5.5 A big advantage of the small upstand solution is that it can be applied throughout a junction or along a whole street. This can provide more choice for physically impaired people which is useful if a particular crossing point is blocked by a parked vehicle.

7.5.6 Issues arise, however, in deciding between surfaces that can be detected and "read" by blind people, and surfaces that are level and smooth for people with wheeled equipment (including wheelchairs). This especially needs to be resolved at the demarcation between footway and carriageway;

7.5.7 Shared surfaces can be easy for wheelchair users, but not if they are littered with parked cars. People with mobility impairments or who feel vulnerable find shared surfaces less easy than conventional footways.

TACTILE SURFACES

7.5.8 The ground is a major source of information for visually impaired people, who learn to move around the environment by searching out and using tactile cues such as changes in the surface texture underfoot. Tactile surfaces were developed to utilise this skill. The surfaces have raised shapes or a soft texture that can be felt under the feet and with a cane and are used to provide warning, guidance or information.

7.5.9 During the early 1980's, the Transport Research Laboratory and National Federation of the Blind investigated the use of a tactile surface in order to help people with vision impairment locate zebra and pelican crossings and traffic signalled junctions with a pedestrian phase. This work led to the development of the 'blister' tactile surface to warn pedestrians they were at a dropped kerb and about to enter the carriageway (DoT, 1983). Research has shown that visually impaired people can distinguish between and remember the meaning of the seven tactile surfaces used in the UK (Savill and Whitney, 2000; Gallon et al., 1991).

7.5.10 The ability to detect changes in texture underfoot varies from one vision impaired person to another and can be influenced by certain medical conditions such as diabetes which can lead to diabetic neuropathy, resulting in reduced sensitivity of the feet. Tactile surfaces, therefore, need to be rigorous enough to be detectable by most visually impaired people whilst not being a hazard, or unduly uncomfortable to other pedestrians. Research conducted by Gallon et al (1991) found that an approximate height of 5mm for the raised profile part of a surface was sufficient for almost all visually impaired people to detect the surface and was acceptable to other pedestrians including wheelchair users.

Use of tactile paving (and dogs) to assist those who may be mobility impaired.

STANDARDS, GUIDANCE AND CODES OF PRACTICE

UNITED KINGDOM

7.5.11 A number of standards, guidance documents and codes of practice exist in the UK cover the use of tactile paving. The Department for Transport (DfT) document, 'Guidance on the Use of Tactile Paving Surfaces' (DETR, 1998), co-authored by the DfT, TRL and the Joint Mobility Unit (JMU) is the most specific regarding tactile paving in the UK and is generally adhered to. Other guidelines or codes of practice relating to the design of transport systems and railway stations reference the DfT document (e.g. Oxley, 2002; SRA, 2002). It is also referenced in British Standards for accessible buildings (BS 8300: 2001) and has recently been incorporated into the British Standard for products used as tactile surface indicators specification: BS 7997. The following section describes the tactile surfaces recommended for use in the UK.

TACTILE SURFACES USED IN THE UK

7.5.12 The DfT guidance document was issued in 1998 to provide consistency in the use of tactile paving throughout the country. The document describes the profile and meaning of seven different tactile surfaces recommended for use in the UK:

- blister surface for pedestrian crossing points,
- corduroy hazard warning surface,
- platform edge (off-street) warning surface,
- platform edge (on-street) warning surface,
- segregated shared cycle track/footway surface and central delineator strip,
- guidance path surface, and the
- information surface

COLOUR AND CONTRAST

7.5.13 The colour and tonal contrast of the tactile paving surface is very important as many visually impaired people have residual sight and use colour/tone to distinguish one surface from another.

7.5.14 In America it is common to find yellow detectable warning surfaces. The ADAAG recommends that the tactile surface material used should contrast by at least 70% (ADDAG A4.29.2, Access Board, 2002). Ketola and Chia (1994) monitored a number of tactile surfaces in field trials at transit stations and found that some of the surfaces installed faded considerably and accumulated dirt, reducing the colour contrast. This finding was linked to the material as the maintenance regime was the same for all the materials. Rubber, polymer composite, polymer concrete and unglazed ceramic materials all discoloured during the trials.

7.5.15   The draft standard published by the International Standards Organisation Working Group 7 for tactile surfaces recommends 30% luminance contrast between tactile surfaces and the surrounding surface (ISO, November 1999).

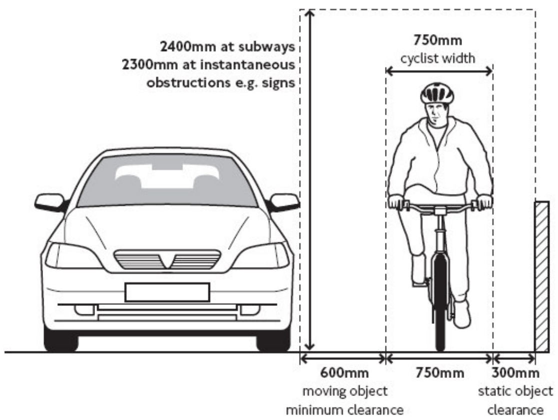
7.5.16   The only colour which is specified in the British Standard for tactile paving surfaces is red (BS 7997: 2003). Red is reserved for controlled pedestrian crossings. Luminance contrast is not specified in this standard but it states the tactile surface should contrast with the surrounding area to assist visually impaired people. This reflects the advice given in the DfT guidance document (DETR, 1998).

Source: Sentinella, J. and Gregory, K. (2003). The use of tactile surfaces at rail stations: a review of the literature and products available. Unpublished project report PR SE/763/03. Crowthorne: TRL Limited

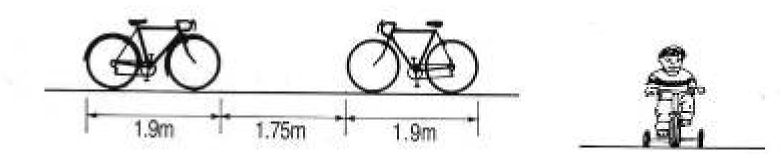
7.5.17   In attempting to address the needs of mobility impaired people, the value of consultation cannot be overstated. This may include local access officers or access groups representing disabled people. Arriving at specific solutions that are acceptable to local communities and integrate satisfactorily into street designs is often best pursued through negotiation.

7.6   CYCLISTS

BASICS



Cyclist in traffic, London Cycling Standards, TfL



7.6.1   Not all cyclists are the same, and variations in speed, competence and motivation must inform the accommodation of cyclists in the street and path network.

7.6.2   An average cycling speed of 12 kph or 200 metres a minute should be assumed. This figure is for average able bodied persons and naturally will need to be adjusted according to whether the person in question has mobility impairment, is young or elderly and where other factors such as topography or journey purpose may have a bearing on cycling speed.

DESIGN PRINCIPLES

7.6.3 Cyclists prefer to move in straight lines and to avoid vertical movement shifts (kerbs) and to avoid where possible having to stop and then get going again.

7.6.4 In areas with low traffic volumes and speeds below 20mph there should not be any need for dedicated cycle lanes on the street. Cyclists should use the connected, permeable street network for movement. Cyclists on the carriageway add to the sense of a safer, slower speed environment and their presence encourages drivers to travel more slowly.

7.6.5 If conditions are inappropriate for on-street cycling, the factors that are contributing to those conditions should be addressed if at all possible to make on-street cycling satisfactory. This is consistent with the hierarchy of approaches philosophy advocated by the DfT (DfT, LTN 1/04) and described in Chapter 11.

7.6.6 The value of 'invisible infrastructure' to cyclists should not be overlooked – non cycle-specific measures such as 20mph limits, bus lanes et al have been shown by research to be popular with cycle users and to significantly improve their safety.

7.6.7 Cyclists should not use footways. However, if sufficient width can be provided, cycle lanes can be provided alongside footways in main streets. These can be at footway level or carriageway level. Cycle paths or ways can be provided where the street grid is "broken" for motor traffic, to maintain accessibility and permeability of the area.

7.6.8 Segregated routes may be provided for leisure routes (e.g. Sustrans National Cycle Network or local cycle networks). Paths used mainly for recreation and without built frontage can be shared with pedestrians (overall minimum width of 3.0m)

7.6.9 Appropriate signage should be provided – but as with all signage this should be kept to an absolute minimum and signs should be positioned on buildings, other street furniture, trees, on the ground etc. Individual posts carrying only cycling related signage should be avoided.

7.6.10 Headroom on paths used by cyclists should normally be 2.7m (minimum of 2.4m). Maximum gradients should be no more than 3% or 5% (over a distance of 100m) or 7% (over a distance of 30m).

7.6.11 Cycle storage (see Section 9.2) must be provided within dwelling curtilages for residents, with sufficient space to accommodate one cycle for every resident. (Lack of secure cycle storage can be a major deterrent to cycling.)

7.6.12 Cycle parking can be provided on the street and in particular at retail and commercial locations and at other places where it may be required e.g. at the bus stop. It should be located close to the carriageway rather than the buildings, or at other places to minimise disruption of pedestrian movement.

Cycle parking that is well overlooked and at a key location – in this example next to a hospital entrance

Cycle storage at the workplace

QUALITY CHECK ON DESIGN FOR PEOPLE ON FOOT AND CYCLE

7.6.13 Before a design is finalised, checks should be carried out to ensure that provision for those on foot and cycle meets the quality criteria set out in Government guidance.

7.6.14 In particular the layout and detailed design should meet the "Five Cs" quality criteria, as shown in the text box below. This is primarily intended for pedestrians but many of the principles also apply to cyclists These criteria can also be used for auditing of quality after construction as a tool for ensuring adherence to required standards before agreeing to "sign-off" for adoption.

The Five Cs

- Connected - is the network continuous?
- Convenient - are all routes direct and without deviation?
- Comfortable - Are the surfaces and crossing places level, and is the microclimate comfortable? Are there resting places and facilities?
- Conspicuous - Are the routes clear and easy to follow? Is there good intervisibility between all streets users to reduce traffic danger?
- Convivial - Are all the routes overlooked and safe, and are there spaces for social activity such as meeting and children's play?

7.6.15 Design processes such as Non-Motorised User Audit (HD 42/05) have been adopted by some Highway Authorities to ensure that these principles are followed throughout the development and implementation of a scheme.

7.7 PUBLIC TRANSPORT

7.7.1 Wherever possible all new developments should be directly served or be within easy reach of public transport (see Chapters 3, 4 and 5). New development can sometimes help to make this possible for existing or proposed new developments that would otherwise be poorly served. It is essential to consider the siting of bus stops and pedestrian desire lines at an early stage of the masterplan process to achieve the most efficient layout for pedestrians thus encourage use of public transport. To achieve this, close co-operation is required between public transport operators, the local authority and the developer. The co-operation should continue from the initial planning stage to the completion of development.

7.7.2 Streets likely to be used by buses should be identified at the outset. Bus routes must be specifically designated as part of the masterplanning process. This must be done in partnership with potential bus operators and the viability and operational aspects of the route or routes must be verified. Bus routes and stops must form the key elements of the walkable neighbourhood (see Section 5.3); a network of streets will provide direct walking routes to the bus stops. The designers and local authority must ensure that densities are high enough to support a good level of service without long term subsidy. In order to design for long term viability the following requirements should be considered:

- The bus route serving the site should be direct;
- Streets with buses should be as straight as possible (bends and chicanes cause passenger discomfort and unsafety). Straight routes also help passenger demand through better visibility;
- Buses and bus facilities should be highly conspicuous to promote their image and use;
- Typical maximum walking distances to bus stops are as follows:

  1.1 Town centres 300m

  1.2 Other urban areas 300m - 400m (maximum)

  (Ref: page 93 & 98 IHT Guidance in Planning for Public Transport in Development)
- There should be no long loops or long distances without passenger catchments;
- A direct route to the town centre or other key destinations should be provided (no long diversions from quickest route);
- The bus service should run throughout the day, evening and weekends;
- A clock-face schedule that can be easily memorised is desirable (e.g. departure from town centre on 00, 15, 30 and 45 minutes past the hour); and
- High quality fully accessible vehicles and stops with level boarding facilities should be provided.

7.7.3 Residents are more likely to get into the habit of using buses if the services are operational when they first move in. Therefore bus operators should be encouraged to start their services as soon as possible, which might require subsidy from the local authority and /or developer. Large developments should be planned to allow the earliest phases to be provided with bus services. Fares need to be attractive in relation to local and town centre parking costs

7.7.4 The use of a residential street as a bus route should not require a restriction on direct access to dwellings. Many buses today are no larger than the service vehicles which normally use residential roads. Consequently, such buses may use streets designed in accordance with recommendations set out in the Manual for Streets. Design requirements for these streets should be determined in consultation with local public transport operators, but typically street widths should normally be a minimum of 6.0m although this could be reduced to 5.5m on short sections with inter-visibility from either end.

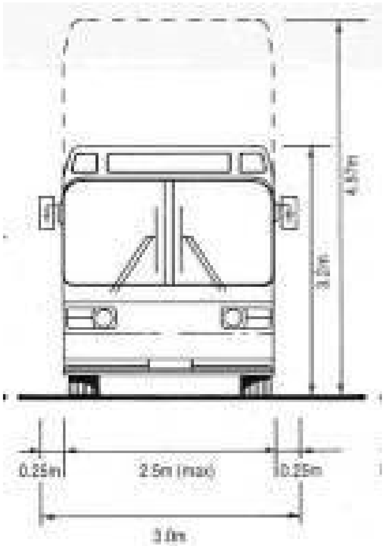
7.7.5 The developer is to provide bus stops with good natural surveillance and lighting at convenient locations linked to main pedestrian routes. Care should be taken to provide bus stops where they will not cause a nuisance or loss of privacy to residents. For safety reasons bus stops on opposite sides of the road should be staggered about 45m apart, tail to tail so that they move apart from each other.

7.7.6 The siting of bus stops should not cause visibility problems for vehicles or obstacles to pedestrians and cyclists.

Horizontal deflection can reduce car speeds, but then it is uncomfortable for bus users and can (as in this example) dominate the street scene (Kings Hill, Kent)

DESIGNING FOR BUS ROUTES

7.7.7 Tracking (see Chapter 8) can be used to determine the ability of all streets and spaces to accommodate large vehicles. But bus routes in residential areas can require more than minimum specification to allow efficient operation - this should be assessed in relation to the frequency of buses and the likelihood of two buses meeting each other on a route. Provision must be made for easy travel at 20mph with as few reasons as possible to slow, stop or negotiate obstacles.



Buses vary in length and height, but less so in width.

7.7.8 Speed control measures are not needed for buses, but those required to slow cars must be designed to have a less severe impact on buses than on cars. Speed cushions, if they can be correctly engineered in relation to specified bus wheel-track dimensions are the most effective. An alternative is the use of overrun areas on horizontal deflections (see photos).

7.7.9 Bus priority can also be build into new schemes and existing streets. The example below uses a central two-way bus route (camera controlled to stop abuse) with restricted width lanes for vehicles.

Bus priority measures on existing street, London

7.7.10 Buses themselves can help to slow traffic, for example by placing stops in divided carriageways to prevent overtaking. This is also helpful for the safety of passengers crossing after leaving the bus. Dedicated bus lay bys are generally not necessary in lightly trafficked streets; it is often better to stop the bus in the carriageway so that traffic has to wait behind it whilst passengers board or alight. This approach can also maximise the presence of public transport in the traffic mix.

7.7.11 Bus stops placed opposite one another (rather than earlier advice to stagger them or separate them at junctions) also reinforces the message that buses are not a marginal form of transport.

Bus stops opposite one another, with quality shelters and well overlooked (Düren, Germany)

7.7.12 Bus stops should be placed near junctions or near specific passenger objectives (schools, shops etc.). Setting back from junctions to assist other traffic should be avoided.

7.7.13 Bus stops must be high quality places that are safe and comfortable to use. In mixed use areas it should be assessed as to whether standard bus shelters can be omitted and the waiting area be provided as part of a mixed use building e.g. within a colonnade.

7.7.14 Footways should be wider at bus stops to include space for waiting and providing shelters (minimum of 4.0m).

7.7.15 Kerb design at bus stops should provide for level boarding to fully accessible buses (for wheelchair users, pushchairs etc.). The technology for boarding must be checked with bus operators.

7.7.16 Bus priority measures may be appropriate within developments to give preferential (more direct) routing or to assist buses in avoiding streets where delays could occur. Measures that only let buses through or that let buses go first include "hurry call" transponders to give the bus the green light at junctions, bus gates and bus-only streets.

7.7.17 In large developments a Travel Plan should be implemented to encourage use of the bus from day one (see Queen Elizabeth Park case study).

7.8 OTHER PUBLIC TRANSPORT MODES

7.8.1 Consideration should be given to design aspects of other transport modes, such as access to railway stations and tram stops and the provision for taxi waiting places at key locations.

7.8.2 Provision for secure controllable parking for Car Club vehicles should also be made. Car Clubs can reduce the demand for residential parking provision, but to function effectively they need dedicated parking that is not available for use by others.

Parking specified for Car Club vehicles (Westerpark, Amsterdam)

7.9 THE MOVEMENT OF OTHER MOTORISED VEHICLES

BASICS

7.9.1 The car is today still a key component of life for many people in the UK and hence needs to be accommodated as part of the street network. It is essential that the accommodation of cars and other vehicles is not at the expense of the pedestrian environment and the movement of pedestrians, cyclists and the use of public transport. Key dimensions for typical vehicles are shown below along with the requirements for vehicles to pass each other and cyclists. These dimensions should be regarded as indicative as many vehicles can pass within smaller distances albeit at a lower speed. The dimensions (on the left hand side of the diagram) relate to and would encourage speeds of less than 20mph. At very low speed, for example in a parking court, two cars should be able to pass in 4 metres or less. It may also be advantageous to provide wider streets in places to allow for parking and other activities to take place.

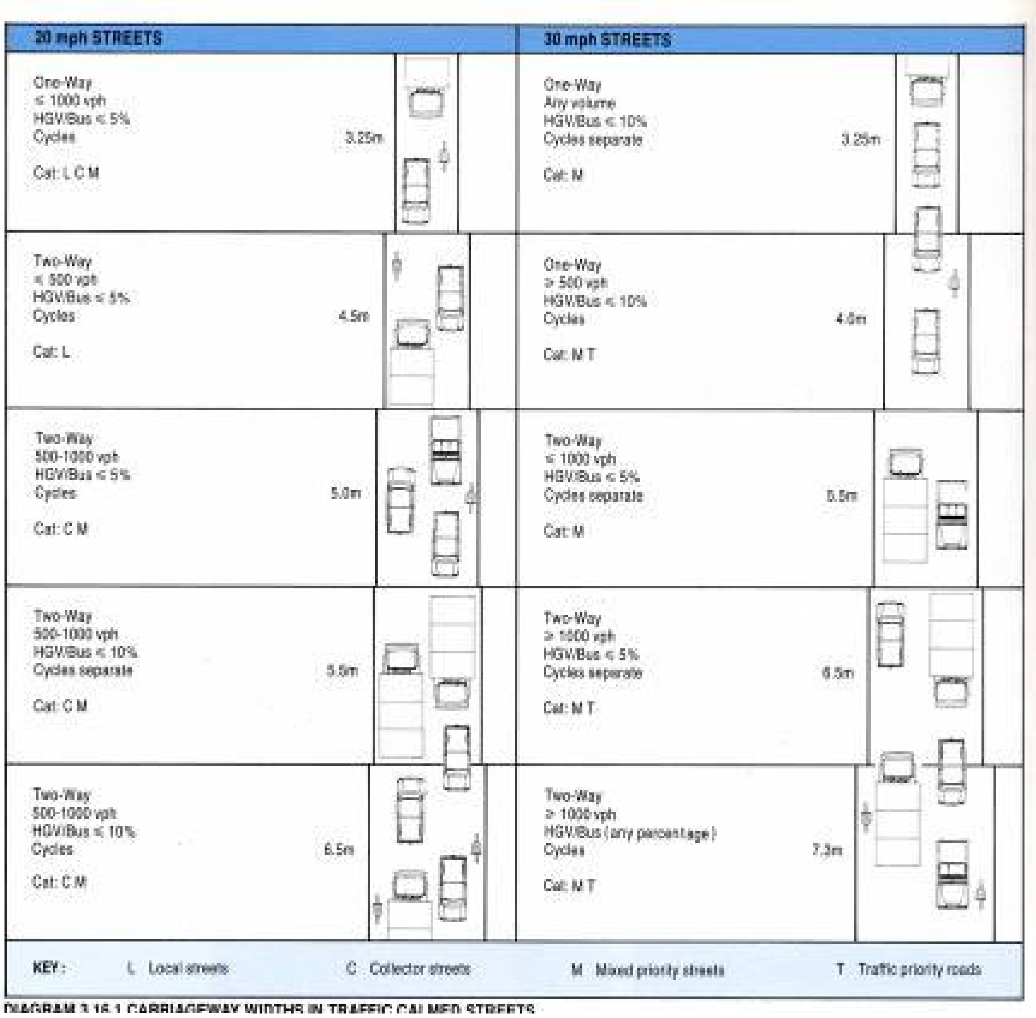


DIAGRAM 3.16.1 CARRIAGEWAY WIDTHS IN TRAFFIC CALMED STREETS

SPEED ATTENUATION (SEE ALSO SECTION 5.5)

7.9.2 All streets whose main function is to provide a residential environment should have vehicle speeds of no more than 20mph. All measures that slow traffic help pedestrians feel safer. The most effective ways to discourage speeds above 20 mph are often to either generate sufficient 'side friction' on streets e.g. by the provision of on street parking, pedestrians, landscaping etc and / or to introduce vertical shifts in the carriageway. This topic is also covered in Chapter 11. Junctions such as crossroads and T's that are part of network also help control vehicle speeds.

7.9.3 There are different ways of encouraging slow driving speeds, and different ways of informing drivers of their legal or other obligations.

Formal speed designations

Formal designations that are enforceable currently are:

- 30 mph speed limit (usually the urban default limit rather than individually signed)
- 20 mph speed limit zone

Other formal designations designed to convey to drivers that they should drive slowly and give priority to others include:

- Home Zones
- Play streets
- Pedestrian streets, with vehicle access

7.9.4 The position as regards enforcement of slower driving speeds is less clear in these zones. Currently there is no provision for formal speed limits below 20mph. Enforcement would therefore need to refer to other legal provision, e.g. relating to dangerous or careless driving, or driving without due care and attention.

Designing for slow speeds

7.9.5 There is not always complete correlation between formal designation of speed limit and the design of streets. It is legally possible to install measures in a 30mph area that make driving above 20mph very unlikely. Equally it is possible to equip a street as a Home Zone with designating the street as such.

7.9.6 Traffic calming measures can be effective in limiting or reducing driving speeds. The measures can act is different ways, and have varying degrees of effectiveness. For example:

- ***Cultural context*** plays a key role. A speed limit sign can be effective in some cultures, but not in others. Respect for the law will depend on a range of factors such as the likelihood of getting caught, or peer group attitudes to breaking the speed limit. Local campaigns can affect attitudes and hence speeds.
- ***Physical interruptions*** in the street that act by causing discomfort to vehicle occupants at speeds faster than wanted. These include mainly vertical features such as humps and ramps, but sharp bends may be included.
- ***Street dimensions*** are important for speed control. Keeping lengths of street between junctions short is particularly effective. Street (or carriageway) widths also influence speed, though the relationship between speed and width is not straightforward.
- ***Changes in priority***. Currently in the UK only roundabouts and stop or give way signs require drivers to give priority to traffic in another direction. This is in sharp contrast to the rest of Europe where the default priority is to traffic from the side.
- ***Psychological measures***, which rely on driver attitudes and perceptions to encourage a lower driving speed. These include narrowing the “optical width” of the street, or introduction “side friction” elements such as trees and furniture, or removing demarcation of vehicle and pedestrian paths (shared surface and “soft separation” techniques).
- ***Mechanical speed limiters***, which act directly on the vehicle’s engine to limit speed. Experiments have been conducted in Germany but no equipment or legal provision is currently available.
- ***Speed control cameras*** are not usually viable in low traffic volume streets. However, a new type of camera control being trialled by Transport for London will

time the passage between two cameras as a means of establishing a driver's average speed, rather than maximum speed.

Attitudes to traffic calming

7.9.7 There is always a danger of a backlash against physical traffic calming measures. There is nevertheless robust data on the reduction of casualties that such measures bring. Driver freedom should not be pandered to at the expense of safety. It often seems to be the case that driver frustration arises when the visual appearance of a street suggests a higher design speed than is permitted and speed restrictions have to be enforced with physical measures. Designing streets with geometries and self-explaining features that communicate the appropriate speed can both offset this frustration and reduce the need for physical measures to control driver behaviour.

7.9.8 Vertical deflections of the carriageway remain the most effective means of limiting driving speeds. Yet these are regarded by some as being unacceptable in new streets. Because of their unpopularity with drivers (and passengers) vertical measures are often avoided by designers and discouraged by local authorities. This can lead, however, to street designs that are both unattractive and ineffective.

7.9.9 The aesthetics of speed control should be considered: there is a balance between the linearity (and legibility) of streets and the introduction of speed attenuation measures that generate horizontal shifts in movement. Vertical shifts (e.g. cushions and tables) can achieve speed control without the loss of linearity.

Traffic calming by the use of speed cushions in Islington, London. The use of cushions allows for the legibility and linearity of the street to be maintained.

7.9.10 Also effective are bends (not curves or wiggles) of certain dimensions and short street lengths (generally less than, say, 100 metres (see section 7.3.1 in relation to block sizes and walking).

7.9.11 Checking for adverse priority is also mostly effective, such as is given by roundabouts or mini roundabouts. This is only effective, however, when there are significant vehicle flows, and where loading are evenly spread between the junction arms.

7.9.12 The following diagram was included in the Devon County Council Traffic Calming Guidelines, 1991, and was drawn up based on a review of traffic calming schemes in the Netherlands and Germany.

SUMMARY OF APPLICATIONS AND EFFECTS OF TRAFFIC CALMING MEASURES	Speed Reduction Rating	Space Reallocation for Other Uses	Visual Enhancement of Street Scene	Suitability L	C	M	T
SPEED REDUCTION MEASURES							
3.7 Vertical Shifts in the Carriageway	A	✗	—	★	★	✚	○
3.8 Lateral Shifts in the Carriageway	B	✓	—	★	★	✚	○
3.9 Carriageway Constrictions	B	✓	✓	★	★	✚	○
3.10 Roundabouts	B	✗	✗	✚	✚	✚	✚
3.11 Small Corner Radii	B	✓	—	★	★	★	○
3.12 Priority Management	B	✗	✗	✚	✚	○	○
3.13 Road Markings	C	✗	✗	○	○	✚	★
3.14 Electronic Enforcement	C	✗	✗	○	✚	✚	✚
SUPPORTING ENVIRONMENTAL AND SAFETY MEASURES							
3.15 Optical Width	C	✗	✓	★	★	★	✚
3.16 Narrow Carriageways	C	✓	✓	★	★	★	✚
3.17 Occasional Strips	C	✓	✓	○	✚	★	✚
3.18 Surface Changes - type/colour/location	C	✗	✓	★	★	✚	○
3.19 Entrances and Gateways	C	✗	✓	★	★	✚	✚
3.20 Central Islands	C	✓	✓	○	✚	★	✚
3.21 Shared Surfaces	C	✓	✓	★	○	○	○
3.22 Footway Extensions	C	✓	✓	★	★	★	✚
3.23 Planting/Greenery	C	✗	✓	★	★	★	★
3.24 Street Furniture and Lighting	C	✗	✓	★	★	★	★
3.25 Regulations	C	✗	✗	✚	✚	★	★

KEY

SPEED REDUCTION RATING:

A Guarantees 85 percentile traffic speeds below desired maximum
B Reduces speeds but does not guarantee 85 percentile level
C Serves as a reminder or encouragement to drive slowly and calmly

SUITABILITY: (FOR DIFFERENT STREET/ROAD CLASSIFICATIONS)

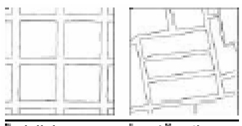
L Local streets
C Collector streets
M Mixed priority streets
T Traffic priority roads

✓ Positive effect
✗ Negative effect
— Neutral

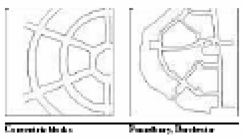
★ Suitable
✚ Possible
○ Not recommended

TABLE 2

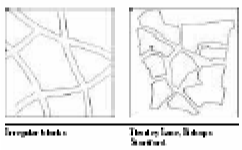
Different network layout types lend themselves to a range of traffic calming techniques.



Rectilinear blocks based on a grid – cushions, squares, tables, build-outs with landscaping to restrict forward visibility



Concentric grids – traffic calmed by form, bends, squares



Irregular layouts with a more 'organic' character – traffic calmed by form, bends, squares

7.10 WHERE STREETS MEET - JUNCTIONS (DB32 3.36-3.52)

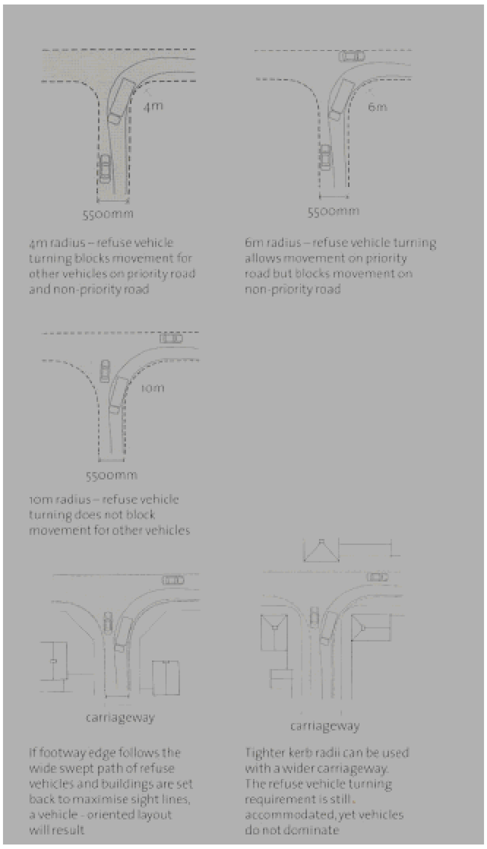
7.10.1 Junctions by definition involve cross traffic or converging traffic movements and they are therefore potential points of interaction and legibility within a development. Depending on their status within the street network and the intensity of movements they provide the best location for activities that need to be noticed by the maximum number of people. Corner shops were so located for sound commercial reasons. The spacing of junctions should relate to the appropriate block structure and permeable pedestrian movement.

7.10.2 Junctions should act as nodes to help with way finding and the definition of a hierarchy of spaces within a development. But junctions are also where there is the greatest potential for conflict between different pedestrians and vehicles.

7.10.3 Appropriate types of junction:

- Cross roads and squares;
- T and Y junctions;
- Staggered junctions; and
- Mini roundabouts.

7.10.4 Often the key element to a well designed junction is the way in which the buildings are placed around it and how they form the space within which the junction sits.



The use of tracking at junctions can create nodes and more pedestrian orientated places.

A tight access street at Poundbury

T AND Y JUNCTIONS, STAGGERED JUNCTIONS

7.10.5 Give way lining may be omitted at junctions in lightly trafficked streets. Note though that the blank boundary wall in this image does little to enhance the street environment – this should be avoided. Research suggests that some junctions where linings are omitted may encourage higher approach speeds by drivers – where this is felt likely to be a concern, the geometry of the junction and its approach should be used to promote safe driving behaviour.

MINI ROUNDABOUTS

7.10.6 Mini roundabouts provide for vehicle priority to be switched from the direction of travel to turning traffic from the right. This means that they can have a speed reducing impact on drivers. Roundabouts can also have the effect of avoiding vehicles having to come to a halt at junctions. This is beneficial for drivers, and may also lessen noise and air pollution. However, it can make conditions worse for pedestrians crossing the street, who cannot rely on drivers slowing or stopping for them. Large roundabouts, especially those with multiple lane entry, are hazardous for cyclists and should be avoided in residential areas.

7.10.7 Roundabouts are also unsightly in most urban street scenes because they often (though not always) require a certain amount of signing and marking, and also a widening of the carriageway compared to a simple junction.

7.10.8 Mini roundabouts occupy less space and may be less visually intrusive. They are significantly better for pedestrians as opposed to larger diameter roundabouts.

7.10.9 Roundabouts may be useful in certain situations:

- To avoid the provision of traffic signals, or to moderate vehicle speeds, at busy junctions where pedestrian provision in not required; and
- To provide a turning facility for large vehicles, e.g. at a bus terminus.

A four way junction that indicates to drivers how they should move around it (i.e. as if it were a roundabout) without any signage or lining being necessary.

7.10.10 Continental style roundabouts should also be considered in residential and lightly trafficked areas. These differ from conventional roundabouts in having narrower circulatory carriageways, minimal flare at entrance and exits and angles of approach that are perpendicular to the central island, leading to significant deflection. Research shows that these measures reduce absolute capacity, but are also effective in reducing entry and circulatory speed of vehicles (TRL 285). The use of these facilities is described in Traffic Advisory Leaflet 9/97.

SPACING OF JUNCTIONS

7.10.11 The spacing or frequency of junctions should be determined by the type and size of urban blocks that are appropriate for the development. This will be decided by taking account of pedestrian movement and desire lines as well as the type and density of buildings. Block sizes generally need to be smaller as density and activity increases, thus increasing the frequency of connections and junctions.

7.10.12 If junctions are provided frequently within a street network in a development then local pedestrian and cycle movement will be easier and the impacts of traffic will be lower and dispersed over a wider area. More junctions do potentially have an effect on traffic capacity (at higher flows) but no evidence to suggest that there are safety implications.

7.10.13 Not all junctions have to cater for all types of traffic. Especially where block sizes are small, some junctions can be designed for pedestrian and cycle movement only. Where this is done, however, it is good practice to maintain the building line through the restricted section for safety and aesthetic reasons. (Narrow alleys are best avoided).

CORNER RADII

7.10.14 The alignment of the kerb at junctions should have the primary function of serving the needs of pedestrians (see section on pedestrians), and the secondary function of enabling vehicle turning movements.

7.11 TURNING

7.11.1 With the design of a permeable, connected street network the need to have to make a three point turn will, in most cases, be eliminated.

7.11.2 Where the ability to make a three point turn is required (e.g. in a dead end street) a tracking assessment should be made to indicate the types of vehicles that may be making this manoeuvre and how they can be accommodated.

7.11.3 The turning space provided must relate to the environment within which it is placed, it should not be specifically relate to the vehicle movement (i.e. hammerhead kerbing or marking should be avoided).

7.11.4 Routing for refuse vehicles should be determined at the concept masterplan stage and should be configured so that ideally the refuse collection can be made without the need for the vehicle to have to reverse (see Chapter 8). Consultation with the local authority should also be made at this stage.

7.12 VISIBILITY (DB32 3.56-3.69)

STOPPING SIGHT DISTANCE

7.12.1 Stopping sight distance (SSD) is defined as the minimum distance that drivers need to be able to see ahead of themselves, in order to stop if confronted by a hazard. SSD is usually related to the 85th percentile wet weather speed of vehicles on the major road.

7.12.2 Normal practice in the UK in the past has been to assume a driver reaction time (the time taken before the vehicle begins to slow down in response to a perceived hazard) of 2 seconds. Once the brakes have been applied a deceleration rate of 0.25g has been assumed to give 'desirable minimum' values (as defined by DMRB).

7.12.3 These criteria give rise to the previously-recommended stopping sight distances (after some rounding) of:

- 90m for 60kph (37mph) design speed;
- 70m for 50kph (31mph) design speed; and
- 33m for 30kph (19mph) design speed.

7.12.4 Drivers are normally able to stop much more quickly than this in response to an emergency, however. Values in the Highway Code assume a driver reaction time of 0.67 seconds and a deceleration rate of 0.67g, which results in stopping distances of:

- 23m for 30mph; and
- 12m for 20mph.

7.12.5 Whilst it would not be appropriate to design junctions for these emergency values, it is now considered that some reduction in the key SSD parameters can be accepted for streets with a design speed of 60kph or less, without compromising road safety. This advice is based upon the following:

- A review of practice in other countries has shown that previous UK values are significantly higher than those in use elsewhere (Reference: *International Sight Design Practices,* Harwood et al);
- Olson found that 85% of drivers will react in less than 1.4 seconds to a "clear and obvious stimulus";
- TRL (Report 332) found 90th percentile reaction times of 0.9 seconds for drivers confronted with a side road hazard in simulator;
- Modern cars, particularly since the development of anti-lock braking, are able to brake more quickly than has been the case in the past; and

- Carriageway surfaces are normally able to develop friction factors of up to around 0.45g in wet weather conditions.

7.12.6 The Highway Code criteria for safe driving speed are fundamental. Most collisions would be avoided if this criterion was adhered to by all drivers. The Highway Code (paragraph 105, page 27) states that drivers should:'

'Drive at a speed that will allow you to stop well within the distance you can see to be clear'

7.12.7 Context is important here. Where the street form and layout are tightly dimensioned, and where traffic is seeking access rather than through movement, then reduced visibility may be accepted and responded to appropriately by drivers. There may be a limit of distance over which drivers will exercise the necessary care. Research is currently underway to enable specific recommendations to be made.

Table 7.1 – Recommended Design Stopping Sight Distances for Streets

Design speed	**Kilometres per hour**	60	50	48	45	40	32	30	25	24	20	16	15	10	8
	Miles per hour	37	31	30	28	25	20	19	16	15	12	10	9	6	5
SSD (metres)	**Zero gradient**	56	43	40	36	31	22	20	16	15	12	9	8		
	10% uphill gradient	51	39	37	33	28	21	19	15	14	11	9	8	5	4
	10% downhill gradient	65	49	46	42	35	25	23	17	17	13	10	9		

7.12.8 It is therefore recommended that SSD values for streets in urban areas, where the prevailing speed is 60kph or less, should now be calculated on the basis of a reaction time of 1.5 seconds and 0.45g. These criteria result in the following design values:

7.12.9 Uphill and downhill gradients also influence braking distance, and hence stopping sight distance, as shown in **Table 7.1**.

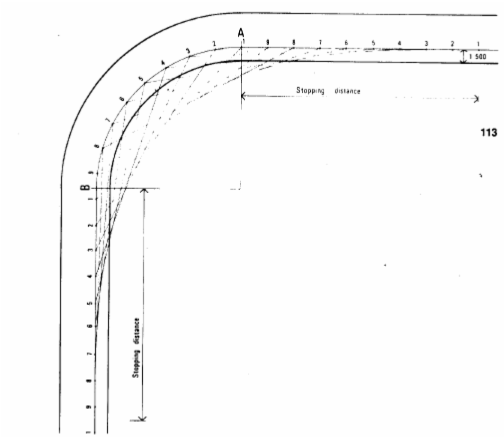
7.12.10 Whilst vehicle speed will obviously affect the time taken to stop, research carried out for MfS has also found that sight distance will affect the speed at which drivers choose to travel. This is an important finding, as it shows that the behaviour of drivers is not a fixed parameter, but can be influenced by the environment through which they travel.

7.12.11 The graph below shows the relationship between observed speeds, forward visibility and carriageway width (insert Figure 3 from TRL paper).

FORWARD VISIBILITY

7.12.12 In general, forward visibility should be provided so that drivers are able to see for a distance equivalent to the Stopping Sight Distance for the prevailing 85th percentile wet weather speed. For new streets, this design speed should take into account factors such as the length of links between junctions, the width of street sections and measures to restraint speed.

Around curves, Forward Visibility should be measured between points in the centre of the nearside traffic lane:



Measurement of Forward Visibility

7.12.13 In situations where it is desirable to reduce forward visibility at curves and bends below that which would normally be required for the prevailing speed, it will be necessary to consider what additional speed restraint measures are required. The restriction on visibility will in itself help to reduce speeds, however, and should be taken into account.

7.12.14 Assessments of forward visibility should be made in three dimensions and take account of vertical curvature and other obstacles. The eye level of drivers can vary from 1.05m above the carriageway in a standard car to approximately 2m in commercial vehicles. An allowance of 600mm from ground level should also be made in relation to the potential presence of small children.

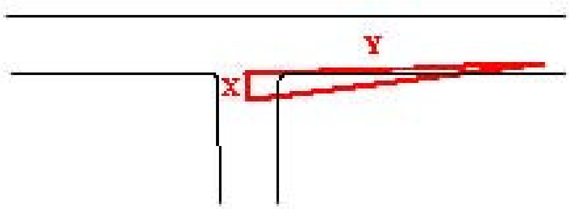
VISIBILITY SPLAYS AT JUNCTIONS

7.12.15 Visibility splays at priority junctions and crossroads enable drivers and other road users to see one another at points of conflict.

7.12.16 The visibility splay is formed from two triangles of X and Y dimensions, defined as follows:

- The X distance is generally measured from the give way line (or the continuation of the edge of the major road carriageway if no line markings are provided) back along the centre line of the minor street. In some circumstances, however (for example where there is a wide splitter island on the minor arm) it may be necessary to consider the most likely lateral position of the driver's eye rather than the centreline of the minor road.

- Y distance to the right is measured from the give way line at the centre of the minor street to a point on the outside of the likely track of a vehicle travelling along the major road. This should normally be taken as 1m out from the kerb, or the edge of the vehicle track if there is no kerb (for example where there are longitudinal parking bays along the edge of the vehicle track).
- Y distance to the left is also measured from the give way line at the centre of the minor street to a point 1m out from the kerb or edge of vehicle track. In some circumstances, however, it may be reasonable to assume that vehicles are unlikely to be travelling at the design speed on the wrong side of the road, and in these situations the visibility triangle to the left can be measured to the road centreline (for example near to the exit from a roundabout or where there are 'no overtaking' road markings).



Measurement of junction visibility splays

X DISTANCE

7.12.17 An x-distance of 2.4m is normally considered acceptable on in most urban situations, as this represents a reasonable maximum distance between the front of the car and the driver's eye.

7.12.18 A minimum figure of 2m may be considered in some very lightly trafficked and slow speed situations, for example in home zones, but using this value will mean that the front of vehicles will protrude slightly into the running carriageway of the major road. The ability of drivers and cyclists to see this overhang from a reasonable distance, and to manoeuvre around it without undue difficulty, should also be considered.

7.12.19 An x-distance of 4.5m is often quoted in many local standards for more significant residential streets, but this distance is no longer recommended in urban areas. Using an x-distance in excess of 2.4m will enable most drivers to look for gaps as they approach the junction, avoiding the need to come to a complete stop and increasing the possibility that they will fail to take account of other road users, particularly pedestrians and cyclists. TRL research report 184 *Accidents at three-arm priority junctions on urban single carriageway roads* found that accident risk increased with greater minor road sight distance.

Y DISTANCE

7.12.20 Requirements for y-distance are normally based on stopping sight distance criteria, on the assumption that a vehicle approaching the junction along the major road may have to stop if a vehicle emerges from the minor road.

7.12.21 Recommended values for SSD at various speeds and longitudinal gradients are given in **Table 7.1** above.

7.12.22 Where the maximum achievable Y-distance is below these values, it should not be assumed that the junction will be unacceptable in road safety terms. Reduced visibility may mean that major vehicles do not come to a complete stop before impact, but where the prevailing speed is 20mph or less and visibilities are only slightly below design values, it may be reasonable to assume that the speed at impact will generally not be sufficient to cause a serious injury in most cases.

OBSTACLES TO VISIBILITY

7.12.23 On-street parking within forward visibility envelopes and junction visibility splays should only be considered as an obstacle when it is occupies a significant part of the drivers' visibility envelope and the spaces are occupied for most of the time.

7.12.24 The impact of other obstacles, such as street trees and street lighting columns, should be assessed in terms of their impact on the overall envelope of visibility. In general, occasional obstacles to visibility that are not large enough to fully obscure a whole vehicle will not have a significant impact on road safety.

ALONG THE STREET EDGE

7.12.25 Vehicle exits at the back edge of the footway can mean that drivers emerging have to take account of people on the footway. The absence of visibility at private driveways will cause most drivers to emerge cautiously. However, some visibility that enables both users to be aware of the other can add to pedestrian comfort. Visibility splays should not, however be marked out or demarcated as such (see Chelmsford case study).

7.12.26 Porches, garage doors or other building elements should not oversail the public footway. Private space adjoining the footway or used as footway should not be over sailed at a height less than 2.6 metres.

7.12.27 Lines of sight can be provided to make this easier to achieve safely. Consideration should be given to whether this will be appropriate, taking into account the following:

- The frequency of vehicle exit movements;
- The frequency of activity on the footway;
- The likely presence of children on the footway;
- The width of the footway; and
- The presence or otherwise of garden or other non-built space that would provide visibility.

7.12.28 When it is judged that visibility can and should be provided, the visibility triangle does not have to be built or in any way made apparent. Consideration can also be given to different means of achieving the visibility:

- Use of boundary railings rather than walls;
- Omission of boundary walls or fences at the exit location;
- Use of wide exit way, and kerbed footway within to ensure vehicles emerge in the middle of the exit way (thus creating a visibility angle). This also provides safe access on foot through the exit way; and
- Built visibility splays (triangles) can be unsightly and should be "designed out."

Placing gates to private driveways at the back of the footpath will encourage drivers to move in and out more slowly, Little Shilling, Dorset (image CABE)

Image, Messestadt Riem, Munich
Exit way (with control barrier) with kerbed footway to keep vehicles away from the wall in order to increase driver's line of sight to the right. Sight to the left is provided by the entry way. Note also the footway paving detail signalling to pedestrians the presence of a vehicle cross-over.

Image Beaulieu Park, Chelmsford
Subtle provision of visibility at private driveway

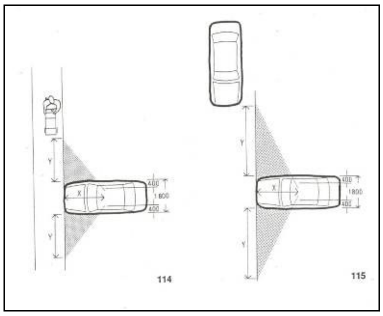


Image – Beaulieu Park Chelmsford
Meaningless expression of visibility splay at exit way- the visibility splay diagram (right) has been interpreted literally. The railings should have followed the property boundary (edge of gravel area).

OVERRUN AREAS

7.12.29 Overrun areas are where parts of a carriageway are surfaced with a rough finish to deter their use by cars and other light vehicles. Their purpose is to allow the passage of large vehicles such as buses and refuse vehicles whilst maintaining "tight" carriageway dimensions that deter smaller vehicles from speeding. Overrun areas can be used as bends and junctions, including at roundabouts.

7.12.30 They should be avoided in residential and mixed use streets where they would:

- Be visually intrusive;
- Interfere with pedestrian desire lines or cause pedestrians to deviate from their direct route across a street or junction; and
- Pose a potential hazard for cyclists.

Image: Queen Elizabeth Park, Guildford, case study
Overrun area at this junction is hazardous for pedestrians and/or requires them to divert from their desire line. Notice also the unsightly placing of inspection covers.