Chapter 4

Junctions and crossings

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4.1 Junction design issues

4.1.1
This chapter provides design guidance on the use and adaptation of junctions and crossings to form safer, coherent and comfortable cycling provision, while maintaining optimum accessibility for pedestrians. It is organised according to four categories: crossings, priority junctions (where vehicles on one route have priority over an intersecting route), signal controlled junctions, and roundabouts (including gyratories).

4.1.2
The six design outcomes may be applied as prompts when considering what improvements could be made to enable cyclists to move through junctions or cross other routes more easily:

safety – are there specific issues that need to be resolved, or specific problem locations, based on the collision record of the junction? how can subjective safety for cyclists be enhanced?

directness – are cyclists asked to deviate from their desire lines? could exemptions be made for cyclists from banned movements or even from certain signals?

comfort – can conflicting movements be managed so that all cyclists can feel confident in negotiating the junction? what constraints does capacity impose?

coherence – is the junction legible and intuitive for cyclists – it is clear how a given move should be made and what position should be taken to do it? is junction treatment consistent along a route?

attractiveness – are there opportunities to create usable, attractive public space as part of junction redesign? what is the balance that should be struck between traffic management infrastructure, and the potential for reducing street clutter, and the overall appearance of the area?

adaptability – how might the use of the junction vary through the day, week or year, and over time (might we expect to find a demand for cycling at particular times of day, and growing over time?) is there a role for trialling new layouts?

4.1.3
Quality of provision for cyclists at junctions and crossings is covered by the Cycling Level of Service Assessment, as shown in figure 4.1.
Figure 4.1 Key junction considerations in CLoS

<table>
<thead>
<tr>
<th>Factor</th>
<th>Indicator</th>
<th>Relates in this chapter to...</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Safety:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collision risk</td>
<td>Left/right hook at junction</td>
<td>Junction design: separation of cyclists in space and/or time, use of traffic signals, ASLs.</td>
</tr>
<tr>
<td>Feeling of safety</td>
<td>Other vehicle fails to give way or disobeys signals</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Separation from heavy traffic</td>
<td></td>
</tr>
<tr>
<td><strong>Directness:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Journey time</td>
<td>Delay to cyclists at junction</td>
<td>Balancing separation of cyclists from other vehicles with appropriate priority for cyclists (ensuring that branded cycle routes have reasonable priority). Long delays at signals will deter cycling and reduce compliance.</td>
</tr>
<tr>
<td><strong>Directness:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Value of time</td>
<td>Value of time</td>
<td></td>
</tr>
<tr>
<td><strong>Coherence:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connections</td>
<td>Ability to join/leave route safely and easily</td>
<td>Use of crossings, appropriate provision at priority junctions and cycle infrastructure at signal-controlled junctions to ensure all desired cycle movements are accommodated.</td>
</tr>
<tr>
<td><strong>Attractiveness:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimise street clutter</td>
<td>Signage and road markings required to support scheme layout</td>
<td>Avoiding over-complication in junction design, so that cycling infrastructure is consistent and intuitive.</td>
</tr>
</tbody>
</table>

4.1.4

Figure 4.2 summarises the content of this chapter by showing potential intervention types for each category of junction for both Superhighways and Quietways. Within each category, more substantial types of intervention are on the left, moving left-to-right through to lighter-touch interventions. This is not to be taken as exclusive of any given approach, but to demonstrate that more decisive changes, likely to have a greater network impact, maybe more appropriate for high capacity Superhighways, while a combination of lighter-touch measures is more likely to be practical for Quietways.

Figure 4.2 Potential junction and crossing interventions for Superhighways and Quietways
4.1.5

Figure 4.3 below matches junction type with different traffic flow levels, to show indicatively how types may vary with flow. Appropriate design for cycling depends on street type and the site-specific conditions set out in the Cycling Level of Service Assessment.

**Figure 4.3 Summary of junction types**

<table>
<thead>
<tr>
<th>Junction Type</th>
<th>Vehicle flows/24 hour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>main road</td>
</tr>
<tr>
<td>Priority – without refuge</td>
<td>&lt;5,000</td>
</tr>
<tr>
<td>Priority – with central refuge in main road</td>
<td>5,000-10,000</td>
</tr>
<tr>
<td>Priority – with controlled cycle crossing</td>
<td>5,000+</td>
</tr>
<tr>
<td>Signal controlled</td>
<td>5,000-20,000</td>
</tr>
<tr>
<td>Normal roundabout, with 2-lane entry *</td>
<td>5,000-10,000</td>
</tr>
<tr>
<td>Mini- or compact roundabout *</td>
<td>Up to 6,000</td>
</tr>
<tr>
<td>Signal controlled roundabout</td>
<td>8,000-15,000</td>
</tr>
</tbody>
</table>

* DMRB TD16/07 defines these roundabout types. See section 4.5 for more details.

4.1.6

Providing for cyclists at junctions is an area where trialling and learning from international practice have had, and will continue to have, a strong influence on design practice. Improvements made by TfL and the London boroughs at junctions and crossings represent an evolving body of practice, and ongoing monitoring and research carried out on such infrastructure schemes will continue to aid understanding of impacts and benefits, and inform future guidance.

4.1.7

From 2012, TfL began working with DfT and other key stakeholders, including borough representatives, on a series of off-street trials at the Transport Research Laboratory test track. Some interim findings from this research have fed into this document but some conclusions may not be available until later in 2014, and so will be incorporated into guidance at a later stage. Wherever possible, innovations in the trial stage have been highlighted in this chapter in anticipation of their eventual full inclusion in LCDS, subject to trial results.
Junction design considerations

4.1.8
It is important for any junction improvement to be based on a comprehensive understanding of the place and movement functions of the location. Sources of information on this include:

- collision history, showing locations, severity of injury and details of the circumstances
- area-wide analysis: relationship between the junction in question and cycling routes, location of public transport stops, information about bus routes, the strategic importance of the streets, kerbside activity, motor traffic speeds
- traffic flow data (including cycling), broken down by time of day and by mode, and traffic modelling
- pedestrian flows, including trip generators and variation by time of day – this should include where crossings currently exist and show pedestrian desire lines

4.1.9
The Junction Assessment Tool, or similar method of analysis, should be applied to any planned intervention, firstly to establish conflicts and cycling movements that are difficult or uncomfortable to make, and then to assess the extent to which a proposal addresses those issues. It is important, however, to keep in mind all desired outcomes: tackling a specific conflict issue could compromise another key outcome, such as directness (avoidance of delay) and may result in poor compliance and more risk taking.

4.1.10
Key conclusions that can be drawn from past research and from analysis of collisions include the following:

‘some of the most significant benefits come from reducing motor vehicle speeds through reducing traffic lane widths, taking out slip lanes and reducing corner radii’ (TRL, Infrastructure and Cyclist Safety PPR 580, 2011)

‘behavioural factors are prominent, with the two most common contributory factors being “failed to look properly” and “failed to judge other person’s path or speed” – this indicates that infrastructure that influences road user behaviour generally may be more significant than interventions that seek to target specific safety issues’ (TfL, Pedal cyclist collisions and casualties in Greater London, 2011)
Junction geometry and corner radii

4.1.11
Relatively minor adjustments to junction geometry can have a significant effect on the speed of turning vehicles. The advantages to safety that arise from reducing speed need to be balanced against the need to provide adequate visibility and allow larger vehicles to turn.

4.1.12
Small corner radii, often used in conjunction with raised entry treatments or raised tables, can reduce the speed of turning traffic, help simplify tactile paving layouts and reduce crossing distances for pedestrians and cyclists. They are also of benefit to cyclists both on- and off-carriageway because they reduce the zone of risk. Unnecessarily large corner radii can encourage higher speeds by motorists and should be reduced where feasible, particularly at priority junctions and where there is an identified relationship with cyclists or pedestrian casualties.

Diagram from Manual for Streets (6.4.6, p71) showing desirability of smaller corner radii for cyclists

Figure 4.4 Indicative corner radii ranges by street type (movement function)

<table>
<thead>
<tr>
<th></th>
<th>arterial road high road city hub/boulevard</th>
<th>connector high street city street</th>
<th>local street town square city place</th>
</tr>
</thead>
<tbody>
<tr>
<td>arterial / high road /</td>
<td>6-10m</td>
<td>6-10m</td>
<td>3-6m</td>
</tr>
<tr>
<td>city hub/boulevard</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>connector / high street</td>
<td>6-10m</td>
<td>2-6m</td>
<td>2-3m</td>
</tr>
<tr>
<td>/ city street</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>local street / town</td>
<td>3-6m</td>
<td>2-3m</td>
<td>minimal</td>
</tr>
<tr>
<td>square / city place</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.1.13
Many existing streets operate in a satisfactory way with minimal corner radii, even a kerb quadrant only. Designers should start from the assumption that corner radii should be minimised to benefit vulnerable road users, and then test whether this raises any issues. Figure 4.4 shows, indicatively, how corner radii might vary according to the two types of street meeting at a junction, based on the movement function of the street type. For types with a higher place function, the lower end of the range should be used.

4.1.14
Street types are not the only site-specific factor to take into account when making decisions about corner radii. Other variables that may justify selecting radii towards the lower end of the ranges in figure 4.4 include:

- lower speeds (ideally with a 20mph limit), either on the individual streets or on an area-wide basis
- few large vehicles needing to turn
- wider carriageways and lanes
- more than one lane (turning vehicles may straddle lanes to turn where there is more than one)
- central islands and ASLs
- uphill or level gradients (on the basis that rear-end shunts could be an issue downhill where turning vehicles may decelerate abruptly to turn)

4.1.15
As part of the design process, swept path analysis should be used to track the paths of larger vehicles around corners. (Manual for Streets, 6.3.13) It is usually acceptable for large vehicles to enter the opposing general traffic lane or adjacent with-flow lane in order to turn, provided there are no physical constraints to them doing so. There may need to be some local strengthening of the footway to allow for larger vehicles occasionally overrunning the corner, and it may be necessary to move back a pedestrian crossing, stop line or ASL in order to accommodate turning movements.

4.1.16
It is important not to design geometry solely based on infrequent use by large vehicles, such as refuse or removal trucks but, in all instances, the designer needs to take account of the individual site characteristics when choosing the appropriate corner radii. Provided
drivers can make the turn within the overall road space available, it is rarely necessary to design so that they can do so while remaining in a single nearside lane.

4.1.17

In most circumstances, the safety benefits to cyclists of tighter geometry and the slowing of motorised vehicle turning movements outweigh risks to cyclists that exist in relation to larger vehicles moving out to the centre of the carriageway to make a left turn. Turning vehicles should, according to Highway Code rule 183, give way to a nearside cycle lane, while cyclists should not seek to undertake at priority junctions where any possibility exists that a vehicle may be turning left.

4.1.18

Any change to junction geometry should also take into account the impact on sight-lines, which are needed to ensure adequate visibility at junctions. Conformity with Manual for Streets guidance is recommended:

- for side roads, the minimum 2.4m ‘X’ distance should be used – allowing full visibility for the driver of an emerging vehicle without needing to cross the give way markings
- in low flow situations, 2.0m may be acceptable, although it is likely to require some protrusion into the main carriageway.
- for cycle tracks crossing other routes or footpaths, the minimum ‘Y’ distance should be 20m (based on a cycling speed of 12mph)

4.1.19

Reducing visibility should not compromise cycle safety at priority junctions and a risk assessment should be undertaken to check whether reduced ‘Y’ distances and tighter geometry generally are acceptable from a cycling perspective. There may, for example, be occasions where horizontal deviations to improve cyclists’ sight lines or speed humps should be added on the approach to a crossing, junction or shared-use area.
4.2 Crossings

4.2.1
Crossings are a significant part of the cycling network in London for two quite different reasons:

- Crossings that bicycles can use are important for safely negotiating roads with high motor traffic speeds and volumes, for linking cycle routes and for giving coherence to cycling networks. The type and location of these crossings has a bearing on the directness, coherence, comfort and safety of cycling provision.

- The location, type and operation of pedestrian priority crossings has an impact on the cycling facilities they cross, whether on- or off-carriageway – they give rise to many of the same considerations as dealing with cyclists at junctions.

4.2.2
Crossing types over carriageways may be categorised as follows, with six different types having the potential to be used for cycling infrastructure, as shown in figure 4.5. Type [4] is included in the consultation draft of TSRGD (2015), issued in May 2014, but will not exist in Regulations until TSRGD is adopted in 2015. At a stand-alone location, parallel cycle and pedestrian crossings could be created but this requires introduction of a signal-controlled junction, so it is the same as type [1]. For the purposes of this guidance, shared, ‘toucan’-type crossings are dealt with as a single type – type [3], regardless of whether they are part of a signal-controlled junction.

Figure 4.5 Cycle and pedestrian crossings over general traffic lanes

<table>
<thead>
<tr>
<th>Crossings that may be used by cyclists</th>
<th>Junctions under signal control</th>
<th>Stand-alone locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>No cycling</td>
<td>Pedestrian-only crossing</td>
<td>Signal-controlled pedestrian crossing (pelican, puffin)</td>
</tr>
</tbody>
</table>
4.2.3

The regulatory framework on crossings is described in the Zebra, Pelican and Puffin Pedestrian Crossings Regulations and General Directions (1997) until this is superseded by the revised TSRGD in 2015. Advice and guidance is provided by DfT in LTN1/95, Assessment of Pedestrian Crossings, LTN 2/95, Design of Pedestrian Crossings, TAL5/05 Pedestrian facilities at signal-controlled junctions (2005) and Signing The Way (2011).

4.2.4

Reference should also be made to Guidance on the use of tactile paving surfaces, which describes requirements for accessible crossings. All crossings should be step-free, which can be achieved either through dropped kerbs or by placing crossings on a raised table or entry treatment. There may also be advantages for partially sighted people in using a surface material for the crossing that has a colour contrast with the carriageway. Relevant streetscape and local design guidance should be consulted for advice about materials.

4.2.5

For a cycle route crossing a road, the most appropriate crossing choice generally depends on the traffic conditions of the road in question – indicative flows by crossing type are shown in figure 4.6. Since signals are expensive to install, operate and maintain and tend to have a negative impact on the street environment, signalisation should be a last resort. For that reason, types [4] to [6] are generally recommended for the lower-intervention Quietways, although new signals may be needed in some locations. Use of zebras and uncontrolled crossings is unlikely to be adequate for high-capacity Superhighways.

4.2.6

At a site-specific level, the appropriate crossing option for a given location also depends on the character of the place in question and considerations of street clutter and accessibility. Where a pedestrian or cycle desire line has been identified, type [6], an
uncontrolled crossing, should be considered first, as the 'lowest intervention' form. This is likely to be suitable for locations with relatively low levels of use by those crossing and where traffic speeds and volumes are low enough to allow safe opportunities for crossing.

**Figure 4.6 Cycle crossing options**

<table>
<thead>
<tr>
<th>Type of crossing</th>
<th>Flows (24hr)</th>
<th>All vehicles (carriageway)</th>
<th>Bicycles (crossing)</th>
<th>Pedestrians (crossing)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Parallel signal-controlled pedestrian &amp; cycle crossing</td>
<td>&gt; 8,000</td>
<td>Medium-High</td>
<td>Medium-High</td>
<td></td>
</tr>
<tr>
<td>2. Signal-controlled cycle-only crossing</td>
<td>&gt; 8,000</td>
<td>Medium-High</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>3. Shared pedestrian/cycle crossing (Toucan / Pegasus)</td>
<td>&gt; 8,000</td>
<td>Low-Medium</td>
<td>Low-Medium</td>
<td></td>
</tr>
<tr>
<td>4. Parallel priority pedestrian/cycle priority crossing</td>
<td>3,000-8,000</td>
<td>Medium</td>
<td>Low-Medium</td>
<td></td>
</tr>
<tr>
<td>5. Shared pedestrian/cycle priority crossing (Zebra)</td>
<td>3,000-8,000</td>
<td>Low to Medium</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>6. Uncontrolled (central refuge)</td>
<td>3,000-8,000</td>
<td>Low</td>
<td>Low</td>
<td></td>
</tr>
</tbody>
</table>

Crossings at signal-controlled junctions

4.2.7

Cycle tracks or shared use paths/areas may be joined across one arm of a junction under signal control by using either a shared or separate, parallel pedestrian and crossings or by using type [3], a shared crossing. Parallel crossings, type [1], are a good option where there is high demand by both cyclists and pedestrians, thus reducing potential conflicts between the two modes on the crossing. They may be particularly useful where cyclists are approaching from a different direction from pedestrians. This is often the case when one route is a side street closed to motor traffic. Type [2] is a variant where there is no parallel pedestrian crossing facility. For this type, reliable cycle detection, or a push-button, should be used so that demand can be prioritised and delay minimised. Where the cycle crossing cannot align with the cycle route in a way that allows cyclists to remain on carriageway, a shared use area will be required to allow access to the crossing.
4.2.8

Square elephant’s footprints markings are recommended for both type [1] and [2] crossings, although pedestrian crossing studs are also sometimes used for this purpose. The consultation draft of TSRGD (2015) proposes a general authorisation for elephants’ footprints to mark a parallel cycle route at a crossing under signal control, where previously site-specific authorisation was required. This should add consistency and will bring the UK into line with other parts of Europe on use of a square-format marking for cycle crossings.

4.2.9

In some cases, providing cycle gaps through islands may more be appropriate than marking elephant’s footprints across the carriageway. It may be necessary to use ‘Keep Clear’ markings so that queuing traffic on the carriageway does not block the crossing.
Stand-alone signal-controlled crossing

4.2.10

Shared crossings at stand-alone signals are known either as toucan or pegasus crossings, the latter being a special type that also allows horse-riders to cross. As part of signal-controlled junctions, they are generally not known by these names but the design issues are similar. In a toucan crossing, the surface of the crossing and footway areas immediately on either side are shared, although there may be some separation up to that point.

Variants to the standard toucan layout are possible for locations such as side-road junctions that can enable more direct crossings. The DfT provides guidance in TAL 10/93, Toucan: an unsegregated crossing for pedestrians and cyclists and in TAL 4/98, Toucan crossing development.
Parallel priority crossings

4.2.12

The consultation draft of the revised TSRGD (2015) proposes a new crossing type that would allow for parallel pedestrian and cycle crossings without the need to install signal controls. This priority crossing is similar in appearance to a zebra crossing but with a parallel route for cyclists, marked with elephants’ footprints within the controlled area of the crossing. This type will be available to use when the new regulations are adopted in 2015 and will bring the UK more into line with international best practice. Details are yet to be established, including whether two sets of elephants’ footprints markings are possible on one crossing and whether diagram 1057 cycle symbols may be used on the crossing area.
4.2.13

The parallel priority crossing could be used to connect off-carriageway tracks across a main road, to allow crossing from and to streets closed to motorised traffic and to shift two-way cycle tracks from one side of the road to the other.

Priority (zebra) crossing

4.2.14

Wherever possible, separate parallel crossings should be provided for pedestrians and cyclists. However, a low-intervention option may be to use a zebra crossing to take a cycle route over a main road. This option is likely to work best where there are low flows of both pedestrians and cyclists, and could be a pragmatic choice where there are existing shared use footways on either side of the carriageway – for example, in a ‘high road’ location near a school.

Conventional zebra crossing (left), with buff blister tactiles. Shared area on either side of the zebra (right) to legitimise cycle use of the crossing.
4.2.15

DfT’s Signing The Way (2011) invited highway authorities to permit, at trial locations, cycle use of zebra crossings where they join off-carriageway cycle routes. TfL’s position, drawing on conclusions from TRL’s Shared Zebra Crossing Study (2006), is that cyclists can legally ride across zebra crossings in this scenario. A risk assessment of any proposal for cyclists to use zebras is important: although it is not illegal for cyclists to ride over zebra crossings in these instances, they do not formally have the same priority as pedestrians over traffic using the carriageway.

4.2.16

Special design considerations for priority crossings that cyclists may use include: geometry designed to accommodate both pedestrian and cycle flows; design to force cyclists to slow or stop and to give them adequate visibility before crossing; and signing and road marking to make other users aware of the likely presence of cyclists on the crossing.

4.2.17

Where a zebra crossing is marked across a street with a cycle lane, the lane markings may not be continued through the zig-zag markings that show the controlled area of the crossing. However, the consultation draft of TSRGD (2014) allows for the zig-zags to be moved away from the kerbside to align with the cycle lane markings and allow for greater visual continuity of the cycle facility.

![Indicative layout 4/02: Continuity of cycle lane at priority crossing](image)

4.2.18

Note that the number of zig-zag markings may be reduced to from eight to two, depending on site-specific conditions such as visibility and the existence of other parking controls. Where the number of zig-zags is reduced, it may be advisable to widen the crossing, especially where the approach is not straight.

For carriageway widths of 6m or less, the central set of zig-zags may be omitted.
Uncontrolled crossings

4.2.19

Uncontrolled crossing points for pedestrians and cyclists generally consist of dropped kerbs on either side of the carriageway, with an 800m strip of blister tactile paving across the width of the crossing area, to the dropped kerb. A 2m-deep central island to provide protected waiting space can be beneficial along with road narrowing, provided this does not create pinch points for cyclists using the carriageway. Some speed reduction measures on the carriageway may also be appropriate.

4.2.20

These ‘courtesy’ crossings do not give priority over vehicles on the carriageway. However, introduction of give-way signs and markings for motorists with a raised table would give formal priority to crossing pedestrians or cyclists without the need for a zebra crossing.
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4.2.21
A variant of the uncontrolled crossing is to use materials and streetscape features to ‘suggest’ that a crossing facility exists, encouraging drivers to slow down through the space and give way as necessary to anyone wanting to cross. These facilities can include informal crossing areas that are striped in the manner of a zebra crossing but do not otherwise meet regulatory requirements (therefore they do not confer any formal priority on the crosser). These kinds of approaches are often used in shared space schemes.

‘Suggested’ crossing places in high street environments in Bexleyheath (left) and Hornchurch (right), using streetscape features such as raised tables, median strips, planting and a distinctive palette of materials to help break down dominance of the environment by motorised vehicles.

Pedestrian crossing of cycle tracks

4.2.22
For segregated lanes/tracks and light segregated lanes, crossings should ideally extend from footway to footway. In that way, the cycling facility is included within the controlled area of the crossing. This also avoids the need to design a separate way for pedestrians to cross a cycle track.

Signalised and priority (zebra) crossings extending over both carriageway and cycle track

4.2.23
Where there is not a crossing facility that can extend across both carriageway and segregated cycle lane/track, then uncontrolled and suggested crossings are likely to be
the most practical options, given that signalisation or installing a fully compliant zebra crossing would be too heavy handed and expensive for a short crossing only involving cyclists and pedestrians. Many other countries have a small, uncomplicated crossing type that gives crossing pedestrians priority over the cycle track.

**4.2.24**

In some instances, it may be appropriate to use an uncontrolled crossing to allow pedestrians to cross a cycle track next to the carriageway to an island and then a zebra or pelican crossing over the main part of the carriageway. In this case, the crossings should be staggered so it is clear that the two sections have a different status.
4.3 Priority junctions

4.3.1

The majority of highway junctions are of the ‘priority’ type – crossroads and T-junctions – where vehicle priority is given to traffic on the major road. The priority is usually indicated by give-way or stop-lines and associated signs, or suggested by pedestrian refuges and traffic islands. In some cases no road markings may be considered to be necessary where vehicle speeds and flows are low.

Figure 4.7 Summary of options for cycle-friendly interventions at priority junctions

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Introduce refuge island(s) Recommended to support cycle and pedestrian crossing, and cycle right turns, but only where avoiding the creation of pinch-points with unacceptable widths.</td>
</tr>
<tr>
<td>2.</td>
<td>Reduce speed on turning (entry treatments and raised tables) Speed reduction generally is beneficial (see chapter 5). On cycle routes, selective use of entry treatments and raised tables can address common risks on turning and suggest visual priority for cyclists and pedestrians. Other changes to geometry that can support speed reduction include: kerb realignment, reduced corner radii, reduced width of junction mouth and footway build-outs. Preventing or restricting parking and loading close to the junction is an important supporting measure in most cases, helping to maintain good visibility.</td>
</tr>
<tr>
<td>3.</td>
<td>Road markings through junction Visual priority can be supported by a combination of: use of TSRGD diagram 1057 cycle symbols, dashed diagram 1010 markings across the mouth of the junction and coloured surfacing. These interventions raise road user awareness of the presence and legitimacy of cycling and specific cycle movements.</td>
</tr>
<tr>
<td>4.</td>
<td>Introduce new crossing Crossings on a main road can help cycle movements in and out of a side road. For streets with a higher movement function, consideration could be given to allowing cycle left and right turns by diverting cyclists onto shared areas of footway and parallel or toucan crossings. See section 4.2.</td>
</tr>
<tr>
<td>5.</td>
<td>Change or reverse priority / Ban specific movements These changes can help address specific conflicts between turning motorised vehicles and cyclists and enhance the directness, safety and comfort of a cycle route. Interventions such as these need to be part of a wider traffic management approach.</td>
</tr>
<tr>
<td>6.</td>
<td>Convert to signalised junction A last resort, justification for which would need to be made on multiple grounds, according to TFL’s Design standards for signal schemes, SQA064 (2014). See section 4.4.</td>
</tr>
</tbody>
</table>
4.3.2
For cyclists, key issues relate to the safety and comfort of moving ahead through a priority junction while motorised traffic seeks to turn in or out, and the safety, comfort and directness of cycle turns into and out of junctions. Priority for ahead cyclists is covered in section 3.5. Any turn for cyclists that involves moving across more than one lane of motorised traffic in one step is likely to be uncomfortable for most users. This section focuses on methods of addressing this issue – its scope is summarised in figure 4.7.

Refuge islands

4.3.3
For cycling infrastructure, two separate issues need to be considered with the use of refuge islands:

- where islands are provided to assist pedestrians crossing the road or for driver guidance, they must avoid creating pinch-points for cyclists; and
- the potential for assisting cyclists by allowing them to make difficult turns under the ‘shadow’ of a protecting island.

Indicative layout 4/04: Cycle lanes at pedestrian refuge island / uncontrolled crossing

4.3.4
Guidance on widths in figure 4.8 should be followed so as to avoid intimidating close passes of cyclists by motorised vehicles at refuge islands. Driver awareness can be increased by continuing a cycle lane through the area (which usually requires conversion from mandatory to advisory in order to allow for some possible encroachment by
motorised vehicles), cycle symbols or coloured surfacing. Cyclists should be able to maintain their speed and consistent line of travel on a direct route, so diverting them off-carriageway around an island should be avoided. ‘Cattle pen’ pedestrian refuges with guard-railing should not be used – refuge treatments should have upstand kerbs to enable safe and direct crossing for pedestrians. In some instances, it may be desirable to replace an informal crossing with a formal pedestrian crossing and achieve consistently wider cycle lanes.

Figure 4.8 One-way lane widths at refuge islands where no cycle track or bypass is provided

<table>
<thead>
<tr>
<th>85th percentile traffic speed</th>
<th>Traffic calmed, no buses or HGVs</th>
<th>No calming, no buses, HGVs etc</th>
<th>No calming, with buses, HGVs etc</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 20 mph</td>
<td>&lt;2.5m</td>
<td>&lt;2.5m or 4.0m+</td>
<td>&lt;3.0m or 4.0m+</td>
</tr>
<tr>
<td>21 – 30 mph</td>
<td>&lt;3.0m or 4.0m+</td>
<td>4.0m+</td>
<td>4.0m+</td>
</tr>
<tr>
<td>&gt; 30 mph</td>
<td>4.0m+</td>
<td>4.0m+</td>
<td>4.5m+</td>
</tr>
</tbody>
</table>

4.3.5

An alternative is to design a bypass to a pinch-point. This should not deviate a cyclist, avoid creating conflict with pedestrians, allow a minimum width of 1.5m between obstructions, be marked with a cycle symbol on the approach and be designed to prevent blocking of the entrance and exit by other vehicles. The last of these may require waiting and loading controls but preferably should be done without relying on enforcement. Any vertical change required for use of the bypass by cyclists should not exceed 1:10.

4.3.6

Uncontrolled pedestrian crossings with islands can, indirectly, play a useful role in helping cyclists to cross, or get on or off, a main road. They give an effective waiting area, with some protection in the ‘shadow’ of the island, and can therefore help cyclists make difficult
or uncomfortable manoeuvres in more than one step. This can be particularly useful where a (minor) cycle route crosses a busier road. Islands either side of a priority junction can provide a even more protected space to make two-stage cycle movements. This arrangement may require banning of right turns by motorised vehicles.

Illustrative layout 4/05: Island-protected cycle right-turn into side road

4.3.7

Islands may be useful for protecting cyclists in other circumstances, such as the continuity and safety of contraflow cycling facilities run through a priority junction, or protecting cycle lanes from motor vehicle incursion just before priority junctions.
Entry treatments, raised tables and footway build-outs

4.3.8

Research has shown that side-road entry-treatments have significant safety benefits for cyclists, particularly where provided in conjunction with other street enhancements, such as tree planting. A reduction of around 30 per cent in cycle collisions was found at over 1,000 sites in London. (TfL, Effect of Side Raised Entry Treatments on Road Safety in London - London Road Safety Unit Research Summary No 9, 2007.) Entry treatments to side roads adjacent to a main road are therefore recommended for a cycle route on the main road. However, all vertical forms of traffic calming, even well designed examples, add some discomfort for cyclists riding over them. They may therefore be appropriate on other roads that are traversed by a cycle route or have cycle usage, but a balanced view needs to be taken of the benefits they offer relative to the downsides.

Entry treatment with asphalt table, Gray’s Inn Road / Heathcote Street, Camden

Block-paved entry treatment with tight corner radii – Walworth Road, Southwark

Typical entry treatments in the City of London, with visual contrast with carriageway: at a narrow street with cycle contraflow (Cloak Lane, left) and at a two-way street (Trump Street, right)

4.3.9

To provide the best conditions for cyclists, and to encourage motorists to make careful turning movements into and out of side roads, entry treatments should:

- narrow the side-road carriageway to between 5.0m and 6.5m, depending on the type of traffic using the road (greater widths are likely be required on access routes used by buses, emergency response vehicles, HGVs and refuse collection trucks)
- use a corner radius of kerb-line below 6.0m – see section 4.1 for further guidance
• raise the carriageway by 50-100mm, up to the same level as the adjacent footway
• use materials that have a visual contrast with the carriageway surface to raise awareness (bearing in mind guidance in chapter 7 of this document and in other streetscape and local design guides on appropriate surface materials, particularly from a maintenance perspective)
• use approach sinusoidal ramps, with 1:10 gradient (shallower gradients may be needed on bus and emergency-service routes)
• be constructed using asphalt ramps or other non-skid material
• provide flat pedestrian crossing areas of at least 3m width with blister tactile-paving (off carriage/cycleway) to indicate crossing location
• avoid upstands of more than 6mm where pedestrians cross (as this is likely to interfere with the movement of people in wheelchairs)
• provide cycle stands on footway space created by the entry treatment where demand for them is reasonably anticipated – allowing for considerations of visibility, these and other forms of street furniture can fulfil a similar function to bollards to prevent vehicle over-run of the footway area.

Illustrative layout 4/06: Raised entry treatment

4.3.10

Raised tables extend the logic of raised entry treatments across all arms of a junction or crossing area, which can be effective in slowing turning movements but, again, puts in place a vertical shift for cyclists moving through a junction. Where assessment of the junction indicates that there would be a net benefit from a safety and comfort perspective in constructing a raised junction table, these are recommended cycle routes, provided they are constructed in accordance with the above advice. Like entry treatments, junction tables convey to motorists not to expect to have priority over other road users, and to turn with appropriate caution.
4.3.11

Entry treatments and raised tables do not require Traffic Orders but are covered by the Highways (Road Humps) Regulations 1999. These state that the highest point on a flat-topped road hump must be within 25 and 100mm of the carriageway surface. In order to construct a raised entry treatment flush with the footway on either side where kerb heights are greater than 100mm, some raising of the carriageway surface in the area leading up to the entry treatment will be necessary to meet the 100mm requirement.

4.3.12

It may be beneficial to continue footway and cycleway treatments across the mouth of the side road to convey further necessary priority for pedestrians and cyclists. Turning vehicles will need to negotiate a change in level, and they must enter and pass through a zone that looks and feels different and where they should clearly cede priority to other users. This is not practised often in the UK but has been applied in key cycling routes in cities such as Copenhagen and Stockholm.
4.3.13

An alternative method employed in Copenhagen is to run a stepped cycle track with a continuous treatment past a side road and continue the footway through but in a different material from the rest of footway. In the UK, a treatment of this kind could be a good method of demonstrating to pedestrians that they have reached a side road, without requiring addition of tactile paving.

Illustrative layout 4/07: Continuous footway treatment

Continuous footways in Lambeth – Coldharbour Lane, Clapham Old Town
4.3.14

Footway build-outs at priority junctions may be used in conjunction with side-road entry treatments to enhance some of the vehicle-slowing aspects of the design and also create either additional footway space or an opportunity for tree planting and greening of the street. Build-outs provide pedestrians with shorter crossing widths and additional visibility when crossing the road at junctions and island sites. However, it is essential from both a road safety and movement perspective that build-outs do not cause pinch-points, forcing cyclists to deviate into the path of vehicles, or restricting cycle flows.

4.3.15

For any proposed build-out, remaining one-way widths should be consistent with the guidance on pinch-points provided in figure 4.7 – namely that, in most instances at least 4.0m one-way width will need to remain after the build-out on most street types, even if there are no large vehicles turning.

For local streets and others in 20mph zones, there can be more flexibility and build-outs can be used that reduce the remaining (two-way) carriageway width to 5.5-6.0m.

Road markings through junctions

4.3.16

As shown in the illustrative layouts throughout this section, marking cycle lanes through priority junctions in the direction of the cycle route is recommended as a method of increasing subjective safety with regard to the potential of other vehicles turning across cyclists. The lane markings raise the awareness of drivers of the likely presence of cyclists in a nearside lane and help give visual continuity to a cycling facility.
4.3.17

As presented in the consultation draft of TSRGD (2015), the diagram 1010 marking, a shorter dash than the advisory cycle lane marking (1000mm rather than 4000mm), should be used for lanes through junctions in order to give a visual indication to all road users of a change in hazard associated with the junction. Until the revised TSRGD comes into operation, DfT has authorised for TfL the a short-dash ‘variant 1010’ marking (850mm wide with an 1150mm gap rather than a 1000mm dash and 1000mm gap) for this purpose and could do the same for other highway authorities. See section 6.3 for further details.

4.3.18

DfT’s Signing the Way (2011) cites qualitative research with cyclists to support the desirability of using lane markings through junctions from a cycle safety perspective. (AECOM, Traffic Signs Policy Review: Research Project into the Awareness of the Meaning of Traffic Signs Project PPRO 04/16/24, 2011) The TRL report for DfT Infrastructure and Cyclist Safety (PPR 580, 2011) is also supportive of cycle lanes continued through junctions.

4.3.19

On streets without cycle lanes, then TSRGD diagram 1057 cycle symbols may be used across junctions and accesses. These are usually positioned at the points where a cyclist should enter and exit from the side road and, in that way, help to guide appropriate cyclist positioning as well as alerting other road users to the presence of cyclists. They remove any need for other warning signs to diagrams 962.1 or 963.1 except for situations where contra-flow cycling is permitted. At side roads with restricted access or less than 5m wide, kerb-to-kerb, one rather than two diagram 1057 markings may be used. On Cycle Superhighways, the CS project symbols (diagram 1057 marking with route number on a coloured patch) may be used to mark continuity of a cycle facility through a priority junction. See section 6.3 for further details on use of road markings for these purposes.

4.3.20

In all instances, analysis of cyclist movements through the junction should be undertaken prior to any decision about placement of lane markings or symbols. Care should be taken not to direct cyclists into taking inappropriate riding positions through the junction. Where there is insufficient space through a junction for a large vehicle to overtake a cyclist, for example, a marked lane should not be provided as cyclists should be discouraged from adopting a secondary riding position.

TSRGD diagram 1057 symbols positioned so as to mark a cycle route through a junction
4.4 Signal-controlled junctions

4.4.1

Various improvements to cycle safety and comfort, and to the directness and coherence of cycle routes may be achieved through remodelling or introducing signal control at junctions, particularly where signal timings can be changed to reallocate time between road users and generate time saving benefits for cyclists. Intervention types covered in this section are summarised in figure 4.9.

Figure 4.9 Summary of options for cycle-friendly interventions at signal-controlled junctions

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Separate signals for cyclists</td>
</tr>
<tr>
<td>2.</td>
<td>Managing or removing conflict with left-turning vehicles</td>
</tr>
<tr>
<td>3.</td>
<td>Support for cycle right turn</td>
</tr>
<tr>
<td>4.</td>
<td>Cycle bypass of signals</td>
</tr>
<tr>
<td>5.</td>
<td>Using ASLs and feeder lanes</td>
</tr>
<tr>
<td>6.</td>
<td>Banning selected motorised vehicle movements</td>
</tr>
<tr>
<td>7.</td>
<td>Convert to a priority junction</td>
</tr>
<tr>
<td>8.</td>
<td>Remove all priority and declutter</td>
</tr>
</tbody>
</table>

1. Complete separation at junctions involves signalling cyclists separately to remove all conflicting movements with other users.
2. This may be done by separately signalling left-turners (removing the conflict) or seeking to move the point of conflict away from the junction itself (managing the conflict), usually through lane markings.
3. As part of a segregated cycling system or a wider strategy on a route or a series of junctions to keep cyclists in a predictable position on the nearside, cyclists could be assisted with right turns by staying on the nearside and making the turn in two stages.
4. In some instances, particularly through signalised T-junctions, cyclists making certain movements may be permitted a bypass of the signal control.
5. ASLs can help cyclists take a safer, more advantageous position at a signal-controlled junction during certain signal phases and so, selectively, can assist cycle movements through a junction.
6. Generally in conjunction with other measures listed here, certain vehicle movements could be banned to improve cycle safety and directness. This should be done as part of a wider traffic management approach rather than on a case-by-case basis.
7. Signal removal can have some beneficial effects where the volume and mix of traffic and nature of conflicting movements does not necessarily justify the existence of a signal-controlled junction. See section 4.3.
8. As part of an integrated, area-wide approach, designers may explore the potential benefits of removing signal control and priority altogether in order to promote more consensual road user behaviour generally. See chapter 3 on cycle-friendly street design.
4.4.2
Introducing new signal control or major re-engineering of existing signal-controlled junctions should be considered primarily as a tool for application to high-capacity Superhighways, on streets with a higher movement function. On Quietways, new or substantially changed traffic signals are less likely to feature, with greater emphasis on simplification of layouts and decluttering. TfL’s Design standards for signal schemes, SQA064 (2014) should be consulted for guidance on procedures involving traffic signals.

4.4.3
The primary purpose of traffic control by light signals is to separate conflicting traffic by the division of time, within the available road space, in a safe, efficient and equitable manner. (Traffic Advisory Leaflet 1/06, General principles of traffic control by light signals, 2006, Part 1) Detection technology is widely used to optimise the operation of traffic signals. This allows for sequence flexibility if no users are detected and for green signal optimisation during busy periods.

4.4.4
Benefits arising from being able to control movements of road users at traffic signals need to be weighed up against the potential disadvantages to cyclists. Minimising delay is a primary objective in achieving a level of service that attracts new cyclists: few advantages are to be gained from signals for cyclists that require them to wait a long time at signals. Delays to cyclists of over 120 seconds due to signals are to be avoided.

4.4.5
Decluttering by minimising use of, or removing, traffic signals is positive for more attractive streets. Although it offers some adaptability through the ability to manage signal timings, junction remodelling with substantial changes to traffic signal infrastructure, may also place limits on the growth of cycling on a given route and necessitate further re-engineering in the near future.

Care should be taken to avoid introducing signal control where it is not justified. This can result in increased journey times for all users and is costly to install and maintain. Over-complicated signal staging and operation can lead to excessive waiting times for cyclists and an increase in non-compliance.

4.4.6
In seeking to improve cycle safety, comfort and directness at junctions, the timing of signals should generally be reviewed and optimised to minimise delay for cyclists, taking account of the needs of all traffic and of pedestrians. When calculating inter-green timings allowance must be made for cycle movements to ensure cyclists can safely clear the junction. This is particularly important where cycle speeds are likely to be lower due to gradients.
Procedures for traffic signals

4.4.7
TfL Traffic Infrastructure, within the Asset Management Directorate, is the Signals Authority for London, responsible for the design, installation, commissioning, maintenance and decommissioning of traffic signals and associated equipment. TfL Network Performance, within the Road Space Management Directorate, is responsible for the management and operation of London’s traffic signals and their accompanying systems, technologies and equipment.

4.4.8
The Traffic Management Act 2004 places a Network Management Duty on all local traffic authorities (LTAs) in England. The Duty requires the LTA to ‘ensure the expeditious movement of traffic on its own road network, and facilitate the expeditious movement of traffic on the networks of others’. ‘Expeditious movement’ and ‘congestion’ are subjective terms. TfL Network Performance therefore uses journey time reliability as a more practical measure to help clarify the legal responsibility. Modelling is the tool used to measure scheme impact on the network and effects on journey time reliability. The way this is applied across London is described in the Traffic modelling guidelines (version 3), issued in September 2010.

4.4.9
For any scheme involving traffic signals, authorities are required to comply with procedures set out in Design standards for signal schemes, SQA064 (2014) and any subsequent document updates.

4.4.10
Criteria in SQA064 are based on the collision rate at the junction, and on flows of traffic, pedestrians and turning traffic. For a new development, modelling evidence is required as a justification for a signal scheme. TfL can work with any client to determine if these criteria are likely to be met.

4.4.11
In practice, initial concept, feasibility and preliminary design is usually carried out by the organisation promoting any scheme involving traffic signals. When requested, TfL provides comments on these preliminary designs for signals and should always be consulted about the method of control to be used.

4.4.12
TfL usually (but not always) carries out the subsequent detailed design work for signals. TfL must also check and approve the completed design before procurement and again after installation, but before commissioning.
4.4.13
The client for the scheme is responsible for obtaining any traffic orders required and for the design and management of civil engineering works, such as ducting, dropped kerbs and tactile paving. This will normally be in advance of any signal works. Scheme installation and maintenance work on site is usually carried out by contractors appointed by competitive tendering or by term contractors.

4.4.14
Where traffic signals are installed on roads for which a London borough is the highway authority, TfL consults with that authority before making major changes to the signal timings and permits reasonable requests for modifications to existing traffic signals and the provision of new signals.

Separate signalling for cyclists

4.4.15
The options covered in this section are generally trial measures that are being developed to enable separation of cyclists’ movements through junctions. They all have the potential to become important parts of the toolkit for cycling infrastructure in the UK. Tried-and-tested designs and layouts are likely to emerge in time are yet to be developed but in order to develop agreed, standardised approaches, it would be constructive if any proposals to trial any of these measures were to be discussed with TfL or DoT from an early stage.

4.4.16
Red cycle aspect on standard traffic signal head
A standard traffic signal head can be used to control traffic consisting solely of pedal cycles. This signal includes green and amber cycle logos and a high-level red cycle aspect. Off-street trials commissioned by TfL have confirmed that a red cycle aspect on a standard traffic signal head is equally well understood and complied with by cyclists when compared with a full red aspect.

The consultation draft of TSRGD (2015) proposes a general authorisation for the use of a red cycle aspect on cycle-only traffic signals. Until the new regulations are adopted, the red cycle aspects remains subject to site-specific authorisation.

Diagram from TSRGD consultation draft (2015), Table 69, Item 3, showing the option of a red cycle aspect.
4.4.17
Low-level cycle signals

A further stage of the trials has seen testing of a smaller signal head, mounted at cyclists' eye level on existing signal poles. On-street trials currently see these low-level cycle signals operate as repeaters to the main signals. However, they have the potential to be used in the future to signal separate cycle movements, including in many of the methods set out below. The consultation draft of TSRGD (2015) includes these as alternatives to the above high-level, full-size signal head, specifying a minimum mounting height of 1200mm (to the underside of the signal head).

TfL Traffic Infrastructure is developing further guidance (SQA0651 Design for low-level cycle signals) that will bring together TRL off-street trial research, on-street trial results, information about equipment and generic design considerations.

4.4.18
Cycle early release

Cycle early release signals allow cyclists to move away ahead of general traffic at a signalised junction. The signal affords them preference in the junction, with timings to be determined by the junction dimensions and the details of signal control for the junction as a whole.
4.4.19
The most likely signal ahead arrangement for this method, as trialled at a site in Cambridge, is a fourth aspect on a standard signal head with a green cycle symbol. However, low-level cycle signals could open up different configurations of infrastructure to manage the early release. The consultation draft of TSRGD (2015) proposes a general authorisation for ‘cycle filter signals’ of this kind.

4.4.20
‘Hold the left turn’ signal arrangement

TfL is planning to trial an arrangement that involves separately signalling cyclists and left-turning vehicles. This requires some segregation of lanes, a dedicated left-turning lane for general traffic, space for inclusion of islands for signal infrastructure, and provision for right-turning cyclists. It has potential for locations where there is a moderate volume of left-turning traffic and a large cycle flow ahead and/or left. Some separation at the stop line may also be needed of left-turning and ahead cyclists, with potential for left-turners to bypass the signals or run with the left-turning general traffic.

4.4.21
Cycle gate

Not to be confused with early start, a ‘cycle gate’ is an alternative method of separating cycle and motorised traffic movements and signals. It could be applied where there is a large number of left-turning motorised vehicle movements, or ‘scissor movement’ conflicts, although it requires a substantial amount of space in terms of road width and depth of reservoir.

4.4.22

The cycle gate relies on there being two sets of signals and two stop lines for cyclists – the first acts as a ‘gate’ to allow cyclists into a ‘cycle reservoir’ ahead of general traffic to await a green light at the second stop line. The reservoir should not be marked in such a way as to make it appear like an ASL – for example, it should not have coloured surfacing or be marked with cycle symbols. Consideration for pedestrian waiting and crossing times also needs to be made, particularly in areas of high pedestrian flow.
4.4.23

Layout principles for cycle gate are as follows:

- The cycle lane/track on the approach must be physically segregated, at least 1.5m wide, preferably 2m, to allow for overtaking. It may have coloured surfacing, up to the first cycle stop line.
- The general traffic stop line should be positioned behind the advanced cycle stop line.
- The segregating strip should widen to allow clearance for mounting the traffic signal head. For a signal head mounted in front of a traffic signal pole, the segregating strip should be at least 1.3m.
- The distance from the first cycle stop line to the advanced stop line at the junction (the depth of the reservoir) should be at least 15m. This is to disassociate the two stop lines from each other and reduce the see-through issue between the two sets of traffic signals.

4.4.24

Signal layouts with dedicated cycle phases may also be considered. Typically this is appropriate where one or more arms of the junction allow access for cyclists only, but it may also be applied where cyclists are physically segregated from other traffic.

Managing conflict with left-turning traffic

4.4.25

Drivers turning left across cyclists moving ahead at junctions is one of the most hazardous collision types and a common cause of cyclist death and serious injury. Addressing the potential for this ‘left-hook’ conflict is essential not just for cycle routes but for design of all highways that cyclists use. At signal-controlled junctions, the above proposed methods of separately signalling cyclists and other traffic are all potential ways of addressing the conflict by seeking to remove it completely. A further technique for doing this is to ban the left turn for general traffic.
4.4.26
It is possible to reduce the risk to cyclists substantially at signal-controlled junctions by managing the conflict rather than by completely removing it. The best method is to calm traffic movement through the junction. In many cases, particularly on local streets, city streets, town square and city places, or in 20mph zones, improvements focused on controlling traffic speeds such as tightening of junction geometry and use of junction tables can allow cyclists and slow-moving motor vehicles to move through junctions comfortably and with reduced risk of conflict. In low-volume and low-speed traffic conditions, ASLs and feeder lanes can be of clear benefit to cyclists, allowing them the advantage of an advanced position at the junction itself.

4.4.27
Other scenarios, particularly those on street types with a higher movement function, will require more substantial intervention. A particular is posed by left-turn general traffic lanes and free-flowing entry and exit slip lanes for left turning vehicles. Reduction in vehicle speeds, particularly on the turning movements, may help, but it is also advisable to seek to reduce the distance where cyclists are vulnerable and move the point of potential conflict away from the junction itself.

4.4.28
The ideal solution is the removal of slip lanes by reconfiguring the junction, which can also release significant space for pedestrian and urban realm enhancements. Where removal of the slip lane is not feasible, measures to reduce vehicle speeds are recommended. If they must remain, the length of slip lanes could be minimised by reducing the taper to 1 in 3 for 30mph roads and 1 in 5 for 40mph roads.

4.4.29
Where it is not practical to reduce the taper adequately, then continuing the ahead cycle lane past the left-turn slip lane will require left-turning vehicles to cross the cycling facility. This can help deter vehicles from changing lanes at lower speeds and generally raise awareness of other road users, particularly if the cycle lane is marked prominently. Guidance set out in the section below on central feeders to ASLs should be followed. However, it is not an ideal solution and it is advisable to apply it only with caution, and where traffic volumes and speeds are not high.

4.4.30
Appropriate measures for managing the conflict at the point of crossover will depend on site-specific conditions such as available width, motor vehicle speeds and flows and mix of vehicles. Interventions that may be considered include ways of encouraging all road users to make an early and clear lane choice, avoiding last-minute manoeuvres. This may involve moving the point of conflict back from the junction. Use of smaller dashed markings (TSRGD diagram 1010), cycle symbols and coloured surfacing can all help to highlight the need for cycle priority at that point of conflict.
4.4.31

Where a slip road joins a main road, the cycle lane on the main road should, again, be continued through the conflict area and highlighted for other road users. Diagram 1003 give-way markings should be used on the nearside of the cycle lane, to require vehicles joining the main road to give way to cyclists and other vehicles on that road, while diagram 1010 markings should be used on the outside of the cycle lane, with diagram 1057 cycle symbols at 5m intervals. Coloured surfacing can also help to highlight the conflict area.

4.4.32

Light or island segregation (on the inside of the lane markings on the offside of the cycle lane, or replacing the lane marking) may be considered as a way of focusing the point of crossover, encouraging motorists to keep their distance from the cycle lane and adding to the subjective safety of cyclists.
4.4.33
Generally, island separation can be used to manage conflicts with left-turning vehicles, and could be applied to bespoke junction redesign in order to give protection to cyclists. Separation of this kind is likely to form the basis for future experimental layouts, in conjunction with innovative use of traffic signals. Any proposal using these methods should be regarded as a trial, and an important contribution to developing local and national standards and best practice for safer junction design.

Support for cyclists making right turns

4.4.34
Many of the above measures are focused on managing conflicts between ahead cyclists and left-turning motor vehicles. However, making right turns on a bicycle can be even more challenging. Crossing multiple lanes of traffic, in the same and the opposing direction, requires assertiveness. It would be of benefit to many cyclists if they could undertake right turns in a different, more comfortable way.

4.4.35
ASLs can help, by allowing a cyclist to position themselves in an appropriate turning position ahead of the traffic, but only if the cyclist arrives during a red phase. Where cycle lanes are segregated, consideration needs to be given to how cyclists can take up an appropriate position to turn right at a junction. Unless another mechanism for turning right is provided at the junction itself, then the segregation will need to end ahead of the ASL to allow cyclists to move into an appropriate position to make the turn.

4.4.36
When faced with a difficult right turn, many cyclists choose to make the turn in two stages on carriageway. This is an informal manoeuvre and not yet specifically encouraged by regulations, signage and lane markings, or the Highway Code. However, current off- and on-street trials in the UK are exploring how it could be used more formally, and supported through regulations.

Two-stage left-turn marking at junction in Stockholm (left); and cyclists in different streams in Copenhagen (right) – left turners are heading to the waiting area to the right
4.4.37

In a informal two-stage turn at a crossroads, a cyclist crosses one arm of the junction in an ahead movement, pulls into the left and stops next to the pedestrian crossing studs on the arm adjacent where they started.

They then turn through 90 degrees to face their exit arm and wait for the traffic signals to allow them a second ahead movement. In this way, they can stay on the nearside and avoid having to move across lanes of traffic in order to turn right.

Lanes marked through junctions can assist cyclists making two-stage right turns informally by giving them lines to wait behind in between the two stages of their turn.

4.4.38

This manoeuvre has a more formal status in some other countries, being the prescribed way to turn right at larger junctions in Denmark, for example. Road markings and surface colour are often used to mark waiting areas or lines to assist making the second stage of the turn – these are seen as supporting measures. Depending on the context, on junction geometry and on the visibility of signal heads from potential waiting areas, existing UK road markings could be adapted for this purpose. TfL is planning to trial a specific junction design that would enable a ‘formal’ two-stage right-turn.

4.4.39

One other option for turning right in two steps, as illustrated in LTN2/08, page 64, is the G-turn or ‘jug handle’ layout. It may be applied either at a signalised junction – in which case it tends to be designed with dropped kerbs, shared areas and toucan crossings to allow cyclists to make part of their right turn off-carriageway – or to make a right-turn off a main road at a priority junction by moving left into an inset waiting and turning area, or up onto a shared area.
Cycle bypass

4.4.40

In some locations, it may be possible to allow cyclists to bypass signals for general traffic (or to bypass other locations where motor vehicles have to stop). Typically this condition arises at T-junctions where an ahead cycle movement around a red light for general traffic does not give rise to any conflicting movements. Some physical segregation through the junction is advisable in this case. Care must be taken to manage pedestrian/cyclist interaction.

Contraflow cycle lane bypassing traffic signals

Cycle bypass of motor vehicle security checkpoint

Bypass to traffic signals for left-turning cyclists, Hills Road / Cherry Hinton Road, Cambridge

Banning selected vehicle movements

4.4.41

One option for dealing with conflicts that cannot be resolved in other ways is to ban turns for motorised vehicles. This can help in design of signal operation at the junction as well as removing a potential source of conflicting movements. Such a decision, however, should be taken in the light of a wider strategy for the road network around the junction in question. Banning a movement in one place could transfer that movement, and a risk to cyclist safety, to another location. The design should support the ban and be self-enforcing.
Lanes marked through junctions

4.4.42

As set out in section 4.3, marking cycle lanes through junctions in the direction of the cycle route can be beneficial to cyclists from the perspectives of directness, coherence and subjective safety. Depending on the arrangement of lanes and method of signal control, it is recommended that TSRGD diagram 1010 markings (or variant as necessary) should be considered at signal-controlled junctions. Although cyclists are not required to stay within the lane, this method is mostly likely to be of benefit where it is acceptable for cyclists to remain on the nearside for ahead as well as left-turning movements.

Lane markings and surface colour continued through junctions on Cycle Superhighways – short-dashed TSRGD diagram 1010 markings are shown in the image on the right and are recommended for use as lanes through junctions.

Use of coloured surfacing for cycling through junctions in Copenhagen

Coloured surfacing (without lane markings) used through a junction on a Cycle Superhighway
4.4.43
Danish practice includes marking a cycle route through a junction using coloured surfacing but without lane markings. Strips and patches of coloured surfacing through junctions have been employed on Cycle Superhighways in London. (Future use of this technique is subject to completion of a research study and a wayfinding strategy to support infrastructure delivered through the Mayor’s Vision for Cycling.)

Advanced Stop Lines

4.4.44
Where provision for cyclists is on-carriageway, signalised junctions should incorporate an advanced stop line (ASL) unless there are over-riding safety or operational reasons not to. ASLs and associated facilities can be used to give cyclists a degree of priority, and help to raise driver awareness of cyclists. Research has shown that ASLs have a zero or very low effect on junction capacity. All ASLs and their access need careful consideration at the design stage, taking into account the junction layout, traffic flows and movements.

ASLs help cyclists to: position themselves in drivers’ line of sight, avoid conflict with left-turning vehicles (when arriving on a red light), wait away from direct exhaust fumes, and enjoy a head start over motorised traffic. General design considerations for ASLs are summarised in figure 4.10.

<table>
<thead>
<tr>
<th>ASL depth</th>
<th>Recommended minimum 5.0m. The consultation draft of TSRGD (2015) proposes increasing the maximum to 7.5m. Authorisation from DfT may be sought for 5.0- to 7.5m-deep ASLs in the meantime (TfL has authorisation for this for TLRN and Cycle Superhighways). 7.5m ASLs are recommended for higher cycle flows.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coloured surfacing</td>
<td>While it is recommended that colour is used in locations of potential conflict, there is no legal requirement. Use of colour for the ASL box or lead-in lane depends on the policy of the relevant highway authority.</td>
</tr>
</tbody>
</table>
### Set-back from pedestrian crossing

1.7m to 3.0m between advanced stop line and pedestrian crossing studs. 1.7m is recommended for cycle routes as it has been shown: to improve compliance by motorised vehicles (except motorcycles), to lead to cyclists waiting in safer and more visible locations ahead of stationary traffic, to result in better ASL use and operation generally, and to allow for tighter geometry at the junction.

Swept path analysis must inform the choice: a greater set-back distance may be required to avoid encroachment from the swept path of large vehicles where there are no splitter islands. Alternatively, a part-width ASL may be appropriate.

### Entry to ASL

Lead-in lane is recommended, although gate entry is also possible.

The consultation draft of TSRGD (2015) proposes a change in regulations to permit cyclists to cross the first stop line at any point, meaning that lead-in lanes and gate entries will be optional from 2015.

The lead-in lane should be at least 1.5m, although 1.2m is preferable to no lead-in, depending on the likely level of encroachment by motorised vehicles. Lead-in lanes may benefit from colour and TSRGD diagram 1057 cycle symbols to discourage encroachment.

![Diagram from TSRGD consultation draft (2015), Table 69, Item 47, showing ASL without lead-in or gate entry.](image)

### Lead-in lane type

Can be mandatory or advisory, depending on:

- adjacent general traffic lane width – if below 3.0m, encroachment by motorised vehicles is likely and lead-in lane needs to be advisory
- flows of cyclists, motor vehicles and wider vehicles – higher cycle flows may be used to justify a wide, mandatory cycle lane, while high flows of wider vehicles mean that wider general traffic lanes are likely to be needed
- the need for consistency of provision on a given cycle route

### Lead-in lane length

Ideally as long as the maximum general traffic queue length during peak periods. Some protection (for example light segregation) may be warranted for lead-in lanes.

### Adjacent general traffic lane width

Minimum 2.5m, and no less than 3.0m where buses and HGVs use the lane. For high frequency bus routes, combined width of the lead-in lane and adjacent general traffic lane should be at least 4.5m. Consideration should be given to lane width reallocation to achieve a lead-in lane.

### Longitudinal lines (edges of ASL box)

The solid longitudinal lines that bound the ASL box on either side must be provided, unless that part of the carriageway is delineated by a raised kerb. In practice, this is usually the case for the nearside and relates to the offside where there is an island.
Chapter 4 – Junctions and crossings

4.4.46

In relation to lane types, a balance needs to be struck between the added protection and subjective safety that a mandatory lane is able to offer over an advisory lane, and the greater flexibility in width that an advisory lane gives because allowance can be made for it to be over-run. For example, a 1.5m mandatory lead-in lane next to a 3.0m traffic lane may, in some circumstances, be preferable to a 2.0m advisory lead-in lane next to a 2.5m general traffic lane, given that the cycle lane in the latter is very likely to be entered by larger vehicles.

Illustrative layouts 4/08a and 4/08b: Nearside advisory lead-in lanes to ASL (adjacent to one and two general traffic lanes)

4.4.47

Gate entry

Provision of 1.0m-wide ‘gate’ entry to an ASL, using the TSRGD diagram 1001.2A road marking, is an option that allows legal entry for cyclists to the reservoir where a lead-in lane cannot reasonably be provided. In all cases, a lead-in lane is preferable; gates represent a lower level of service. Nearside gate entry was permitted in amendments to TSRGD in 2011. Offside gate entry requires site-specific authorisation from DfT.
4.4.48

Shared nearside lane with gate entry
Where there is left-turning motor traffic and a gate entry instead of a lead-in lane, cyclists should be encouraged to adopt a primary cycling position for the ahead movement. On Cycle Superhighways, one option to help promote this is to use full-width coloured surfacing in the nearside lane, giving an indication to motor vehicle drivers that they are entering a space intended for cycling when they make their left turn.

4.4.49

On Cycle Superhighway pilot routes, use of this method showed no negative effect on conflicts and an increase in the separation distance between motor vehicles and cyclists, compared with a non-treated equivalent. This option may be particularly useful where straight ahead movements from the nearside lane are restricted (eg to buses and/or cyclists only) and there are high proportions of left-turning motor vehicles. In this situation, signing to Diagram 877 (see Chapter 6) should be provided to permit specified road users to proceed ahead at the junction.
4.4.50

Central or offside lead-in lane

Another option to reduce the risk from left-turning motor vehicles is a centrally located or offside ASL lead-in lane. Central feed-in lanes should be at least 2.0m in width. Where traffic is expected to be fast-moving, cyclists will need a safe way of reaching the cycle lane in the middle of the road, ideally via continuation of a cycle lane projected from the start of a left turn flare. The lane should not be so long between two general traffic lanes that cyclists are encouraged to join them where other traffic is fast-moving, accelerating and/or weaving. One option may be to use mandatory lane markings for this lead-in lane with a short section of broken lane in advance of the junction, thereby encouraging drivers to cross in a predictable location.

Illustrative layout 4/10: Central lead-in lane to ASL

Central lead-in at signalised junction (left). Long central lead-in to allow for left-turn flare, positioned to facilitate overtaking stopped buses (right).

Offside protection on central lead-in (left). Offside lead-in lane (right)
4.4.51
Consideration may also be given to protecting cyclists from other traffic changing lanes, or from the tendency for other traffic not to remain within lane markings around a bend. Small sections of segregating strips (preferably with battered kerb upstands) may, for example, be introduced on the off-side of a cycle lane.

4.4.52
**Part-width ASLs**
In some situations, part-width ASL reservoirs, not covering the full width of all the approach lanes, may be appropriate. They tend to be better observed by motorists than full-width ASLs. This includes junctions where:

- right turns are not permitted (for cyclists or all vehicles)
- there are multiple right-turning lanes
- tracking of vehicle movements into the arm of the junction shows that they would encroach on the ASL reservoir if it were full-width
- a nearside lane is controlled with a left-turn filter signal

4.4.53
General authorisation for part-width ASLs, raised in *Signing The Way* (2011), has been proposed in the consultation draft of TSRGD (2015).
4.4.54

Split ASLs are possible on a single junction arm where movements are separately signalled and where lanes are physically separated by an island.

4.4.55

Where there are multiple traffic lanes, there may be a case for marking recommended positioning for different cyclist movements through use of a split ASL with a dividing line and direction arrows for cyclists.

A good example would be where there is a left filter movement for general traffic that precedes the ahead movement, and where it would appropriate to indicate specific suitable places to wait for cyclists undertaking different movements. Site-specific or authority-wide authorisation may be sought for this technique.

4.4.56

The consultation draft of TSRGD (2015) proposes that ASLs will be prescribed for use at stand-alone signalised crossings as well as signalised junctions. Until the regulations come into force, site-specific authorisation will continue to be required for this use.

4.4.57

At junctions with ASLs, **blind-spot safety mirrors** mounted on signal poles can help give motorists a better view of cyclists in a lead-in lane on their nearside and in the ASL box. Blanket authorisation for their use was notified by DfT to local authorities in England in February 2012 and is confirmed in the consultation draft of TSRGD (2015).
4.4.58

However, there is currently little evidence of the safety benefits of blind spot safety mirrors and trials of their effectiveness have been inconclusive. There is, therefore, no general requirement for safety mirrors on every signal-controlled junction with an ASL but they should be considered on a case-by-case basis.

4.4.59

Any decision to include blind-spot safety mirrors should be taken by the highway authority, as they are regarded as signage rather than traffic signal equipment. However, since they are mounted on signal poles, their installation will need to be considered and assessed by TfL Asset Management Directorate in a similar way to any other signal equipment – see section 2.5 for guidance on these procedures. A risk assessment approach should also be made, with mirrors being most appropriate at junctions with both ahead and left-turn movements and where there are high cycle and HGV flows.

4.4.60

To achieve the optimum position, and reduce the risk of tampering and vandalism, mirrors will usually be mounted on the nearside primary signal pole, between 2.4 and 2.5m clearance above footway level. Ongoing maintenance costs must be considered by the scheme sponsor.

Bus lanes at signal controlled junctions

4.4.60

Some benefits for cyclists can be achieved by continuing bus lanes up to the stop line at a junction. This can only be done where there is no left turn for general traffic (unless the bus lane is separately signalled). This is subject to traffic and safety considerations, including impacts arising from ahead traffic moving left to pass vehicles waiting to turn right within the junction.

4.4.61

There may be situations with a bus lane on the approach where an ASL is not desirable, such as at an intermediate stop line in a multi-junction layout. On the exit from a junction, a bus lane can re-commence immediately by providing diagram 1010 markings rather than a taper to give cyclists more protection and deter ‘squeezing’ by merging of non-bus lane traffic. (Traffic Signs Manual figure 17-1 refers).
4.5 Roundabouts and gyratories

4.5.1 Roundabouts and gyratories are rarely comfortable facilities for cyclists to use. It is essential to understand cyclists’ desire lines and manoeuvres in order to provide for their safety. At many roundabouts, the geometry creates difficulties for cyclists by not sufficiently reducing motor vehicle speeds. On the other hand, however, the ability to keep moving through the junction with no loss of momentum makes some types of roundabout, when well designed, potentially more appealing to cyclists under some circumstances than signal-controlled junctions.

4.5.2 The ranges of roundabout types, their locations and usage are wide in the UK, and will have varying effects on cycling. The size of a roundabout, and the volumes and speeds of motorised traffic they accommodate, has an impact on the subjective safety of vulnerable road users. Pedestrians also suffer where they are required to undertake circuitous and often hazardous routes to negotiate a large roundabout. Types are defined in DMRB TD16/07 (2007), as follows:

**Normal** – a roundabout with a kerbed central island at least 4m in diameter, usually with flared entries and exits. Small versions have a single-lane circulatory carriageway. Larger versions can have multiple lanes, or enough width on the circulatory carriageway and on the arms to accommodate two or three vehicles alongside one another.

**Compact** – a roundabout having a central island, with single-lane entries and exits, and with a circulatory carriageway that does not allow two cars to pass one another.

**Mini** – a type that has a domed or flush circular solid white road marking of between 1m and 4m in diameter instead of a central island.

**Signalised** – a roundabout having traffic signals on one or more of the approaches and at the corresponding point on the circulatory carriageway itself. Design guidance for signalised roundabouts is provided in DMRB TD50/04 (2004).

**Double** – a junction comprising two roundabouts (normal, compact or mini) connected by a short link and designed as a single system rather than two separate roundabouts.

As a rule, the larger the roundabout, the greater the problems for cyclists. On cycle routes, large roundabouts should be considered for conversion to a signalised junction or to a more cycle-friendly roundabout type: a compact or a protected roundabout.
4.5.3

Most accidents involving cyclists arise from vehicles entering the roundabout and colliding with cyclists who are on the circulatory carriageway. Interventions that can reduce risks to cyclists include:

- controlling entry, circulatory and exit speeds
- reallocating unused carriageway space, such as reducing approach lanes, ideally to one
- providing an alternative route or by-pass for cyclists that does not result in additional delay
- raising driver awareness of cyclists
- giving cyclists clear, unobstructed passage up to, through, and leaving the roundabout
- managing traffic and conflicting manoeuvres through the use of signals
- reducing motorised traffic volumes
- reducing excessive visibility

Normal and signalised roundabouts

4.5.4

Normal roundabouts with single approach lanes and low flows will normally be satisfactory for cyclists as long as the geometry is ‘tight’. Large conventional roundabouts pose greater problems for cyclists.

4.5.5

One intervention that has been shown to have safety benefits is to signalise the roundabout. A study of before and after collision data of 28 roundabouts that had signals installed found a statistically significant decrease in the number of collisions involving cyclists (J. Kennedy and B. Sexton, Literature review of road safety at traffic signals and signalised crossings, TRL, PPR 436, 2009). This report also cites a TfL study from 2003 of ten at-grade and ten grade-separated junctions, finding significant safety benefits for cyclists from signalisation for the at-grade types (F. Martin, An analysis of accidents at roundabouts ‘before’ and ‘after’ signal implementation, London Accident Analysis Unit, 2003).

4.5.6

It is likely, however, that the effect of large roundabouts in deterring most cyclists outweighs the benefits that signalisation provides. Where roundabouts are signalised, ASLs can be introduced at signals on the entry lanes and even on the circulatory carriageway. Cycle early start or cycle gates could also be considered.
4.5.7

The greatest degree of separation that could be implemented would be to remove cyclists from the circulatory lane of the roundabout altogether, which may be appropriate if the total junction flows exceed about 25,000 vehicles per day. This could be done by separating cyclists on each entry arm, leading them off-carriageway to cross other arms on parallel pedestrian/cycle or toucan crossings. In this instance, the impact on directness and coherence of cycling facilities and on the potential for pedestrian-cyclist conflict needs to be balanced with the safety benefits of removing cyclists from the carriageway.

4.5.8

Other ways to reduce the risks to cyclists include:

- Minimise the number and width of entry and circulatory lanes. More than one entry lane greatly increases the number of potential conflicts involving cyclists at the roundabout. Single lane approach and exit widths of between 4.0m and 5.0m, and single lane circulatory carriageways of between 5.0m and 7.0m are desirable.
- Reduce circulatory speeds by introducing over-run strips around the central island of the roundabout, thereby reducing the width of the circulating carriageway.
- Minimise entry and exit flares (between 20° and 60°). Generally, aim to provide arms that are perpendicular, rather than tangential to the roundabout.
- Provide entry deflection to the left on entering the roundabout.
- Provide islands to segregate cyclists at entry/exit and greater deflection for motorised vehicles.
- Remove unused carriageway space and increase size of deflector islands while ensuring pinch-points for cyclists are not created.
- Provide spiral lane markings for general traffic to improve lane discipline.
- Put the whole junction on a speed table, which can help reduce speed on entry and exit, but is unlikely to make a difference to speed on the circulatory carriageway.

4.5.9

As described in DMRB TD50/04, signalised roundabouts vary significantly: some or all of the arms may be signalised; the signals may be on the external approaches only, or on both external approaches and on the circulatory carriageway; and the signals may operate full-time or part-time. Taken together with differences in numbers of arms and lanes, there are therefore many permutations governing how they operate. Whether they provide good facilities for cyclists tends to depend on the detail of how potential conflicts have been managed.
Mini-Roundabouts

4.5.10
Mini-roundabouts are not recommended for inclusion on cycle routes. The main problems they raise are failure of vehicles to observe give way due to their geometry and failure to reduce speed through the junction. Where they exist, they should be considered for replacement where they have more than one entry lane and/or where there is an angle approaching 180 degrees between the entry and exit arms (and therefore little horizontal deflection).

4.5.11
Interventions that could improve existing mini-roundabouts for cycling include:

- minimising entry and circulatory widths and speeds
- altering geometry to create greater deflection angles
- making it impossible for vehicles to overtake within the roundabout circulatory area
- reducing single lane carriageway to a maximum width of 5m
- raising the central island to 4m diameter to slow general traffic
- incorporating a speed table to reduce speeds on entry and exit
- incorporating additional deflector islands for motor traffic (and considering omission of ‘keep left’ bollards from those islands wherever possible, as these can impair the visibility of turning motor vehicles and their indicator lights – such a proposal should be subject to a risk assessment).

Compact and continental roundabouts

4.5.12
These two types of roundabout are described, respectively, in DMRB TD16/07 (2007) and in TAL 9/97, Cyclists at roundabouts: continental design geometry (1997). They can be useful in addressing cycle and pedestrian safety issues because they reduce motor vehicle speeds significantly and they prevent weaving and overtaking on the circulatory carriageway, making it easier for cyclists to adopt the primary riding position around the roundabout.

Compact roundabout in UK with overrun strip

‘Continental’ roundabout in Lund, Sweden
4.5.13
As outlined in TAL 9/97, 'continental' roundabouts, which may be suitable for flows of between 5,000 and 20,000 vehicles per day, are likely to have a positive impact on cyclists' safety and comfort because:

- their tighter geometries encourage all vehicles to take the junction more slowly
- they provide only one lane on entry and exit on every arm
- the central island is larger relative to the overall size of the junction when compared to a 'conventional' roundabout, meaning that the entry path curvature of circulating vehicles is increased (they are deviated more and therefore cannot take the roundabout at higher speeds)
- they are recommended for use in lower speed, lower traffic volume contexts.

They are also advantageous for pedestrians because the tighter geometry allows for pedestrian crossings on desire lines much closer to the entry to the roundabout than would be the case for conventional roundabouts.

4.5.14
International best practice shows that roundabouts of this type may also be appropriate in situations where cycle flows are heavy (cyclists comprising a very high proportion of all traffic). This has been seen to be reinforced in some instances by prominent use of the cycle symbol on the circulatory carriageway.

4.5.15
Compact roundabouts, as described in DMRB, are similar to 'continental' types, having single-lane entries and exits, but are tighter still. They are described as being suitable for roads of 40mph or below, with up to 8,000 vehicles per day. Importantly, the width of the circulatory carriageway is such that motor vehicles cannot overtake each other. Entries and exits should be tight, without flares, and the central island may need an overrun area to account for the movements of larger vehicles. The Irish National Cycle Manual shows a similar model, the ‘Shared Roundabout’, with cycle symbols on the circulatory carriageway, but suggests that the maximum traffic flow for such a facility ought to be 6,000 vehicles per day. Roundabout types and attributed are summarised in figure 4.10.
Figure 4.10 Comparison of roundabout types

<table>
<thead>
<tr>
<th>Roundabout type</th>
<th>Design feature</th>
<th>Normal (TAL 9/97)</th>
<th>Compact (TD16/07)</th>
<th>Mini</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approach arms</td>
<td>Ideally perpendicular but can be skewed</td>
<td>Perpendicular</td>
<td>Perpendicular</td>
<td>Preferably perpendicular but can be skewed</td>
</tr>
<tr>
<td>Entry width</td>
<td>Add one lane to entries</td>
<td>One lane, usually 4m</td>
<td>One lane, usually 4m</td>
<td>Variable</td>
</tr>
<tr>
<td>Entry radius</td>
<td>20m, 6m minimum</td>
<td>Not specified but about 10m</td>
<td>Not specified but about 10m</td>
<td>Not specified</td>
</tr>
<tr>
<td>Entry angle</td>
<td>Preferably 20° to 60°</td>
<td>Approx 30° to 45°</td>
<td>Preferably 20° to 60°</td>
<td>Deflection desirable</td>
</tr>
<tr>
<td>Entry path curvature</td>
<td>Not to exceed 100m</td>
<td>Not to exceed 100m</td>
<td>Not to exceed 70m</td>
<td></td>
</tr>
<tr>
<td>Exit arms</td>
<td>Easy exits</td>
<td>Tight perpendicular exits</td>
<td>Tight perpendicular exits</td>
<td>Not specified</td>
</tr>
<tr>
<td>Exit radius</td>
<td>40m desirable, 20m minimum</td>
<td>Approx 10m</td>
<td>Approx 10m</td>
<td>Not specified/max 5m</td>
</tr>
<tr>
<td>Exit width</td>
<td>Add extra lane</td>
<td>Single lane 4-5m</td>
<td>Single lane 4-5m</td>
<td>Not specified</td>
</tr>
<tr>
<td>External diameter ICD</td>
<td>28-100m</td>
<td>25-35m</td>
<td>28-36m</td>
<td>Dependent on movements</td>
</tr>
<tr>
<td>Island diameter</td>
<td>Min 4m</td>
<td>16-25m</td>
<td>4-18m (including overrun area)</td>
<td>1-4m</td>
</tr>
<tr>
<td>Circulatory carriageway</td>
<td>1-1.2 times entry width</td>
<td>Single lane 5-7m</td>
<td>Single lane &lt; 6m</td>
<td>5-7m</td>
</tr>
</tbody>
</table>

Roundabouts with annular cycle lanes

4.5.16
Cycle lanes around the periphery of roundabouts have been used in both the UK and other European countries. They work well where drivers are accustomed to giving way when turning, but are more challenging to design in countries without that cycling culture. They may generate more problems for cyclists unless the lanes are particularly wide and the main problems of vehicle speed and flow are tackled.

Roundabout with annular cycle lane in Utrecht (sharks’ teeth markings mean ‘give way’)
4.5.17
Instructing all vehicles to give way on entry to cyclists in the annular lane in the UK could be achieved through diagram 1003 and diagram 1023 ‘give way’ road markings but this still requires good driver behaviour.

4.5.18
Motorists are not accustomed to giving way on exit to others on circulatory lanes. Use of intermittent segregating islands at key points of conflict can help protect circulating cyclists from collision with motor vehicles seeking to exit.

4.5.19
Increasing the degree of separation of cyclists on roundabouts could be achieved through the use of more infrastructure, effectively creating segregated lanes around the roundabout itself. This leaves the problem of circulating cyclist priority over vehicles entering and exiting from the arms of the roundabout – a similar problem to the generic issue of lane or track priority across side roads (see section 3.5). Marking parallel cycle and pedestrian crossings across each arm in such a way that the cycle crossing aligns with the annular cycle lane is one way of addressing this issue. This will be available when the revised TSRGD comes into operation in 2015 (see section 4.2).

‘Dutch style’ roundabouts with segregated cycle lanes

4.5.20
Distinct from the UK definition of ‘continental’ roundabout geometry, this roundabout is a type where cyclists are segregated from other road users with orbital cycle tracks. ‘Dutch style’ roundabouts of this sort typically have one general traffic lane with parallel cycle and pedestrian crossings on each arm, close to the roundabout itself, to minimise deviation of pedestrians from desire lines. Where these roundabouts are used in urban areas in the Netherlands, motor vehicles entering or exiting the roundabout are required to give way to both pedestrians and cyclists. The geometry is arranged such that motor vehicles leaving the roundabout approach the crossings at close to 90 degrees to maximise inter-visibility.

4.5.21
A ‘Dutch style’ roundabout is being trialled off-street by TfL, with results available later in 2014. The focus of the trial is on functionality and safety – ensuring that all users understand and use the roundabout in the way that is intended, particularly the various requirements to give way.
Informal roundabouts

4.5.21
Traffic management or speed reduction features that look like roundabouts but without formal road markings or signage are occasionally used where there is a benefit in encouraging vehicles to act as if there were a roundabout present. These are a flexible alternative to priority junctions and are sometimes used as part of a wider shared space-type approach. There are no set dimensions for such a feature, and they allow for more creative uses of materials and colour.

4.5.22
Where there is little traffic present, vehicles can progress through the 'roundabout' as they would at any priority junction. Where traffic is slightly heavier, vehicles are encouraged by the appearance of the feature to act as if it were a roundabout and give way to the right.

4.5.23
Informal roundabouts can be advantageous to cyclists, allowing them to progress through a junction without having to stop and start, and generally encouraging lower speeds.
Gyratories and one-way systems

4.5.24
Gyratories in London vary from area-wide one-way systems to large, ‘roundabout-type’ junctions. This variation in types means that each needs looking at on its own merits, as part of a wider network management approach. It is essential that an area-wide analysis takes place and that all opportunities for improvements of the local area and for better pedestrian accessibility are taken into account. The Junction Assessment Tool (see chapter 2) can assist in analysing cycle movements through various junctions that may form part of a gyratory.

4.5.25
For cycling, the issues that gyratories and one-way systems present generally include the following:

- motor traffic speed and volume, and close proximity to fast-moving traffic and/or large vehicles
- lack of directness
- lack of legibility
- the need to move across lanes of moving traffic to get into the appropriate road position (the confidence to take the primary road position as necessary)

4.5.26
Gyratory removal and a return to two-way working is an option that can help address the above issues. It is more intuitive, likely to be lower speed, almost always leads to more direct journeys and can enliven and ‘humanise’ streets that previously were blighted by fast-moving bursts of one-way traffic, helping to foster a more diverse range of active street and land uses. However, gyratory removal should not be an end in itself. The focus of any gyratory redesign should be on enabling more direct journeys with less delay, particularly for pedestrians and cyclists, and on allowing more ‘conventional’ approaches to be taken to cycling provision and to management of motor traffic speed and volume. This may only entail part-removal or partial remodelling of a gyratory or one-way system.

4.5.27
Other selected interventions can also be made to improve conditions for cyclists. Taking a filtered permeability approach and allowing cyclists to make movements that are banned for other vehicles, together with opening up one-way sections to contraflow cycling, are of obvious benefit for cyclists from a coherence and directness perspective. However, care needs to be taken to avoid putting cyclists into conflict with fast-moving opposing traffic. A higher degree of separation, such as use of full or light segregation, might be appropriate in such cases.
4.5.28
Where one-way systems are likely to remain, and where space is available, an opportunity exists to run cyclists in contraflow around much of the system. This can constitute a high level of service, provided each junction within the system is designed so as to minimise conflicts and delays for cyclists. It can help in avoiding issues related to integration with bus infrastructure.