# 9

# chapter 9 Priority Junctions

# 9.1 Introduction

Priority junctions are the most common form of junction arrangement. They require one or more minor roads to yield (or stop) for the major road traffic flow. A high proportion of accidents occur at these locations and therefore it is important that they are well designed and secure to ensure the safe interchange of conflicting traffic flows with the minimum of delay to all road users.

While priority junctions can be cost effective in terms of land take and on-going maintenance costs, they may not be as good as other junctions at accommodating access to and from areas which generate large numbers of traffic movements.

TD 42/95[1] Geometric design of major/minor priority junctions together with NRA addendum, provides comprehensive advice on the layout and provision of priority junctions on national routes. Some of this advice is not applicable in urban areas where a higher level of pedestrian and cycling activity occurs, speeds are lower and site constraints are generally more onerous. This chapter concentrates on urban area issues and indicates radii and road widths appropriate to such areas. Further guidance on the design of residential roads is provided in Section A, Chapter 1.8.

The main options available to the designer for new priority junction arrangements are:

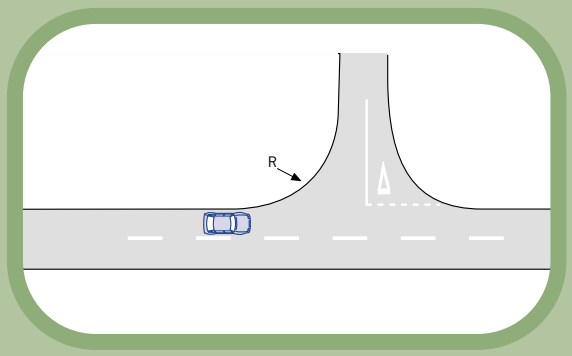
**'T' Junctions**

A simple 'T' junction layout is shown in Diagram 9.1 and a more complex layout is shown in Diagram 9.3. The most appropriate form of junction depends on the traffic flow volumes on the major and minor roads in the design year.

**Staggered junctions**

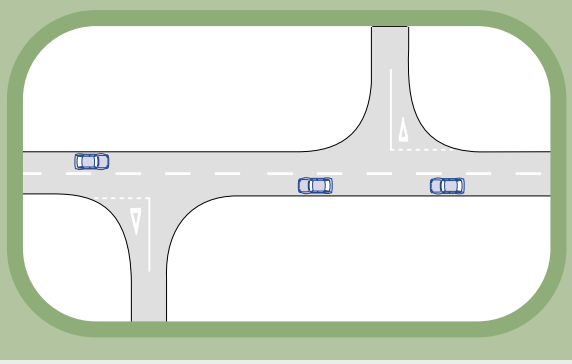
A typical staggered junction layout is shown in Diagram 9.2. Staggered junctions involve offsetting the minor road arms at the junction. This minimises the number of conflicting traffic movements. A right-left stagger is the preferred orientation for the minor roads because it better caters for right turning movements both into and out of the minor roads.
Crossroads layouts are no longer recommended for priority junctions on Primary and District Distributor roads because of the number of conflicting vehicle movements that they create.

Diagram 9.1 'T' Junction




In an urban area, radii are typically 4 to 6m (with a maximum of 10m)

Diagram 9.2 Staggered Junction (right-left)



A crossroads layout can lead to a higher number of accidents than for other layouts. However it can be appropriate in low speed, low volume environments eg residential cells.

## 9.2 Type of junction and typical layouts

This section gives advice on the most appropriate type of priority junction and illustrates some typical layouts. Whilst standard layouts are useful on new roads it is often difficult to achieve ideal layouts on existing roads in urban areas and compromises may need to be made. TD42/95[1] and NRA addendum gives examples of different layouts. The 'T' and staggered junctions have a number of variations depending on the main road layout.

- Simple layouts without any local widening for turning lanes, see Diagram 9.1
- Ghost island layouts which include provision for right turning vehicles, see Diagram 9.3
- Dual carriageway layouts which include single lane dualing (which is normally used at rural locations only) and dualing with two or more lanes, see Diagram 9.4

The most appropriate type of junction depends on the intended traffic flow volumes on the major and minor roads in the design year and the requirements of vulnerable road users. Diagram 8.1, Chapter 8 gives approximate levels of provision for various major and minor road flows.

In urban areas simple 'T' junctions are the most common arrangement for priority junctions. They often operate at traffic levels well above those recommended in Diagram 8.1.

The provision of ghost island layouts at such locations can bring a number of benefits:

- reduced delays
- reduced accidents associated with right turns and nose-to-tail (shunts) collisions
- opportunities for the provision of islands in the hatched areas to assist pedestrians crossing a road

Disbenefits of traffic islands include

- reduction of the effective road layout width (loss of space for bus or cycle facilities in many cases

Diagram 9.3 Ghost island layout on main road

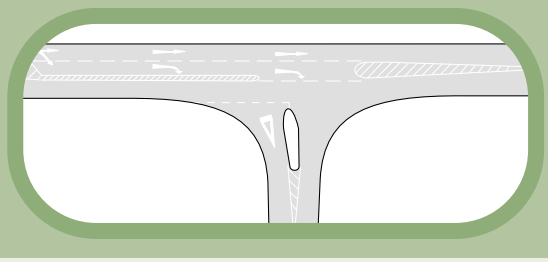
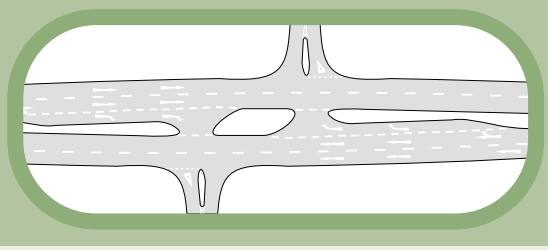


Diagram 9.4 Dual two lane with right/left stagger (for Primary or District Distributor roads only)



- creation of pinch point for cyclists
- potential hazard if isolated and not repeated along a road
- requirement for separate electrical supply for internal lighting

Consideration should be given to upgrading simple junctions to ghost island layouts on Primary and District Distributor roads. However this would not apply to Access roads.

## 9.3 Design principles

The principles of junction design are contained in TD 42/95 – Geometric Design of Major/Minor Priority Junctions1 and NRA addendum.

Priority junctions should be designed and constructed to ensure that:

- delays for main road traffic are minimised
- minor road traffic does not experience significant delays
- the safety of all road users is considered and a layout that operates as safely as practically possible is achieved
- good provision is made for all road users with particular emphasis on vulnerable road users such as pedestrians, cyclists and people with mobility impairments
- drivers are discouraged from overtaking near the junction
- parking and loading is precluded within the sight triangle of the junction

### Siting

Priority junctions should not be sited:

- on or near bends (except on low speed residential roads with little turning traffic). Problems with visibility for vehicles on the minor road can occur at a junction sited on the inside of a bend
- on crests where the layout may be difficult for drivers to judge when approaching the junction on the main road
- when a minor road approaches a junction on a gradient greater than 2%. This can lead to drivers failing to perceive the junction correctly (uphill) or overshooting the yield markings (downhill). In such circumstances a level section, at least 15m in length, should be created at the junction.

### Design speed

The design speed for a junction is based on the measured 85 percentile speed of traffic on the major road. For new roads this will have to be estimated and advice on this is given in NRA TD9/002 Road link design and NRA TA 43/002 Guidance on road link design and NRA addendum.

### Right turning movements

Right turns are the most difficult movement to cater for at priority junctions because they have to cross opposing traffic streams. Vehicles waiting to turn right can cause significant delays for other traffic at a priority junction. As the majority of accidents at priority junctions on primary or district distributor roads involve right turning movements, therefore right turn movements should be well provided for in the design. On single carriageways the provision of a ghost island layout is the best way to cater for right turns (see Diagram 9.3). On dual carriageways, a break in the central reservation together with a turning lane is required (see Diagram 9.4). The turning lanes require detailed design based on the speed of traffic and gradient on the major road. On Local Collector and Access Roads dedicated right turn facilities are not required.

### Merging and diverging lanes

Merging and diverging lanes are only used in an Urban area on Primary Distributor roads. Merging lanes are useful to assist left turning vehicles to join high speed dual carriageways. Vehicles on the major roads can change lane to facilitate access for merging vehicles.

**Merging lanes should not be used on single carriageways because major road vehicles cannot change lanes to allow joining vehicles easier access.**

Diverging lanes can offer advantages when there are high volumes of vehicles turning left from the major road. They should not be introduced without providing for cyclists and pedestrians in urban areas. On single carriageways turning vehicles in the diverging lane can mask minor road drivers' views of other traffic when they are waiting at the yield markings.

## Traffic signs and road markings

In urban areas there are many priority junctions but not all of them require signing (direction or warning). However, key junctions where there are routes to specific destinations or services will require signing. Direction signs should be provided in advance of these junctions to ensure that road users are made aware of the proximity of a junction as they approach it. Advance direction and warning signs in advance of the junction should only be provided at priority junctions in urban areas where there are particular needs. These could include junctions with substantial turning traffic volumes, accident problems involving turning vehicles or inadequate advance visibility of the junction. All signs should be of a sufficient size to be read by drivers and larger signs are required on roads with higher traffic speeds. Warning signs and advance direction signs should be located within a prescribed distance of the junction in relation to the speed of approaching traffic. This will allow drivers to react to the signs and slow down or stop if necessary.

The signs should also be clearly visible to approaching drivers. Care should be taken to ensure that signs are not positioned at locations where they may be obscured by foliage from trees/bushes or by structures. The signs themselves should not obscure visibility for other road users.

'Yield' signs and markings control the majority of priority junctions. Stop signs and markings can be used at priority junctions when visibility from the minor road is restricted.

Detailed advice on the provision of signs and road markings is given in the Traffic Signs Manual.[3]

## Lighting

Road lighting is intended to illuminate the road surface brightly and evenly. Vehicles and people are silhouetted against the road surface so that they can be easily distinguished. Junctions should be well lit in urban areas so that drivers can see the layout of the junction and other road users such as pedestrians who may be crossing the road or waiting to cross. The lighting columns should be positioned at the back of footways so that they do not obstruct the passage of pedestrians and to minimise the risk of their being hit by vehicles. High pressure sodium lighting is preferred to low pressure sodium lighting as it provides a better quality of light and illumination for road users.

## Lane widths for Primary Distributor roads in Urban areas

Lane widths need to be adequate to cope with the volume and type of vehicles likely to use them. Table 9.1 recommends desirable and minimum widths for lanes on Primary Distributor roads at priority junctions in urban areas. When converting (or improving) existing urban simple junctions to a ghost island layout there may be constraints on the lane widths that can be achieved. The provision of turning lanes even with the minimum width will still produce significant benefits in a number of circumstances, for example where:

- the volume of trucks and buses is low (5% or less)
- speeds are low (85% speeds are less than 30mph)
- there is a need to provide islands for pedestrian crossing movements

The widths in Table 9.1 do not include provision of hard strips and cycle lanes. Widening of the lanes may be required on bends with radii of 100m or less.

## Lane widths for district distributor, local collector and access roads in urban areas

Lower vehicle speeds are required on these categories of roads. Lane widths greater than the widths recommended in table 9.2 will increase speeds and will reduce capacity and/or safety, and are therefore undesirable.

## Visibility

Good visibility is essential at junctions to ensure that road users can complete their movements safely and so that vehicles can slow down or stop if traffic conditions require.

**Visibility from the minor road**

As drivers on the minor road approach the yield or stop lines they should have adequate visibility of traffic on the major road to both their left and right. Diagram 9.5 and Table 9.4 summarise the required visibility splays based on the approach speed of traffic on the major road. This visibility should be available from a set distance back along the centre line of the minor road the 'x' distance and forms a visibility splay, with the 'y' distance along the major road.

**For urban areas, an 'x' distance of 4.5m or greater should be provided. This may be reduced to 2.4m in exceptional circumstances.**

If it is not possible to achieve these distances then an alternative access position should be considered (for new junctions) or measures to reduce the approach speed of the major road traffic should be implemented.

**Forward visibility on the major road**

Drivers approaching the junction on the major road need to be able to see the junction in order to be aware of traffic entering from the minor road and to be able to slow down and safely stop, if required. The junction and its approaches should be clearly visible from a distance equivalent to the 'y' distance in Table 9.4 for the approach speed of traffic. This is known as the stopping site distance and detailed advice on this is given in NRA TD9/002 and NRA addendum. If it is not possible to achieve the required distance then an alternative access position should be considered (for new junctions) or measures to reduce the approach speeds should be implemented.

## Corner kerb radii

It is important that the swept paths of the longest vehicles likely to use the junction can be catered for. This requires the provision of adequate kerb radii on the corners of the junction. Swept paths can be tested on junction layouts using either proprietary computer software or by using templates for different vehicles with a variety of turning radii and angles.

Table 9.1 Typical lane widths for single carriageways (Primary Distributor roads)

| TYPE OF LANE | DESIRABLE WIDTH (m) | MINIMUM WIDTH (m) |
|---|---|---|
| Through lane | 3.65 | 3 |
| Right turn lane | 3.5 | 2.5 |
| Bus lane | 3.5 | 3.0 |

Kerb to Kerb width should be a minimum of 7.0m (See cycle manual regarding provision of cycle facilities)

Table 9.2 Typical lane widths for District Distributors and Local Collector roads

| TYPE OF LANE | DESIRABLE WIDTH (m) | MINIMUM WIDTH (m) |
|---|---|---|
| Through lane | 3.0 | 3.0 |
| Right turn lane (District Distributor only) | 2.5 | 2.5 |
| Bus lane | 3.0 | 2.8 at pinch point |
| Cycle lane (See cycle manual) | 1.8 | |

Kerb to Kerb width should be a minimum of 6.5m

Table 9.3 Access Roads

Kerb to kerb width (excluding any inset parking) should generally be a maximum of 5m.

In an urban context, side road junction mouths should be as compact as possible - this reduces pedestrian crossing times, assists cyclists, and discourages inappropriate vehicle turning speeds. However, on primary and district distributor roads, these swept paths should generally be catered for without requiring long vehicles to overrun into other traffic lanes. This may require the provision of a taper (local widening at the corner, see Diagram 9.6) which also helps to avoid the rear wheels of long vehicles encroaching onto footways.

On local roads with few long vehicle movements it is acceptable to cater for their swept paths by allowing occasional overrunning of other vehicle lanes providing that there is adequate visibility. Such movements should not cause significant problems if long vehicle movements are infrequent. This allows the kerb radii to be reduced in areas where there are likely to be pedestrian movements. This also helps to reduce vehicle speeds and the distance to walk across the bellmouth of the junction. Care needs to be taken to ensure that the reduction in corner radii does not cause long vehicles to overrun the footway.

As a general guide for urban areas the following kerb radii should be adequate:

- 6m on local roads where there are low numbers of long vehicles turning
- 10m on busier roads. Tapers (30m long developed at 1:5) can be provided where long vehicles are likely to overrun the footway. These are not generally suitable for urban areas because they make pedestrian and cycle movements more difficult. Such tapers are more likely to be provided in industrial areas

At locations where long vehicles form a significant proportion of turning vehicles then larger radii or a compound curve can be considered. In such cases reference should be made to TD42/95[1] and NRA addendum.

Islands can also be installed in the bellmouths of junctions to channelise traffic and assist pedestrians crossing the mouth of wide junctions or accesses. Care needs to be taken that the swept paths for all vehicles likely to use the junction can be accommodated.

Diagram 9.5 Visibility splay requirements from minor road

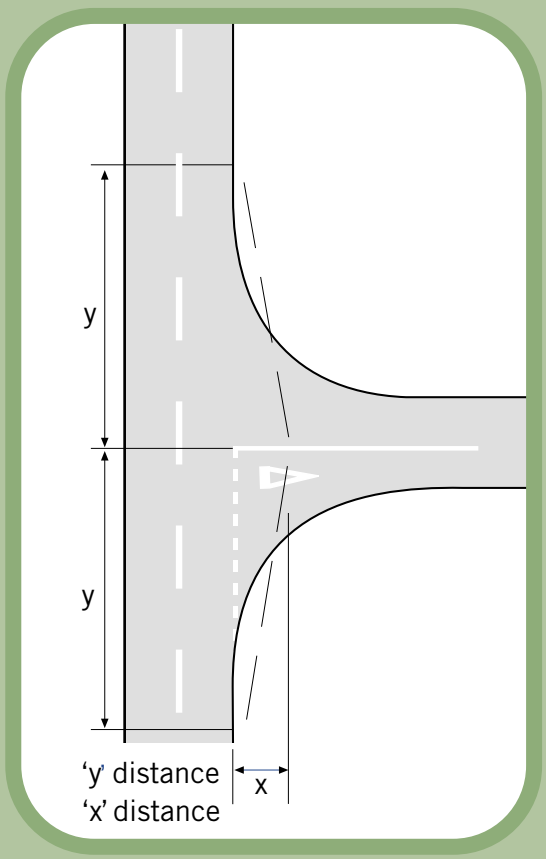



Table 9.4 Visibility distance from minor road

| Design speed (or 85% actual speed) of major road (km/h) | 'Y' distance (m) |
|---|---|
| 50 | 70 |
| 60 | 90 |
| 70 | 120 |
| 85 | 160 |
| 100 | 215 |
| 120 | 295 |

## 9.4 Capacity analysis and computer models

New or improved priority junctions should be designed with a view to their impact on the overall network. In many cases it may be desirable to limit access from the side road onto the main road (to discourage rat running for instance). On the other hand, it may be desirable to provide some reserve capacity for future traffic growth. However, as conditions change (eg pedestrian needs) an alternative form of junction such as traffic signals may be required in the future.

Capacity calculations are undertaken using computer software packages. The most commonly used computer software available is produced by the Transport Research Laboratory (TRL). PICADY (Priority Junction Capacity and Delay) uses geometric parameters to enable different layouts to be modelled against a range of predicted flows. The model outputs information on queues, delays and capacity (RFC – Ratio of Flow to Capacity) for each arm of the junction. It will also output accident predictions (based on UK experience). If the RFC value for each arm is less than 0.85 in the design year then no significant delays would be expected at a junction.

As with all computer models, care is needed with the interpretation of the results and checks are necessary to ensure that the overall design still produces safe and acceptable operating characteristics.

Unfortunately, the programme does not consider the needs of vulnerable road users in the design process and any outputs of accident rates should be checked against local control data to ensure that they are applicable to local conditions.

Diagram 9.6 Corner with taper

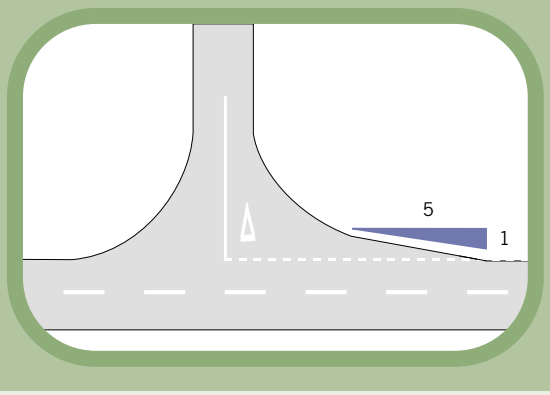
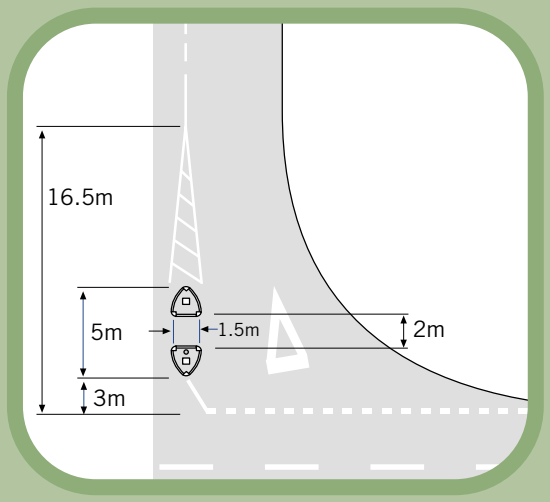



Diagram 9.7 Island in junction bellmouth



## 9.5 Safety issues

Priority junctions are the most common form of junction control and (perhaps as a result of this) a high proportion of accidents occurs at these locations. It is therefore important that good design and construction practice for both safety and capacity is followed.

The most common accident types at priority junctions are those involving right turns. Provision of the following features can help to improve safety at priority junctions:

- measures to reduce approach speeds to the junction
- high-friction surface on the major road approaches to a junction
- dished crossings and tactile paving (see Section E, Chapter 13)
- adequate visibility splays for traffic. Care needs to be taken that the visibility splays provided are not too much greater than the desirable standards indicated in Chapter 9.3 otherwise drivers may misjudge traffic speeds or the presence of two-wheeled vehicles

For Distributor roads only, the following features should be considered:

- ghost island layouts to shelter right turning traffic
- use of double white lining, ribbed markings or coloured surfacing in conjunction with islands or hatching
- high visibility guardrail and central islands at pedestrian crossing points. These can often be provided in conjunction with ghost island layouts
- replacing problem crossroads junctions with staggered junctions

Road safety audits should be carried out on the designs of all new priority junctions and on existing ones which are being improved significantly.

### Cyclists

Cyclists are at risk at priority junctions because many drivers fail to see them. Facilities should be provided to cross cyclists through the junction on the road, where possible. If possible, a cycle lane with a contrasting surface colour together with appropriate cycle logos should be provided. This will help to alert drivers to the presence of cyclists. Detailed advice on the provision of cycling facilities is given in 'Provision of Cycle Facilities – National Manual for Urban Areas'.[4]

### Pedestrians

The provision of facilities for pedestrians at priority junctions should be carefully considered. Pedestrians will always desire to cross the mouth of the junction directly from footpath to footpath. With the exception of high speed distributor roads, pedestrians should be accommodated at the junction mouth. On major roads such as District Distributor roads the provision of central refuges or formal crossings can help the more vulnerable pedestrians to cross. Dished crossings should be provided for pushchairs and wheelchairs (see Section E, Chapter 13). Islands can be installed in the bellmouths of wide junctions to help pedestrians to cross (see Diagram 9.7).

## 9.6 References

1. TD42/95 – Geometric Design of Major Minor Priority Junctions and NRA addendum – NRA addendum available from NRA, St Martin's House, Waterloo Road, Dublin 4, Ireland. Tel 01 660 2511 Fax 01 668 0009.
   TD42/95 available from The Stationery Office, Telephone orders +44 870 600 5522, Fax orders +44 870 600 5533

2. NRA TD9/00 Road link design and NRA TA43/00 Guidance on road link design. Available from National Roads Authority, St Martin's House, Waterloo Road, Dublin 4, Ireland. Tel 01 660 2511 Fax 01 668 0009

3. Traffic Signs Manual – Department of the Environment. (Available from Government Publications Sale Office, Sun Alliance House, Molesworth Street, Dublin 2, or by mail order from Government Publications, Postal Trade Section, 51 St. Stephen's Green, Dublin 2, Tel 01 6476879; Fax 01 6476843)

4. Provision of cycle facilities – National Manual for Urban Areas – Dublin Transportation Office / Department of the Environment & Local Government.
   (Available from Government Publications Sale Office, Sun Alliance House, Molesworth Street, Dublin 2, or by mail order from Government Publications, Postal Trade Section,