**Relationship with Austroads Guide to Road Design - Part 4A (2010)**

The Department of Transport and Main Roads has, in principle, agreed to adopt the standards published in the *Austroads Guide to Road Design (2010) Part 4A: Unsignalised and Signalised Intersections*.

When reference is made to other parts of the Austroads Guide to Road Design or the Austroads Guide to Traffic Management, the reader should also refer to Transport and Main Roads related manuals:

- *Road Planning and Design Manual*
- *Traffic and Road Use Management Manual*.

Where a section does not appear in the body of this supplement, the *Austroads Guide to Road Design - Part 4A* criteria is accepted unamended.

This supplement:

- has precedence over the *Austroads Guide to Road Design - Part 4A* when applied in Queensland
- details additional requirements, including accepted with amendments (additions or differences), new or not accepted
- has the same structure (section numbering, headings and contents) as *Austroads Guide to Road Design - Part 4A*.

The following table summarises the relationship between the *Austroads Guide to Road Design - Part 4A* and this supplement using the following criteria:

<table>
<thead>
<tr>
<th>Austroads Guide to Road Design - Part 4A</th>
<th>RPDM relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accepted</td>
<td>Where a section does not appear in the body of this supplement, the <em>Austroads Guide to Road Design - Part 4A</em> is accepted.</td>
</tr>
<tr>
<td>Accepted with amendments</td>
<td>Part or all of the section has been accepted with additions and or differences.</td>
</tr>
<tr>
<td>New</td>
<td>There is no equivalent section in the Austroads Guide.</td>
</tr>
<tr>
<td>Not accepted</td>
<td>The section of the Austroads Guide is not accepted.</td>
</tr>
</tbody>
</table>

### 1 Introduction

- **1.1 Purpose** - Accepted
- **1.2 Scope of this part** - Accepted
- **1.3 Road safety** - Accepted
- **1.4 Design criteria in part 4A** - Accepted with amendments
- **1.5 Road design objectives** - Accepted
- **1.6 Intersection safety** - Accepted with amendments
- **1.7 Grade separation of traffic movements** - Accepted

### 2 Layout design process

- **2.1 Design process** - Accepted
- **2.2 Alignment of intersection approaches** - Accepted with amendments
- **2.3 Bicycles** - New
### 3 Sight distance

<table>
<thead>
<tr>
<th>3.1 General</th>
<th>Accepted</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2 Sight distance requirements for vehicles at intersections</td>
<td>Accepted with amendments</td>
</tr>
<tr>
<td>3.3 Pedestrian sight distance requirements</td>
<td>Accepted with amendments</td>
</tr>
<tr>
<td>3.4 Sight distance at property entrances</td>
<td>Accepted with amendments</td>
</tr>
</tbody>
</table>

### 4 Types of intersection and their selection

<table>
<thead>
<tr>
<th>4.1 General</th>
<th>Accepted</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2 Intersection types</td>
<td>Accepted</td>
</tr>
<tr>
<td>4.3 Types of turn treatments</td>
<td>Accepted</td>
</tr>
<tr>
<td>4.4 Intersection selection</td>
<td>Accepted (also in Austroads Guide to Traffic Management - Part 6)</td>
</tr>
<tr>
<td>4.5 Basic turn treatments (type BA)</td>
<td>Accepted (also in Austroads Guide to Traffic Management - Part 6)</td>
</tr>
<tr>
<td>4.6 Auxiliary lane turn treatments (type AU)</td>
<td>Accepted (also in Austroads Guide to Traffic Management - Part 6)</td>
</tr>
<tr>
<td>4.7 Channelised turn treatments (type CH)</td>
<td>Accepted with amendments</td>
</tr>
<tr>
<td>4.8 Warrants for BA, AU and CH turn treatments</td>
<td>Accepted with amendments</td>
</tr>
<tr>
<td>4.9 Intersection treatments – rural divided roads</td>
<td>Accepted (also in Austroads Guide to Traffic Management - Part 6)</td>
</tr>
<tr>
<td>4.10 Intersection treatments – urban divided roads</td>
<td>Accepted (also in Austroads Guide to Traffic Management - Part 6)</td>
</tr>
<tr>
<td>4.11 Staggered T-intersections</td>
<td>Accepted (also in Austroads Guide to Traffic Management - Part 6)</td>
</tr>
<tr>
<td>4.12 Seagull treatments</td>
<td>Accepted (also in Austroads Guide to Traffic Management - Part 6)</td>
</tr>
<tr>
<td>4.13 Wide median treatment</td>
<td>Accepted with Amendments</td>
</tr>
<tr>
<td>4.14 Channelised intersections with right-turn restrictions</td>
<td>Accepted (also in Austroads Guide to Traffic Management - Part 6)</td>
</tr>
<tr>
<td>4.15 Median turning lanes or two way right-turn lanes (TWRTL) on an urban road</td>
<td>New</td>
</tr>
</tbody>
</table>

### 5 Auxiliary lanes

<table>
<thead>
<tr>
<th>5.1 General</th>
<th>Accepted</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.2 Determining the need for auxiliary lanes</td>
<td>Accepted with amendments</td>
</tr>
<tr>
<td>5.3 Deceleration turn lane length</td>
<td>Accepted</td>
</tr>
<tr>
<td>5.4 Determination of acceleration lane length for cars</td>
<td>Accepted with amendments</td>
</tr>
<tr>
<td>5.5 Acceleration lane design for trucks</td>
<td>Accepted</td>
</tr>
<tr>
<td>5.6 Auxiliary through lane design</td>
<td>Accepted with amendments</td>
</tr>
</tbody>
</table>

### 6 Traffic islands and medians

<table>
<thead>
<tr>
<th>6.1 General</th>
<th>Accepted</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.2 Raised traffic islands and medians</td>
<td>Accepted with amendments</td>
</tr>
<tr>
<td>6.3 Painted traffic islands and medians</td>
<td>Accepted</td>
</tr>
<tr>
<td>6.4 Desirable clearances to traffic islands and medians</td>
<td>Accepted</td>
</tr>
<tr>
<td>6.5 Road width between kerbs and between kerb and safety barrier</td>
<td>Accepted</td>
</tr>
<tr>
<td>6.6 Kerb and channel</td>
<td>Accepted</td>
</tr>
</tbody>
</table>
## 7 Right turn treatments – layout design details

<table>
<thead>
<tr>
<th>Section</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1 Introduction</td>
<td>Accepted with amendments</td>
</tr>
<tr>
<td>7.2 Opposed right-turns</td>
<td>Accepted</td>
</tr>
<tr>
<td>7.3 Right-turn bans at signalised intersections</td>
<td>Accepted</td>
</tr>
<tr>
<td>7.4 Right-turn lanes for cyclists</td>
<td>Accepted with amendments</td>
</tr>
<tr>
<td>7.5 Rural right-turn treatments – undivided roads</td>
<td>Accepted</td>
</tr>
<tr>
<td>7.6 Rural right-turn treatments – divided roads</td>
<td>Accepted</td>
</tr>
<tr>
<td>7.7 Urban right-turn treatments – undivided roads</td>
<td>Accepted</td>
</tr>
<tr>
<td>7.8 Urban right-turn treatments – divided roads</td>
<td>Accepted</td>
</tr>
</tbody>
</table>

## 8 Left-turn treatments

<table>
<thead>
<tr>
<th>Section</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1 General</td>
<td>Accepted with amendments</td>
</tr>
<tr>
<td>8.2 Rural left-turn treatments</td>
<td>Accepted with amendments</td>
</tr>
<tr>
<td>8.3 Urban left-turn treatments</td>
<td>Accepted with amendments</td>
</tr>
</tbody>
</table>

## 9 U-Turn treatments

<table>
<thead>
<tr>
<th>Section</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.1 General</td>
<td>Accepted</td>
</tr>
<tr>
<td>9.2 Rural roads</td>
<td>Accepted</td>
</tr>
<tr>
<td>9.3 Urban roads</td>
<td>Accepted</td>
</tr>
</tbody>
</table>

## 10 Signalised intersection

<table>
<thead>
<tr>
<th>Section</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1 General</td>
<td>Accepted</td>
</tr>
<tr>
<td>10.2 Design process</td>
<td>Accepted</td>
</tr>
<tr>
<td>10.3 Signal operation considerations</td>
<td>Accepted with amendments</td>
</tr>
<tr>
<td>10.4 Sight distance</td>
<td>Accepted with amendments</td>
</tr>
<tr>
<td>10.5 Intersection layouts</td>
<td>Accepted with amendments</td>
</tr>
<tr>
<td>10.6 Traffic lanes</td>
<td>Accepted with amendments</td>
</tr>
</tbody>
</table>

## References

<table>
<thead>
<tr>
<th>Section</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>References</td>
<td>Accepted with amendments</td>
</tr>
</tbody>
</table>

## Appendices

<table>
<thead>
<tr>
<th>Section</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appendix A Extended Design Domain (EDD) for intersections</td>
<td>Accepted with amendments</td>
</tr>
<tr>
<td>Appendix B Crash types at unsignalised intersections</td>
<td>Accepted</td>
</tr>
<tr>
<td>Appendix C Truck stability at intersections</td>
<td>Accepted with amendments</td>
</tr>
<tr>
<td>Appendix D Set out details for a high-entry angle CHL</td>
<td>Accepted</td>
</tr>
<tr>
<td>Appendix E Swept paths for road trains at high entry angle left-turn treatments</td>
<td>Accepted</td>
</tr>
<tr>
<td>Appendix F Basic left-turn (BAL) layouts at rural intersections</td>
<td>New</td>
</tr>
</tbody>
</table>

## Commentaries

<table>
<thead>
<tr>
<th>Section</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commentary 1</td>
<td>Accepted</td>
</tr>
<tr>
<td>Commentary 2</td>
<td>Accepted</td>
</tr>
<tr>
<td>Commentary 3</td>
<td>Accepted</td>
</tr>
<tr>
<td>Commentary 4</td>
<td>Accepted</td>
</tr>
<tr>
<td>Commentary 5</td>
<td>Accepted</td>
</tr>
<tr>
<td>Commentaries</td>
<td>RPDM relationship</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Commentary 6</td>
<td>Accepted</td>
</tr>
<tr>
<td>Commentary 7</td>
<td>Accepted</td>
</tr>
<tr>
<td>Commentary 8</td>
<td>Accepted</td>
</tr>
<tr>
<td>Commentary 9</td>
<td>Accepted</td>
</tr>
<tr>
<td>Commentary 10</td>
<td>Accepted</td>
</tr>
<tr>
<td>Commentary 11</td>
<td>Accepted</td>
</tr>
<tr>
<td>Commentary 12</td>
<td>Accepted</td>
</tr>
<tr>
<td>Commentary 13</td>
<td>Accepted</td>
</tr>
<tr>
<td>Commentary 14</td>
<td>Accepted</td>
</tr>
<tr>
<td>Commentary 15</td>
<td>Accepted</td>
</tr>
<tr>
<td>Commentary 16</td>
<td>Accepted</td>
</tr>
<tr>
<td>Commentary 17</td>
<td>New</td>
</tr>
</tbody>
</table>
Contents

1 Introduction ........................................................................................................................................... 1
1.4 Road design criteria in Part 4A ........................................................................................................ 1
1.6 Intersection safety ............................................................................................................................ 1
2 Layout design process .......................................................................................................................... 1
  2.2.1 Horizontal alignment ................................................................................................................. 1
  2.2.2 Vertical alignment ...................................................................................................................... 2
2.3 Bicycles ............................................................................................................................................. 2
3 Sight distance ....................................................................................................................................... 3
  3.2.2 Safe Intersection Sight Distance (SISD) .................................................................................. 3
3.3 Pedestrian sight distance requirements .......................................................................................... 3
3.4 Sight distance at property entrances .............................................................................................. 4
4 Types of intersections and their selection .......................................................................................... 4
  4.4.2 Traffic management considerations .......................................................................................... 4
4.5 Basic turn treatments (Type BA). ..................................................................................................... 4
4.6 Auxiliary lane turn treatments (Type AU). ..................................................................................... 4
4.7 Channelised turn treatments (Type CH). ......................................................................................... 5
4.8 Warrants for BA, AU and CH turn treatments ................................................................................. 6
4.9 Intersection treatments – rural divided roads ................................................................................. 10
4.10 Intersection treatments – urban divided roads .............................................................................. 10
4.11 Staggered T-intersections .............................................................................................................. 10
4.12 Seagull treatments ......................................................................................................................... 10
4.13 Wide median treatment ................................................................................................................. 10
4.14 Channelised intersections with right-turn restrictions ................................................................. 11
4.15 Median turning lanes or Two Way Right-Turn Lanes (TWRTL) on an urban road .................. 11
5 Auxiliary lanes .................................................................................................................................... 12
  5.2.2 Acceleration lanes ...................................................................................................................... 12
  5.4.1 General ...................................................................................................................................... 12
  5.4.2 Acceleration Distance ................................................................................................................. 12
5.6 Auxiliary through lane design .......................................................................................................... 15
6 Traffic islands and medians .................................................................................................................. 15
  6.2.1 Raised islands ............................................................................................................................ 15
7 Right-turn treatments – layout design details ..................................................................................... 15
7.1 Introduction ....................................................................................................................................... 15
7.4 Right-turn lanes for cyclists .......................................................................................................... 15
8 Left-turn treatments .............................................................................................................................. 16
  8.1.1 Types of treatments and selection .......................................................................................... 16
  8.1.4 Sight distance requirements ..................................................................................................... 16
  8.2.1 Rural Basic Left-turn treatment (BAL) .................................................................................... 17
  8.2.6 Provision for cyclists at rural free flow left-turn lanes on bicycle routes .................... 17
  8.2.7 Offset rural Channelised Left-turn lane treatment (CHL) .................................................. 18
  8.3.1 Urban Basic Left-turn treatment (BAL) .................................................................................. 19
  8.3.6 Provision for cyclists at urban channelised treatments .................................................. 20
1 Introduction

1.4 Road design criteria in Part 4A

Additions

Guidance on the use of values outside of the design domain (Normal and Extended) should be undertaken in accordance with this document and the Transport and Main Roads Guidelines for Road Design on Brownfield Sites.

1.6 Intersection safety

Additions

Intersections represent a particular road safety hazard for motorcyclists. Therefore intersection layouts should be kept obvious, as simple as possible, and particular attention given to the following:

- visibility between vehicles – note that motorcycles may be difficult to detect and motorcycles may take longer to stop in some situations
- recognition of the layout – night time visibility is critical for motorcyclists and it is best to keep it simple
- parked vehicles – may obscure a motorcycle
- locations where gravel may build up
- surface treatments must have adequate skid resistance
- islands – need to be lit because of the limited effectiveness of the motorcycle headlights
- signal detector loops should be set to detect motorcycles, and
- zebra crossing and other markings at left-turn slip lanes must have adequate skid resistance as motorcycles lean into the corner.

Transport and Main Roads Traffic control sign TC1775 is intended to warn other road users at junctions where motorcyclists have a history of being hit by turning traffic.

Speed has been identified as a major contributing factor to the occurrence and severity of many crashes at intersections. At rural intersections this factor is exacerbated due to the high speed differential between conflicting movements. Austroads (2014) describes methods for reducing speeds on rural roads and includes a range of treatments for application at rural intersections.

2 Layout design process

2.2.1 Horizontal alignment

Additions

The alignment of intersecting roads at an intersection should preferably consist of:

- a minimum straight section of road, equivalent in length to two seconds travel time at the design speed on both upstream and downstream sides of the intersection (most desirable), or
- a continuous curve of constant radius through the intersection (less desirable) with tangent points located at a distance no less than the equivalent in length to two seconds travel time at the design speed either side of the intersection.
It is not good practice to have a straight approach followed by a tight curve on the downstream exit from an intersection.

Careful attention to the design of minor road legs of unsignalised intersections with high approach speeds is required as these legs record high crash rates.

Intersections on the outside of small radius horizontal curves should also preferably be avoided, especially on curves with a large deflection angle.

### 2.2.2 Vertical alignment

**Additions**

The vertical profile of the major road at the intersection should consider the following:

- Should preferably be located within a sag curve with relatively gentle slopes to the intersection or on a section of relatively flat vertical grade.

- Where intersections are located on grades on the major road, the grade should preferably be less than 3% but can be accepted on grades of up to 6% with consideration given to the additional stopping / decelerating distance required in the downhill direction.

- Steeper grades can lead to problems with perception of the intersection in the uphill direction and stopping / deceleration issues in the downhill direction.

- If an intersection must be located within a large radii crest vertical curve, it can be located anywhere on the crest provided all sight distance parameters are met.

- Intersections located on short radii crest curves should be located at the apex of the crest (not either side) and, preferably, on straight horizontal alignment. These locations apply only to brownfields locations.

### 2.3 Bicycles

There is no equivalent Section 2.3 in *Austroads Guide to Road Design - Part 4A*.

**New**

Intersections are areas of high conflict and can be difficult for cyclists to traverse. The following additional documents should be reviewed for additional specific design guidance for bicycles:

- Transport and Main Roads *Technical information for cycling – Cycle notes*, and


Transport and Main Roads requires the design for bicycles to be an integral part of the design of the various components of the road, not an ‘add-on’ after the basis for the design has been established.

In accordance with the Transport and Main Roads *Cycling Infrastructure Policy*, road upgrades are to incorporate ‘cycle-friendly’ designs. Along priority cycling routes, these cycle friendly designs are marked cycle lanes, cycle paths, shared paths or other facilities for cyclists.

A ‘cycle-friendly’ design feature of urban intersections is the provision of 1.0 m minimum offsets from the edge of lane to kerb faces where there is no other provision for cyclists (e.g. there is no separate bicycle lane). This is to avoid cyclists having to negotiate ‘squeeze points’ at the intersection. On the major road in rural areas, the minimum offset is the greater of the shoulder width and 1.0 m.

If bicycle lanes are present either side of an intersection, specific cycle facilities are to be provided to guide cyclists through the intersection. Even a short marked cycle lane through an intersection that
does not provide route continuity may provide safety advantages to cyclists provided that its termination point does not lead cyclists into an unsafe situation.

Where there are a high number of cyclists or an intersection has a poor cycle safety record, a green coloured pavement surface for the cycle lane may deliver added cycle safety. Refer to the Transport and Main Roads TRUM manual for guidance on the use of green coloured pavement surfaces.

Wide kerbside lanes enable greater separation of cyclists and motor vehicles, creating a higher level of safety and increased operational efficiency. Wide kerbside lanes should be carried through intersections to avoid ‘squeeze points’.

Where a road is identified as a principal cycling route, a bike lane treatment on the uphill leg(s) may be appropriate to account for side-to-side movement of the bicycle and the large speed differential between bicycles and motorised vehicles uphill. A bicycle lane is also desirable on the downhill leg(s).

3 Sight distance
3.2.2 Safe Intersection Sight Distance (SISD)

Additions

The time gaps provided by applying the SISD model are generally sufficient for heavy vehicles to undertake the following movements:

- left or right-turn from the minor road onto the major road
- through movement from the minor road at a cross intersection
- right-turn from the major road into the minor road.

However, the time gaps may not be sufficient for heavy vehicles to undertake these movements in particular circumstances, for example:

- where the design heavy vehicle is greater than a 19 m semi-trailer
- the major road is on a steep grade
- the major road comprises more than one lane in each direction.

Under such circumstances, advice from TMR specialists should be sought as to whether the minimum values of SISD are sufficient to cover the particular heavy vehicle movements.

3.3 Pedestrian sight distance requirements

Differences

The formula for the critical safe gap \( t_c \) in Austroads Guide to Road Design - Part 4A is to be replaced with the following:

\[ t_c = \frac{\text{crossing length (m)}}{\text{walking speed (m/s)}} \]

Additions

Pedestrian walking speeds can vary significantly and are affected by age, sex, motivation, presence of other pedestrians and other traffic impediments. The distribution of free flow walking speeds varies as follows:

- minimum walking speed 0.74 m/s
- maximum walking speed 2.39 m/s
• maximum speed of wheelchairs 10 km/h = 2.78 m/s (wheelchairs are classified as pedestrians in legislation)
• average unimpeed free-flow 1.35 m/s walking speed.

Calculation of green time at traffic signals is based on an average design walking speed of 1.2 m/s, but this is still faster than some pedestrians can manage. In particular, elderly pedestrians often adopt significantly lower speeds than the younger part of the population. Table 4A-1 provides guidance on the walking speed to adopt for various circumstances.

### Table 4A-1 - Walking speeds for senior pedestrians

<table>
<thead>
<tr>
<th>Walking Pace</th>
<th>Mean Speed (m/s)</th>
<th>10th Percentile Speed (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>1.13</td>
<td>0.8</td>
</tr>
<tr>
<td>Hurried</td>
<td>1.41</td>
<td>1.0</td>
</tr>
<tr>
<td>Rushing</td>
<td>1.71</td>
<td>1.0</td>
</tr>
</tbody>
</table>

3.4 **Sight distance at property entrances**

**Additions**

At many properties (for example major shopping centres), the entrance may appear to a driver to be an intersection as opposed to the more common form of a property entrance. Due to the variety of different designs and pavement/kerb treatments that can be used at property entrances, no clear distinction can be made as to what is an intersection and what is a property entrance.

In considering the sight distance requirements to be applied at a property entrance, a judgement is to be made on the basis that if drivers are likely to consider that a property entrance looks like an intersection, then it should be designed in accordance with the requirements for an intersection.

4 **Types of intersections and their selection**

4.4.2 **Traffic management considerations**

**Additions**

Section 4.4.2 of the Austroads Guide to Road Design - Part 4A has been reproduced in Austroads Guide to Traffic Management - Part 6 and will not appear in the next edition of Austroads Guide to Road Design - Part 4A. Refer to Sections 2.1 and 2.3.7 of the Austroads Guide to Traffic Management - Part 6.

4.5 **Basic turn treatments (Type BA)**

**Additions**

Section 4.5 of the Austroads Guide to Road Design - Part 4A has been reproduced in Austroads Guide to Traffic Management - Part 6 and will not appear in the next edition of Austroads Guide to Road Design - Part 4A. Refer to Section 2.2.2 of the Austroads Guide to Traffic Management - Part 6.

4.6 **Auxiliary lane turn treatments (Type AU)**

**Additions**

Section 4.6 of the Austroads Guide to Road Design - Part 4A has been reproduced in Austroads Guide to Traffic Management - Part 6 and will not appear in the next edition of Austroads Guide to Road Design - Part 4A. Refer to Section 2.2.3 of the Austroads Guide to Traffic Management - Part 6.
4.7 Channelised turn treatments (Type CH)

Additions

Section 4.7 of the Austroads Guide to Road Design - Part 4A has been reproduced in Austroads Guide to Traffic Management - Part 6 and will not appear in the next edition of Austroads Guide to Road Design - Part 4A. Refer to Section 2.2.4 of the Austroads Guide to Traffic Management - Part 6 subject to the following amendments.

Channelisation has particular application in the following areas:

- Intersections at odd angles (Y-junctions, skewed cross roads), or multi-leg intersections (generally only appropriate if the intersection is realigned and/or if traffic signal control is used).
- Sites where turning traffic movements are particularly heavy.
- Locations where the safety record of an intersection is shown to be susceptible to particular accident types, such as opposing side swipe and head on crashes, right-turn opposing, and high speed rear end collisions.
- Sites where a refuge area for pedestrians is desirable.
- Sites where unusual manoeuvres are occurring, or where unwanted movements are to be eliminated. A channelised layout may be the only solution appropriate at some sites. These include some multi-lane divided roads, and sites where it is necessary to provide positive protection of the furniture (signs, traffic signal posts, etc.) associated with the form of traffic control adopted.

The associated furniture (particularly raised medians) can be regarded as a hazard, which means that the increased risk must be clearly outweighed by other advantages.

All channelised intersections with raised medians and kerbed islands must be lit in accordance with the standards set out in Volume 6 of this Road Planning and Design Manual.

Channelised intersections always require good sight distance to the starting point of the median (especially raised). The median or island may have to be extended to meet this requirement. A few large islands are always preferable to a large number of small islands.

Drainage of raised medians and islands can be expensive. Regular sweeping may be necessary.

Where traffic volumes are high, the number of approach lanes, including auxiliary lanes, will increase and channelisation (in some form) becomes inevitable. Preliminary, approach lane requirements may be assessed using the techniques of Volume 3, Part 3 of this Road Planning and Design Manual. Detailed design requirements for medians and islands are given in Section 6 of Austroads Guide to Road Design - Part 4A. As urban channelised intersections are often controlled by traffic signals, the possibility of this form of control should be established early in the process so that appropriate provision can be made.

CHR turn treatments record much lower crash rates than BAR and AUR turn treatments, but are not significantly different than CHR(s) treatments. CHL treatments record a slightly higher crash rate on BAL treatments but the increase is not significant.
Therefore, warrants for CHL turn treatments should not be selected on the basis of safety. Instead, they may be justified by circumstances such as:

- Improving capacity and delays at the intersection.
- Improving safety for other conflict types. CHL treatments on the major road may provide greater visibility for drivers on the minor road as per the example at Section 8.6 of *Austroads Guide to Road Safety - Part 6*.
- Providing a bypass facility for left-turning vehicles at traffic signals.
- Changing the give way rule in favour of other manoeuvres at the intersection.
- Defining more appropriately the driving path by reducing the area of bitumen surfacing, especially at skewed intersections catering for large and over dimensional vehicles.

### 4.8 Warrants for BA, AU and CH turn treatments

#### Additions

Section 4.8 of the *Austroads Guide to Road Design - Part 4A* has been reproduced in *Austroads Guide to Traffic Management - Part 6* and will not appear in the next edition of *Austroads Guide to Road Design - Part 4A*. Refer to Section 2.3.6 of the *Austroads Guide to Traffic Management - Part 6* subject to the following amendments.

#### Differences

The following warrants apply to major road turn treatments for the basic, auxiliary lane and channelised layouts discussed in Section 2.2.2, 2.2.3 and 2.2.4 of *Austroads Guide to Traffic Management - Part 6*. Additionally, many lower-order existing intersections on two-lane, two-way roads have historically been constructed without any widening and do not meet the minimum design layout for a BAR/BAL. These intersections are referred to as Simple Right (SR) and Simple Left (SL) intersections.

The warrants shown in Figure 4A-1 are for greenfield sites (i.e. new intersections on new roads) on two-lane two-way roads (2L2W). At these intersections the minimum turn treatment shall be a BAR/BAL. SR/SL intersections types are not to be constructed at new intersections on new roads. These warrants are to be applied as Normal Design Domain (NDD) for the selection of the preferred intersection type at any intersection.

The preferred minimum intersection turn treatment on major roads and highways is a CHR(s)/AUL(s) due to the combination of operational and safety issues.

Warrants for 4-lane, 2-way (4L2W) and 6-lane, 2-way (6L2W) situations have now been explicitly analysed (Sullivan & Arndt, 2014) considering the relative crash rates, traffic volumes and construction costs for these intersections. This analysis has established that the warrant curves for 2L2W roads are appropriate for these road configurations as well, but that the major road traffic volume (QM) is calculated as per note 4 to Figure 4A-1.

The warrants shown at Figure 4A-1 are therefore to be applied for greenfield sites on 4L2W and 6L2W roads. At these intersections the minimum turn treatment shall be a CHR(s)/BAL. At new four and six lanes roads, it is preferred practice that a median of sufficient width would be included to accommodate a CHR(s) or CHR treatment at every intersection allowing a right turn from the major road. These warrants are to be applied as Normal Design Domain (NDD) for the selection of the preferred intersection type at any intersection.
The warrants provide guidance on where a full-length deceleration lane must be used, and where a shorter lane, AUL(s) and CHR(s), may be acceptable based on traffic volume. Figure 4A-1 contains three graphs for the selection of turn treatments on roads with a design speed:

- Greater than or equal to 100 km/h. Figure 4A-1(a) applies for high speed rural roads.
- Greater than 70 km/h and less than 100 km/h. Figure 4A-1(b) applies for higher speed urban roads, including those on the urban fringe and lower speed rural roads.
- Less than 70 km/h. Figure 4A-1(c) applies for urban roads.

If a particular turn from a major road is associated with some geometric minima (for example, limited sight distance, steep grade), consideration should be given to the adoption of a turn treatment of a higher order than that indicated by the warrants. For example, if the warrants indicate that a BAR turn treatment is acceptable for the relevant traffic volumes, but limited visibility to the right-turning vehicle is available, consideration should be given to the adoption of a CHR(S) or CHR turn treatment instead. Another example is a major road on a short steep downgrade where numerous heavy vehicles travel quickly down the grade, in which case it would not be appropriate to adopt a BAL turn treatment. Instead, an AUL(S) or an AUL would be a preferred treatment.

Development of the warrants in this section is detailed in Arndt & Troutbeck (2006), Sullivan & Arndt (2014) and briefly discussed in Commentary 5 to Austroads Guide to Traffic Management - Part 6.

The warrants in Figure 4A-1 are based on achieving a specific level of safety performance. An evaluation of the operational performance of the intersection should also be undertaken. If the operational performance indicates a higher level treatment is needed, then it should be adopted in lieu of the warrants in Figure 4A-1.

An EDD version of these warrants is provided at Appendix A.10. Further commentary on the methodology behind these warrants is provided at Commentary 17.
Figure 4A-1 - Warrants - major road turn treatments - Normal Design Domain

(*) the minimum right turn treatment for multi-lane roads is a CHR(s)
The following notes apply to the warrants in Figure 4A-1:

1. Curve 1 - For 2L2W roads, curve 1 represents the boundary between a BAR and a CHR(S) turn treatment and between a BAL and an AUL(S) turn treatment. For 4/6L2W roads, curve 1 represents the boundary between a BAL and an AUL(S) turn treatment only. The minimum right turn treatment is a CHR(S) on 4/6L2W roads.

2. Curve 2 represents the boundary between a CHR(S) and a CHR turn treatment and between an AUL(S) and an AUL/CHL turn treatment. The choice of CHL over an AUL will depend on factors such as the need to change the give way rule in favour of other manoeuvres at the intersection and the need to define more appropriately the driving path by reducing the area of bitumen surfacing.

3. The warrants apply to turning movements from the major road only (the road with priority). For turns from the minor road, turn treatments are determined through an operational performance evaluation applying gap acceptance analysis and an evaluation of acceptable delays and queues.

4. \( Q_{M} \)
   a) For 2L2W roads, Figure 4A-2 is to be used to calculate the value of the major road traffic volume parameter \( (Q_{M}) \) and is the total through traffic flow in both directions \( (Q_{T1} + Q_{T2}) \).
   b) For 4/6L2W roads, the major road traffic volume parameter \( (Q_{M}) \) for right turns uses the full opposing flow \( Q_{T2} \) and only the traffic flow in the nearest lane of the following flow \( Q_{T1} \) as shown in Figure 4A-2. For left turns the major road traffic volume parameter \( (Q_{M}) \) uses only the traffic flow in the leftmost through lane of the following flow \( Q_{T2} \).

**Figure 4A-2 - Calculation of the major road traffic volume parameter ‘\( Q_{M} \)’**

<table>
<thead>
<tr>
<th>Road Type</th>
<th>Turn Type</th>
<th>Splitter Island</th>
<th>( Q_{M} ) (veh/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Lane 2 Way</td>
<td>Right</td>
<td>No</td>
<td>( Q_{T1} + Q_{T2} + Q_{L} )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>( Q_{T1} + Q_{T2} )</td>
</tr>
<tr>
<td></td>
<td>Left</td>
<td>Yes/No</td>
<td>( Q_{T2} )</td>
</tr>
<tr>
<td>4 Lane 2 Way</td>
<td>Right</td>
<td>No</td>
<td>( 50% \times Q_{T1} + Q_{T2} + Q_{L} )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>( 50% \times Q_{T1} + Q_{T2} )</td>
</tr>
<tr>
<td></td>
<td>Left</td>
<td>Yes/No</td>
<td>( 50% \times Q_{T2} )</td>
</tr>
<tr>
<td>6 Lane 2 Way</td>
<td>Right</td>
<td>No</td>
<td>( 33% \times Q_{T1} + Q_{T2} + Q_{L} )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>( 33% \times Q_{T1} + Q_{T2} )</td>
</tr>
<tr>
<td></td>
<td>Left</td>
<td>Yes/No</td>
<td>( 33% \times Q_{T2} )</td>
</tr>
</tbody>
</table>
5. Traffic flows applicable to the warrants are peak hour flows, with each vehicle counted as one unit (i.e. do not use equivalent passenger car units [pcus]). Where peak hour volumes or peak hour percentages are not available, assume that the design peak hour volume equals 15% of the AADT for 500 hours each year, use 5% of the AADT for the rest of the year.

6. If more than 50% of the traffic approaching on a major road leg turns left or right, consideration needs to be given to possible realignment of the intersection to suit the major traffic movement. The shaded area (A) denotes the traffic flow combinations where this occurs. However, route continuity issues must also be considered (for example, realigning a highway to suit the major traffic movement into and out of a side road would be unlikely to meet driver expectation).

7. If a turn is associated with other geometric minima, consideration should be given to the adoption of a turn treatment of a higher order than that indicated by the warrants.

8. At higher traffic volumes, consideration should also be given to the operational performance of the intersection which may require a higher level turn treatment, or alternative intersection control, than required by these warrants based on crash analysis.

### 4.9 Intersection treatments – rural divided roads

**Additions**

Section 4.9 of the *Austroads Guide to Road Design - Part 4A* has been reproduced in *Austroads Guide to Traffic Management - Part 6* and will not appear in the next edition of *Austroads Guide to Road Design - Part 4A*. Refer to Section 2.2.5 of the *Austroads Guide to Traffic Management - Part 6*.

### 4.10 Intersection treatments – urban divided roads

**Additions**

Section 4.10 of the *Austroads Guide to Road Design - Part 4A* has been reproduced in *Austroads Guide to Traffic Management - Part 6* and will not appear in the next edition of *Austroads Guide to Road Design - Part 4A*. Refer to Section 2.2.6 of the *Austroads Guide to Traffic Management - Part 6*.

### 4.11 Staggered T-intersections

**Additions**

Section 4.11 of the *Austroads Guide to Road Design - Part 4A* has been reproduced in *Austroads Guide to Traffic Management - Part 6* and will not appear in the next edition of *Austroads Guide to Road Design - Part 4A*. Refer to Section 2.2.7 of the *Austroads Guide to Traffic Management - Part 6*.

### 4.12 Seagull treatments

**Additions**

Section 4.12.1 of the *Austroads Guide to Road Design - Part 4A* has been reproduced in *Austroads Guide to Traffic Management - Part 6* and will not appear in the next edition of *Austroads Guide to Road Design - Part 4A*. Refer to Section 2.2.8 of the *Austroads Guide to Traffic Management - Part 6*.

### 4.13 Wide median treatment

**Additions**

Section 4.13 of the *Austroads Guide to Road Design - Part 4A* has been reproduced in *Austroads Guide to Traffic Management - Part 6* and will not appear in the next edition of *Austroads Guide to Road Design - Part 4A*. Refer to Section 2.2.9 of the *Austroads Guide to Traffic Management - Part 6* subject to the following amendments.

Wide Median Treatments, even in isolated locations, can be confusing with drivers mistaking the intersection for a roundabout. This can potentially lead to hazardous situations where traffic travelling...
Supplement to Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections

across the median (right turning traffic from the major road and through/right traffic from the minor road) may fail to give way to through traffic on the opposing major road. In these cases designers should consider additional measures to further alert drivers that the wide median treatment is not a roundabout. These measures may include additional and larger signage, particularly at the give way lines within the median treatment.

4.14 Channelised intersections with right-turn restrictions

**Additions**


4.15 Median turning lanes or Two Way Right-Turn Lanes (TWRTL) on an urban road

There is no equivalent Section 4.15 in Austroads Guide to Road Design - Part 4A.

**New**

Median Turning Lanes or Two Way Right Turn Lanes (TWRTL) can be used to maintain capacity and level of service for the through lanes by removing the obstruction caused by a right-turning vehicle. It has the added advantage of providing shelter for vehicles both entering and exiting from an access. A diagram of such a treatment is shown in Figure 4A-3.

This treatment is particularly applicable in commercial and residential areas with closely spaced access points. It has been used successfully where arterial roads bisect country town business and industrial areas and access is required for motels, service centres commercial establishments and adjoining low traffic volume side streets.

TWRTLs should not be introduced without consideration of existing and future land use. They should not be allowed to provide unlimited and uncontrolled right-turn movements. However, when used on roads with traffic signal control, TWRTLs may provide sufficient gaps to adequately service low volume side properties with efficiency and safety. In non-access controlled areas they can encourage ad-hoc land development with inappropriate accesses provided at developments.

On new heavily travelled arterial roads and commercial and industrial areas with widely spaced access points, median control of right-turn movements is preferred.

TWRTLs should be restricted to the urban environment with travel speeds of 70 km/h or less. They should not be used in high density residential areas due to the potential conflict with uncontrolled pedestrian movements.

A TWRTL must not be used in conjunction with an intersection. The ends of the TWRTL treatment must not be closer than 10 m from the start of any right-turn lane at an intersection.

The through road should have no more than two lanes in each direction resulting in a total of five lanes with the introduction of a TWRTL.

**Geometric considerations**

The TWRTL is to be paved flush with the adjacent lanes. To improve the definition of the lane a different coloured pavement material other than red (Bus Only lanes) or green (Cycle lanes) can be used. The desirable width is 3.0 m to 4.8 m. TWRTLs and right-turn auxiliary lanes within the same length of median must be separated by a raised island and adequately sign posted.
Figure 4A-3 - Two-way Right Turn Lanes on an urban road

Notes:
1. This diagram does not show any specific bicycle facilities. Where specific bicycle facilities are required (eg exclusive bicycle lanes), refer Austroads (2011).
2. See Manual of Uniform Traffic Control Devices (Transport and Main Roads) for linemarking, spacing of pavement arrows, advance warning and regulatory signs.
3. Minimum offset is as per Figure 6.4 of Austroads Guide to Road Design - Part 4A.
4. Diagram shows two lanes in each direction but this treatment can be used for roads with a single lane in each direction.

5 Auxiliary lanes

5.2.2 Acceleration lanes

Additions
The impact of acceleration lanes on cyclist safety and convenience should be carefully considered, particularly in urban areas. These issues are discussed further in Sections 8.2.6 (rural) and 8.3.6 (urban).

5.4.1 General

Additions
Note to Figure 5.4 of Austroads Guide to Road Design - Part 4A. The emergency run-off area is to be designed as per the requirements detailed in Volume 3, Part 3, Section 9.4 of this Road Planning and Design Manual.

5.4.2 Acceleration Distance

Differences
All references to Tables 5.4 and 5.5 in this Section of Austroads Guide to Road Design - Part 4A are to be replaced respectively with references to Tables 4A-2 and 4A-3.
Replace “Table 5.4: length of acceleration lanes for cars on a level grade” (and associated notes) with Table 4A-2 (and associated notes).

Table 4A-2 - Length of acceleration lanes for cars on level grade

<table>
<thead>
<tr>
<th>Design speed of road entered(^{(1)}) (km/h)</th>
<th>Length of acceleration lane A (m) (including length of merge taper) – for flat grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design speed of entry curve (km/h)</td>
<td>0(^{(2)})</td>
</tr>
<tr>
<td>50</td>
<td>105</td>
</tr>
<tr>
<td>60</td>
<td>125</td>
</tr>
<tr>
<td>70</td>
<td>150</td>
</tr>
<tr>
<td>80</td>
<td>215</td>
</tr>
<tr>
<td>90</td>
<td>300</td>
</tr>
<tr>
<td>100</td>
<td>405</td>
</tr>
<tr>
<td>110</td>
<td>600</td>
</tr>
</tbody>
</table>

Notes:
1. For the purpose of calculating the acceleration lane lengths at intersections, the speed reached is the design speed of the through road as defined in Volume 3, Part 3 of this Road Planning and Design Manual.
2. Length required where a vehicle accelerates from a zero speed.

General Notes:
- Values in the non-shaded areas are based on the distance required to accelerate from the turning speed to the design speed of the road being entered.
- Values in the grey-shaded areas are based on the distance travelled in four seconds plus the merge length. In this area of the table these values are greater than the distance to accelerate from the turning speed to the design speed of the road being entered.
- Values shown in table are for level grade. Adjust for grade using Table 4A-3. Flat grade is any road with a grade given by \(1\% \text{ downgrade} \leq \text{grade} \leq 1\% \text{ upgrade}.

The values in Tables 4A-2 and 4A-3 have been generated from VEHSIM acceleration curves for a typical car. The VEHSIM curves are reproduced in Commentary 9, Volume 3, Part 4C of this Road Planning and Design Manual.

In practice the vertical profile of an acceleration lane may consist of sections of varying grade due to design issues such as the natural topography or other constraints. In these situations the overall length of the acceleration lane required can be established by determining the vehicle speed at the start of the final section of grade, and determining the remaining length required for vehicles to meet the required design speed. A worked example of determining lane lengths on compound grades is included at Commentary 9, Volume 3, Part 4C of this Road Planning and Design Manual.
Replace “Table 5.5: Correction of acceleration distances as a result of grade” and associated notes with Table 4A-3 (and associated notes).

### Table 4A-3 - Correction of acceleration distances as a result of grade

<table>
<thead>
<tr>
<th>Design speed of road entered (km/h)</th>
<th>Ratio of length on grade to length on level (Table 4A-2)</th>
<th>Design speed of turning roadway curve (km/h)</th>
<th>1% &lt; upgrade ≤ 3%</th>
<th>1% &lt; downgrade ≤ 3%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 20 30 40 50 60 70 80</td>
<td></td>
<td>0 20 30 40 50 60 70 80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>1.00 1.00 1.00 1.00</td>
<td>1.00 1.00 1.00 1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>1.00 1.00 1.00 1.00 1.00</td>
<td>1.00 1.00 1.00 1.00 1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>1.05 1.00 1.00 1.00 1.00</td>
<td>0.90 0.90 0.85 0.95 1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>1.15 1.15 1.15 1.15 1.05 1.00</td>
<td>0.90 0.85 0.90 0.85 0.85 0.95 1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>1.20 1.20 1.20 1.20 1.20 1.25 1.25 1.15</td>
<td>0.85 0.85 0.85 0.85 0.85 0.85 0.85 0.85 1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>1.40 1.40 1.40 1.40 1.45 1.45 1.50 1.55</td>
<td>0.80 0.80 0.80 0.80 0.80 0.75 0.75 0.75 0.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>110(2)</td>
<td></td>
<td>0.70 0.70 0.65 0.65 0.65 0.65 0.65 0.65 0.60</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Design speed of road entered (km/h)</th>
<th>3% &lt; upgrade ≤ 5%</th>
<th>3% &lt; downgrade ≤ 5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>1.00 1.00 1.00 1.00</td>
<td>1.00 1.00 1.00 1.00</td>
</tr>
<tr>
<td>60</td>
<td>1.00 1.00 1.00 1.00</td>
<td>0.80 0.85 0.85 0.95</td>
</tr>
<tr>
<td>70</td>
<td>1.15 1.15 1.05 1.00</td>
<td>0.80 0.75 0.75 0.75</td>
</tr>
<tr>
<td>80</td>
<td>1.35 1.40 1.45 1.45</td>
<td>0.75 0.75 0.75 0.75</td>
</tr>
<tr>
<td>90</td>
<td>1.45 1.45 1.50 1.50</td>
<td>0.70 0.70 0.65 0.65</td>
</tr>
<tr>
<td>100</td>
<td>1.55 1.55 1.55 1.60</td>
<td>0.60 0.60 0.60 0.60</td>
</tr>
<tr>
<td>110(2)</td>
<td>0.70 0.70 0.65 0.65</td>
<td>0.55 0.55 0.55 0.55</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Design speed of road entered (km/h)</th>
<th>5% &lt; upgrade ≤ 6%</th>
<th>5% &lt; downgrade ≤ 6%</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>1.00 1.00 1.00 1.00</td>
<td>1.00 1.00 1.00 1.00</td>
</tr>
<tr>
<td>60</td>
<td>1.10 1.05 1.00 1.00</td>
<td>0.80 0.85 0.85 0.95</td>
</tr>
<tr>
<td>70</td>
<td>1.35 1.25 1.20 1.05</td>
<td>0.70 0.70 0.70 0.80</td>
</tr>
<tr>
<td>80</td>
<td>1.75 1.80 1.80 1.90</td>
<td>0.70 0.70 0.70 0.80</td>
</tr>
<tr>
<td>90</td>
<td>2.00 2.00 2.10 2.10</td>
<td>0.60 0.60 0.60 0.55</td>
</tr>
<tr>
<td>100</td>
<td>2.25 2.20 2.25 2.30</td>
<td>0.60 0.60 0.60 0.55</td>
</tr>
<tr>
<td>110(2)</td>
<td>0.70 0.70 0.70 0.70</td>
<td>0.60 0.60 0.60 0.55</td>
</tr>
</tbody>
</table>

Notes:
1. For the purpose of calculating the acceleration lane lengths at intersections, the speed reached is the design speed of the through road as defined in Volume 3, Part 3 of this Road Planning and Design Manual.
2. Empty cells at these speeds indicate that the modelled acceleration does not result in vehicles reaching 110 km/h. In these cases the acceleration lanes should be converted to an added lane.

General Notes:
Values in the non-shaded areas are based on the distance required to accelerate from the turning speed to the design speed of the road being entered.
Values in the grey-shaded areas are based on the distance travelled in four seconds plus the merge length. In this area of the table these values are greater than the distance to accelerate from the turning speed to the design speed of the road being entered.
5.6 **Auxiliary through lane design**

*Additions*

The start and termination points of an auxiliary lane should be clearly visible to approaching drivers in accordance with the sight distance requirements outline in Table 9.7 in *Austroads Guide to Road Design - Part 3* and the additional considerations for merge points discussed at Section 5.4.4.

6 **Traffic islands and medians**

6.2.1 **Raised islands**

*Additions*

Semi-mountable kerbs are preferred for raised islands and medians. However in some locations, a barrier kerb type may be appropriate. Guidance on the selection and application of the various kerb types is discussed in Table 6.5 of *Austroads Guide to Road Design - Part 4A*. Further information on kerb types and their application in Queensland is detailed in Volume 3, Part 3 of this *Road Planning and Design Manual*.

Islands at intersections should be designed to suit turning paths of design vehicles and may need to consider the use of mountable islands in some circumstances. The design of the islands should ensure that the continuity of the major road through the intersection is maintained and is legible for approaching drivers.

7 **Right-turn treatments – layout design details**

7.1 **Introduction**

*Additions*

Motorcycle and cyclist risks should also be considered in determining the preferred layout for right turns at a site. These road users are more difficult to see and when stopped waiting to turn right from the major road are at increased risk of rear end crashes. There is also likely to be an increased risk of motorcyclists and cyclists accepting smaller gaps in traffic due to the perceived risk of rear end crashes.

Locations with a crash history involving motorcyclists/cyclists or in areas with higher proportion of motorcycle/cyclist traffic should consider the CHR treatment to provide additional protection to vehicles making the right turn movement.

7.4 **Right-turn lanes for cyclists**

*Additions*

Right-turn lanes for cyclists are generally not provided where a cyclist would need to cross two or more lanes to access the facility. In this case a hook turn storage box may be provided to accommodate the right turn for cyclists (refer to Section 10.6.4 for further details on hook turns).
8 Left-turn treatments

8.1.1 Types of treatments and selection

_additions_

The form of the left turn treatment may also need to consider the sight distance requirements for vehicles turning out of the side road. In these cases an offset CHL or CHL(s) treatment may be required as described in Section 8.2.7.

8.1.4 Sight distance requirements

There is no equivalent Section 8.1.4 in Austroads Guide to Road Design - Part 4A.

_new_

General sight distance requirements are set out in Section 3.2.

When the minor road angle of approach to an intersection exceeds 120° (that is 60° or less between the left turning vehicle and vehicles approaching from the right) it can result in a driver losing stereo vision. Drivers only able to sight approaching traffic with the right eye lose depth of field vision and can have difficulty in accurately detecting the position and speed of approaching traffic.

In existing situations, where sighting requirements to approaching vehicles are below the criteria explained in Section 3.2 and Section 8.1.3, the following remedial treatments should be considered:

_a) Reconstruction_

Reconstruction of the left-turn to overcome sighting problems may be an option. By providing a protected acceleration lane on the departure side of the turn, observation angle criteria are no longer applicable and are replaced by merging requirements.

Generally, acceleration lanes are associated with multi radii (three centred curve) returns. If a left-turn slip lane exists without a protected acceleration lane, and the observation angle exceeds 120°, reconstruction to a high entry angle turn may be appropriate (refer to Section 8.3.4 for details).

Elimination of the slip lane, and provision of a single radius return, may be appropriate depending upon capacity requirements.

Relocation of an intersection to overcome sighting problems is generally more practical in rural areas than in urban situations.

_b) Reduce approach speed_

The traffic speed on the priority road is reduced to ensure that the available sight distance meets sight requirements. This is generally only possible on local streets where effective speed control measures, such as speed humps, thresholds, or similar forms of speed control, can be introduced.

On collector, sub arterial and arterial roads, speed reduction can be achieved with a roundabout (mostly urban application) but different sight requirements will then apply. However, roundabouts can create problems where there are high volumes of other road users (e.g. motorcyclists, pedestrians and cyclists). Roundabouts should not be used solely as a speed control device to remedy sight distance deficiencies.

Speed zoning over short, isolated lengths is not appropriate.
c) **Provide traffic signals**

Traffic signals can be used to resolve safety problems when sight distances are deficient. This solution can be costly and network consequences must be carefully examined (particularly in terms of delay). However, note that sight distance requirements are still applicable at intersections controlled by traffic signals (refer to Section 10.4).

d) **Banning the turn**

This is the final available option and should only be applied when convenient alternative access is available and the effect on the road network acceptable. Banning a left turn out of a minor road can only be effectively achieved by banning all movements turning out of the minor road.

### 8.2.1 Rural Basic Left-turn treatment (BAL)

**Additions**

Figure 8.2 in *Austroads Guide to Road Design - Part 4A* shows a widened shoulder for movements from the major to minor road which is based on a left-turning vehicle having a speed reduction of 30 percent in the through lane, prior to moving onto the shoulder and decelerating. This is based on the assumption that drivers decelerate at a maximum value of 3.5 m/s² (d = 0.36) from the start of the taper to the start of the kerb return. The total width of through lane plus widened shoulder is a minimum of 6 m.

Figure 8.2 in *Austroads Guide to Road Design - Part 4A* also shows an optional kerb return, which can provide the following advantages:

- better perception of the intersection, especially for intersections with limited visibility
- reduce the amount of ‘corner cutting’ by drivers, and
- reduce the amount of scouring in areas of high rainfall, if provided with batter protection for the drainage paths.

Figure 8.2 in *Austroads Guide to Road Design - Part 4A* shows turning paths for two movements only to demonstrate the paths for left turning vehicles. The intersection design must also conform to all swept path requirements.

An EDD version of *Austroads Guide to Road Design - Part 4A* Figure 8.2, that can be used at low volume intersections where there are not significant numbers of heavy vehicles is given in Appendix A.6 (EDD treatment of a constrained left turn radius).

### 8.2.6 Provision for cyclists at rural free flow left-turn lanes on bicycle routes

**Additions**

To comply with the bicycle friendly component of the Transport and Main Roads *Cycling Infrastructure Policy* and safe system principles, the island should be amended to not extend beyond the red line shown in the Figure 4A-5. This setback distance would be the same as the bicycle lane width for the corresponding speed zone. Slip resistant chevrons in this zone (no RRPM’s) would help to advise cyclists that a potential hazard is approaching (the added lane in this case) and that the appropriate route is the detour. If a cyclist does not use the detour for some reason the cyclist’s operating space will not be immediately compromised.
8.2.7 Offset rural Channelised Left-turn lane treatment (CHL)

There is no equivalent Section 8.2.7 in *Austroads Guide to Road Design - Part 4A*.

**New**

Significant numbers of vehicles, particularly heavy vehicles making a left turn from the major road at an intersection with an AUL/AUL(s)/CHL/CHL(s), may restrict the sight distance for vehicles turning out of the minor road, particularly right turning vehicles.

In this situation, offsetting the left turn lane from the adjacent through lane on the minor road improves the sight distance for vehicles turning out of the minor road. In particular sight distance to vehicles following a left turning vehicle can be substantially improved. An offset left turn lane should therefore be considered at an intersection where sight distance past left turning vehicles may improve the intersection safety.

The factors that may warrant the use of an offset rural channelised left turn lane include:

- High through traffic volumes on the major road.
- High proportion/number of vehicles (particularly heavy vehicles) turning left from the major road.
- The capacity of the turning movements from the minor road and resultant delays to vehicles.
- Intersection geometry and sight lines.

A diagrammatic layout for the intersection is shown at Figure 4A-5.
Notes:
1. The left turn channelisation should comply with the layouts for CHL treatments at Section 8.2.4 or 8.2.5.
2. The offset from the adjacent through lane is determined based on the provision of MGSD as per Section 3.2.3.
3. Provision of cycle lanes through the intersection should be as per Section 8.2.6. The cycle lane width can be included within the calculated offset and may negate the need for any further offset.

8.3.1 Urban Basic Left-turn treatment (BAL)

Additions
Where a left turn is not permitted, a minimum kerb return radius of at least 0.5 m is to be designed. A right-angle in the kerb line is generally unacceptable, even in these circumstances as the arris is so prone to damage.

Where a left-turn is permitted, the minimum kerb return radius without a corner cut-off (which interferes with the adjoining property) is equal to the footway width provided. Such an arrangement is appropriate for cars and the occasional Single Unit truck (such as the garbage truck) provided that there is sufficient pavement width available for the turning path.

This arrangement can be used for the left-turn out of a local street into local and collector roads, especially if one-way conditions apply.

However, this layout is generally not acceptable at sub-arterial and arterial intersections. At such sites there may be a need to accommodate heavy vehicle turning movements. Appropriate arrangements are shown in Figures 8.8 and 8.9 of Austroads Guide to Road Design - Part 4A.

For left turn movements from the major road to the minor road it is preferable to provide a widened area using part of a parking lane and providing a parking limit.
8.3.6 Provision for cyclists at urban channelised treatments

**Additions**

Treatment options for left-turn lanes include:

- a crossing treatment close to the island gore (refer to Figures 5.4 and 10.1 in *Austroads Guide to Road Design - Part 4A*, or

- the weave right transition shown in the Figure C16.1 in Commentary 16, *Austroads Guide to Road Design - Part 4A*.

A multi-lane left-turn roadway requires a signalised pedestrian crossing. In this case the associated provision of a bicycle crossing lantern with the pedestrian signals would be preferred over the weave right transition.

10 Signalised intersections

10.3.1 Traffic operation at an intersection

**Additions**

Complex intersections, such as fast diamonds, require additional consideration to ensure safe operation is maintained. Additional signal aspect redundancy ensures that drivers can see multiple operational traffic signals. The safety consequences may be high at these types of intersections when individual traffic signal aspects fail.

10.4 Sight distance

**Additions**

If the road alignment does not provide sufficient sight distance and the existing geometry cannot be adjusted, provision of advance warning signs or advance warning signals (e.g. flashing yellow lights) may be considered as a mitigating device.

10.5.1 General

**Additions**

In addition to the requirements for design of unsignalised intersections, the following guidance applies to signalised intersections:

- The layout of the intersection should provide for the optimum location of traffic signal hardware and appropriate clearance to this hardware. Median widths must be large enough to store traffic signal equipment.

- While appropriately balancing the needs of other geometric parameters, the distance that vehicle and pedestrian movements need to travel from the stop line to clear the intersection should be minimised. Longer distances require longer intergreen times to safely allow these movements to clear the intersection and thereby reduce the intersection capacity.

- Where it is desirable to use diamond phasing, appropriate clearance should be provided between right-turning movements (Refer to *Austroads Guide to Traffic Management - Part 6*).

- A late start interval may be used to delay the introduction of a green signal group at a controlled left-turn slip lane where there is a large corner island (instead of increasing the clearance interval for the entire signal group). This allows vehicles to clear the conflict area before the left-turn is introduced. Refer to Figure 4A-6.
• Medians and islands
  – Refer to Table 4A-4 below. The absolute minimum width of raised medians for two stage pedestrian mid-block crossings of 2.5 m is needed to store pedestrians; refer to Volume 3, Part 4, Section 8.2.2 of this Road Planning and Design Manual.

<table>
<thead>
<tr>
<th>Situation</th>
<th>Desirable (m)</th>
<th>Absolute (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No posts</td>
<td>1.2</td>
<td>0.9</td>
</tr>
<tr>
<td>Post with single 200 mm lanterns</td>
<td>2.4</td>
<td>1.2</td>
</tr>
<tr>
<td>Post with dual 200 mm lanterns</td>
<td>2.4</td>
<td>1.5</td>
</tr>
<tr>
<td>Two stage mid-block pedestrian crossing</td>
<td>4.0</td>
<td>2.5</td>
</tr>
</tbody>
</table>

– The use of wide medians reduces intersection capability because of increased clearance times for vehicle and pedestrian movements. For intersections with wide medians, consider staging pedestrian movements. Also, wide medians may cause the problem of interlocking opposing right-turn vehicles and therefore should be avoided.

### 10.5.2 Service road treatments

**Additions**

As an alternative to the treatments shown in Figure 10.3 of the Austroads Guide to Road Design - Part 4A, if space is available, the service road can be ‘bulbed’ to intersect the cross road at a distance from the intersection sufficient to form a separate intersection. This distance should be longer than the expected queue at the intersection or a minimum of 20 m (allows a semi-trailer to do a U-turn between inside lanes).
10.6.3 Pedestrian treatments

Additions

In addition, the following should be considered.

Pedestrian crossings on all intersection legs.

During planning of new signalised intersections the base case of traffic analysis should consider pedestrian crossings on all legs of the intersection. At some intersections it may be desirable to only include pedestrian crossings on three legs due to every vehicle phase resulting in movements across a single leg. In these cases, pedestrians can still access all corners of the intersection although some movements may require negotiating all three remaining legs of the intersection. However, in many cases the inclusion of a pedestrian crossing on the fourth leg may have minimal traffic impact.

Intersection of pedestrian crossings

Where two pedestrian crossings meet, the intersection point of the outside edges should be no more than 1 m from the face of the kerb. This is to minimise conflicts by pedestrians in separate phases and to deter pedestrians from waiting on the road pavement. Refer to Figure 4A-7.

Figure 4A-7 - Intersection of pedestrian crossings

Median islands

When a pedestrian crossing is provided, the median should preferably terminate at the crossing unless a gap in the median as wide as the crossing is provided and the median continued for at least 2 m beyond the crossing. Refer to Figure 4A-8 below.
Queensland road rules require drivers to give way to pedestrians crossing a left-turn slip lane regardless of whether a pedestrian crossing is established or not. Use of pedestrian crossings at slip lanes may dilute knowledge of this road rule. However, vision impaired pedestrians have great difficulty crossing slip lanes because the road rule is rarely complied with in practice. Refer to Transport and Main Roads TRUM to assess the warrant for a zebra crossing located on a left-turn slip lane.

The preferred treatment to minimise the consequences of a possible pedestrian/vehicle conflict with turning vehicles is shown in Figure 4A-9. The side street phase pedestrian movement may be protected if required.
**10.6.4 Cyclist facilities**

*Additions*

*Detector loops*

Where a bicycle lane is to be retrofitted through an existing signalised intersection the position of existing detector loops is to be established. Reinstallation of the loops may be required depending on the proposed lateral shift of traffic lanes induced by the bicycle lane.

*Bicycle lane widths*

The width of stand up lanes at signalised intersections are to be as required by the speed environment, in accordance with Table 4.17 of Austroads Guide to Road Design - Part 3.

*Head start and bicycle storage areas*

Use of head start and bicycle storage areas should to be considered when upgrading or retrofitting signalised intersections. Bicycle storage areas should be considered where there is a signal controlled left-turn lane, coupled with high volumes of left-turning vehicles, buses or heavy vehicles.
Head start areas across multiple lanes as shown in Figure 10.10(d) of *Austroads Guide to Road Design - Part 4A* are not to be used in Queensland on state controlled roads.

**Right-turn bicycle lanes**

Where right-turn bicycle lanes are provided, it is assumed that alternative paths through the intersection will be provided for younger and less experienced cyclists. It is considered that bicycle hook turns and/or bicycle crossing signals would cater for less experienced cyclists.

**Bicycle paths**

Where a bicycle path forms one of the arms of a signalised junction, loop detectors, provided sufficiently in advance, can trigger the appropriate phase at the signals with minimal delay to a cyclist using the path.

**Inter-green times**

On particularly long intersections (e.g. single point diamond) a check of inter-green time should be made to ensure an on-road cyclist can clear the intersection.

Notes to Figure 10.10 of *Austroads Guide to Road Design - Part 4A*:

- LHS = 3 m minimum, 4 m to 5 m desirable.
- Treatment (b): The left-turn phase must occur at the same times at the through traffic phase to avoid conflicts between left turning vehicles and cyclists stopped in the storage box.
- Treatment (d): Hook turns can be completed by cyclists at any intersection unless otherwise signed. The painted hook turn storage box is intended to make cyclists aware of the alternative right-turn method available and indicate the appropriate location to wait. Installation of a painted hook turn storage box is recommended where cyclists would need to cross two or more through traffic lanes to access a right-turn lane. Installation of a bicycle detection loop under the painted hook turn storage area should be considered if the side street signal phase is only activated on demand and it is estimated that a cyclist could have a lengthy wait before a vehicle would arrive to activate the side street the phase. For hook turns to work effectively the traffic signal phase should progress clockwise around the intersection.
- Treatment (d): Head start/bicycle storage areas across multiple traffic lanes are not recommended. The provision of head start/bicycle storage box areas with multiple traffic lanes may result in some cyclists crossing in front of lanes at the commencement of the green phase, causing potential safety problems (particularly when it is possible for visibility of cyclists to be obscured by large vehicles). Head start/bicycle storage areas may also allow for an early release bicycle phase if required (only to be used as defined in *Austroads Guide to Road Design - Part 4A*, in low speed areas).
References

Transport and Main Roads publication references refer to the latest published document on the departmental website (www.tmr.qld.gov.au).

Additions


Sullivan DP and Arndt OK (2014) Additional Warrants for Unsignalised Intersection Turn Treatments, Transport and Main Roads Internal Report No. 201311SU, Brisbane, QLD

Transport and Main Roads Cycling Infrastructure Policy, Brisbane, QLD

Transport and Main Roads Guidelines for Road Design on Brownfields Sites, Brisbane, QLD

Transport and Main Roads Manual of Uniform Traffic Control Devices, Brisbane, QLD

Transport and Main Roads TC Signs, Brisbane, QLD

Transport and Main Roads Technical information for Cycling – Cycle notes, Brisbane, QLD

Transport and Main Roads Traffic and Road Use Management Manual (TRUM), Brisbane, QLD
Appendix A - Extended Design Domain (EDD) for intersections

A.2.2  **Base and check cases**

**Differences**

In *Austroads Guide to Road Design - Part 4A*, Table A1 Case types used for EDD sight distance, the case descriptions for “Truck-day” and for “Truck-night are replaced with the following:

<table>
<thead>
<tr>
<th>Case Type</th>
<th>Case Code</th>
<th>Case description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base case (mandatory application)</td>
<td>Truck-day</td>
<td>Truck driver travelling at the 85th percentile truck speed in daylight hours</td>
</tr>
<tr>
<td>Check case (ensure that adequate capability exists under these conditions, as relevant)</td>
<td>Truck-night</td>
<td>Truck driver travelling at the 85th percentile truck speed on an unlit roadway at night</td>
</tr>
</tbody>
</table>

A.2.5  **EDD Safe Intersection Sight Distance (SISD)**

**Differences**

Delete the word “only” in the second sentence in third dot point, *Longitudinal Deceleration*, to read “Dry weather stopping is not used under SISD….”

In Table A9 of *Austroads Guide to Road Design - Part 4A*, “Mean Nght” should read “Mean Night” in the last row of the second column.

A.6  **EDD treatment of a constrained left-turn radius**

**Additions**

The following figures, 4A-A 1 and 4A-A 2 present EDD layouts for BAL turn treatment subject to constraints. These treatments allow for heavy vehicle encroachment onto adjacent lanes when making left turns into or out of the minor road.
Figure 4A-A 1 - Basic EDD Left Turn Treatment (BAL) on an urban road

Notes:

1. Where approach is two lanes or more in widths, heavy vehicles (12.5 m long or more) must turn from the kerbside or adjacent lane, unless otherwise controlled by signs and pavement arrows.

2. Where side street approach and/or departure is not used by vehicles over 12.5 m long, a turning path for a bus/truck may be used.

3. This diagram does not show any specific bicycle facilities. Where specific bicycle facilities are required (e.g. exclusive bicycle lanes), refer Austroads (2011).
Figure 4A-A 2 - Basic Left Turn Treatment (BAL) on a rural road, side road < 50vpd AADT

Notes:

1. Minimum distance between outer edge of the swept path and the edge of formation is to be 2.5 m to allow for situations where a vehicle arrives during the large vehicle turning movement and attempts to continue to pass.

2. Layout not to be used when:
   - Annual Average Daily Traffic (AADT) of the side road is more than 50 vehicles/day
   - AADT of the major road is more than 500 vehicles/day
   - there are significant volumes of articulated vehicles (more than about one turning articulated vehicle per day)
   - it is associated with other minimum criteria (e.g. sight distance restricts or tight horizontal curves).

3. This figure shows EDD Swept Paths only. All other dimensions are shown at Figure 8.2 of Austroads Guide to Road Design - Part 4A.

A.10 EDD warrants for intersection turn treatments

There is no equivalent Section A.10 in Austroads Guide to Road Design - Part 4A.

New

The EDD warrants for determining the preferred intersection turn treatment (refer Figure 4A–A 3) represent alternative design criteria for application at sites subject to site constraints or where the costs of the intersection upgrade are considered impractical. These criteria can therefore be considered for application at brownfields sites where construction costs are higher due to the as-hoc nature of the works and the management of traffic.

These warrants apply to two-lane two-way roads (2L2W) and can be applied for 4L2W and 6L2W roads. MNR intersection types, as discussed in Section 2.2.2 of Austroads Guide to Traffic Management - Part 6, may be retained at these intersections subject to a Design Exception evaluation. SR/SL turn treatments are described in Section 4.8.
The EDD Warrants should be applied to NDD turn treatment layouts. Only in extreme constrained situations should the EDD Warrants be combined with the EDD turn treatment layouts. The combination of the two EDD elements should be treated as a design exception.

The warrants in Figure 4A-A 3 are based on achieving a specific level of safety performance. An evaluation of the operational performance of the intersection should also be undertaken. If the operational performance indicates a higher level treatment is needed, then it should be adopted in lieu of the warrants in Figure 4A-A 3.

Further commentary on the methodology behind these warrants is provided at Commentary 17.
Figure 4A-A 3 - Warrants - major road turn treatments - Extended Design Domain

* - the minimum right turn treatment for multi-lane roads is a CHR(s)

Figures 4A-A 4(d), (e) and (f) respectively expand the view of the bottom left corner of diagrams(a), (b) and (c)
**Figure 4A-A 3 (continued)**

(expanded view of the bottom left corner of the warrants diagrams at 4A-A 3(a), (b) and (c))

* * - the minimum right turn treatment for multi-lane roads is a CHR(s)*
The following notes apply to the warrants in Figure 4A-A 3

1. Curve 1 - For 2L2W roads, curve 1 represents the boundary between a BAR and a CHR(S) turn treatment and between a BAL and an AUL(S) turn treatment. For 4/6L2W roads, curve 1 represents the boundary between a BAL and an AUL(S) turn treatment only. The minimum right turn treatment is a CHR(s) on 4/6L2W roads.

2. Curve 2 represents the boundary between a CHR(S) and a CHR turn treatment and between an AUL(S) and an AUL/CHL turn treatment. The choice of CHL over an AUL will depend on factors such as the need to change the give way rule in favour of other manoeuvres at the intersection and the need to define more appropriately the driving path by reducing the area of bitumen surfacing.

3. Curve 3 represents the boundary between a Simple Intersection Treatment and a BAR/BAL turn treatment for 2L2W roads only.

4. The warrants apply to turning movements from the major road only (the road with priority). For turns from the minor road, turn treatments are determined through an operational performance evaluation applying gap acceptance analysis and an evaluation of acceptable delays and queues.

5. \( Q_M \)
   a) For 2L2W roads, Figure 4A-A 4 is to be used to calculate the value of the major road traffic volume parameter \( (Q_M) \) and is the total through traffic flow in both directions \( (Q_{T1} + Q_{T2}) \).
   b) For 4/6L2W roads, the major road traffic volume parameter \( (Q_M) \) for right turns uses the full opposing flow \( Q_{T2} \) and only the traffic flow in the nearest lane of the following flow \( Q_{T1} \) as per Figure 4A-A 4. For left turns the major road traffic volume parameter \( (Q_M) \) uses only the traffic flow in the leftmost through lane of the following flow \( Q_{T2} \).

\[ \text{Figure 4A-A 4 - Calculation of the major road traffic volume parameter ‘} Q_M \text{‘} \]

<table>
<thead>
<tr>
<th>Road Type</th>
<th>Turn Type</th>
<th>Splitter Island</th>
<th>( Q_M ) (veh/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Lane 2 Way</td>
<td>Right</td>
<td>No</td>
<td>( = Q_{T1} + Q_{T2} + Q_L )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>( = Q_{T1} + Q_{T2} )</td>
</tr>
<tr>
<td></td>
<td>Left</td>
<td>Yes/No</td>
<td>( = Q_{T2} )</td>
</tr>
<tr>
<td>4 Lane 2 Way</td>
<td>Right</td>
<td>No</td>
<td>( = 50% \times Q_{T1} + Q_{T2} + Q_L )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>( = 50% \times Q_{T1} + Q_{T2} )</td>
</tr>
<tr>
<td></td>
<td>Left</td>
<td>Yes/No</td>
<td>( = 50% \times Q_{T2} )</td>
</tr>
<tr>
<td>6 Lane 2 Way</td>
<td>Right</td>
<td>No</td>
<td>( = 33% \times Q_{T1} + Q_{T2} + Q_L )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>( = 33% \times Q_{T1} + Q_{T2} )</td>
</tr>
<tr>
<td></td>
<td>Left</td>
<td>Yes/No</td>
<td>( = 33% \times Q_{T2} )</td>
</tr>
</tbody>
</table>

6. Traffic flows applicable to the warrants are peak hour flows, with each vehicle counted as one unit (i.e. do not use equivalent passenger car units [pcus]). Where peak hour volumes or peak hour percentages are not available, assume that the design peak hour volume equals 15% of the AADT for 500 hours each year, use 5% of the AADT for the rest of the year.
7. If more than 50% of the traffic approaching on a major road leg turns left or right, consideration needs to be given to possible realignment of the intersection to suit the major traffic movement. The shaded area (A) denotes the traffic flow combinations where this occurs. However, route continuity issues must also be considered (for example, realigning a highway to suit the major traffic movement into and out of a side road would be unlikely to meet driver expectation).

8. If a turn is associated with other geometric minima, consideration should be given to the adoption of a turn treatment of a higher order than that indicated by the warrants.

9. At higher traffic volumes, consideration should also be given to the operational performance of the intersection which may require a higher level turn treatment, or alternative intersection control, than required by these warrants based on crash analysis.
Appendix C - Truck stability at intersections

C.2 Lateral friction force on vehicles

Differences

Figure C 1 of the Austroads Guide to Road Design - Part 4A is accepted for use up and including speeds of 50 km/h. Transport and Main Roads is aware of additional research work which suggests alternative Lateral Friction Factors for trucks at speeds above 50 km/h. In this guide, speeds above 50 km/h are not considered generally appropriate for the truck design speed for turning movements. Where designs are based on truck turning speeds greater than 50 km/h, specialist input should be sought and reference should be made to Volume 3, Part 3 of this Road Planning and Design Manual.
Appendix F - Basic Left-Turn (BAL) layouts at rural intersections

There is no equivalent Appendix F in *Austroads Guide to Road Design - Part 4A*.

**New**

This appendix provides set-out details to cater for various design vehicles at rural BAL turn treatments.

Figure 4A-F 1 - Details of type “BAL” layout for rural sites to suit B-double operation

---

This intersection treatment is for low volume conditions.

B-double, Prime Mover & Semi-Trailer and large SU Truck:

These have a satisfactory observation angle when stopped at the Give Way/Stop Line.

Small SU Truck:

Will describe a larger turning radius than a B-double. More difficult observation angle when stopped at the Give Way/Stop Line but low volumes and observation angle prior to the line means gap assessment is rarely a problem.

---

Observation Angle Assumptions

**Cars:**

Will describe a much larger turning radius due to available space.

Position A - satisfactory observation angle provided no object blocks the sight line.

Position B - difficult observation angle but low volumes means gap assessment is rarely a problem.

Position C - satisfactory observation by mirror, aided by low volumes and assessment at previous positions.
Figure 4A-F 2 - Details of type “BAL” layout for rural sites to suit type 1 (double) road train operation

This intersection treatment is for low volume conditions by virtue of rural conditions and road train operation.

Road Train, B-double, Prime Mover & Semi-Trailer: These have a satisfactory observation angle when stopped at the Give Way/Stop Line.

SU truck: Will describe a larger turning radius than a road train. More difficult observation angle when stopped at the Give Way/Stop Line but low volumes and observation angle prior to the line means gap assessment is rarely a problem.

Cars: Will describe a much larger turning radius due to available space.

Position A – satisfactory observation angle provided no object blocks the sight line.

Position B – difficult observation angle but low volumes means gap assessment is rarely a problem.

Position C – satisfactory observation by mirror, aided by low volumes and assessment at previous positions.

Observation Angle Assumptions
Figure 4A-F 3 - Details of type “BAL” layout for rural sites to suit type 2 (triple) road train operation

This intersection treatment is for low volume conditions by virtue of rural conditions and road train operation.

Road Train & B—double: Those have a satisfactory observation angle when stopped at the Give Way/Stop Line.

Prime Mover & Semi-trailer and SU truck: Will describe a slightly larger turning radius than a road train. More difficult observation angle when stopped at the Give Way/Stop Line but low volumes and observation angle prior to the line means gap assessment is rarely a problem.

Cars:
Will describe a much larger turning radius due to available space.

Position A — satisfactory observation angle provided no object blocks the sight line.

Position B — difficult observation angle but low volumes means gap assessment is rarely a problem.

Position C — satisfactory observation by mirror, aided by low volumes and assessment at previous positions.

Observation Angle Assumptions
Commentary 17

There is no equivalent Commentary 17 in Austroads Guide to Road Design - Part 4A.

New

Section 4.8 of this document details NDD warrants for selection of intersection turn treatments at unsignalised intersections. Appendix A.10 provides details the respective EDD warrants. Both of these sets of warrants are based on the mathematical relationships described in this Commentary.

In highly constrained circumstances, the mathematical approach in this section may be used to undertake a more detailed calculation based on site specific factors including the site specific construction cost estimate for each level of turn treatment and the historical crash rate. This resultant BCR assessment can then be used to evaluate the possible design exception.

The safety benefits, determined from the reduction in estimated accident costs, are estimated for using a higher order left or right-turn treatment as calculated in Equation 4A–17.1.

\[
C_{RM} = 2.75 \times 10^{-12} \times C_A \times T_{DL} \times Q_i^{0.406} \times Q_M^{0.912} \times S_{MT}^{2.94} \times (e^{TTM} - e^{TTA}) \quad \text{(Equation 4A–17.1)}
\]

Where:

- \( C_{RM} \) = safety benefit of using the higher order turn treatment ($)
- \( C_A \) = average cost of a Rear-End-Major vehicle accident = $38,974 from Arndt (2004)
- \( T_{DL} \) = design life (years)
- \( Q_i \) = turning traffic flow from the major leg (veh/h) (QR or QL as per Figure 4A A 4)
- \( Q_M \) = traffic flow (veh/h) on the major legs according to Figure 4A A 4
- \( S_{MT} \) = 85th percentile through major road speed (km/h)
- \( TTM \) = type of lower-order turn treatment (values given below)
- \( TTA \) = type of higher-order turn treatment (values given below)

\[
\begin{align*}
\text{MNR} &= 4.59, \text{BAR}=3.83, \text{CHR(S)} & \text{& CHR}=0.00, \text{BAL}=0.666, \text{AUL(S)} & \text{& AUL}=0.0493
\end{align*}
\]

Example Calculation

The safety benefit of providing a CHR turn treatment in lieu of an existing BAR turn treatment for the following conditions:

Design life \( T_{DL} \) = 10 years
Design right-turn traffic flow \( QR \) = 60 veh/h
No splitter island opposite the right turn
Design approaching through traffic flow \( QT_1 \) = 190 veh/h
Design opposing through traffic flow \( QT_2 \) = 200 veh/h
Design opposing left-turn traffic flow \( QL \) = 50 veh/h
85th percentile through speed \( S_{MT} \) = 70 km/h

Answer

\[
Q_M = QT_1 + QT_2 + QL = 190 + 200 + 50 = 440 \text{ veh/h from Figure 4A-A 4 (for no splitter island).}
\]

Lower-order turn treatment \( TTM \) = 3.83 for a BAR
Higher-order turn treatment \( TTA \) = 0 for a CHR

Using Equation 4.8.1:

\[
C_{RM} = 2.75 \times 10^{-12} \times 38974 \times 10 \times 60^{0.406} \times 440^{0.912} \times 70^{2.94} \times (e^{3.83} - e^0)
\]

\[
= 17,429
\]