The ‘Design Manual for Roads & Bridges’ (DMRB) outlines the mandatory requirements for a ghost island right-turn lane at priority T-junctions on trunk roads, based on a threshold for minor road traffic flow of 500 vehicles per day (TD 42/95). However, more recent guidance for local roads, in the form of ‘Manual for Streets 2’, acknowledges that junctions without ghost island provision "will often be able to cater for higher levels of turning traffic without resulting in significant congestion".

This research seeks to establish more applicable guidance for local roads, specifically studying urban junctions with a 30mph speed limit and built up environs. Building upon a review of previous research projects, this study includes a detailed assessment of the two key design considerations relating to the provision of ghost islands: junction operation and road safety. The respective empirical traffic capacity, delay and accident prediction models that are incorporated into the PICADY software programme have been utilised to assess these key design factors with respect to the provision of ghost islands.

**Figure 1: Ghost Island T-Junction Layout**

The operation of the two junction types has been assessed utilising the empirical traffic capacity model developed by Kimber & Coombe (1980), as well as the vehicle delay model developed by Kimber & Hollis (1979). These models are incorporated into the PICADY software programme, which has been utilised to undertake detailed junction operation assessments, as summarised below:

- Two simple priority T-junction layouts and two ghost island priority T-junction layouts have been assessed. The adopted geometric parameters for these junction layouts have been defined to represent typical values for urban priority T-junctions.
- The four junction layout models have been tested against 25 traffic flow scenarios, with a mix of major road traffic flows, minor road traffic flows, and turning proportions.
• The results indicate that the capacity levels for the minor road traffic streams are generally consistent across the low and medium major road flow scenarios for the assessed junction layouts. The vehicle delay results are consistent with the patterns highlighted by the capacity modelling, with lower traffic capacities corresponding to commensurately longer queues and delays.

• There are not expected to be any capacity, delay or congestion issues at simple junctions for the estimated level of peak hour traffic flows that correspond with the DMRB threshold for a ghost island (500 two-way minor road AADT), with a maximum RFC of 4%, which is comfortably below the 85% level that is widely adopted as an indicator of satisfactory junction operation. This appears to confirm the view expressed in ‘Manual for Streets 2’ (CIHT, 2010), with the modelling results suggesting that a simple junction would generally be expected to operate without significant congestion for peak hour major road flows of up to 1,000 two-way (AADT of approximately 11,750).

![Diagram of junction layouts](image)

**Figure 2: Peak Hour Representation of the DMRB Ghost Island Threshold**

The road safety performance of the two junction types has been analysed through use of the collision prediction model developed empirically by Summersgill et al. (1996), and through comparison of recent STATS19 data collision records at a sample of each junction type, as summarised below:

• The four junction layouts and 25 traffic scenarios assessed as part of the junction operation assessment have been tested utilising the urban collision prediction model of Summersgill et al. (1996), which is incorporated into PICADY.

• This collision model doesn't specifically assess whether there is a ghost island or not, but rather it utilises geometric parameters such as carriageway width and hatching width that can indirectly represent a ghost island. Therefore, suitable values for the input parameters have been defined to represent the typical urban situation, taken from relevant sources of information.

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• It is acknowledged that the collision frequencies derived by Summersgill et al. (1996) are based on collisions records in the 1980s, and as such are unlikely to be representative of current and future collision frequencies. Therefore, changes in road safety records have been assessed, with all results presented in this report based on the expected collision values in the most recent 5 year period of 2009/13, calculated using an appropriate scaling factor.
• The results highlight that the ghost island layout is expected to result in higher collision frequencies than both of the simple junction layouts for all combinations of major/minor road traffic flow and turning proportions.
• Against one of the simple junction layouts, the ghost island layout would be expected to increase the number of PICs per annum by a mean of 15.9% across the 25 assessed traffic scenarios, with a mean increase of 16.9% against the other simple junction layout.
• The collision prediction model provides a detailed breakdown of the collision types, analysis of which highlights that there is not predicted to be a difference in road safety performance between simple and ghost island junctions for the majority of collision types (12 of the 16 categories).
• Ghost islands are not expected to reduce the collision frequency relative to simple junctions of any of the 16 collision types, for any of the 25 tested scenarios, with at best a nil detriment outcome.
• The most recent available collision data has been assessed for 10 sample ghost island and 10 sample simple urban priority T-junctions. Overall, this research indicates that the number of collisions at each junction type was the same (29 PICs at simple junctions, 29 PICs at ghost island junctions), also with an identical severity ratio of 17.2%.
• Detailed investigation of individual collision records found some apparent patterns emerging:
  o The most frequently occurring collision type involved a vehicle turning right from the minor road (stream B-A) colliding with vehicles travelling straight ahead on the major road from the right (stream A-C).
  o There were notably fewer collisions involving vehicles turning right from the major road when a ghost island was present, although this appears to correspond to an increase in rear shunts on the arm approaching the ghost island lane.
  o There were a number of collisions that were seemingly unrelated to movements at the junction, with a variety of circumstances (e.g. parked vehicles).
• The results from the assessment of sample junctions appear to indicate that there is no difference in road safety performance between the two junction types, although it is acknowledged that there are severe constraints on the robustness of any conclusions drawn from this analysis. It is therefore considered that the results based on the Summersgill et al. (1996) are more robust.
The results of the research appear to indicate that ghost islands can provide capacity and delay benefits with respect to non-priority major road traffic, relative to a simple junction. However, the overall operation of a junction can be primarily influenced by the level of capacity and delay for the non-priority minor road traffic, and the results show that ghost islands can increase delays for this stream during the majority of the assessed scenarios. So ghost islands would be preferred to simple junctions for some traffic patterns, with the converse true for others, in terms of capacity and delay implications.

Recommendations on the type of priority T-junction for the different assessed level of traffic flow and turning proportions have been derived from these junction operation results, as illustrated in Table 1:

**Table 1: Recommended Priority T-Junction Form**

<table>
<thead>
<tr>
<th>Major Road Peak Hour Entry Flow</th>
<th>Minor Road Peak Hour Entry Flow</th>
<th>Typical Turning Proportions (75/25)</th>
<th>Heavy Turning Proportions (50/50)</th>
<th>Low Turning Proportions (90/10)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>6.0m Major</td>
<td>7.3m Major</td>
<td>6.0m Major</td>
</tr>
<tr>
<td>800</td>
<td>250</td>
<td>Other</td>
<td>Other</td>
<td>Other</td>
</tr>
<tr>
<td>800</td>
<td>150</td>
<td>Ghost</td>
<td>Ghost</td>
<td>Other</td>
</tr>
<tr>
<td>800</td>
<td>50</td>
<td>Ghost</td>
<td>Ghost</td>
<td>Other</td>
</tr>
<tr>
<td>500</td>
<td>250</td>
<td>Ghost</td>
<td>Simple</td>
<td>Ghost</td>
</tr>
<tr>
<td>500</td>
<td>150</td>
<td>Simple</td>
<td>Simple</td>
<td>Simple</td>
</tr>
<tr>
<td>500</td>
<td>50</td>
<td>Simple</td>
<td>Simple</td>
<td>Simple</td>
</tr>
<tr>
<td>200</td>
<td>150</td>
<td>Simple</td>
<td>Simple</td>
<td>Simple</td>
</tr>
<tr>
<td>200</td>
<td>50</td>
<td>Simple</td>
<td>Simple</td>
<td>Simple</td>
</tr>
<tr>
<td>160</td>
<td>10</td>
<td>Simple</td>
<td>Simple</td>
<td>Simple</td>
</tr>
</tbody>
</table>

In terms of road safety, the research indicates that ghost islands are likely to increase the number of collisions at a priority T-junction. There is, therefore, a strong case that ghost islands should not be provided at urban priority T-junctions on road safety grounds. On a site-by-site basis, a detailed economic appraisal would help balance the possible benefits in terms of reduced delay, against the expected disbenefits in terms of collision costs. However, this analysis would need to carefully consider whether the junction is new or existing, and also whether a public or private organisation would be funding the works, as the implications of a cost-benefit analysis is likely to vary for these different contexts.

Overall, it is considered that the recommendations outlined in Table 1 relating to junction operation are a suitable starting point when considering whether to provide a ghost island at an urban priority T-junction on a non-trunk road.