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# Guide to Traffic Management Part 12

## Traffic Impacts of Developments



# **Guide to Traffic Management Part 12: Traffic Impacts of Developments**



*Austroads*

Sydney 2016

## Guide to Traffic Management Part 12: Traffic Impacts of Developments

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### Abstract

The Austroads *Guide to Traffic Management* has 13 parts and provides a comprehensive coverage of traffic management guidance for practitioners involved in traffic engineering, road design, town planning and road safety.

*Part 12: Traffic Impacts of Developments* is concerned with identifying and managing the impacts on the road system arising from land use developments. It provides guidance for planners and engineers associated with the design, development and management of a variety of land use developments. The aim is to ensure consistency in the assessment and treatment of traffic impacts, including addressing the needs of all road users and the effect upon the broader community.

Part 12 presents the land use and transport planning context for traffic impact assessment, including travel demand, safety, parking and access management issues. It provides guidance on the need and criteria for impact assessments, and a detailed procedure for identifying and assessing the traffic impacts, and mitigating their effects. Assessment of safety, infrastructure and environmental effects is also covered. Examples are given of checklists, report structures, traffic generation rates and case study projects.

### Keywords

Traffic management, developments, traffic impacts, transport planning, town planning, planning schemes, travel demand management, sustainable development, traffic planning, road network planning, access, traffic impact assessment, traffic impact assessment, traffic generation, trip generation, land use, development

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**Austroads**

### About Austroads

Austroads is the peak organisation of Australasian road transport and traffic agencies.

Austroads' purpose is to support our member organisations to deliver an improved Australasian road transport network. To succeed in this task, we undertake leading-edge road and transport research which underpins our input to policy development and published guidance on the design, construction and management of the road network and its associated infrastructure.

Austroads provides a collective approach that delivers value for money, encourages shared knowledge and drives consistency for road users.

Austroads is governed by a Board consisting of senior executive representatives from each of its eleven member organisations:

- Roads and Maritime Services New South Wales
- Roads Corporation Victoria
- Queensland Department of Transport and Main Roads
- Main Roads Western Australia
- Department of Planning, Transport and Infrastructure South Australia
- Department of State Growth Tasmania
- Department of Transport Northern Territory
- Transport Canberra and City Services Directorate, Australian Capital Territory
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# 1. Introduction

## 1.1 Purpose and Scope

This Guide helps traffic and transport practitioners identify and manage the impacts on the road system arising from land use developments. The impacts being considered are those directly affecting road use and road users of all classes, from large freight vehicles and buses to cyclists and pedestrians. Transport modes which run on separate alignments or are grade separated such as elevated bus rapid transit, heavy rail or metro rail are not directly considered. Specifically, guidance is given on how to:

- identify the types of traffic impacts and interactions which will result from a specific land use development proposal
- assess the size of those impacts
- determine how those impacts need to be managed, either within existing infrastructure or through the provision of additional infrastructure.

The outcome of these identifications, assessments and determinants are the elements of a *Traffic Impact Assessment (TIA)*. The TIA is usually presented as a report which provides the road agency, town-planning authority and others with an adequate understanding of the issues, and the actions required for the development to proceed.

It will also help road agencies and others to check and respond to reports on traffic impact assessments, for projects as varied as in the following examples:

- small single site commercial developments which generate customer traffic and goods vehicle movements
- large single site or single use commercial developments (including mines, tourism facilities) which generate customer traffic and goods vehicle movements
- multi-use commercial or retail developments, including small and large shopping centres, which require significant on-site traffic facilities
- residential subdivisions, whether for a limited number of lots or for a major expansion of an urban area
- industrial subdivisions.
- Within the context of the matters outlined above, the aim of the Guide is to ensure that:
- traffic impact assessment of developments is undertaken in a uniform manner leading to consistent treatment of similar developments
- the level of impact assessment is appropriate for the level of potential impacts
- a road or a road network continues to operate at an agreed level of service following the opening of a development
- both 'soft' solutions (e.g. road use management such as alternative routes) and 'hard' solutions (e.g. changes to infrastructure) are considered when mitigating impacts
- the needs of all road users are considered and appropriate facilities (e.g. bicycle lanes, footpaths, bus lanes, intersection widening or upgraded intersection controls) are provided
- a development is considered within its physical context and not in isolation from nearby features such as intersections, footpaths and other driveways
- road safety is treated as a first-class object in the planning process
- environmental impacts (both natural and built) are given due consideration.

Whilst the bulk of this work focuses on urban development, the principles espoused (together with any applicable jurisdictional guidance) are transferrable to non-urban developments such as quarries and mines (see Appendix E).

## 1.2 Context

The structure and content of the *Guide to Traffic Management* is presented in *Part 1: Introduction to Traffic Management* (Austroads 2015c). Table 1.1 summarises the 13 parts of the *Guide to Traffic Management*, several of which may need to be referred to when assessing a particular development. For example, when assessing larger developments practitioners may have to:

- consider network management implications (*Guide to Traffic Management Part 4* (Austroads 2016a))
- consider road management (mid-block) issues such as road space allocation on the surrounding network (*Guide to Traffic Management Part 5* (Austroads 2014a))
- develop traffic management arrangements for intersections and crossings (*Guide to Traffic Management Part 6* (Austroads 2013c))
- analyse the traffic performance of options (*Guide to Traffic Management Part 2, 3 and 9* (Austroads 2015d, 2013b, 2014b))
- develop traffic control, sign and marking schemes (*Guide to Traffic Management Part 10* (Austroads 2009d))
- consider parking requirements (*Guide to Traffic Management Part 11* (Austroads 2008b))
- manage the interface between the development and adjacent local areas (*Guide to Traffic Management Parts 7 and Part 8* (Austroads 2015e and 2008a)).

It is fair to say that without land use development there would be no need for road construction, transport systems or traffic management. In this sense the traffic impacts generated by development underpin the requirements for planning, designing and building transport infrastructure and associated systems.

Part 12 deals specifically with traffic management advice related to assessing the traffic impacts of individual developments. It is assumed that matters such as parking policy (e.g. meeting or constraining demand) have already been determined and the traffic impact assessment will take place within an established policy framework. See Section 1.3.3 for further discussion of the broader context.

Where there is a need to consider the impact of a development as part of a larger area, practitioners are referred to the *Guide to Traffic Management Part 7: Traffic Management in Activity Centres* (Austroads 2015e). Examples of activity centres include city and town centres, major commercial and transport hubs that are often situated around railway stations, traditional universities, hospitals, airports and sea ports.

Relevant references to other Austroads guides are given when appropriate. In some cases a brief discussion is included in the present document, for example to provide a summary of the planning context in which traffic assessments are undertaken.

The art of traffic management depends critically on the physical design of the roads being managed and contributes significantly to safety outcomes for all road users. Discussion of these topics has been by necessity, brief. Indeed, the *Guide to Traffic Management* should not be read in isolation; there are copious references to relevant material from both the *Guide to Road Design* (Austroads 2008–15a) and the *Guide to Road Safety* (Austroads 2006–15) throughout.

Table 1.1: Parts of the Guide to Traffic Management

Part	Title	Content
Part 1	Introduction to Traffic Management	<ul style="list-style-type: none"> <li>• Introduction to the discipline of traffic management.</li> <li>• Breadth of the subject and the relationship between the various parts of the guide.</li> </ul>
Part 2	Traffic Theory	<ul style="list-style-type: none"> <li>• An introduction to the characteristics of traffic flow and the theories, models and statistical distributions used to describe many traffic phenomena.</li> <li>• Processes that practitioners should consider.</li> </ul>
Part 3	Traffic Studies and Analysis	<ul style="list-style-type: none"> <li>• Traffic and transport data collection surveys and studies.</li> <li>• Traffic analysis for mid-block situations (including freeways/motorways).</li> <li>• Analysis of signalised and unsignalised intersections, including roundabouts.</li> </ul>
Part 4	Network Management	<ul style="list-style-type: none"> <li>• Broader issues and aspects of managing networks of roads to provide effective traffic management for all road users.</li> <li>• Network needs of freight, public transport, pedestrians, cyclists and private motor vehicles.</li> <li>• Guidance on transport networks and network operation planning.</li> </ul>
Part 5	Road Management	<ul style="list-style-type: none"> <li>• Guidance on managing mid-block traffic conditions.</li> <li>• Good practice for access management, allocation of space to various road users, lane management.</li> <li>• Application of speed limits.</li> </ul>
Part 6	Intersections, Interchanges and Crossings	<ul style="list-style-type: none"> <li>• Types of intersection and selection of intersection type.</li> <li>• Appropriate use and design of various intersection types.</li> <li>• Traffic management issues and treatments for intersections, interchanges and other crossings.</li> </ul>
Part 7	Traffic Management in Activity Centres	<ul style="list-style-type: none"> <li>• Principles for planning the management of traffic in activity centres and associated transport nodes.</li> <li>• Techniques for traffic management in activity centres.</li> <li>• Examples and key considerations for various types of centres.</li> </ul>
Part 8	Local Area Traffic Management	<ul style="list-style-type: none"> <li>• Planning and management of road space in a local area.</li> <li>• Guidance on selection, design, application and effectiveness of traffic control measures on an area-wide or at least whole-of-street basis.</li> </ul>
Part 9	Traffic Operations	<ul style="list-style-type: none"> <li>• Applications used in traffic operations.</li> <li>• System configuration and operation guidance.</li> <li>• Current practice for common systems including network monitoring, traffic signals, congestion management, incident management, freeway/motorway management and traveller information.</li> <li>• Related systems integration and interoperability issues.</li> </ul>
Part 10	Traffic Control and Communication Devices	<ul style="list-style-type: none"> <li>• Signing and marking schemes.</li> <li>• Traffic signs, static and electronic.</li> <li>• Pavement markings and delineation.</li> <li>• Traffic signals and islands.</li> </ul>
Part 11	Parking	<ul style="list-style-type: none"> <li>• Parking policy.</li> <li>• Demand and supply.</li> <li>• On-street and off-street.</li> <li>• Parking guidance and control devices.</li> </ul>
Part 12	Traffic Impacts of Developments	<ul style="list-style-type: none"> <li>• <b>Guidance on the need and criteria for impact assessment.</b></li> <li>• <b>Detailed procedure for identifying and assessing traffic impacts and mitigating their effects.</b></li> <li>• <b>Assessment of safety, infrastructure and environmental effects.</b></li> </ul>
Part 13	Road Environment Safety	<ul style="list-style-type: none"> <li>• Principles and management of the safety of road environments within a traffic management context.</li> <li>• Links to relevant sections of the <i>Guide to Road Design</i> and <i>Guide to Road Safety</i>.</li> </ul>

## 1.3 Traffic Impacts and Developments

### 1.3.1 Why Assess the Traffic Impacts of Developments?

Road agencies are responsible for the safe and efficient management of road networks. Land use developments (henceforth referred to simply as 'developments') generate traffic movements as people move to, from and within the development. Without a clear picture of the type of traffic movements (e.g. cars, pedestrians, cyclists, trucks, etc.) or their scale, timing and location, there is a risk that these traffic movements may contribute to safety problems, induce congestion or cause other issues where the development connects to the road system, or elsewhere on the road network.

Potential impacts are not only the direct and obvious ones such as congestion or crashes at an entrance driveway. They may include:

- amenity impacts on local communities (e.g. excessive traffic on minor streets)
- increased traffic many kilometres away from a development, especially in the case of remote developments such as mines
- road safety impacts some distance from the development
- greater demands placed on existing and future transport networks (including on-road public transport, pedestrian and bicycle facilities)
- reduced operational efficiency of roads near to and approaching the proposed development
- the degree to which the development or its traffic and transport impacts align with government objectives.

All potentially affected modes of transport need to be considered.

### 1.3.2 Considering the Type and Scale of a Development

Developments vary from small establishments that generate relatively little traffic to large retail, commercial, industrial or residential developments that generate large volumes of traffic. Consequently, access requirements can vary from minor alterations to an existing driveway to substantial roadworks or new road links.

The extent of a traffic impact assessment will vary according to the scale of the development. Some developments require major traffic assessment, whereas others may require only a brief traffic impact statement (see Sections 4.1 and 4.2 for details). Similarly, it is important to recognise that developments occur in a variety of situations that require different types of analysis and treatment, for example:

- greenfield sites in rural or outer urban areas may require a different assessment to that required at 'brownfield' ('recycled' and often constrained) sites
- inner urban sites can be different from middle suburb sites
- variance between rural and urban sites due to differing traffic volumes and speeds
- residential developments typically have different issues from commercial developments or industrial developments – and the latter ones are different again.

### 1.3.3 Traffic Impact Assessments in Context

For many developments, the traffic impacts and the options for accommodating the generated movement of people and goods cannot be considered in isolation from government planning and transport policies, and strategies. These policies and strategies provide a framework within which the matters in this Guide need to be considered.

In the broadest context, transport planning involves the setting of objectives, the development of policy, system planning and the identification of infrastructure and non-infrastructure initiatives. Community objectives or whole-of-government objectives are an important part of the process as they recognise the relationships between transport systems, environmental issues and health (refer to the Austroads *Guide to Road Transport Planning* (Austroads 2009c)). These objectives may include encouraging the use of non-motorised transport modes and public transport, enhancing sustainability and improving air quality.

Transport planning takes place at several levels that may be described as:

- multi-modal network or regional planning
- area or corridor planning
- route or link planning.

Planning in general and transport planning in particular sets the scene for traffic impact assessment through land use policy, parking policy and various strategies and plans that determine the accessibility within and through an area – and the transport modes that will provide that accessibility. It is not the purpose of this Guide to provide guidance on transport planning.

## 2. Setting The Scene for Traffic Impact Assessments

This section provides some background information on town planning (otherwise referred to as land use planning), transport planning, traffic planning, planning for on-road public transport and thinking ahead about road safety using a Safe System approach (Australian Transport Council 2011) as an integral part of the planning process (Austroads 2015f). Transport efficiency and safety should be basic considerations for town planning and transport planning (Welle et al. 2015).

### 2.1 Transport and Town Planning

#### 2.1.1 Planning Schemes and Transport

Management of the use of land occurs through planning schemes. A planning scheme is a legal document established under town planning legislation (typically state or territory legislation in Australia and at regional council level in New Zealand). Planning schemes set out policies and provisions for the use, development and protection of land. Each local government area (LGA) in Australia is covered by a planning scheme. Whilst planning schemes are prepared individually by each LGA (or in some cases by a regional planning authority), they usually have provisions mandated by state and territory governments to ensure that issues of national, state or territory significance are dealt with consistently.

Planning schemes typically include:

- maps showing how all public and private land is zoned
- map-based information about where specific protection requirements apply
- written requirements of the scheme, such as policies, standards and codes of practice.

Land use zones ensure land use activities are appropriately grouped to minimise land use conflicts. Arterial roads or other traffic routes are often included in planning schemes as specific zones. In some cases, local streets are included in the adjoining land use zone (e.g. residential).

Because of the impacts that adjacent land uses and proposed developments can have on the efficiency and safety of arterial roads, governments generally have legislation or policies that require planning consent authorities to refer planning and development proposals that will impact on arterial roads to the relevant road agencies.

The fundamental interaction between land use development and transport is typically recognised in local and regional planning strategies by adopting objectives such as local self-containment, which seek to inhibit intra-regional or inter-centre travel in the interests of sustainable development.

#### 2.1.2 Planning Processes

Planning processes typically consist of:

- preparing a planning scheme, which sets out on maps and in written descriptions and requirements how land may be used and developed
- adoption of the planning scheme as a legal document
- amendments to the planning scheme from time to time
- application by a developer to the planning authority for a new or changed use of an area of land, or a new or changed access to a road
- consideration of the application by the planning authority, taking account of the details in the planning scheme, applicable policies, submissions by experts and other information

- referral of the application to a potentially affected road agency and other potentially affected authorities for comment, and setting conditions of approval including any infrastructure charges that will be incurred
- consultation with parties affected by the proposal in the application
- a decision by the planning authority that the development application be agreed to, modified or refused
- the opportunity for appeal to a centralised state planning review body by the developer or a third party if the planning decision is disputed.

### 2.1.3 Transport Considerations

During consideration of both an application and any appeal, access to arterial roads or traffic impacts on local areas are often contested issues. Issues typically focus on the impacts on the adjacent road, the road network, or other modes (including modal split) created by:

- the type of development
- the scale, form or layout of the development
- the location and type of access onto adjacent roads.

Transport issues considered during these processes typically include:

- traffic safety at the access points, on the approach roads and within the site, for all likely groups of road users
- types of vehicles generated by the development and their impact on the existing network
- the suitability of the development for its location, considering the transport options available for potential users
- compatibility of the development and its access requirements with the traffic function of the adjacent road
- the impact on the wider road network, both arterial and local
- the likely use of public transport, cycling and walking instead of using motor vehicles for access (modal split)
- trip generation (both people and goods), especially peak generation periods (development and background traffic)
- traffic volume generation and its distribution and accommodation, including traffic capacity issues
- impact on pavements where development involves significant haulage during the construction or operation phases
- the access and site layout needs of delivery and service vehicles, and public transport vehicles
- parking demands and where they are to be provided for
- the accommodation of pedestrians and cyclists, including access to and location of pedestrian and cycling facilities
- whether access to the development from an arterial or a lower priority access road is more appropriate
- noise assessment and mitigation
- air quality (transport emissions – e.g. for a proposed childcare centre adjacent to a major road carrying a large traffic volume).

These are examples of ‘traffic impacts’ or ‘transport impacts’, which will need to be assessed during the evaluation of a development application. In addition, these and broader traffic and transport impacts need to be considered when a major rezoning of land is proposed or when large areas of land are planned for future urban development. Traffic impact assessment and the broader transport assessment are compared in Commentary 1.

[see Commentary 1]

#### 2.1.4 Road Safety Considerations

Road safety is one of the most important aspects of managing the road system. This has been clearly recognised with the advent of the Safe System approach to road operation and planning. Planning decisions can strongly affect road safety outcomes, a link which has been recognised and addressed in publications such as Austroads (2015e), Austroads (2015f) and Welle et al. (2015). It is evident that in order for road safety to be given due consideration in both strategic plans and in individual development proposals, it needs to be incorporated into town planning processes. Legislation establishing the town planning framework needs to define road safety as one of the primary objectives of a planning scheme. Experience suggests that where this does not happen, road safety is often viewed as a matter that can be addressed later through good design, which is not always the case (Parliament of Victoria 2014).

Road safety needs to be given prominence from the earliest stages of strategic planning. For example, if safety is not a primary consideration when the locations of land use zones are decided, intractable safety problems can arise. There are examples of shops and schools being located on opposite sides of a major road – or expanded retail zones being approved on the opposite sides of arterial roads. The relative positioning of these land uses leads to new pedestrian movements across the major roads and increases the risk of pedestrian crashes. Redesign or traffic management initiatives would not necessarily be as effective as planning initiatives in addressing the fundamental land use issues giving rise to that risk.

The incorporation of road safety assessment into the town planning approvals process (whether through formal road safety audits or some other procedure) needs to be coordinated and controlled by the planning authority. Clear procedures need to be established for deciding these questions:

- When, during the development and design of a project does a road safety audit or assessment need to be done?
- Who is responsible for obtaining the road safety report (the developer or the planning authority)? Whoever it is, the report should be addressed to the planning authority as an independent report.
- Who is accredited or accepted as suitably experienced and qualified to provide the road safety report?
- How will the road safety report’s recommendations<sup>1</sup> be dealt with and what mediation, arbitration or third party assessment arrangements are needed if there is disagreement?
- Will any further road safety assessment of a redesign be required?

To reduce the likelihood of crashes occurring once a development is operating, road safety needs to be given specific consideration at the project planning and design stages. This requires that road safety engineering skills are applied to the project through an audit or some other approved and effective procedure. The *Guide to Road Safety Part 6: Road Safety Audit*<sup>2</sup> (Austroads 2009b) recommends that an audit of a development be done separately from any ‘traffic impact assessment’, as those assessments are usually part of the design process and are not independent.

A framework for assessing road safety within a Safe System context has recently been published (Austroads 2016b, Austroads 2016c) and should be consulted as needed during the planning process.

<sup>1</sup> All agencies other than Roads and Maritime Services allow recommendations in road safety reports.

<sup>2</sup> The Austroads *Guide to Road Safety Part 6: Road Safety Audit* is currently being revised. Practitioners should refer to the new version when it is published.

Strategic plans involve considerable negotiation and consultation. Experience in Australia and New Zealand indicates that the most effective way to include road safety engineering expertise into strategic plans is to employ an independent road safety engineer in the negotiations and consultation, rather than subject the finally negotiated plan to an independent audit. Understandably, other parties involved in developing a strategic plan will be very reluctant to accept significant changes to the negotiated plan when they have already put significant effort into it – even if road safety is the issue.

### 2.1.5 Travel Demand Management and Sustainable Development

Historically, road transport system management in Australia and New Zealand has predominantly focussed on attempting to meet the demand for motor vehicle travel by supplying new roads or increasing the capacity of existing roads. However, it has been recognised that increases in road capacity are rapidly absorbed by latent demand and that many communities do not have the economic capacity to remove road traffic congestion through the continual provision of additional road capacity. Observations in large cities show that many urban dwellers have a high tolerance for the daily delays created by the traffic congestion to which they add (Stilgoe 2005). How can urban transport, travel and accessibility be better managed to reduce travel delay, improve travel-time reliability and reduce the negative impacts of motor vehicle use on urban communities?

Travel demand management (TDM) seeks to answer this question. TDM involves interventions to modify travel decisions so that enhanced transport, social, economic or environmental objectives can be achieved, and the adverse impacts of travel can be reduced. It involves managing the transport and traffic task through:

- reducing dependence on the private car for many trips
- encouraging people to better organise their travel so they make fewer trips, make shorter trips, use one vehicle to carry more people and combine journey purposes
- reducing the distance of trips via self-containment objectives
- encouraging walking, cycling and the use of public transport
- introducing road pricing schemes (e.g. congestion charging)
- supporting alternative commuting arrangements such as teleworking, car-pooling.

TDM should be considered at all scales of urbanisation from large conurbations to smaller centres. Ultimately, reducing travel demand benefits everyone by reducing energy consumption and greenhouse gas emissions. In the case of non-motorised modes there are benefits to public health that should not be underestimated in the long run.

#### ***Travel plans***

One approach to reducing the impact of travel associated with land use developments involves the preparation of travel plans for the developments. There is a case for encouraging, if not requiring developers of new land use developments, or a major expansion of an existing development, to prepare a travel plan to mitigate the traffic generated by the development. The travel plan may influence decisions on the appropriate traffic facilities to be provided.

Workplaces generate large amounts of travel, and often large amounts of car traffic – by staff, deliveries, and visitors. Workplace travel plans aim to reduce vehicle use associated with the workplace, especially private car use. In Australia, workplace travel plan initiatives are being encouraged in government agencies, in business and in community institutions such as universities and hospitals (TravelSmart Australia 2008).

While reduction of car travel to work is voluntary in Australia, in some countries (e.g. UK and USA) it is mandatory for organisations over a certain size. Such organisations are required to prepare a travel plan which outlines the initiatives that will be taken to reduce car use. Evidence cited by Giblin, Ampt and Smith (2007) indicates that workplace travel plans can reduce the number of work trips by private car by up to 20%.

Travel plans typically involve encouragement for employees to change their work travel from private car use to walking, cycling, public transport, or car-pooling, by means such as financial incentives, provision of special facilities (showers, lockers), or subsidies for public transport use. Organisations typically also revise policies – for example, on fleet composition and management, or on flexible working arrangements – in order to facilitate a reduction in the impact of car use associated with the workplace. There are potential benefits for the organisation and employees, as well as for the community.

### **Logistics plans**

In the case of mining and agricultural operations in the Australian hinterland, there is a need to move bulk goods safely, efficiently and sustainably to coastal ports for export. In some cases mine owners build and maintain their own dedicated rail and road infrastructure, in others publicly owned infrastructure is used. In the latter case it may be necessary for the mine owners to formulate a logistics plan detailing potential routes, loads, times of travel and vehicle types. The traffic impact of a mine may be experienced many hundreds of kilometres from the pit when small towns suddenly experience vast increases in heavy vehicle traffic. In some cases dedicated town centre bypasses may need to be constructed for road safety and liveability reasons.

In the case of very high continuous volumes, dedicated freight rail lines from pit to port with optimised and automated loading and unloading directly into a ship's hold may be a viable and community acceptable solution.

### **Sustainable development**

Sustainable development can be described as attempting to reduce resource depletion and environmental impacts of a development activity, and leaving the environment in at worst the same state as it is now so it can be enjoyed by future generations (World Commission on Environment and Development 1987). It has also taken on meanings that refer to economic vitality and quality of life. These three objectives may not always be compatible even though policy statements attempt to accommodate them all.

The interest in sustainable development reflects a growing awareness and concern in urban communities about the problems created by growth in traffic, particularly car use and the resultant congestion and concomitant greenhouse gas emissions. Increasing the capacity of the road network at a rate that would satisfy growing demand is both infeasible and undesirable. Apart from the quality of life for citizens who are dependent on cars for daily travel, the issues of poor air quality, greenhouse gas emissions and reliance on non-renewable energy resources are of major concern.

Sustainability of transportation centres on policies and land use plans that encourage the use of public transit and non-motorised modes perhaps through introducing road user charging or other measures.

For additional discussion of this topic, refer to Commentary 2, the *Guide to Traffic Management Parts 4 and 7* (Austroads 2016a and Austroads 2015e) and the *Guide to Road Transport Planning* (Austroads 2009c).

[see Commentary 2]

#### **2.1.6 Parking Supply and Parking Restraint**

One type of intervention to limit the amount of car travel is to limit the amount of parking space in developments where public transport can play a significant role. For example:

- In central business districts of cities, frequent, reliable public transport is available and suitable for a large number of trips. In these situations, it is common for individual developments to be required to have little or no on-site parking, as part of a parking-restraint policy.
- In high-density residential areas where frequent, reliable public transport is available, the permitted provision of parking spaces is often lower than rates stated in parking-demand tables. Alternatively, some residents may choose to have no car or fewer cars per household.

However, practitioners should be aware that unless it is properly managed across a region, the adoption of a parking-restraint policy will not automatically lead to more trips by public transport, a reduction in car trips or a reduction in parking demand. For example:

- Because there is no restriction on the number of cars an individual or a family is allowed to possess, a reduction in the number of on-site parking spaces in a residential development poorly served by public transport will inevitably lead to on-street parking and continued use of cars for all or most trips. The public transport needs to be frequent, reliable and provided in the desired directions of travel.
- At the other end of a regular work journey, the lack of parking at or close to a place of employment will lead to some workers parking as close as they can and walking the last section (or making a short public transport trip). For a parking-restraint policy to be effective (e.g. in a central business district), restrictions to on-street parking need to be implemented over a wide buffer area around the restraint area.
- Rural and regional areas where public transport is either not available or infrequent.
- Some types of trips are inherently unsuitable to travel by public transport, such as a weekly family shopping trip. Implementing a parking restraint policy is not appropriate for land uses at each end of this type of trip.

Therefore, when considering the adoption of a parking-restraint scheme, these types of potential problems need to be acknowledged and plans prepared to avoid them. These plans may include improved public transport services, restrictions to on-street parking (near homes or near work locations) and the provision of local commercial facilities, which are accessible by bicycle or on foot and which reduce the need for car travel.

Refer to the *Guide to Traffic Management Part 11* (Austroads 2008b) for further information about the parking and stopping of vehicles.

### 2.1.7 Planning for Public Transport

While public transport use in some urban areas is presently limited, this may not always be the case and provision of travel options is a worthwhile objective. For these reasons, it is important that urban areas are planned in ways that assist in providing road-based public transport, notably buses. Non-road-based public transport options such as rail also play an important role, although the opportunities are more limited for extending or modifying routes to accommodate urban growth.

The following planning checklist, based on material in Department of Transport (2008), indicates ways public transport can be assisted and promoted, and not hindered when planning new urban areas:

- Consult public transport operators when preparing or revising structure plans.
- When planning or proposing new urban areas ensure that public transport service provision performance requirements can be met and development densities enable cost-effective public transport service provision.
- Avoid mixed-function collector roads (i.e. through traffic and property access functions) as these will ultimately require restrictions on traffic, to the detriment of buses.
- Create a comprehensive network of traffic routes/arterial roads such that 90% of homes are within 400 metres of a bus route.
- Assume all traffic routes/arterial roads are potentially bus routes.
- Consider where bus priority will be needed to allow buses to 'jump' traffic queues on arterial roads.
- Allow enough space for the appropriate design vehicle and checking vehicle to be accommodated at bus stops and intersections.
- Plan higher residential densities to be near major public transport services.

- Plan for, and assess the impact of, bus routes through residential subdivisions or serving industrial subdivisions.
- Where practical and appropriate locate residential development on both sides for the full length of all bus routes and provide bus routes directly between activity centres.
- Provide employment areas with through bus routes, minimum route deviation and lay them out so that all areas fall within 400 metres of a bus route.
- Provide direct pedestrian access to bus routes at 400 metre intervals for bus stops.
- Ensure pedestrian routes to bus stops are located where they are attractive and convenient to use, with safe access across roads (e.g. plan for refuge islands), especially for arterial and collector routes.
- Where appropriate, land reservation for rail corridors should be considered in some cases.
- Light rail may need to be considered in some jurisdictions.

## 2.2 Road Network Planning

### 2.2.1 Road Classification

When considering the potential impact of a development on particular roads in the network, it is important to establish the agreed traffic function of each of the roads potentially affected. Is it primarily a traffic route or a local street? This then enables an objective assessment of whether the development, and its access and traffic needs, are compatible with the road's function.

In these guidelines 'road classification' means a road's 'functional classification' – its traffic function.

For further advice and information on road hierarchy and functional classification, refer to Commentary 3 and the *Guide to Traffic Management Parts 1, 4 and 5* (Austroads 2015c, 2016a and 2014a).

For effective traffic management of the road network, a clear distinction needs to be made between those roads that are to function principally as arterial roads (or traffic routes) and those that are to function principally as local streets. Within each of these two primary categories of traffic function, finer distinctions can be made.

[see Commentary 3]

### 2.2.2 Arterial Roads and Local Streets

In urban areas, the principal classification of each road as either a traffic route or a local street should result in an interconnecting network of traffic routes at a sufficiently close spacing, considering the intensity of traffic generating development. Each area bounded by traffic routes is a local traffic area which should be small enough that no road within it has excessively high traffic volumes.

Town planning schemes may include objectives for road networks such as 'to provide a network of streets with clear physical distinctions between traffic routes and residential streets based on function, legibility, convenience, traffic volumes, vehicle speeds, public safety and amenity' (Department of Transport, Planning and Local Infrastructure 2005). The distinction between arterial roads and local streets supports such objectives.

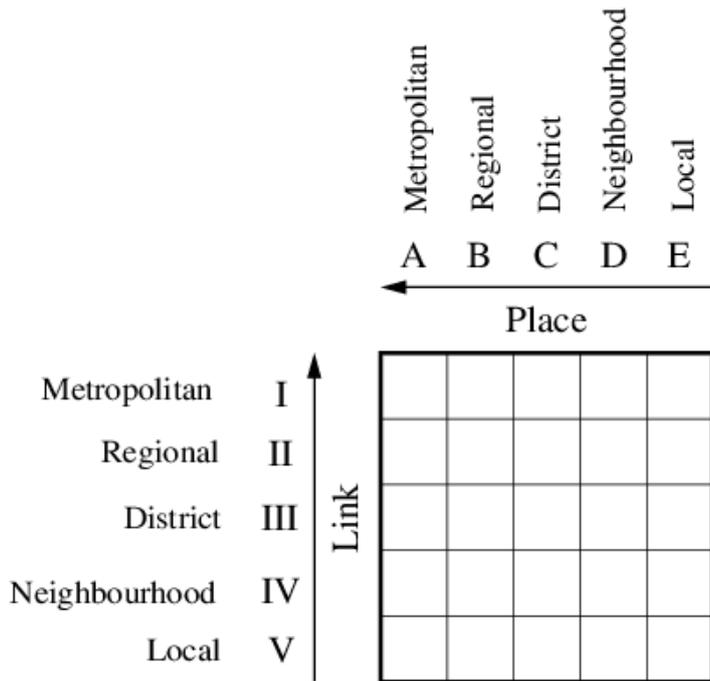
The single most important step in achieving the clear two-class arterial road/local street separation in areas of new development is to prevent frequent direct-frontage driveway access from roads which will function primarily as traffic routes. Ideally, traffic routes need to be provided at 0.8 to 1.5 km spacings and may be on existing or newly created road alignments. Indeed, many jurisdictions mandate that direct access to a traffic route is not permitted when practical, alternative access is available via a lower-priority road.

### 2.2.3 Recent Developments

There is a growing belief in the planning community that roads not only provide vehicular movement and access they also provide a sense of 'place'. These ideas were formulated by Jones, Boujenko and Marshall (2007) and have been applied in London (Boujenko et al. 2007) and elsewhere (see Boujenko, Morris & Jones 2012, for example).

The basic idea is that link and place form two components that can be used to evaluate or rate a particular road segment or network. The basic idea is shown in Figure 2.1.

Figure 2.1: The basic idea of link and place



Source: Based on Boujenko, Morris and Jones (2012).

In general the higher the link status, the greater the traffic volume and the higher the place status, the more traffic it will generate (or attract). Further, each transport mode (cycling, walking, bus, etc.) will have its own link function that will be evaluated based on local planning policy or other criteria. In this sense, a link (road) may be optimised for cyclists or buses rather than general traffic. A fuller explanation may be found in the *Guide to Traffic Management Part 4: Network Management* (Austroads 2016a) and *Guide to Traffic Management Part 7: Traffic Management in Activity Centres* (Austroads 2015e).

## 2.3 Traffic Planning

### 2.3.1 Road Access Management

Access management is an important part of managing roads in a way that is safe and consistent with their primary traffic function. There is often pressure to permit direct driveway access onto the majority of roads in a developing area, to reduce development costs per site. However, if this occurs on roads that, due to their location in the network, will need to function as through-routes, the lower site development cost is inevitably offset by higher transport, amenity and safety costs, to the detriment of future residents and road users.

There is a general right of access between a road and abutting property, unless action is taken to restrict that access. Access management is the process of controlling where and how that access may take place. Clearly, the mobility, safety and amenity of road users and occupiers of abutting land are influenced by the provisions for access to and from roads. Taken in this light, the objective of access management is to achieve a level of interaction between the road and abutting land that is consistent with the function of the particular road. Access needs to be designed and managed in a way that allows the road to perform its traffic functions safely and efficiently.

Access to and from roads is generally controlled in two ways:

- Access control by laws, statutory regulations or planning regulations that apply to a particular road, a class of road or a type of development for the abutting land.
- Access control by geometric design. One example is the provision of service roads, where the driveway, side street and parking interactions take place clear of the main carriageway.

Providing arterial roads is a basic part of the town planning system and so access management is an essential part of the larger planning framework. Broad planning policies and objectives need to incorporate access management.

The need for access planning and management arises because vehicle movements generated by a development can potentially create interruptions to traffic on a road. On many roads, these interruptions are of little or no concern because they are infrequent, and traffic volumes are low. However, on roads carrying high traffic volumes or fast moving traffic these interruptions can create inefficiencies and other costs to the community, such as:

- increased crash rates, due to incompatible traffic activity or unexpected traffic movements
- increased delay and interruptions, including to public transport
- reduced arterial road capacity
- reduced efficiency of the road network
- deterioration in the driver's perception of the safety and ease of use of an access point
- increased vehicle emissions and reduced air quality
- increased fuel consumption
- functional obsolescence of the roadway (i.e. the ability of the road to perform its primary traffic function is slowly degraded)
- diminished value of the public investment.

*A Framework for Arterial Road Access Management* (Austroads 2000b) provides basic steps and factors around road access management that should be considered when planning new roads, preparing development applications or assessing proposals. Table 2.1 from the report sets out the crash experience for various levels of access management.

**Table 2.1: Access related to crashes**

<b>On Rural Roads</b>	<ul style="list-style-type: none"> <li>As a rule of thumb, there are 10 crashes per 100MVkm<sup>(1)</sup> of travel per access point.</li> <li>Typically, the comparative crash rates for no access control: partial control: high level of control will be roughly in the ratios 100:60:40. That is, there could be 2–3 times the number of crashes if there is no access control.</li> <li>On four-lane rural roads, each private access adds 2–3 per cent to the crash rate, and much more at higher degrees of road curvature.</li> <li>Each commercial access point per kilometre can add 5–10 per cent to the crash rate at low access frequencies (perhaps 10–15 accesses/100MVkm for each access point).</li> <li>An access point on a four-lane rural highway can be up to 10 times more hazardous without a median than with one.</li> </ul>
<b>On Urban Arterials</b>	<ul style="list-style-type: none"> <li>Allowing direct access and frequent minor junctions can increase the casualty crash rate by 30 per cent on divided roads and 70 per cent on undivided roads.</li> <li>Each non-commercial access point adds 1–2 per cent to the crash rate on low-access four-lane roads, and 2–3 per cent on two-lane roads.</li> <li>Going from zero to 10 commercial access points per km on two-lane urban roads can add about 80 per cent to the crash rate. Going from zero to 20 access points per km can double or treble the rate.</li> <li>On four-lane roads, each extra commercial access point can add 5–10 accesses/100MVkm above 10 access points per km.</li> <li>Urban arterials without medians have a 30–40 per cent higher crash rate than divided sections.</li> </ul>

1. MVkm denotes million vehicle kilometres.

Source: Austroads (2000b).

For more details about access management, see Austroads (2000b) and the *Guide to Traffic Management Part 5* (Austroads 2014a).

### 2.3.2 Parking Issues

#### **Parking needs**

When planning a development and assessing its impacts, the need for vehicles to be parked or to stop for picking up or setting down passengers or goods needs to be assessed, taking into account the following:

- types of vehicles
- types of vehicle users
- duration of stay for the parked or stopped vehicle
- times of the day, week or season when required
- locations to be used for stopping and parking and their feasibility, practicability and impact on moving vehicles and pedestrians
- demand for (i.e. numbers of) parking and stopping spaces
- order of priority in allocating spaces when demands at particular places or times exceed supply
- use of each mode of travel
- vehicular access to and from the parking or stopping spaces
- pedestrian or goods delivery access to and from the parking or stopping spaces
- the provision of off-street parking may be required for road safety or other reasons, it may be mandated in the case of large developments
- dimensions and layout of spaces and access routes so that the likely types of vehicles can be accommodated.

### ***Types of vehicles and their needs***

Every trip involving an on-road vehicle creates a demand for parking or stopping:

- Cars need to be garaged or parked at residences and parked at shops, businesses and other attractions, for varying amounts of time. Passengers often need to be dropped off or picked up, creating a demand for places to stop briefly.
- Motorcycles have similar parking demands.
- Cars with caravans need to stop at toilets, rest areas and tourist attractions.
- Buses need to stop to pick up or set down passengers. They also need a place to stop or lay over at the end of the scheduled route.
- Taxis need places to store and queue (taxi ranks), places to wait for passengers and places to set down passengers and collect a fare.
- Cyclists need somewhere to park their bicycles. Security from theft is a particular issue.
- Charging points for electric vehicles may need to be provided (AS IEC 61851.23:2014, AS IEC 62196.2:2014).
- Marked parking spaces for car-sharing schemes may need to be provided.
- Trucks need space to stop for loading and unloading. On longer journeys, truck drivers need space to park their vehicles when they rest.

### ***Factors affecting parking demand***

Car parking demand is a function of the land use that is served. Different land uses generate different demands for parking, in terms of the time when they are used and the duration of stay, as well as the numbers of parking spaces for a set size of development. The parking demand at a specific land use is influenced by factors such as:

- the extent to which the need for the particular land use is satisfied in the locality or region (undersupply or oversupply of the land use)
- the availability and suitability of public transport and the ease with which it provides access to the land use, compared with access by motor vehicle
- the cost of parking for different durations of stay
- the ease of local access on foot or by bicycle.

Typical parking rates (i.e. number of spaces required per unit of development such as floor area or number of seats) for different types of land uses have been surveyed. They appear as tables of information in most town planning schemes and they form the basis on which the actual parking demands at a particular site will be assessed (Section 3.3.3). However, these rates are only a surrogate measure; creation of retail space or an office seat does not explicitly create demand for parking spaces; the actual demand is created by the people who need to, or wish to, come to the property. Parking demand may also be assessed by estimating the maximum demand (parking accumulation) from known information about duration of stay and arrival rate.

Details of parking requirements and management approaches are given in the *Guide to Traffic Management Part 11* (Austroads 2008b).

## 3. Traffic Management for Developments

### 3.1 Elements

This section provides advice on the elements that contribute to a land-use development working well from a traffic perspective – whether the traffic is pedestrian, bicycle, or motorised.

Table 3.1 provides an initial checklist for use in ensuring that traffic management arrangements assist in achieving the basic function of the development efficiently and safely. All expected users of the development should experience site access and internal movement which is both efficient and safe. Traffic operations and safety on adjacent roads should not be unduly compromised by the development. Practitioners are encouraged to apply these principles in traffic management for developments and to gauge the traffic impacts of a development with these requirements in mind.

**Table 3.1: Elements to consider in traffic management of developments**

Issue	Considerations	Prompt questions
Access and traffic movements	Origins	From where will the likely users come? At what typical times of day? What are the prime approach directions and modes of travel? What parts of the development are the prime access points?
	Road user types	Who are the likely users of the development? Will they come by vehicle? If so, in private vehicles or by public transport? Where within the development will they need to go?
	Vehicle types	What vehicle types will be accessing the site? Does this vary for different sections of the development? Are all relevant vehicle types catered for?
	Non-motorised users	Will pedestrian movements, adjacent to and within the site, be prime factors? Are special facilities needed?
	Disabled users	What is the extent of disabled access requirements? What are the relevant statutory requirements or design rules?
	External areas	What traffic controls and parking arrangements are there on roads adjacent to the site? Do these need to be modified?
Safety	Safe speeds	What are the likely traffic speeds – for approaching, adjacent and within-development traffic? Does the site design naturally promote safe speeds? Are additional controls needed? Planners and designers should be aware of the Safe System speeds and kinetic energy minimisation, see (Austroads 2016b and 2016c).
	Conflicts	How are potential vehicle-vehicle and vehicle-pedestrian conflicts to be controlled or managed? Do pedestrians and vehicles need to be grade separated? How can conflicts be reduced by choice of intersection (e.g. roundabouts) or grade separation?
	Sight distance	At all potential conflict points, is there adequate sight distance? Is additional traffic control needed?
Environmental effects	Adjoining developments	Will the traffic movements be compatible with those from adjoining developments?
	Noise, pollution	Will the types of vehicles accessing the site give rise to noticeably increased noise or atmospheric pollution?

## 3.2 Road User Considerations

### 3.2.1 General Traffic

Effective operation of traffic around and within land use developments is assisted by applying the guidance given in other relevant Parts of the *Guide to Traffic Management*, particularly Part 5, Part 6 and Part 9 (Austroads 2014a, 2013c, 2014b).

The safety of general traffic is assisted by incorporating road safety and Safe System principles into town planning processes (see Section 2.1.4 and Austroads 2015f) and by the adoption of such safety processes as road safety audit during the design and development of a project (see the *Guide to Road Safety Part 6* (Austroads 2009b)).

Different groups of road users have different design and safety needs. The first step in successfully designing for vehicle users, pedestrians and cyclists is to establish who will be the users of the development and how will they arrive. The users may include:

- pedestrians, walking to and within a development
- pedestrians who are accessing the development from public transport
- road-based public transport vehicles: buses, trams, light rail, taxis
- heavy vehicles, making deliveries and collecting rubbish
- couriers and smaller delivery vehicles
- emergency vehicles, notably fire engines and ambulances
- cars carrying residents, shoppers, workers, etc.
- motorcycles
- bicycles, either from dedicated cycleways or shared facilities.

Some of these user groups will have common access needs, yet may need to reach different parts of the development and have different parking or stopping requirements. Some user groups, such as large delivery vehicles, will have quite specific needs when access layout is being considered.

Consideration also needs to be given to the level of access demand likely to be required by the development. Over-provision or under-provision of traffic facilities can result in inefficiencies, excessive costs, unnecessary traffic movements, environmental impacts and adverse safety effects.

### 3.2.2 Vehicle Types

Australia has the largest and heaviest vehicles operating on public roads in the world. Each state and territory maintains its own list of allowed vehicle types and the roads on which they are allowed to operate. See National Heavy Vehicle Regulator (n.d.) for a discussion of allowed vehicle types in New South Wales, Victoria, Queensland, Australian Capital Territory, South Australia and Tasmania. Neither Western Australia nor the Northern Territory are signatories to the National Heavy Vehicle Regulator (NHVR), and both regions permit extremely large vehicles to be used on their roads. Western Australian regulations for heavy vehicles may be found at Main Roads Western Australia (2016) and these apply in the Northern Territory as well.

In New Zealand heavy vehicle regulation is carried out by the NZ Transport Agency (NZ Transport Agency 2016b).

Access roads and circulation areas need to accommodate the right vehicle classes. Except within those parts of car parks used exclusively by cars, this will always include larger vehicles. Each access route needs to account for all likely types of road users (and their likely volumes), whether they are on foot or using a vehicle. For vehicles, this is done by specifying the design vehicle and checking vehicle appropriate for each category (traffic function) of access road and designing for it (Austroads 2013a). See also *Guide to Road Design Part 4* (Austroads 2009a) for advice on large-vehicle turning requirements.

Within new residential subdivisions, most traffic will be cars and vans. However, service and emergency vehicles also require access. In general, the right design vehicles will be:

- design vehicle: design service truck, 8.8 m
- checking vehicle: design single-unit truck/bus, 12.5 m
- general access vehicle, 19 m.

Within a subdivided area any roads that function as bus routes or access routes to offices, shopping centres or emergency facilities will need to be designed using larger design and checking vehicles. Within a large shopping centre, some access roads will be used by delivery vehicles and possibly buses, as well as by customers' cars.

To design for the right vehicle:

- On public roads, the traffic function needs to be determined and adopted, based on effective road hierarchy principles (Section 2.3.1); then the correct design vehicle and checking vehicle needs to be assigned to each road category and to intersections along them. For example, arterial roads may be sub-categorised into primary arterial and other arterial, with different design and checking vehicles. Non-arterial roads which regularly accommodate larger vehicles (e.g. bus routes) need to be assigned suitable design and checking vehicles.
- Within developments and at their access driveways, the access routes and circulation routes for the different road user groups need to be identified (who are the likely users and where within the site will they need to travel?); then for each group the appropriate design vehicle and checking vehicle needs to be selected.

### 3.2.3 Heavy Vehicles

It is important to identify the type and size of heavy vehicles that will need to gain access to the development. This will help in determining the appropriate design vehicle and checking vehicle to be used in the development's design.

Most planning schemes require that in new areas, as well as with large developments in existing areas, loading and unloading must take place on-site rather than from a vehicle stopped on a public road. Most developments that have significant loading or unloading have a loading dock where vehicles are required to reverse into position. Developments in new areas should be designed so that all reversing and other manoeuvring takes place on-site and away from conflicts with pedestrians and other vehicles. Reversing of trucks off public roads creates a potential hazard for other road users, including pedestrians and cyclists. While it often cannot be avoided in existing areas, it should not be permitted for new developments on an existing traffic route/arterial road, due to the degree of conflict.

The type of development has a bearing on the type of heavy vehicles that require access. Examples are:

- local shops – food delivery trucks (design service truck, 12.5 m long)
- shopping centres – large delivery trucks (design prime mover and semi-trailer, 26.0 m overall length)
- offices – furniture removal trucks (design single-unit truck/bus, 12.5 m long)
- factories – large delivery vehicles (design prime mover and semi-trailer, 19.0 m overall length; or long extendable semi-trailers for indivisible loads, up to 25 m long; or B-doubles, up to 26 m long)
- warehouses – similar to factories
- hospitals – food delivery vehicles, including large ones (design single-unit truck/bus, 12.5 m long)
- rubbish tips – garbage trucks and large waste transfer trucks (design single-unit truck/bus, 12.5 m long; design prime mover and semi-trailer, 19.0 m overall length)
- service stations – 19.0 to 26.0 m; may be up to 53.3 m in some jurisdictions and locations
- mines – truck-trailer combinations, B-doubles, B-triples or other configurations
- farming – truck-trailer combinations, B-doubles, B-triples or other configurations.

### 3.2.4 Buses

Buses run to schedules. Delays (i.e. greater travel time variability) for buses make the choice of this travel mode option less desirable. Whether a development includes roadways traversed by buses or it simply generates a demand for on-road bus stops, the layout of the bus route and the number and location of the bus stops should take account of bus scheduling needs, as well as the convenience of bus passengers.

Bus passengers need safe and convenient pedestrian access to and from bus stops. Where several bus routes service one location, convenient and safe interchanging between bus routes should also be provided in the design.

Developments of a recreational or tourist nature will often require on-site parking for coaches. This needs to be located so that passengers can safely alight and access the venue. Where will they be able to safely stand if they are waiting for a coach to arrive? Can the coaches travel without reversing in areas used by pedestrians or other vehicles? Matters such as these should be considered at the planning stage so that adequate space is provided in the layout for the safe operation of buses and coaches.

### 3.2.5 Emergency Vehicles

Emergency vehicles need to be considered in the layout of approach roads, access driveways or intersections and with any internal roads or driveways. Development plans also need to take account of any nearby facility frequently used by emergency vehicles (e.g. a hospital, ambulance station, fire station or police station) to ensure the plans do not result in delays to emergency vehicles or do not involve placement of traffic-restrictive devices on trunk access routes required on a regular basis by emergency services.

Every property must be readily accessible by emergency vehicles. In some commercial or industrial areas, large and heavy fire appliances need direct access. The level of accessibility and the extent of speed restriction need to be determined in consultation with emergency service operators, taking into account accepted criteria for response times and bearing in mind that vehicles may not always be available from the nearest emergency service station. Some emergency service authorities have their own planning guidelines for emergency vehicle access, which should be consulted when planning the layout of a development.

### 3.2.6 Pedestrians

Where a development is designed to be used by people in nearby residential areas, direct convenient and attractive pedestrian access should be provided. This will assist in encouraging walking and reduce the number of short car trips. Pedestrian facilities should also address the needs of people with vision impairment and other disabilities.

Issues of pedestrian safety and amenity within a development are discussed in Section 3.3.3.

### 3.2.7 Cyclists

Depending on the nature and scale of a development, cyclists may access it from the adjacent road system or from dedicated bicycle routes. Where there are nearby bicycle facilities (off-road bicycle paths or on-road bicycle lanes) bicycle links into the development need to be considered. Convenient, safe and attractive cycle access should be provided.

Secure bicycle parking is an essential part of a network of bicycle facilities. For security reasons bicycle parking needs to be provided in a location that is convenient and visible to the public. In some planning schemes, there are specific requirements for bicycle parking at developments in particular land use zones. The recently updated Australian/New Zealand Standard for bicycle parking (AS 2890.3: 2015) outlines the requirements.

### 3.2.8 Light Rail and Bus Rapid Transit Systems

Like regular on-road bus systems, light rail (trams) and bus rapid transit systems (BRT) run to schedules, but they require purpose-built route ways (tracks for trams) (Austroads 2010a) or guidance channels for BRT (Currie 2006), which often remove vehicular capacity from the road network. Unlike on-road buses, these services are frequently able to run with greater reliability and thus may be more desirable as a travel mode.

Tram and BRT passengers need safe and convenient pedestrian access to and from stops. Where several routes or modes (including regular buses) service one location, convenient and safe interchanging between them should also be provided in the design.

Where land use development ingress and egress routes interact with trams or BRT, special treatments may be required. In some cases turns may be physically impossible for considerable distances, and U-turn provisions may be required.

### 3.2.9 Network Operating Frameworks and Plans

Many jurisdictions are developing overarching transport modal policies that may prioritise particular modes in certain areas (e.g. bus lane provision in a CBD) or at certain times (e.g. street closed to vehicles on weekends to encourage pedestrian use). Such policies are known as network operating frameworks and they are enacted by the road (or transport) agency through network operations plans (NOPs).

Land use development should be carried out with full knowledge of any local NOPs and especially large developments should be provisioned to support any network operating framework, perhaps by providing on-site bus stops or access to nearby cycleways or by encouraging non-standard working hours for staff (which also has TDM benefits).

## 3.3 Access to Developments

### 3.3.1 Approach Roads

Depending on the type, scale and location of a development, the traffic impacts may need to be assessed for a considerable distance on the approach route(s) along an arterial road and geometric elements of the road may need to be expanded, modified or redesigned at mid-block locations and at intersections. Consider the following examples:

- A large development involving signalisation of an access point is likely to require assessment of existing nearby major intersections for capacity and safety. Also, the intervening sections of the approach road must carry the total predicted traffic volume (through traffic plus development traffic), and the traffic approaching the development must be in the correct lane (left or right); auxiliary lanes may be required. Successive and closely spaced access points and side streets are each likely to need dedicated turning lanes.
- A rural development (e.g. involving an extractive industry) may produce a significant increase in the proportion of heavy vehicles using the access road(s), as well as a significant increase in total traffic volume. In this situation any haul route needs to be identified and then assessed for traffic operation on road sections and at intersections, and for pavement impact and safety. An increase of 5% or 10% in traffic volume may be sufficient to warrant an assessment (Section 4.2.2).

For advice concerning traffic management on approach roads see the *Guide to Traffic Management Parts 5 and 6* (Austroads 2014a and Austroads 2013c).

### 3.3.2 Driveways or Intersections into the Development

Vehicle access to most developed land is via one or more driveways. At larger developments, driveways are usually replaced by intersections, where the trafficked areas remain at road level instead of rising across the footpath.

#### **Driveways**

Driveways have the following characteristics:

- The speed of traffic can be better controlled by the rise in level, thereby assisting the safety of pedestrians walking along the intersecting footpath.
- The lower speed of turning vehicles may mean that a left-turn deceleration lane, clear of the through-traffic lane, is required to avoid rear-end collisions with faster moving through traffic.
- Some aspects of the road rules apply differently at driveways to private land, compared with intersections of roads.

In all cases, each driveway needs to be wide enough to accommodate the swept paths of the types of vehicles that will use the access point. At commercial developments, driveways need to be wide enough to accommodate entering and exiting vehicles at the same time. Where larger vehicles are infrequent and not regular, and where car use is intermittent, it may be acceptable to design a driveway for two-way car use and accept that a larger vehicle will need to occupy both lanes. The kerb radius at a driveway must be able to accommodate the likely classes of vehicles (i.e. the design vehicle) without the need to mount a kerb. Where the kerb radius is large, care is required to ensure the safety of pedestrians using the footpath. A wide two-way driveway may need to be divided so pedestrians can negotiate one-half at a time. Any driveway needs to provide adequate sight lines for pedestrians using the footpath: structures near the property line need to be set back or splayed.

Petrol stations and associated convenience stores should preferably be designed with separate entry and exit driveways so that internal circulation past the petrol pumps is unidirectional. These developments are typically on corner blocks at intersections; entry driveways should be far enough away from a major intersection that a following driver who is concentrating on activity at the intersection has time to be aware of any slowing and turning vehicles ahead. This applies for left and right turns. Right turns after major intersections should only be considered where a separate right-turn lane with adequate deceleration and storage length can be provided, otherwise the occurrence of rear-end crashes may increase. On typical undivided urban roads, the safety implications of allowing right turns from a through lane into a development within 100 m of a major intersection needs careful consideration.

In cities with trams or at-grade light rail, the implications of allowing right turns from or across the tracks needs to be assessed.

### **Intersections**

Intersections into developments:

- may be controlled by lines, control signs, roundabouts or traffic signals
- can be combined with an existing intersection, where appropriate
- permit faster turning movements, which are better for safety on higher speed roads, but they do require that the safety of pedestrians and their ease of access across the intersection be carefully considered during planning and design.

A decision to control an intersection into a development site by give-way signs should be made using the same decision criteria as for any other intersection. If sight distance is so poor that safe intersection sight distance is not achievable, or worse still, stop signs are warranted (see Australian Standard AS 1742.2: 2009), the intersection should be redesigned, relocated or both, so that adequate sight distance is attained. Refer to the *Guide to Traffic Management Part 6* (Austroads 2013c) for details of intersection traffic management.

If the traffic volume accessing a development is only a small proportion of the total traffic along a road, roundabout control of the access intersection is usually not appropriate due to the disruptive impact it has on all vehicles travelling along the road. If, for example, a development experiences peaks of traffic, which warrant a greater level of control than give-way signs can safely provide, then traffic signals are a more suitable option. This may be the case with sporting or concert facilities. If the access point forms the fourth leg off an otherwise major T-intersection, traffic signals or a roundabout may be appropriate.

In the case of developments in rural areas that have access only to high-speed roads it may be prudent to provide a so-called seagull intersection that uses a triangular island to separate right turning traffic from through traffic in the same carriageway (Austroads 2010b) and an acceleration lane for traffic exiting to the left especially if the sight-lines are poor.

### 3.3.3 Internal Roads, Circulation Areas and Parking

#### **Site access**

It is particularly important, when planning the layout of trafficked areas within a site, to consider who the likely road user groups will be, how they will arrive, where they need to go and what they need (in terms of layout) for their safety. For example, people arriving by car need:

- convenient and obvious ways to approach the entrance to the car park
- safe passage from the access road to the parking area
- convenient ways of circulating within the car park and advice about the location of pedestrian access to entrance doors
- safe routes to walk amongst or past the parked cars to reach the entrance doors.

The safety of the users of the development is enhanced by the following layout characteristics and diminished when they are absent:

- a safe form of intersection control coming off the access road, considering volumes and site layout
- separation of the internal access road or driveway from any parking spaces (with their parking manoeuvres, stopped vehicles, restrictions on sight lines, etc.)
- separation of the internal access road or driveway which leads to parking, from the manoeuvring area for loading and unloading of goods
- a car park layout and design which physically limits vehicle speeds and which provides safe space for pedestrians, including adequate sight lines at intersection points and conflict points
- a pedestrian link between the car park and entrance doors that does not require pedestrians to cross a trafficked roadway, driveway or circulation route within the site.  
This requirement applies equally for access to bicycle parking facilities.

For advice on car park layouts and the design of car park accesses, see the *Guide to Traffic Management Part 11* (Austroads 2008b).

#### **Conflicting traffic activities**

Where practicable, incompatible traffic activities should be segregated from each other. In most situations, mixing of trucks and cars while they travel along a section of internal road or driveway is no more of a safety problem than on the external road network. However, when manoeuvring of trucks is required, the potential for conflicts and unexpected manoeuvres (by either group of road users) increases significantly. Truck manoeuvring areas (i.e. for turning and reversing) should be kept separate from areas trafficked by the car drivers or used by pedestrians or cyclists.

#### **Cycling**

In large developments, separate cycle ways may be introduced to minimise the conflicts between cyclists and other road users (including pedestrians).

### ***Pedestrian safety and amenity***

Pedestrian safety in car parks may be enhanced by designing the parking aisles to include measures that keep vehicle speeds low. Where there are significant numbers of pedestrians, separate footpaths should be provided. Provision should also be made for ensuring that pedestrians with disabilities have adequate access to all areas (including car parks) within a development. Where a footpath meets a trafficked area, consideration should be given as to whether drivers or pedestrians will expect arrival of the other, and whether they can see each other in sufficient time.

Pedestrian/traffic conflict can be addressed by:

- avoiding the conflict altogether (put the trafficked route somewhere else)
- having the conflict point at a location with low traffic speeds
- reducing traffic speeds
- having the conflict point at a location where traffic movements are simple, so pedestrians do not need to make complex decisions about when to proceed
- providing good sight distance in combination with low speeds (avoiding pedestrians walking out from between parked cars or near walls or stopped trucks or buses)
- having the conflict point where it is expected, rather than where it might not be expected
- ensuring that the priority for drivers and pedestrians is correctly indicated to both groups and is compatible with the traffic speeds
- ensuring that any pavement markings are in accordance with the relevant standard and correctly installed.

## **3.4 Subdivision Developments**

A development that consists of the subdivision of land and the creation of new urban areas requires consideration of some broad design issues, as well as the application of good design and management practices in the local details.

### **3.4.1 Residential Subdivisions**

Residential subdivisions need to be planned within the context of an agreed network of arterial roads.

It is important for both local amenity and efficiency of the arterial roads that, at the network planning and subdivision approval stages, arterial road networks are developed with satisfactory spacing, adequate capacity and interconnection, without missing links. The spacing and size of arterial roads depends on the intensity of development. In areas of more intense development, more arterial links are likely to be needed.

If, for example, a subdivision is a further extension of the urban area on the edge of a town or city, then the future arterial road network needs to be established first. Otherwise, intractable traffic problems will occur once the new area is fully developed: the local area will be too large and high traffic volumes will occur on some local streets.

Having established the arterial network, each section of the residential subdivision within the local area needs to be part of an overall plan, which has low traffic impacts. For example, residential development should not occur as a series of isolated cul-de-sacs off an arterial road, as each block of land is developed.

Traffic impacts of residential subdivisions can occur at connections with the arterial network, in adjacent residential areas or within the development itself. Adverse impacts can include:

- excessive volumes of traffic at connections with the arterial road network (e.g. at certain times of day or in other particular circumstances)
- too many conflict points at connections (e.g. when cul-de-sacs directly connect to arterials)
- poorly managed traffic conflicts at connection points (e.g. due to the wrong number, location or types of intersection controls)
- excessive volumes on local streets leading to the connection points
- excessive trip lengths to exit the subdivision
- excessive speeds on streets within a new or existing local area
- crashes involving motor vehicles on local streets.

Factors influencing the efficiency, safety and amenity of local streets include:

- under-provision of arterial roads
- arterial road congestion and delay
- external connectivity of the local street system
- internal connectivity of the local street system
- location of traffic generating developments.

The relationship between local areas and arterial roads is discussed further in the *Guide to Traffic Management Part 8* (Austroads 2008a). A summary of the major issues as they relate to assessing traffic impacts of developments is given in Commentary 4.

[see Commentary 4]

### 3.4.2 Industrial Subdivisions

Industrial subdivisions need to have their own street access to the arterial road network, so that heavy vehicle traffic does not interact with residential traffic on residential streets or with other non-industrial traffic on streets that provide access to offices, shopping centres or community facilities. As well as avoiding safety-related conflicts between heavy vehicles and local manoeuvring traffic, the separation of industrial subdivisions avoids amenity conflicts as well.

Equally, industrial subdivision roads should not provide connectivity between two arterial roads as this will lead to higher traffic volumes on the industrial road, with conflicts between turning trucks and shortcutting vehicles. Where practical industrial driveways should not be permitted directly onto arterial roads or other significant traffic routes, because conflict between the through traffic function and the property access function can be severe.

Heavy vehicles accessing industrial areas include long vehicles. The design vehicle and checking vehicle for these areas will be larger than for residential subdivisions (Section 3.2.2). To cater for turns and manoeuvres to, from and within these areas, larger intersections and wider roads will be needed. This in turn will result in higher speeds by drivers of cars, which can be difficult to address in designs. Therefore the design and layout of approach roads and internal streets needs to recognise this and provide elements such as clear sight lines, which are consistent with likely speeds. The parking of cars on local industrial streets may need to be banned to maintain adequate sight lines at driveways and car parks. Consider the common contributors to problems in residential streets (Section 3.4.1) when designing industrial subdivisions; the issues are often similar.

Heavy vehicles have lower acceleration performance than motor cars; they therefore take longer to turn or proceed at an intersection. This will influence the location of intersections onto the adjacent arterial roads as well as the types of control. While give-way control may be suitable in some locations (e.g. where sight lines are long, the proportion of left turns is high, exiting volumes are low or arterial volumes are low, etc.) the design of an industrial subdivision may need to include a signalised intersection for access onto an arterial road. *Roundabouts provide one of the safest forms of intersection from a Safe System point of view.* Right-turning vehicles have right of way over opposing through traffic which can improve the level of service for these vehicles. However, due to large swept paths, roundabouts need to be carefully and properly designed to accommodate the swept path of the design heavy vehicle.

## 4. Traffic Impact Assessment

This section describes the traffic impact assessment (TIA) process and discusses why it is needed; it sets out the steps involved in carrying out a TIA and discusses some of the issues to consider during these steps.

It is worth noting that with the advent of multi-modal thinking in transportation planning (as noted in Section 2.2.3) many jurisdictions are pondering the move towards 'transportation impact assessment' which entails a much more detailed assessment of public transport, cycling, walking, etc., than presented here. Whilst some aspects of multi-modality are captured in a TIA, general treatment is beyond the scope of the current Guide and practitioners should seek local guidance where appropriate. Institute of Transportation Engineers (2010) provides a general introduction to transportation impact assessments.

### 4.1 What is a Traffic Impact Assessment?

A TIA is the process of compiling, analysing information on, and documenting the effect that a development is likely to have on the operation of adjacent roads and transport networks. The assessment needs to consider the impacts on all classes of road user, both motorised and non-motorised.

The scope of a TIA will depend on the location, type and size of the development and the ability of the road network to handle traffic generated by the development. The assessment may have to address broader transport planning and environmental considerations as discussed in Section 5 and will need to take into account any existing traffic management strategy, and strategic or local development plans.

In general, each jurisdiction (road agencies, local and state government planning bodies) will have their own requirements as to the conditions that trigger the necessity for a TIA. Typically, the trigger will be a certain peak-hour trip rate but a TIA may be mandated for certain classes of development, irrespective of the generated trips. Section 4.2.2 discusses the requirements for a TIA in more detail.

A TIA is undertaken by competent experts on behalf of the proponent of a development and is documented in a report (sometimes called a traffic impact report). The report is typically prepared for a planning body or road agency to consider.

In the case of smaller developments (there is no general definition; seek jurisdictional guidance) a less comprehensive traffic impact statement (Section 4.1.2) may be deemed sufficient by the relevant planning agencies.

#### 4.1.1 Traffic Impact Assessment Report

The steps in carrying out a TIA are outlined in Section 4.3, with details given in Section 4.4. Checklists are provided in Appendix A and Appendix B. A TIA report should be structured as suggested in Appendix C and practitioners should consider the need to include information on all the subjects and issues listed.

#### 4.1.2 Traffic Impact Statement

A traffic impact statement (TIS) serves the same purpose as a TIA report but is not as comprehensive. It should be noted, however, that:

- a lower threshold, in terms of additional traffic generated, may be appropriate in more densely populated areas
- a TIA report or a TIS may be required for reasons other than the volume of peak-hour traffic to be generated by the development.

A TIS should include:

- a brief description of the development in terms of proposed land use and trips generated
- a brief description of the existing operational conditions of the road network in the immediate vicinity of the development
- analysis of the operation of the accesses to the development
- analysis of the operation of the first intersection, as a minimum, on either side of the accesses
- a conceptual geometric layout of the access arrangements, including any nearby driveways and intersections
- professional opinion on the expected traffic impact based on a site observation during the expected critical peak hour and the analysis conducted.

## 4.2 The Need for Traffic Impact Assessment

### 4.2.1 General

The traffic attracted to a new land use development or a major expansion of an existing development, such as an industrial project or a major shopping centre, can have significant impacts on the performance of the current or future arterial road network. These need to be properly assessed and addressed so that a satisfactory level of road safety and transport efficiency is maintained.

In many cases, criteria are already established for requesting a TIA to be carried out. For example, legislation may require developments on state controlled roads to be referred to the relevant road agency for assessment. Planning authorities and road agencies may have the power to seek a TIA where it is considered that a development is likely to have a significant impact on the safety or efficiency of one or more roads (e.g. impacting general traffic or pedestrians, cyclists or public transport).

But whether or not such powers exist, judgment is required to decide whether a project requires a full TIA or some lesser analysis of traffic issues. For example, small urban developments may only require alterations to driveways and off-street parking spaces, whereas a similar development on a rural road may require turn lanes because of the high-speed environment, the level of traffic generated or site geometry that restricts visibility. The following section provides a guide for deciding on the level of traffic assessment required.

### 4.2.2 Criteria for Traffic Impact Assessment

Criteria for traffic impact assessment for developments may be based on the size of the development, or on the expected level of or increase in, generated traffic. Some jurisdictions may set the criteria for a TIA around land-use-generated increases in specific vehicle types, especially heavy vehicles.

In Victoria, for example, a traffic impact assessment is required where the proposal constitutes a 'major development' as defined by certain numerical trigger points, as illustrated in Table 4.1 (VicRoads 2006). A road agency or relevant planning authority may also request an impact assessment where those criteria are not met but the proposed development is considered to have an impact on the safety or efficiency of the adjacent roads.

As a further example, in Western Australia, the threshold values for impact assessments are in terms of the level of likely transport impact and are related to the type and size of development, as illustrated in Figure 4.1 and Table 4.2 (Western Australian Planning Commission 2006).

**Table 4.1: Thresholds for a major development**

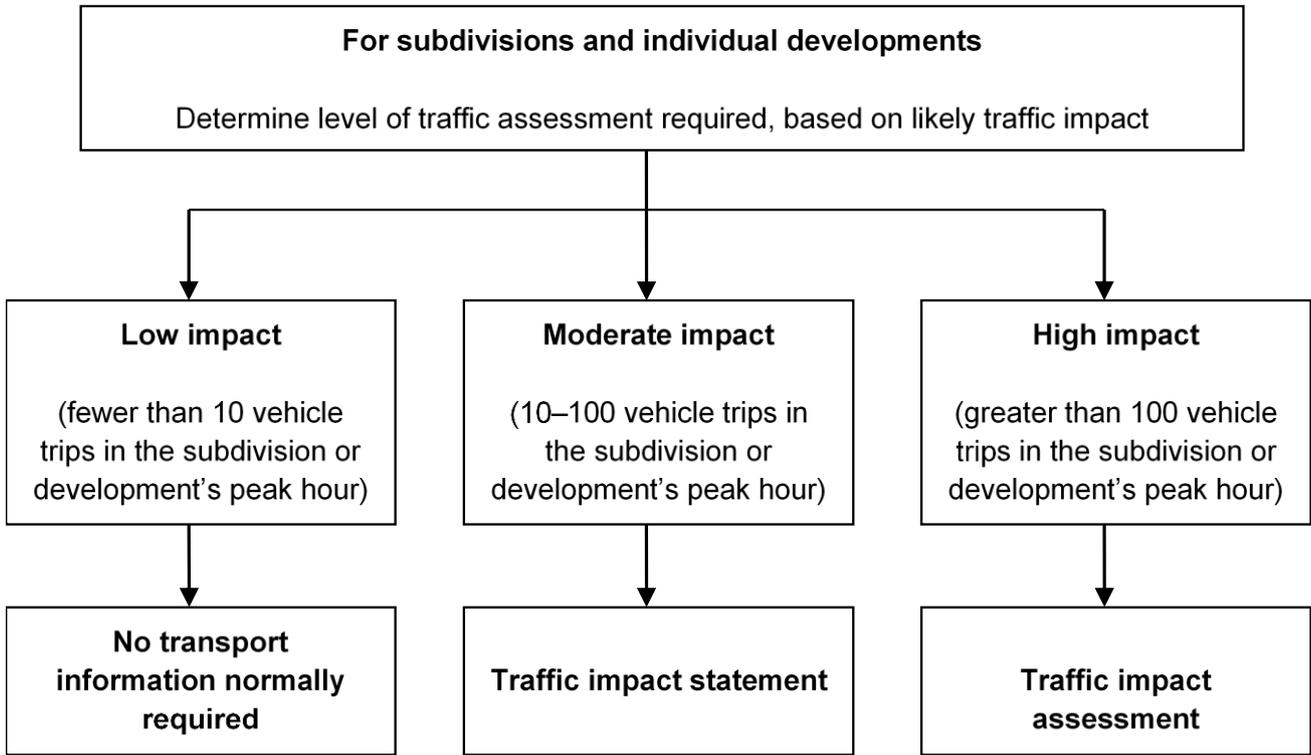
Item	Type of Development	Scale of Development (trigger points)
1	Residential flat – building	75 dwellings
2	Retail	500 m <sup>2</sup> GFA
3	Retail and commercial	1000 m <sup>2</sup> GFA
4	Commercial	5000 m <sup>2</sup> GFA
5	Commercial and industry	4000 m <sup>2</sup> GFA
6	Industry	5000 m <sup>2</sup> GFA
7	Residential subdivision	50 allotments
8	Tourist facilities Recreational facilities Showgrounds Sportsgrounds	50 car parking spaces
9	Clubs Hotels	50 car parking spaces
10	Places of assembly Places of public worship	50 car parking spaces
11	Refreshment rooms Restaurants	300 m <sup>2</sup> GFA
12	Drive-in take-away food outlets	50 car parking spaces
13	Service stations	Any scale
14	Motor showrooms	50 car parking spaces
15	Hospitals	100 car parking spaces
16	Roadside stalls	Any scale
17	Educational establishments	50 students
18	Drive-in theatres	Any scale
19	Transport terminals Bulk stores Liquid fuel depots	Any scale
20	Junk yards Waste disposal depot	Any scale
21	Heliports Airports Aerodromes	Any scale (heliports: only commercial ports require a TIA report)
22	Extractive industry Mining	Any scale
23	Parking area	50 car parking spaces

Note: GFA is gross floor area.

Source: VicRoads (2006).

Trigger levels are defined on a jurisdictional basis (indeed they may vary from one local government area to the next). The thresholds provided in Table 4.1 are purely illustrative.

Figure 4.1: Level of traffic assessment required for developments



Source: Modified from Western Australian Planning Commission (2006).

Table 4.2: Level of traffic assessment required by land use and size

Land Use	Moderate impact	High impact
	Traffic impact statement required	Traffic impact assessment required
	10–100 vehicle trips in the peak hour	> 100 vehicle trips in the peak hour
Residential	10–100 dwellings	> 100 dwellings
Schools	10–100 students	> 100 students
Entertainment venues, restaurants	100–1 000 persons (seats) or 200–2 000 m <sup>2</sup> gross floor area	> 1 000 persons (seats) or > 2 000 m <sup>2</sup> gross floor area
Fast food restaurants	50–500 m <sup>2</sup> gross floor area	> 500 m <sup>2</sup> gross floor area
Food retail/shopping centres with significant food retail outlet	100–1 000 m <sup>2</sup> gross floor area	> 1 000 m <sup>2</sup> gross floor area
Non-food retail	250–2 500 m <sup>2</sup> gross floor area	> 2 500 m <sup>2</sup> gross floor area
Offices	500–5 000 m <sup>2</sup> gross floor area	> 5 000 m <sup>2</sup> gross floor area
Industrial	1 000–10 000 m <sup>2</sup> gross floor area	> 10 000 m <sup>2</sup> gross floor area
Other uses	Discuss with approving authority	Discuss with approving authority

Source: Modified from Western Australian Planning Commission (2006).

### ***Discretion of the road agency***

The need for a TIA can be influenced by many factors apart from traffic generation. Where other criteria are significant, the discretion of the road agency can be exercised. For example, a development may be located in a particularly sensitive area and a TIA report may be deemed necessary, even though fewer than 50 peak-hour trips are generated. Conversely, there may be cases where the development is in an isolated and insensitive area and a TIS is considered to be sufficient even though the development generates more than 150 peak hour trips.

Factors other than total generated traffic, which may determine the need for a TIA report or a TIS, include:

- existing or potential safety or traffic problems on the roads serving the proposed development, such as a crash issue, complex intersection geometry, roads operating at or close to capacity
- accessibility for local communities, cyclists, pedestrians, persons with a disability or vision impairment and public transport users
- the generated traffic applies to one turning movement
- significant impact to the current or projected level of service or the operational characteristics of roads that have high projected traffic growth adjacent to the development
- situations where there may be an adverse impact on public transport services
- situations where traffic from other existing or proposed abutting developments is likely to compound traffic impacts (e.g. by increasing or complicating traffic demands due to the locations of existing and proposed driveways/intersections)
- areas that will have their environmental capacity adversely affected (e.g. traffic volume, speed or noise in residential areas; sensitive natural environment near the development)
- developments that will generate a different type of traffic that may require geometric improvements or cause damage to an existing pavement (e.g. heavy vehicles, buses, road trains).

### **4.2.3 Assessing Site Suitability for Development**

At the time a major development is first proposed it should not be assumed, simply because the use fits the general use criteria in the planning scheme, that the proposed site is automatically acceptable or can be made so by measures to mitigate impacts on the surrounding road network or transport system.

The site proposed by the developer may not be appropriate because of complications or hazards it will create when access requirements are established. Poorly located developments can result in access arrangements that create intractable traffic operational issues or road safety problems.

If there are concerns of this nature, a TIA report can be requested, to highlight the extent of the problems and indicate the cost of the necessary mitigating works – or perhaps indicate that the problems cannot be realistically solved. In such cases it may be necessary for the planning or road agency to demonstrate through the use of reliable analytical techniques or prediction models that the proposed development will result in an unacceptable crash or traffic operational outcome for the community. This may require the authority, rather than the developer, engaging independent expertise.

### **4.2.4 Other Assessments**

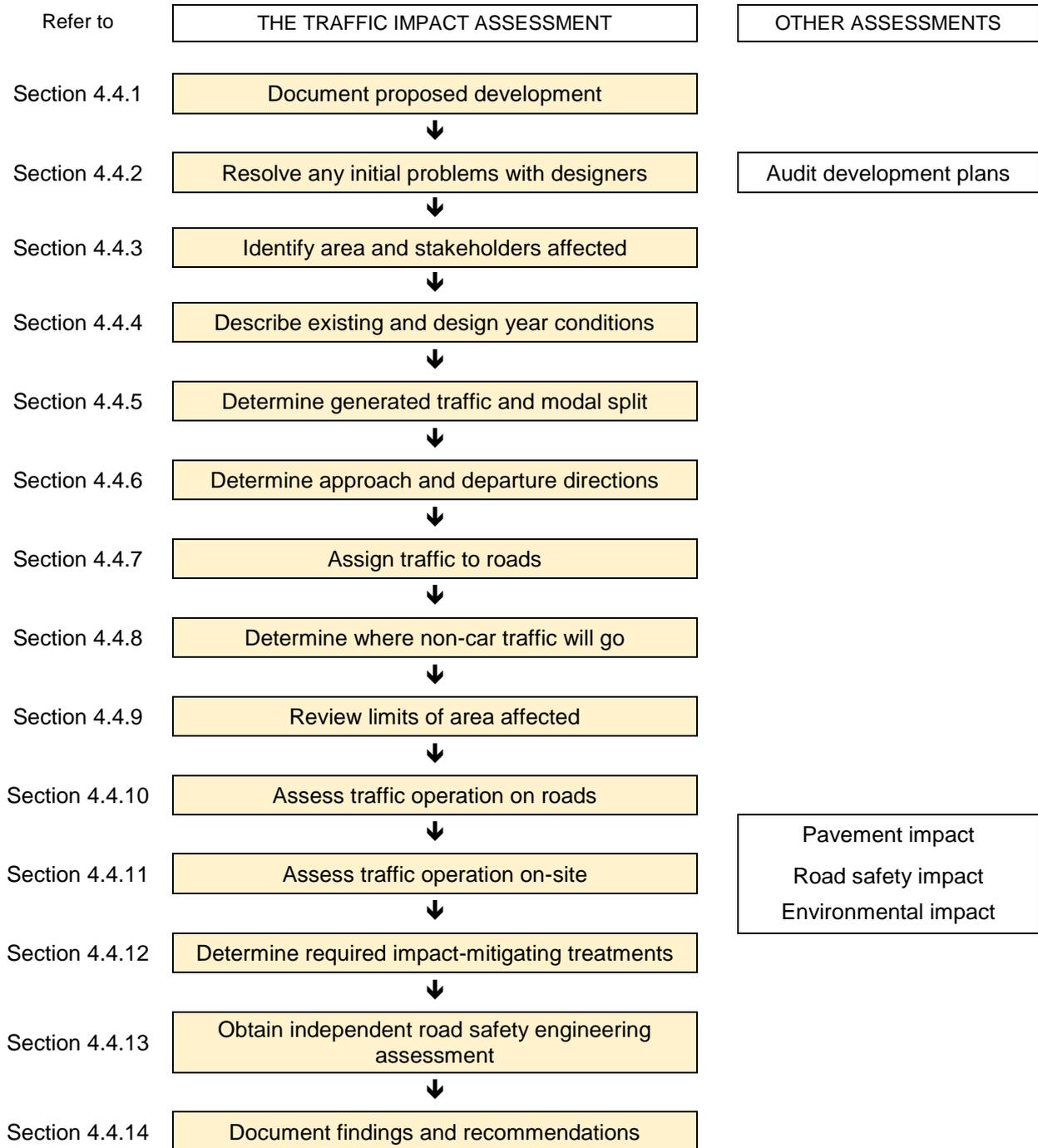
A TIA may be just one of several assessments that are needed to examine the impacts a development may have on a road network. Other assessments for consideration (discussed in Section 5) relate to:

- formal road safety audits or assessments
- road infrastructure (including pavement) impacts
- the utility for expected users (walkability, cycleability, availability of public transport)
- environmental impacts and cultural or heritage issues.

### 4.3 Steps in a Traffic Impact Assessment

The steps in carrying out a TIA are summarised in Table 4.3 with detailed guidance given in Section 4.4.

**Table 4.3: The steps in a traffic impact assessment**



## 4.4 Conducting a Traffic Impact Assessment

This section explains how to conduct a TIA, using the steps shown in Table 4.3. For each sub-heading there is a list of tasks to be carried out. These are shown in the highlighted box. To conduct a TIA, go through each of the tasks and associated steps.

Appendix A provides a checklist based on these steps.

Appendix B provides similar checklists based on the ITE procedure (ITE 2010) and the process used in Queensland (Queensland Department of Main Roads 2006).

Appendix C contains a suggested structure for a TIA report, based on Institute of Transportation Engineers (2010).

The steps detailed in this section apply generally to all types of development whether urban or rural, residential or commercial or industrial, large or small. It is possible with a small development that some tasks are not required. Detailed requirements should be determined in consultation with the planning authority.

### 4.4.1 Document the Proposed Development

#### *The tasks*

1. Provide a plan, or plans, which show the layout of all the traffic and pedestrian areas on the site, plus the locations of vehicle and pedestrian accesses onto roads, plus the position and layout of all nearby driveways and intersections.
2. Check that each type of internal access (e.g. cars, pedestrians, trucks, etc.) is direct, connected, continuous and makes sense.
3. Check that the approach roads and paths are clearly understood and are practical.
4. Check that the correct design vehicle and checking vehicle has been used in the various sections of the development (Austroads 2013a).
5. Check that basic design requirements have been applied.
6. Document the land use planning zonings in the vicinity, for use when assessing impacts later.
7. Summarise/list the traffic-related features of the development, including those which may be taken directly from the plans (e.g. total number of parking spaces, access points to roads, internal access to different sections for pedestrians, cars, trucks, bicycles, etc.).
8. Describe the timing and phasing of the development and note any connection with external events and activities (e.g. sporting events, community events, other nearby developments, etc.).

#### *On-site layout for large developments*

Large developments may have internal roads to which legislated road rules apply (e.g. major shopping centres). In such cases it is desirable that the internal layout:

- minimises conflict between pedestrians and motor vehicles (e.g. design to eliminate the need for pedestrians to cross internal roads at grade, as much as possible)
- provides delineated, direct, safe and well-signed paths for pedestrians (e.g. moving from local areas, public transport stops, interchanges or stations to the development)
- provides efficient, safe, and well-signed and delineated lanes or paths for cyclists accessing the development from roads, dedicated cycle paths or the shared network
- encourages and reinforces safe speeds
- segregates the movement of trucks servicing the development from all other traffic within the site

- enables all deliveries by truck to be made on-site (i.e. no loading or unloading from the external road network) and all trucks to enter and leave the site in a forward direction (i.e. not reverse out onto any public (and where practical internal) road
- supports the safe and efficient movement of public transport within the site and between the site and the external road network
- incorporates bus interchange facilities, which are safe and readily accessible for users.

### ***Parking-related layout issues***

The amount of on-site parking, its location and layout, the position and control of accesses and the layout of access routes within the site – for motor vehicles and bicycles – should ensure that:

- traffic is able to flow freely into and out of the development and is not hindered by drivers queuing for parking, exiting a space or waiting for a particular space to become vacant
- parking aisle intersections with access driveways are far enough away from access points onto the external road that queuing or turning vehicles do not inhibit access to the site or inhibit exiting from parking aisles
- there is sufficient parking in desired locations to avoid a spillover of parking onto adjacent traffic routes or local streets; whilst planning ordinances specify the amount of parking to be provided for particular land uses, these may not reflect the actual parking demands likely to occur at any particular site
- the objectives, intent and requirements of AS/NZS 2890 (Set): 2009 *Parking Facilities* are achieved; refer also to the *Guide to Traffic Management Part 11* (Austroads 2008b).

The mix of business types in larger developments may affect the total amount of parking required, because peak parking demands for different land uses may occur at different times. This also affects traffic generation at different times of the day or day of the week.

### ***Relationship to surrounding development***

It is desirable that developments along arterial roads should be complementary to each other and to the function of the road. For example, internal connections between car parks and access via service roads will improve circulation and reduce conflicts.

### ***Development characteristics***

Any structure plan that describes the context in which the development will operate (e.g. the land use transport relationship) should be referred to.

All relevant characteristics of the development should be established, collated and documented. Important details include:

- site location and boundaries
- current and intended use of the land
- current and intended use of adjacent parcels of land and their relationship to the development
- other proposed developments that may not be adjacent to the site but which may have substantial impact on the transport or road system
- size of the development and proposed activities (e.g. floor area for different commercial purposes or number of dwellings)
- timing of the development, at opening and any subsequent stages

- proposed access locations to the road network for cars, public transport, cyclists, pedestrians and delivery vehicles (including heavy vehicles)
- proposed layout of internal roads and parking areas
- proposed arrangements for pedestrian, bicycle, public transport and heavy vehicles within the site.
- For non-residential uses, additional details such as the following should be provided:
  - proposed hours of operation
  - peak traffic periods
  - numbers of employees and visitors, where appropriate, for both construction and operational phases
  - the volume and origins/destinations of major product inputs and outputs, where haulage is involved.

#### **4.4.2 Resolve Any Initial Problems with Designers**

##### ***The tasks***

1. Identify any initial problems or issues needing resolution by designers.
2. Advise the designers of the need to resolve any problems before proceeding with the impact assessment.
3. Re-document the amended proposal.

If any of the documentation in the previous step highlights a traffic-related problem (e.g. parking requirements not applied, driveway conflicts with nearby intersections, layout resulting in high pedestrian/traffic conflicts which are avoidable or should be controlled, etc.) do not proceed with the TIA without referring these to the designers.

Design audit or road safety audit reports may be available.

#### **4.4.3 Identify Area and Stakeholders Affected**

##### ***The tasks***

1. Document the agreed functional road hierarchy in the area, identifying the roads that are principally traffic routes and those which are principally local streets.
2. Document the non-car transport networks or services affected or of relevance.
3. Make an initial assessment of the area affected by the changed traffic conditions.
4. List the sites that are potentially impacted and will need to be included in later analyses.
5. Identify all the affected stakeholders and give them the opportunity to provide input.

##### ***Defining the network***

For small developments, the area affected may be quite localised. Where a major development such as a regional shopping centre is involved, the impacts may be experienced several kilometres away at critical intersections.

In general terms the affected area is determined from the magnitude and distribution of generated traffic volumes in relation to existing and future volumes on the surrounding road network. Preliminary traffic analysis may be necessary to define the area.

Is the area affected just the frontage section of road? Are intersections some distance from the development affected? If so, how far away and in which directions? Do footpaths and bicycle routes need to be examined? Over what area of roads will there be an impact on public transport?

## **Stakeholders**

Where a development in one jurisdiction is likely to affect the transport network and roads in another jurisdiction, the appropriate organisations in the neighbouring area need to be adequately consulted, and have the opportunity to provide input. In some instances, a rail authority could be a relevant stakeholder or developer. Key aspects include the scope of the study, the extent of the network to be analysed, staging, critical analysis periods, traffic generation rates and traffic distribution.

### **4.4.4 Describe Existing and Design Year Conditions**

#### ***The tasks***

1. Document the existing conditions on the site.
2. Document the existing traffic conditions. Do this for critical periods of the day or week.
3. Select the design year (or years, for a staged development) and document the same types of traffic conditions for that time. Exclude the traffic generated by the development. Show the traffic volumes on a plan.
4. Describe the parking conditions to the extent this will be relevant, e.g. parking controls, parking locations, parking occupancy, existing parking spill-over or problems.
5. Document the traffic crashes at the potentially impacted locations.
6. Document any known traffic safety or operational problems and any proposals to address them.
7. Document any traffic, transport or parking policies that affect the proposed development.

#### ***Existing conditions***

Conditions on-site should include the traffic and parking conditions, as these may need to be accounted for when calculating traffic generation and new parking demands.

The surrounding transport networks (including public transport, freight, bicycle, and pedestrian networks as well as roads) should be identified. The sections that are likely to be affected by the development should be identified in consultation with the transport-facility owners and operators.

Documentation of existing conditions – for the external sites, road lengths or areas identified as potentially impacted – should include items such as number of lanes, through volumes, turning volumes, commercial fleet mix, bus frequencies, pedestrian volumes, types of traffic controls and speed limits.

#### ***Design volumes***

In considering the design year conditions, sources of traffic growth information, e.g. forecasts by the planning authority or road agency, should be identified.

The process used to determine design volumes will vary depending on the nature and size of the proposed development. Small proposals may simply involve adding generated traffic volumes to existing traffic volumes and undertaking a traffic capacity analysis of the access to the external roads. Major developments such as residential suburbs or sub-divisions, or regional shopping centres will normally require a more comprehensive approach. Details of the process, including data collection and projection considerations, are given in Commentary 5.

[see Commentary 5]

### ***Items for consideration***

The items to be described (with maps or diagrams as appropriate) may include:

- road condition, width, alignment and cross-section detail
- public transport routes and facilities (including bus, tram and train)
- current public transport patronage information, if available, and land use/access arrangements
- pedestrian and bicycle routes generally, and specific links between the development and public transport facilities (e.g. nearby railway stations and tram stops)
- access facilities for pedestrians, particularly the elderly and those with disabilities
- existence and details of on-street parking
- intersection configurations including median breaks and traffic control devices
- existing daily traffic volumes by vehicle type
- existing peak periods and associated traffic volumes by vehicle type
- traffic growth trends and assumptions relied upon to produce the 'without development' traffic volume forecasts at the time of each stage of the development
- details of any planned changes to public transport services or significant road improvements
- identification and inventory of routes through local street networks in the vicinity of the development that may be subjected to increased traffic flow if capacity issues arise on the surrounding arterial network
- any limits on the types of vehicles permitted on the surrounding roads (e.g. by type, length, height or mass)
- for development involving significant numbers of heavy vehicles or haulage of production outputs (e.g. from mines, industrial use, distribution centres), the routes that can or may be used and their associated issues (e.g. suitability of the route, current and development related pavement loadings)
- other proposed developments or road network changes that may affect assessment of the proposed development.

In some cases additional traffic, patronage, pedestrian, parking or other types of survey will need to be carried out.

#### **4.4.5 Determine Generated Traffic and Modal Split**

##### ***The tasks***

1. Determine the number of trips that will be generated by the development (e.g. daily, peak period). Do this for the design year or years.
2. Determine the generated volume of general traffic, commercial vehicles, public transport vehicles (including taxis), bicycles and pedestrians and their proportions of the total number of trips.

##### ***Traffic generation***

The trips likely to be generated by the development will need to be estimated for each stage of development. This should include vehicle trips generated by all vehicle types, public transport trips and pedestrian and cycling activity. When available and applicable, results from a transport model of the city, region or town should be used to estimate the trip demands for each mode of transport during each stage of development.

Peak-period traffic volume generation may need to be forecast for the assessment of mid-block and intersection capacity. Traffic generation is normally considered for the peak periods of the surrounding road system, and for other normal weekly peak periods associated with the development and the surrounding area (e.g. evenings or weekends).

For some developments the peak traffic generated by the development may coincide with peak recreational flows on the surrounding road network. In these cases data will be required for the normal weekday situation as well as recreational periods.

Traffic generation can be estimated using trip generation rates computed from previous surveys. Locally derived rates are preferred to those applying elsewhere. Such information may be available in consultant reports (copyright provisions permitting) including those reported in town planning appeals, local government files and collated traffic generation reports (e.g. Roads and Maritime Services 2013). Given new governmental open data initiatives, it would be hoped that survey data and derived rates would be made available to the planning community.

In New Zealand, a database has been established (Clark 2007), to capture traffic and parking generation rates for developments in New Zealand and Australia. See Commentary 6 for a fuller discussion of traffic-generation data available both locally and internationally.

[see Commentary 6]

Some examples of traffic-generation rates<sup>3</sup> that apply to the more common land uses and activities are provided in Appendix D.

Further advice on the computation of traffic generated by land use developments is given in Commentary 7.

[see Commentary 7]

### ***Transport modal split***

Different urban locations can have different transport services, which can affect modal split (the proportion of trips by different modes). Inner areas of cities are likely to have a higher density of existing development and a mature public transport system. Consequently, a higher percentage of the overall trips generated by a development are likely to be made by public transport, or involve walking and cycling. Conversely, developments in outer areas may not be well served by public transport, resulting in higher car usage.

The data for determining realistic modal splits can come from census information, transport surveys or transport studies. More directly, mode use and parking surveys for similar developments in areas with similar characteristics can serve as useful surrogates.

Modal split estimation should take into account transport strategies such as parking restraint or travel demand management initiatives (refer to the *Guide to Traffic Management Part 4* and *Part 7* (Austroads 2016a, 2015e)).

The number of vehicle trips potentially generated by the development can be mitigated by initiatives for walking, cycling, public transport use, car-pooling, telecommuting or through other demand management techniques such as alternative working hours or out-of-hours delivery. Some jurisdictions may require large companies to actively implement such initiatives through their corporate travel plans (Section 2.1.5).

## **4.4.6 Determine Approach and Departure Directions**

### ***The tasks***

1. Determine the approach and departure directions of traffic.
2. Take account of traffic that returns to its point of origin and traffic that stops while passing by.

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<sup>3</sup> A new traffic-generation rate supplement is currently being developed in NSW.

### **Factors**

The directions from which traffic will access the site can vary depending on many factors (ITE 2010), including:

- the type of proposed development and the area from which it will attract traffic (its catchment area)
- competing developments (if applicable)
- size of the proposed development
- surrounding land uses and population centroids, and their locations with respect to the development location
- traffic conditions on and the layout of the surrounding road network, and the mode of travel.

Some journeys will involve a return trip to the same point of origin while others will involve the trip continuing to additional destinations (see *Linked trips* below).

These factors are relevant to all transport modes that serve the development.

### **Methods**

Various methods can be used to estimate site traffic distribution. Note that distribution refers to establishing directions of travel, while assignment refers to allocating those trips onto specific routes. The three most commonly acceptable methods of traffic distribution (ITE 2010) are:

- an analogy method that is based on data collected from a similar development (if one exists) located near the proposed development
- a gravity model or other locally acceptable trip distribution model (see Hensher & Button 2008 for a detailed exposition of available models) that may be available and is capable of being applied to a specific site by experienced practitioners
- a surrogate data method that involves the development of origins and destinations from data when an adequate socio-economic, demographic database of usable detail by zones and sub-areas is available for the population or employment distribution representative of the study target year. For example, population can be used as the basis for estimating office, retail and entertainment trips whereas employment is a reasonable surrogate for residential trips.

Marketing studies and strategies may provide an insight into traffic distribution.

In the absence of more rigorous data, and where the development is relatively small, the access directions can be estimated by splitting the compass rose into the four familiar quadrants and allocating proportions of trips to each quadrant, taking account of the population or catchment in each direction.

The method used should be specified in the report. Where there is a degree of uncertainty, this should be acknowledged and the use of ranges of direction estimates should be considered. Sensitivity analysis is particularly important where a development will have a significant impact on the transport network or where the network has limited capacity, or both.

Microsimulation models may also be used to assist with the distribution and assignment of generated trips. See the *Guide to Traffic Management Part 3* (Austroads 2013b) for further advice.

### ***Linked trips***

The concept of linked trips is based on the fact that traffic generated by (or attracted to) a development will be composed of:

- new trips that will not be made on the network if the development does not proceed
- existing trips between an origin and destination that divert a significant distance to visit the development
- existing trips that use the roads immediately abutting the development and break the journey to use the development.

For a given development, proportions for each type of trip are estimated based on studies of similar land uses.

Further discussion of linked trips in the context of traffic impact assessment is given in Commentary 8.

[see Commentary 8]

## **4.4.7 Assign Traffic to Roads**

### ***The tasks***

1. Assign the generated traffic to the road network in the potentially affected area for the design year(s).
2. Show this development-generated traffic on plans.
3. Add the background traffic (i.e. existing volumes factored to the design year) and development-generated traffic together.
4. Show the total traffic on plans for critical times of the day or week.

In determining the assignment of traffic, take account of the approach and departure directions, the road network layout and road features such as one-way streets and medians. Patriksson (1994) may be regarded as the definitive reference on (static) traffic assignment methods as required here.

### ***Sensitivity analysis***

Where there is uncertainty about the magnitude of estimated traffic movements it may be beneficial to test the ability of the existing or proposed road layout to carry a range of volumes (e.g.  $\pm 20\%$ ). This is important for key links and key intersections, such as those where priority measures for public transport exist, or are planned. Sensitivity analysis should also be undertaken for locations that are approaching traffic capacity, as an underestimation of design volume could result in inadequate impact mitigation measures.

## **4.4.8 Determine Where Non-car Traffic Will Go**

### ***The tasks***

1. Determine what paths and lanes will be required for pedestrians, cyclists, buses or delivery vehicles.

Examine continuous lengths of routes and identify any missing links, significant conflict points or other potentially difficult locations.

#### 4.4.9 Review Limits of Area Affected

##### *The tasks*

1. Check to see whether the limits of the area affected need to be altered.
2. If so, make the changes and carry out further analysis.

Additional intersections may need to be analysed.

Pedestrian or cycling issues may need to be assessed over a greater area.

#### 4.4.10 Assess Traffic Operation on Roads

##### *The tasks*

1. Analyse the traffic operations (traffic volumes, capacity, level of service, delays) and assess any likely consequences such as diversion to other roads or streets. Do this for the access points at the development as well as intersections and mid-block sections, as required, within the affected area on the road network.
2. Consider the circulation of traffic near the site.
3. Establish whether the development will result in on-street parking and whether this will occur on suitable streets, or will impact traffic routes or residential streets.
4. Assess the impact on public transport services, arising from any use of public transport to access the development, and from increased vehicular traffic on public transport routes (buses and trams).

##### *Performance criteria*

Traffic operation and safety analysis is generally required:

- on affected arterial and local road links
- at affected intersections on the surrounding road network
- at site entry and exit points.

The performance of the surrounding road network concerns both mid-block links and intersections. Intersections are often considered the critical locations in relation to network capacity. In the case of signalised intersections, the capacity is limited by the requirement to share green-signal time between conflicting approaches. For unsignalised intersections, the capacity is limited by the availability of suitable spatiotemporal gaps through which vehicles in conflicting traffic streams must move or merge (Luttinen 2004). However, mid-block sections or road links can be critical if they are not adequately managed. For example, if parking is permitted in the kerbside lane between major intersections it can have a dramatic and critical impact on the movement of traffic along a route.

The traffic impact assessment produces design-hour volumes for use in analysing the performance of roads and intersections that serve a development. Common practice is to design for the peak 15-minute rate of flow (in Australia, a period of 30 minutes is often used), which is commonly accepted as the shortest interval during which stable flow exists, to allow for fluctuations that are likely to occur within the design hour. This is done by dividing the design hour volume by an appropriate peak-hour factor (Austroads 2013b).

### **Road link performance criteria**

The performance of mid-block road links discussed here is based on the concept of *level of service*. Level of service (LOS) is a qualitative measure describing operational conditions within a traffic stream, and their perception by road users. Six levels of service are defined for each type of facility, from A to F, with LOS A representing the best operating conditions and LOS F the worst. LOS A is a condition of free flow in which individual drivers are virtually unaffected by the presence of others in the traffic stream whereas LOS F is a condition of forced flow, usually involving flow breakdowns, extensive queuing and delays. Further information and advice on LOS considerations is given in Commentary 9 and the *Guide to Traffic Management Part 3* (Austroads 2013b).

[see Commentary 9]

### **Rural roads**

Aspects that may require consideration include the effect of additional traffic and access treatments on:

- overtaking opportunities
- speed differentials and reduction in LOS where significant heavy vehicle movements occur
- inadequate sight lines due to crests, curves or dips (may be critical for safe heavy vehicle operations)
- dust nuisance and visibility impediment from unsealed shoulders
- noise for adjoining properties.

### **Urban roads**

Aspects that may require consideration include the effect of the development on:

- public transport generally
- changes to bus routes
- the need for and location of bus stops and tram (light rail) stops
- amenity including traffic infiltration to local streets, traffic noise, dust and speeding issues
- the effect on community accessibility (e.g. severance, areas inaccessible by other modes)
- existing on-street parking.

The LOS estimated to apply to the road system surrounding the development may indicate the need to provide or protect the integrity of public transport priority measures, allocating road space (e.g. bus lanes) or other treatments to improve or maintain public transport running times through congestion points. Generally, the average travel speed for buses needs to be maintained at 20–25 km/h but this value will vary between jurisdictions, depending on the road system available and traffic demand.

### **Pedestrians and cyclists**

Pedestrian and cyclist flows associated with some developments can be significant. It is important that pedestrian and cyclist LOS be considered in a TIA report. A development should be planned, designed and built to guide pedestrians and cyclists to safe and efficient road crossings. Excessive pedestrian delays can lead to higher levels of non-compliance with traffic signals; delays should be kept to a minimum in relation to the competing traffic demands at various times of the day.

### ***Intersection performance criteria***

The performance of intersections may be estimated using a variety of analytical and computational techniques. It is the developer's responsibility to provide estimates of the performance of all existing intersections that are affected by the development; and for any new intersections required specifically for access to the development. Analytical methods are available for signalised intersections, roundabouts and major/minor intersections (i.e. where the minor road is controlled by signs or the T-junction rule). Various software packages are available for analysing intersections and modelling traffic networks. Some of those commonly used in Australia are described in the *Guide to Traffic Management Part 3* (Austroads 2013b). Calculated intersection performance figures should be reported in a jurisdictionally approved manner.

The performance of intersections is commonly described by the degree of saturation (DOS) of the critical traffic movements, a measure of the volume/capacity ratio or degree to which available intersection capacity is utilised. The performance of intersections may also be described in terms of a LOS based on the average stopped delay (Transportation Research Board 2010) and this approach may be preferred by some jurisdictions or for some purposes.

The design for a new or upgraded development-related intersection should be assessed for safety (i.e. as part of the TIA and quite separately from any independent road safety audit), other operational considerations and convenience for *all* road users. For example, check that:

- adequate sight distances are achieved (refer to the *Guide to Road Design Parts 3 and 4* (Austroads 2010a and 2009a))
- pedestrians do not experience excessive delays (e.g. by having a long signal cycle time)
- the intersections provide for the safe movement of cyclists through all turning manoeuvres
- priority for on-road public transport is considered
- any co-ordinated traffic signal system is not adversely affected; these systems can be rendered totally ineffective if too many intersections are signalised along a section of road
- access to other properties is not unduly impeded or made more hazardous
- heavy vehicle stability is not compromised during turning movements
- pedestrian safety due to interaction with turning vehicles, is not compromised
- pedestrians, including those who have mobility problems, are catered for.

Intersection analysis should consider operation during the normal peak periods on affected arterial roads and, for larger developments, during peak traffic generation due to the development, or during a combined peak. For signalised intersections, computer-aided analysis is recommended to enable consideration of factors such as:

- pedestrian crossing times
- public transport priority measures
- the effect of shared lanes
- the effect of short lanes
- constraints imposed on cycle time, phase sequence and green splits if the intersection is coordinated with other intersections.

For signalised intersections, the key indicator of operational performance used is the DOS. For unsignalised intersections, the DOS is equivalent to the utilisation ratio (volume/capacity or service volume/service rate) for entering movements that must give way. This is also a measure of LOS.

The limits of operation for the different types of intersection are generally accepted as being:

- Signalised intersections – the intersection DOS, which represents the proportion of available green time capacity taken up for the critical movement(s), should generally not exceed 0.90. This represents 90% of theoretical capacity and is considered a 'practical capacity' beyond which delays increase substantially for modest increases in volume.
- Roundabouts – the DOS for any movement should not exceed 0.85.
- Priority junctions – the DOS for any movement should not exceed 0.80.

A key parameter in the analysis of signalised intersections is the saturation flow (capacity of a lane during the time it is serviced by a signal phase). However, the saturation flow that can be achieved depends on the traffic environment and the general environment at the intersection (e.g. type of abutting land use, lane widths, road gradient and the presence of public transport services.). The planning authority or road agency, and consultant to the developer should agree on the appropriate saturation flows to be used in the analysis of intersections, accesses and crossings that serve the development. The appropriateness of a particular value can be confirmed by field measurements at comparable sites. Austroads (2013c) and Luttinen and Nevala (2002) provide a fuller discussion of signalised intersection performance and capacity.

Traffic queuing and the implications of queue lengths (refer to the Guide to Traffic Management Part 6 (Austroads 2013c)) should also be assessed. For arterial roads, the 95th percentile queue length should generally be used. This queue length has only a 5% (100 minus 95) probability of being exceeded during the design period. A higher percentile queue length (which corresponds to a lower probability that the queue length will be exceeded) may be chosen when long queues are likely to cause significant problems.

#### **4.4.11 Assess Traffic Operation On-site**

##### ***The tasks***

1. Analyse the traffic operation of roads, aisles and access ways on the site.
2. Determine whether the expected traffic volumes and the expected vehicle types can be safely and efficiently accommodated within the traffic and parking areas on-site.
3. Establish whether the on-site parking provision is adequate and is suitably located.

Consider the circulation of traffic within the site.

Some on-road effects may also arise within the development. For example, there should be sufficient storage for queues of vehicles departing the site so they can discharge onto the road network without interacting with pedestrian activity or parking/un-parking movements. Similarly, sufficient storage should be available for incoming vehicles prior to the first conflict point, which might generate queues tailing back to the external road network.

#### 4.4.12 Determine Required Impact-mitigating Treatments

##### ***The tasks***

1. From the traffic analysis, determine what changes, improvements, upgrades or modifications are required to road and intersection layouts, traffic lanes, intersection controls and access driveways.
2. From the parking assessment, determine what changes are required on-site and on nearby roads and streets to manage parking and to assist efficient and safe traffic operations.
3. From the assessment of non-car traffic issues, determine what works and what traffic management arrangements are required to accommodate pedestrians, cyclists, public transport and delivery vehicles on-site and in the nearby area.
4. From the assessment of the other issues listed in Section 5, determine what other treatments are required.
5. Co-ordinate consideration of all the above items so that they complement each other and do not work against each other.

##### ***Timing and co-ordination***

An important consideration is the timing of the development and the road agency investment program. A road agency requires time to incorporate new infrastructure investment into a program. It is desirable that proposed developments are brought to the attention of the agency as early as possible. On the particular road(s) involved, the road agency may have works planned. In other cases there may be no intention of improving the road for the foreseeable future.

The agency and developer need to work through a process to determine how best to fund and deliver the necessary works. Cost sharing and other responsibilities for works may be detailed in an agreement between the proponent and affected agencies.

It is also essential that the developer determine whether utility authorities have any existing services or planned works that would be affected by the development and its access roads and intersections.

A road use management plan may also be used to set out what is to be delivered, by whom and how. The requirements for such a plan could be attached to the conditions of approval for the development to ensure implementation before commencement of works or use of the development.

##### ***Co-ordinate the response to all issues***

Impact-mitigating treatments are treatments that are required in response to operational, safety or other issues. These may relate to:

- traffic capacity or operational issues
- parking management or operational issues
- non-car-related traffic operational issues (including pedestrians as well as vehicles)
- other issues including infrastructure, road pavement, road safety, and environmental problems.

It is important that consideration of solutions to these different types of problems be co-ordinated, and that each area is not considered in isolation.

The mitigating measures should be developed as long-term solutions. They should take into account any long-term land use and transport plans. Selection of an appropriate design year is paramount.

### ***Traffic operation***

The traffic operation assessment will highlight the areas of each network (e.g. road, bicycle) that require improvements to remedy any adverse effects likely to result from the development. It is generally the responsibility of the developer to investigate and design the mitigation measures for developments in consultation with the relevant road agency.

Depending on the size of the development, the required road improvements may include:

- additional through traffic lanes
- additional arterial, service or local roads
- new intersections
- new medians, closed median breaks, new turning lanes
- modified driveways
- rumble strips for road edge delineation
- guardrails on embankments
- acceleration and deceleration lanes
- provision, relocation or upgrading of bus/tram stops and services
- modifications to parking arrangements (e.g. removal of parking near the new driveway(s) or more extensively to provide better capacity, safety or operating conditions on approach roads)
- new, relocated or upgraded footpaths, bicycle paths and shared paths
- pedestrian and cyclist crossing facilities (e.g. signals, refuges)
- pedestrian and cyclist grade separations
- pedestrian fencing.

Remedial work at existing intersections may require items like:

- additional turn lanes
- new signalisation or changes to the phasing of signals
- signal co-ordination where new intersections are implemented
- new, relocated or upgraded bus stops, bus bays and bus priority measures
- bicycle lanes.

### ***Economic considerations***

Where they contribute jointly to works on the surrounding network, the developer and road agency may wish to evaluate the economic benefits of alternative options for the treatment of mid-block sections and intersections. The *Guide to Project Evaluation* (Austroads 2005–12) is designed to assist transport agencies and practitioners charged with the task of evaluating projects in the road sector. The evaluation methods in the Guide provide:

- guidance on good practice
- a consistent approach to key data used in analysis
- details on state-of-the-art tools.

Reference should also be made to the Economic Evaluation Manual (NZ Transport Agency 2016a) where appropriate.

#### 4.4.13 Obtain Independent Road Safety Engineering Assessment

##### **The tasks**

1. Obtain an independent assessment of the road safety aspects of the development by a qualified road safety engineer or road safety audit team.

Depending on the size, type and location of the development, specialist expertise may be required in undertaking the road safety assessment. Details on the requirements for road safety assessment and auditing activities are given in Section 5.2 and in the *Guide to Road Safety Part 6* (Austroads 2009b).

#### 4.4.14 Document Findings and Recommendations

##### **The tasks**

1. Document the above steps and their outcomes.

##### **Checklists**

To assist developers and road agencies in the preparation and consideration of traffic impact assessment reports, checklists of matters that may have to be considered are contained in the appendices.

Appendix A provides a checklist based on the steps set out in Table 4.3.

Appendix B provides example checklists based on the ITE procedure (ITE 2010) and the process used in Queensland (Queensland Department of Main Roads 2006).

##### **Reports**

It is desirable that reports for traffic impact assessments be set out in a reasonably uniform way.

Appendix C contains a suggested structure for a TIA report, based on Institute of Transportation Engineers (2010), the headings providing a guide to a logical presentation of information.

It is important that the report clearly and separately:

- describes the proposed development and the traffic it will generate
- establishes the potential impacts of the development on the road and transport network
- outlines the appropriate mitigation measures.

Appendix E provides an example of a TIA study for a rural quarry development.

Appendix F provides an example of a TIA study for an urban industrial or commercial development.

## 5. Assessment of Other Impacts

### 5.1 Introduction

The full assessment of the impact of a development will frequently require consideration of other issues. These include:

- road safety impacts
- road infrastructure and pavement impacts
- environmental and other issues.

A TIA report should not be viewed as the only traffic-related development assessment report that may be needed. In particular, for developments of a size, scope or location as described in Section 5.2.2, a road safety audit report will form an essential part of an effective development assessment.

### 5.2 Road Safety Assessment

#### 5.2.1 Types of Road Safety Assessments

A road agency or planning authority should consider the level of road safety assessment required for a particular development. Some developments will require both types of assessment.

##### ***An assessment of road safety as part of the TIA report***

The types of development projects that should include this type of assessment are described in Section 5.2.2. This assessment:

- may involve reviewing the known crash pattern at or near the development site, so that development works can either address the problem, not make it worse or be designed to accommodate future road agency works to address the problem
- for larger developments, should consider traffic accessing the development site during construction (trucks, cranes, etc.) and its changing nature during the development
- should assess the safety of the development's access points in relation to nearby access points, intersections and traffic control devices.
- should assess the safety of the internal traffic layout, access point layouts, pedestrian and cycle path layouts and commercial vehicle area layouts.

##### ***An independent road safety audit of the design***

The types of development projects that should be audited are described in Section 5.2.2. The types of practitioners suitable for conducting road safety audits are discussed in Section 5.2.3.

#### 5.2.2 Types of Developments to be Assessed or Audited

Current advice from Safe System in the Planning Process (Austroads 2015f) is that a road safety audit should be carried out for all scales of development. Individual jurisdictions may provide additional guidance as to the scale and nature of safety assessments required for particular development types.

**A road safety assessment as part of a TIA report**

This should be undertaken for any project where:

- the internal traffic layout consists of more than a short driveway leading to a single parking area of, say, 10 spaces, or
- the conditions for road safety audit (below) apply.

**An independent road safety audit**

This should be undertaken where the risks to the public are significant, specifically where:

- roads surrounding the development have existing road safety issues
- the development is large and complex with high levels of activity by all road users (e.g. residential subdivisions and industrial subdivisions of more than 20 lots; shopping centres (new and expanding) with more than 50 car parking spaces)
- large-scale rural projects such as mines or quarries which significantly change the type and behaviour of traffic in the area of the development and its approach routes
- there is significant use by pedestrians or cyclists, or both
- the development directly abuts an arterial road/traffic route (i.e. the volumes of traffic and traffic speeds are higher).

Examples include petrol stations, convenience stores, offices, medical consulting rooms, other commercial developments and increased density developments on a single site.

**5.2.3 Who Should Undertake an Assessment or Audit**

Designers should consider road safety issues as they design a development. The design should complement the Safe System principles applied at the planning stage. However, to be consistently effective, a road safety assessment requires the input of a road safety engineer. This is someone with experience in the diagnosis and treatment of crash locations and the design of effective remedial treatments. This experience is gained from the investigation of hazardous locations (see the *Guide to Road Safety Part 8* (Austroads 2015b)) and is an essential ingredient in road safety auditing (see the *Guide to Road Safety Part 6* (Austroads 2009b)). The following are requirements for who should undertake an assessment or audit:

- For a road safety assessment of a development as part of a TIA report, the road safety engineer may be directly employed by the developer.
- For a separate road safety audit report, the road safety engineer *must* be independent of both the development's proponents and advisors, and the authors of the TIA report. If the development is large, an audit may be required at more than one design phase.

In addition to the above requirements, road safety engineering input into a design can also be sought through less formal consultation with a road safety engineer during the design process.

Experience is a vital part of road safety engineering. Most road agencies have lists of accredited road safety auditors and senior road safety auditors. These lists are a good starting point when considering who to engage to conduct an audit, but they do not include information on experience levels. It is important that the auditor has:

- experience with the types of issues and developments being assessed
- an appropriate level of professional experience (see Austroads (2009b) and relevant jurisdictional guidance).

### 5.2.4 Typical Road Safety Issues

The purpose of an assessment or audit is to ensure that all potential road safety issues on-site and on existing and proposed roads near a development have been identified and addressed. Depending on the type, size and location of the development it is suggested that the following types of issues be considered:

- vehicular and pedestrian site access, including driveway locations and shape, new turn lanes, swept paths of large vehicles, footpath locations near traffic
- pedestrian-vehicle conflicts on-site and adjacent to the site
- adequacy of parking provision and the need to avoid parking overflow onto nearby roads (especially into traffic lanes on traffic routes)
- speeds within the site and at access/conflict points
- visibility at conflict points
- safe provision for public transport and its patrons
- generation of pedestrian and cyclist movements across existing arterial roads
- safety impact of congestion in peak periods, including changes to turning movements and the use of nearby streets
- type, layout and operation of adjacent intersections.

## 5.3 Infrastructure and Pavement Impact Assessment

Some projects, because of their size, location or the types of vehicles involved, will have a direct impact on the road pavement – and possibly bridges and culverts – in the area near the development. Examples include quarries (where the vehicles accessing the development are large and heavy) and developments that generate volumes of traffic, which exceed the earlier design volume for the road pavement, in terms of the number of equivalent standard axles (ESAs). In these cases, an assessment of the development's impacts on the road pavement will be required.

Where existing roads will be exposed to increased heavy vehicle traffic or new vehicle types, e.g. buses resulting from subdivision development, pavement impact can be a significant consideration, especially where old road pavements are involved.

Issues to be considered with any large road project may also include drainage, utility service relocation and effects on existing structures or watercourses.

Further discussion and advice on pavement impact issues is given in the *Guide to Pavement Technology* (Austroads 2006–14).

## 5.4 Environmental and Other Impacts

Where necessary, an assessment of environmental and other issues should be undertaken, including those associated with the natural, social, economic and built environments. The assessment may need to include the effects on environmentally sensitive, conservation and heritage areas. Issues may include:

- adverse effects on waterways, wetlands, flora and fauna
- hydrological impacts on waterways and abutting private land, including changes to surface and subsurface drainage, and water quality
- storm-water control
- geotechnical stability
- treatment of surface run-off during construction traffic noise at opening and in the design year

- dust, noise and inconvenience to the public associated with construction of the development and access roads
- air pollution
- contribution to greenhouse gas emissions
- spillage of road lighting
- distracting lighting from the site
- general visual impact or aesthetic appearance of the development or abutting roads; this could include buildings, kerbing, road surfacing, street lighting, road furniture, fences and walls; and large signs
- visual impacts associated with the scale of development
- landscaping
- heritage issues.

A general reference for environmental impact assessment in Australia is Elliott (2014); however, each jurisdiction will have requirements based on size, location or the nature of the proposed land use development.

A number of Austroads publications cover environmental matters that are relevant to issues that may arise in the planning, design, construction and ongoing management and maintenance of developments. Examples include:

- Road Investment Profiles and Potential Environmental Consequences (Austroads 2000c)
- Guidelines for Environmental Reporting (Austroads 2011)
- Environmental Considerations for Planning and Design of Roads (Austroads 2003)
- Environmental Risk Management Guidelines and Tools for Road Projects (Austroads 2001a)
- Road Runoff and Drainage: Environmental Impacts and Management Options (Austroads 2001b)
- Maintenance Techniques to Reduce Social and Environmental Impacts (Austroads 2006).

When considering environmental impacts relating to traffic using local areas adjacent to the development (traffic volume, speed, safety) refer to the *Guide to Traffic Management Part 8* (Austroads 2008a).

## References

- Australian Transport Council 2011, *National road safety strategy 2011-2020*, ATC, Canberra, ACT.
- Austrroads 1995, *Strategy for ecologically sustainable development*, AP-40-95, Austrroads, Sydney, NSW.
- Austrroads 2000a, *Ecologically sustainable development 'toolbox'*, AP-R166-00, Austrroads, Sydney, NSW.
- Austrroads 2000b, *A framework for arterial road access management*, AP-R163-00, Austrroads, Sydney, NSW.
- Austrroads 2000c, *Road investment profiles and potential environmental consequences*, AP-149-00, Austrroads, Sydney, NSW.
- Austrroads 2000d, *Strategy for ecologically sustainable development: progress and directions*, AP-139-00, Austrroads, Sydney, NSW.
- Austrroads 2001a, *Environmental risk management guidelines and tools for road projects.*, AP-R185-01, Austrroads, Sydney, NSW.
- Austrroads 2001b, *Road runoff & drainage: environmental impacts and management options*, AP-R180-00, Austrroads, Sydney, NSW.
- Austrroads 2003, *Environmental considerations for planning and design of roads*, AP-R217-03, Austrroads, Sydney, NSW.
- Austrroads 2005–12, *Guide to project evaluation parts 1-8*, Austrroads, Sydney, NSW
- Austrroads 2006, *Maintenance techniques to reduce social and environmental impacts*, AP-R291-06, Austrroads, Sydney, NSW.
- Austrroads 2006–14, *Guide to pavement technology parts 1-10*, Austrroads, Sydney, NSW
- Austrroads 2006–15, *Guide to road safety parts 1-9*, Austrroads, Sydney, NSW
- Austrroads 2008–15a, *Guide to road design parts 1-8*, Austrroads, Sydney, NSW
- Austrroads 2008–15b, *Guide to traffic management parts 1-8*, Austrroads, Sydney, NSW
- Austrroads 2008a, *Guide to traffic management part 8: local area traffic management*, AGTM08-08, Austrroads, Sydney, NSW.
- Austrroads 2008b, *Guide to traffic management part 11: parking*, AGTM11-08, Austrroads, Sydney, NSW.
- Austrroads 2009a, *Guide to road design part 4: intersections and crossings – general*, AGRD04-09, Austrroads, Sydney, NSW.
- Austrroads 2009b, *Guide to road safety part 6: road safety audit*, AGRS06-09, Austrroads, Sydney, NSW.
- Austrroads 2009c, *Guide to road transport planning*, AGRTP-09, Austrroads, Sydney, NSW.
- Austrroads 2009d *Guide to traffic management part 10: traffic control and communication devices*, AGTM10-09, Austrroads, Sydney, NSW.
- Austrroads 2009e, *Network operations planning framework*, AP-R338-09, Austrroads, Sydney, NSW.
- Austrroads 2010a, *Guide to road design part 3: geometric design*, 2nd edn, AGRD03-10, Austrroads, Sydney, NSW.
- Austrroads 2010b, *Guide to road design part 4a: unsignalised and signalised intersections*, 2nd edn, AGRD04A-10, Austrroads, Sydney, NSW.
- Austrroads 2011, *Guidelines for environmental reporting*, AP-G70-11, Austrroads, Sydney, NSW.
- Austrroads 2013a, *Austrroads design vehicles and turning path templates guide*, 3<sup>rd</sup> edn, AP-G34-13, Austrroads Ltd., Sydney, NSW.
- Austrroads 2013b, *Guide to traffic management part 3: traffic studies and analysis*, 2nd edn, AGTM03-13, Austrroads, Sydney, NSW.

- Austrroads 2013c, *Guide to traffic management part 6: intersections, interchanges and crossings*, 2nd edn, AGTM06-13, Austrroads, Sydney, NSW.
- Austrroads 2014a, *Guide to traffic management part 5: road management*, 2nd edn, AGTM05-14, Austrroads, Sydney, NSW.
- Austrroads 2014b, *Guide to traffic management part 9: traffic operations*, 2nd edn, AGTM09-14, Austrroads, Sydney, NSW.
- Austrroads 2015a, *Austrroads glossary of terms (2015 edition)*, 6th edn, AP-C87-15, Austrroads, Sydney, NSW.
- Austrroads 2015b, *Guide to road safety part 8: treatment of crash locations*, 2nd edn, AGRS08-15, Austrroads, Sydney, NSW.
- Austrroads 2015c, *Guide to traffic management part 1: introduction to traffic management*, 3rd edn, AGTM01-15, Austrroads, Sydney, NSW.
- Austrroads 2015d, *Guide to traffic management part 2: traffic theory*, 2nd edn, AGTM02-15, Austrroads, Sydney, NSW.
- Austrroads 2015e, *Guide to traffic management part 7: traffic management in activity centres*, 2nd edn, AGTM07-15, Austrroads, Sydney, NSW.
- Austrroads 2015f, *Safe system in the planning process*, AP-R488-15, Austrroads, Sydney, NSW.
- Austrroads 2016a, *Guide to traffic management part 4: network management*, 4th edn, AGTM04-16, Austrroads, Sydney, NSW.
- Austrroads 2016b, *Safe system assessment framework*, AP-R509-16, Austrroads, Sydney, NSW.
- Austrroads 2016c, *Safe system roads for local government*, AP-R518-16, Austrroads, Sydney, NSW.
- Boujenko, N, Gowen, H, Willey, B & Jones, P 2007, *Network management planning manual: planning for London's future*, issue 2B, TfL, London, UK.
- Boujenko, N, Morris, P & Jones, P 2012, *Streets for people: compendium for South Australian practice*, South Australian Active Living Coalition, South Australian Active Living Coalition, Adelaide, SA.
- Brindle, RE & Lansdell, H 1999, *Integrated planning and sustainable development*, ARR-333, ARR Transport Research, Vermont South, Vic.
- Brindle, RE 2001, 'Planning and road safety: opportunities and barriers', *Australasian Transport Research Forum (ATRF), 24th, 2001, Hobart, Tasmania*, Department of Infrastructure, Energy and Resources, Canberra, ACT, 23pp.
- Clark, I 2007, 'Trip rate and parking databases in New Zealand and Australia', *Australian Institute of National Traffic Planning and Management (AITPM) national conference, 20th, 2007, Canberra, ACT*, AITPM, Adelaide, South Australia, pp. 49-57.
- Currie, G 2006, 'Bus rapid transit in Australasia: performance, lessons learned and futures', *Journal of Public Transportation*, vol. 9, no. 3, pp. 1–22. Commonwealth of Australia 2015, *Quarterly update of Australia's national greenhouse gas inventory: march 2015*, Commonwealth of Australia, Canberra, ACT.
- Department for Communities and Local Government 2015, *Transport evidence bases in plan making and decision taking: planning practice guidance*, DCLG, London, UK, viewed 17 December 2015, <<http://planningguidance.communities.gov.uk/blog/guidance/transport-evidence-bases-in-plan-making/>>.
- Department of the Environment 2015, *Quarterly update of Australia's national greenhouse gas inventory: March 2015*, Department of the Environment, Canberra, ACT.
- Department of Infrastructure, Local Government and Planning 2007, 'Guide to using the IDAS development application forms: guide 3: referrals in relation to state-controlled roads', Department of Infrastructure and Planning, City East, Qld.

- Department for Transport 2007, *Guidance on transport assessment*, Department for Transport, London, UK viewed 8 December 2015, <[www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/263054/guidance-transport-assessment.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/263054/guidance-transport-assessment.pdf)>.
- Department of Transport 2008, *Public transport guidelines for land use development*, Department of Transport, Melbourne, Vic.
- Department of Transport, Planning and Local Infrastructure 2005, Planning scheme history for the Victoria planning provisions: clause 56.03: movement network, DPTLI, Melbourne, Vic.
- Elliott, M 2014, *Environmental impact assessment in Australia: theory and practice*, 6th edn, The Federation Press, Annandale, NSW.
- Everett, JD 2009, *An investigation of the transferability of trip generation models and the utilization of a spatial context variable*, PhD thesis, University of Tennessee, Knoxville, USA.
- Giblin, S, Ampt, E & Smith, R 2007, 'Towards a sustainable future: encouraging corporate responsibility', *Australian Institute of National Traffic Planning and Management (AITPM) national conference, 20th, 2007, Canberra, ACT*, AITPM, Adelaide, South Australia, pp. 263-70.
- Hallam, CE 1988, 'Land use traffic generation revisited', *Australian Road Research Board Conference, 14th, 1988, Canberra, ACT*, ARRB, Vermont South, vol. 14. Part 3, pp. 201-13.
- Hensher, DA & Button, KJ (eds.) 2008, *Handbook of transport modelling*, 2nd edn, Elsevier, Amsterdam.
- Holguín-Veras, J, Sánchez-Díaz, I, Lawson, C, Jaller, M, Campbell, S, Levinson, H & Shin, H-S 2013, 'Transferability of freight trip generation models', *Transportation Research Record*, no. 2379, pp. 1-8.
- Institute of Transportation Engineers 2010, *Transportation impact analyses for site development: an ITE recommended practice*, ITE, Washington, DC, USA.
- Institute of Transportation Engineers 2012, *Trip generation manual*, 9<sup>th</sup> ed, ITE, Washington, DC.
- Jones, P, Boujenko, N & Marshall, S 2007, *Link & place: a guide to street planning and design*, Local Transport Today Ltd., London.
- Luttinen, RT & Nevala, R 2002, *Capacity and level of service of Finnish signalized intersections*, Finnish Road Administration, Helsinki.
- Luttinen, T 2004, *Capacity and level of service at Finnish unsignalized intersections*, Finnish Road Administration, Helsinki.
- Main Roads Western Australia 2016, *Heavy vehicles*, webpage, MRWA, WA, viewed 11 May 2016, <<https://www.mainroads.wa.gov.au/UsingRoads/HeavyVehicles/Pages/HeavyVehiclesHome.aspx>>.
- Mousavi, A, Bunker, J & Lee, B 2012, 'A new approach for trip generation estimation for use in traffic impact assessments', *25th ARRB Conference, 25th ARRB Conference Proceedings, 2012, Perth, Western Australia, Australia*, ARRB Group Ltd., 15pp.
- Millard-Ball, A 2015, 'Phantom trips: overestimating the traffic impacts of new development', *Journal of Transport and Land Use*, vol. 8, no. 1, pp. 31-49.
- Mwakalonge, JL, Waller, JC & Perkins, JA 2012, 'Temporal stability and transferability of non-motorized and total trip generation models', *Journal of Transportation Technologies*, vol. 2, no. 4, pp. 285-296.
- National Heavy Vehicle Regulator n.d., *Mass, dimension and loading*, webpage, NHVR, Fortitude Valley, Qld, viewed 11 May 2016, <<https://www.nhvr.gov.au/road-access/mass-dimension-and-loading/classes-of-heavy-vehicles>>.
- NZ Transport Agency 2009, *Comparisons of NZ and UK trips and parking rates*, report no. 374, NZTA, Wellington, New Zealand.
- NZ Transport Agency 2016a, 'Economic evaluation manual', NZTA, Wellington, NZ.
- NZ Transport Agency 2016b, *High productivity motor vehicles and permits*, webpage, NZTA, Wellington, NZ, viewed 11 May 2016, <<https://www.nzta.govt.nz/commercial-driving/permits/high-productivity/high-productivity-motor-vehicles-and-hpmv-permits/>>.

- Parliament of Victoria 2014, *Inquiry into serious injury*, report by Victoria Road Safety Committee, parliamentary paper 329 of 2010-2014, Melbourne, Vic.
- Patriksson, M 1994, *The traffic assignment problem: models and methods*, VSP, Utrecht.
- Queensland Department of Main Roads 2006, *Guidelines for assessment of road impacts of development proposals*, Queensland Department of Main Roads (QDMR), Brisbane, Qld.
- Roads and Maritime Services 2013, *Guide to traffic generating developments. Updated traffic surveys*, TDT 2013/04a, RMS, Sydney, NSW, viewed 2 November 2015, <<http://www.rms.nsw.gov.au/trafficinformation/downloads/td13-04a.pdf>>.
- Roads and Traffic Authority 2002, *Guide to traffic generating developments*, RTA, Sydney, NSW.
- Roads and Traffic Authority n.d., *Draft interim guidelines on transport management and accessibility plans*, RTA, Sydney, NSW, viewed 17 December 2015, <[www.transport.nsw.gov.au/sites/default/files/b2b/abouttrans/trans-management-accessibility-plans.pdf](http://www.transport.nsw.gov.au/sites/default/files/b2b/abouttrans/trans-management-accessibility-plans.pdf)>.
- Scottish Executive 2006, *Guide to transport assessment in Scotland*, Scottish Executive, Edinburgh, Scotland, viewed 16 March 2016, <[www.scotland.gov.uk/consultations/transport/gtta-01.asp](http://www.scotland.gov.uk/consultations/transport/gtta-01.asp)>.
- Stilgoe, JR 2005, *Landscape and images*, University of Virginia Press, Charlottesville, US.
- Transportation Research Board 2010, *Highway capacity manual*, 5th edn, TRB, Washington, DC.
- TravelSmart Australia 2008, TravelSmart publication list, viewed 8 December 2015, [www.travelsmart.gov.au/resources/index.html#publications](http://www.travelsmart.gov.au/resources/index.html#publications)
- TRICS Consortium n.d., *TRICS*, website, TRICS Consortium, Surrey, UK, viewed 15 December 2015, <<http://www.trics.org/>>.
- VicRoads 2006, 'Guidelines for transport impact assessment reports for major land use and development proposals', VicRoads, Kew, Vic.
- Welle, B, Liu, Q, Li, W, Adiazola-Steil, C, King, R, Sarmiento, C & Obelheiro, M 2015, *Cities safer by design*, version 1.0, World Resources Institute, Washington, DC, viewed 26 November 2015, <[http://www.wri.org/sites/default/files/CitiesSaferByDesign\\_final.pdf](http://www.wri.org/sites/default/files/CitiesSaferByDesign_final.pdf)>.
- Western Australian Planning Commission 2006, *Transport assessment guidelines for developments: introduction: version for trial and evaluation*, WAPC, Perth WA, viewed 8 December 2015, <[www.planning.wa.gov.au/dop\\_pub\\_pdf/Introduction\\_Aug\\_06.pdf](http://www.planning.wa.gov.au/dop_pub_pdf/Introduction_Aug_06.pdf)>.
- World Commission on Environment and Development 1987, *Our common future*, Oxford University Press, Oxford, UK.

### **Australian and New Zealand Standards**

- AS 1742.2: 2009, *Manual of uniform traffic control devices: traffic control devices for general use*.
- AS 2890.3: 2015, *Parking facilities: bicycle parking*.
- AS/NZS 2890 (Set): 2009, *Parking facilities set*.
- AS IEC 61851.23: 2014, *Electric vehicle conductive charging system: D.C. electric vehicle charging station*.
- AS IEC 62196.2: 2014, *Plugs, socket-outlets, vehicle connectors and vehicle inlets: conductive charging of electric vehicles: dimensional compatibility and interchangeability requirements for A.C. pin and contact-tube accessories*.

# Appendix A Checklist for Traffic Impact Assessments

Table A 1: Technical completeness checklist

**TECHNICAL COMPLETENESS CHECKLIST**  
**Austrroads Guide to Traffic Management – Part 12**

Project Name: \_\_\_\_\_

Reference \_\_\_\_\_

Section	Steps in traffic impact assessment	Done (✓)
<b>Section 4.4.1</b>	<b>Document proposed development</b>	
	Obtained plans showing layout of all traffic and pedestrian areas on site, locations of vehicle and pedestrian accesses, position and layout of nearby driveways and intersections.	
	Each type of internal access (e.g. cars, pedestrians and trucks) is direct, connected, continuous and makes sense.	
	Approach roads and paths are clearly understood and practical.	
	The correct design vehicle and checking vehicle have been used in various sections of the development.	
	Basic design requirements have been applied.	
	Land use planning zonings in the vicinity are documented.	
	Traffic-related features of the development have been summarised.	
	Timing and staged phasing (if any) has been described, including any connections with external timings.	
<b>Section 4.4.2</b>	<b>Resolve any initial problems with designers</b>	
	Any initial problems or issues needing resolution by designers have been identified.	
	Designers notified.	
	Issues have been checked and re-worked by designers.	
	Amended proposal has been re-documented.	
<b>Section 4.4.3</b>	<b>Identify area and stakeholders affected</b>	
	Agreed functional road hierarchy in area has been documented.	
	Relevant or affected non-car transport networks or services have been documented.	
	Initial assessment of area affected by changed traffic conditions has been made.	
	Sites potentially impacted have been listed.	
	All affected stakeholders have been identified and a note made about when each needs to be consulted.	

Section	Steps in traffic impact assessment	Done (✓)
<b>Section 4.4.4 Describe existing and design year conditions</b>		
	Existing on-site conditions, including traffic and parking, have been documented.	
	Existing traffic conditions for external sites, road lengths and/or areas identified as potentially impacted have been documented for critical periods.	
	Design year has been selected, and traffic conditions, excluding traffic generated by the development, have been documented. Volumes shown on plan.	
	Parking conditions, as relevant, have been described.	
	Traffic crashes at potentially impacted locations have been documented.	
	Other known traffic safety or operational problems, and any proposals to address them, have been documented.	
	Any traffic, transport or parking policies which affect the proposed development have been documented.	
<b>Section 4.4.5 Determine generated traffic and modal split</b>		
	Number of trips which will be generated by the development (e.g. daily or peak-period) has been determined for the design year or years.	
	The split of general traffic, commercial vehicles, public transport vehicles (including taxis), bicycles, pedestrians and other relevant modes has been determined.	
<b>Section 4.4.6 Determine approach and departure directions</b>		
	Approach and departure directions for the traffic have been determined.	
	Nature of attracted traffic (e.g. the same origin and return destination or linked trips) has been considered and described.	
<b>Section 4.4.7 Assign traffic to roads</b>		
	Traffic generated by the development has been assigned to the road network in the potentially affected area for the design year or years.	
	Development-generated traffic has been shown on plans.	
	Background traffic (existing volumes factored to the design year) and development-generated traffic have been added together.	
	Total traffic has been shown on plans for critical times of day or week, etc.	
<b>Section 4.4.8 Determine where non-car traffic will go</b>		
	Paths, lanes, etc. required for pedestrians, cyclists, buses, delivery vehicles, etc. have been determined.	
<b>Section 4.4.9 Review limits of area affected</b>		
	Limits of area impacted by the development have been checked, and necessary alterations noted.	
	If assessment over a greater area is needed, further analysis has been done.	

Section	Steps in traffic impact assessment	Done (✓)
<b>Section 4.4.10</b>	<b>Assess traffic operation on roads</b>	
	Traffic operations (e.g. traffic volumes, capacity, level of service and delays) for access points, mid-blocks and intersections have been assessed; consequences noted.	
	Circulation of traffic near the site has been considered.	
	Need for on-street parking, and potential impact on arterial roads/traffic routes, has been determined.	
	Impact on public transport services, from development generated use and from increased traffic on public transport routes (buses and trams) has been assessed.	
<b>Section 4.4.11</b>	<b>Assess traffic operation on-site</b>	
	Traffic operation of roads, aisles, access ways on-site, including traffic circulation within the site, has been analysed.	
	Expected traffic volumes and vehicle types can be safely and efficiently accommodated within the traffic and parking areas on-site.	
	On-site parking provision is adequate and is suitably located.	
<b>Section 4.4.12</b>	<b>Determine required impact-mitigating treatments</b>	
	Required changes, improvements, upgrades and/or modifications to roads, intersections, traffic lanes, controls, access driveways, have been determined.	
	Required changes on-site and on nearby roads/streets to manage parking have been determined.	
	Required works and traffic management to accommodate pedestrians, cyclists, public transport, delivery vehicles, on-site and in the nearby area, have been determined.	
	Required treatments relating to pavements, safety and environmental issues have been determined.	
	Coordination of all required treatments has been considered.	
<b>Section 4.4.13</b>	<b>Obtain road safety engineering assessment</b>	
	Need for an independent assessment of the road safety aspects of the development has been considered.	
	If necessary, independent road safety engineering assessment has been arranged.	
<b>Section 4.4.14</b>	<b>Document findings and recommendations</b>	
	The above steps and their outcomes have been documented in a suitable report.	

## Appendix B Example Checklists

### B.1 Technical Completeness Checklist

Table B 1: Technical completeness checklist 1

<p><b>TRAFFIC IMPACT STUDY</b></p> <p><b>TECHNICAL COMPLETENESS CHECKLIST</b></p> <p>Project Name: _____</p> <p>Reference Code: _____</p>		
		<b>TRAFFIC REQUIREMENT</b>
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Traffic generated greater than vehicles per day
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Study required comment: _____ Date: _____
		<b>BACKGROUND AND INFORMATION</b>
<input type="checkbox"/> Yes	<input type="checkbox"/> No	
		<b>INTRODUCTION AND SUMMARY</b>
<input type="checkbox"/> Yes	<input type="checkbox"/> No	
		<b>EXISTING CONDITIONS</b>
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Roadway network – summary of roadway classifications and description of study areas
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Analysis period correct (AM, mid-day, PM and/or Saturday, recreational traffic)
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Existing traffic operations (current level of services, traffic volumes, speeds, crash data, etc)
		<b>IMPACTS</b>
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Trip generation – daily, peak hour trips generated by site development
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Trip distribution
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Level of service analysis – projected LOS with site build out, existing traffic and background traffic growth (identify existing and projected LOS deficiencies)
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Signal warrant analysis
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Turn lane warrant analysis
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Analysis of sight distance at frontage road access point(s)
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Identify safe route to school or school bus stops (contact with school district)

<input type="checkbox"/> Yes	<input type="checkbox"/> No	Analysis of safe pedestrian/bicycle access to nearest transit stop (if within 500 m of project site)
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Identify accessibility to public transport
		<b>MITIGATION</b>
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Identify need for right/left turn lanes, storage capacity and length
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Identify possible corrections of any LOS deficiencies
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Identify any access deficiencies (including pedestrian/bicycle connections)
		<b>FIGURES</b>
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Vicinity map
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Site plan
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Existing peak hour turn movement volumes (counts conducted within previous 12 months)
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Trip distribution (%) including added project peak hour traffic volumes (see sample)
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Project completion year peak hour traffic volumes (see sample)
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Comprehensive plan future year turn movement volumes
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Programmed transportation improvements and transportation mitigation outlined in study
		<b>TABLES</b>
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Intersection performance existing conditions
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Project trip generation
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Intersection level of service
		<b>OTHER</b>
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Technical appendix – sufficient material to convey complete understanding of traffic issues (e.g. HCM analyses, trip generation calculations, signal warrant analyses, turn lane warrant analyses, etc.)
		<b>LOCAL AREA TRAFFIC MANAGEMENT MITIGATION</b>
<input type="checkbox"/> Yes	<input type="checkbox"/> No	Meets requirements for mitigation of NTM. Provide data, and preliminary design and locations
Completed by: _____ Date: _____		

Source: Slightly modified from Institute of Transportation Engineers (2010).

## B.2 Checklists for Road Impact Assessment

The following tables provide checklists for road impact assessment (RIA) and therefore include items related to areas other than traffic (e.g. flooding, drainage, pavements, visual amenity). However, many of the items are directly related to a traffic impact assessment.

Table B 2 and Table B 3 are from the *Guidelines for Assessment of Road Impacts of Development Proposals* (Queensland Department of Main Roads 2006). RIP refers to Main Roads Queensland *Roads Implementation Program* document.<sup>4</sup>

Table B 4 has been taken directly from Austroads (2015f) and incorporates Safe System principles.

**Table B 2: Issues checklist for intensive road use, such as feedlots or mining/extractive industries**

	Generally required <sup>(1)</sup>	MR discretion
<b>Development context</b>		
Site locality	X	
Site access (existing use, location and layout)	X	
Preferred land use	X	
Adjacent land uses/approvals		X
Description of road network (function, alignment, grade, lanes, intersections, median breaks, etc.)	X	
Existing traffic volumes (daily & peak)	X	
Traffic growth trends	X	
Speed environment/speed surveys		X
Existing parking provision	X	
Current MR planning and Roads Implementation Program (RIP)	X	
Road hierarchy	X	
Public transport network and services (existing and planned)	X	
Pedestrian/bicycle facilities		X
Crash history		X
Flood immunity of access route		X
Existing pavement standard/condition	X	
<b>Development proposal</b>		
Proposed uses and scale (dwellings, rooms, floor area)	X	
Operating hours, peaks	X	
Number of employees/visitors	X	
Travel demand management policies		X
Site layout (including adjoining connections to properties and other roads)	X	
Access form and location	X	
Development staging	X	
Traffic demand (vehicle/pedestrian/bicycle/public transport)	X	
Stormwater and drainage works (internal)		X
Stormwater and drainage works (external)	X	
Construction traffic	X	

<sup>4</sup> Note that a new version of the Guidelines for Assessment of Road Impacts of Development Proposal is due for publication in late 2016.

	Generally required <sup>(1)</sup>	MR discretion
<b>Development context</b>		
Service vehicle arrangements (access and on-site manoeuvring areas etc.)	X	
Proposed parking provision	X	
Trip distribution/assignment	X	
Haulage routes (including vehicle type and operating times)	X	
<b>Impact assessment and remedial works treatments</b>		
Traffic operation (including pedestrian, cycle and public transport)	X	
Road safety issues	X	
Pavement and bridge impacts	X	
Changes to the road network or planning	X	
Noise/hydraulic impacts on state-controlled roads		X
Visual amenity and other environmental impacts		X

<sup>1</sup> Depending upon the size/location of the development proposal, Main Roads may reduce the number of issues to be considered in an RIA.

**Table B 3: Issues checklist for other developments**

	Generally required <sup>(1)</sup>	MR discretion
<b>Development context</b>		
Site locality	X	
Site access (existing use, location and layout)	X	
Preferred land use	X	
Adjacent land uses/approvals		X
Description of road network (function, alignment, grade, lanes, intersections, median breaks, etc.)	X	
Existing traffic volumes (daily and peak)	X	
Traffic growth trends	X	
Speed environment/speed surveys		X
Existing parking provision	X	
Current Main Roads planning and RIP	X	
Road hierarchy	X	
Public transport network and services (existing and planned)	X	
Pedestrian/bicycle facilities	X	
Crash history		X
Flood immunity of access route		X
Existing pavement standard/condition		X
Development proposal		
Proposed uses and scale (dwellings, rooms, floor area)	X	
Operating hours, peaks	X	
Number of employees/visitors	X	
Travel demand management policies		X
Site layout (including adjoining connections to properties and other roads)	X	

	Generally required <sup>(1)</sup>	MR discretion
<b>Development context</b>		
Access form and location (queuing and storage)	X	
Development staging	X	
Traffic demand (vehicle/pedestrian/bicycle/public transport)	X	
Stormwater and drainage works (internal)		X
Stormwater and drainage works (external)	X	
Construction traffic	X	
Service vehicle arrangements (access and on-site manoeuvring areas etc.)	X	
Proposed parking provision	X	
Trip distribution/assignment	X	
Haulage routes (including vehicle type and operating times)		X
<b>Impact assessment and remedial works treatments</b>		
Traffic operation (including pedestrian, cycle and public transport)	X	
Road safety issues	X	
Pavement and bridge impacts		X
Changes to the road network or planning	X	
Noise/hydraulic impacts on state-controlled roads		X
Visual amenity and other environmental impacts	X	

1 Depending upon the size/location of the development proposal, Main Roads may reduce the number of issues to be considered in an RIA.

**Table B 4: Safety issues checklist for all developments**

Road Safety Planning Issue	Priority	Yes	No	Comment
<b>1. Promote Clear and Functional Road Hierarchy</b>				
Is the road hierarchy clear and serving the integrated transport objectives?	A			
<b>2. Integrate Safe System into all Transport Modes</b>				
Are the proposed arterial roads of a standard consistent with the intended function (e.g. divided carriageways, infrequent intersections, off-road cycling for high speed roads; consideration of pedestrians and cyclists needs where they are likely to interact with the road network)?	B			
Are opportunities (preferably segregated) for pedestrians and cyclists provided to travel between activity centres and public transport (PT) interchanges?	C			
<b>3. Minimise High-Severity Traffic Conflicts</b>				
Are cross-intersections between arterials grade separated or controlled with roundabouts?	B			
Are proposed new arterial roads/road upgrades separated from residential areas and strip shopping centres?	C			

Road Safety Planning Issue	Priority	Yes	No	Comment
Is side-road and property access to arterial roads controlled or prevented?	C			
Are new railway crossings grade separated?	B			
<b>4. Promote Clear and Functional Road Hierarchy</b>				
Does the road hierarchy promote standards consistent with the intended function (e.g. high-standard, high-speed roads for major links, low-speed environments for local access and mixed land use)?	A			
<b>5. Minimise High-Severity Conflicts</b>				
Do all collector and local roads encourage low operating vehicle speeds?	A			
Is side-road and property access to arterial roads suitably controlled or prevented?	B			
Does the local road network layout deter through traffic movements (low vehicle connectivity)?	C			
Is the local road network planned to minimise the number of intersections?	B			
Are intersections designed to reduce opportunities for conflict and to minimise speeds e.g. roundabouts, modified-T's?	B			
Are roadside hazards minimised? Work with streetscape designers to select vegetation that is flexible or will break on impact and encourage provision of underground services alongside transport routes. Street furniture should be breakable or impact absorbing. If these are not possible, encourage provision of safety barriers.	C			
Is kerbside parking prevented, restricted or suitably designed on arterial and collector roads?	D			
<b>6. Minimise Exposure of Pedestrians and Cyclists to Vehicular Traffic</b>				
Are the needs of pedestrians and cyclists considered on the local network (e.g. off-road paths, footpaths, clearly marked crossing points)?	B			
Are major pedestrian/cycle paths physically separated from motorised traffic carrying roads (e.g. off-road path or Copenhagen type)?	B			
Are pedestrian/cycle crossings separated or road speeds reduced to ≤ 30 km/h for at-grade crossings?	B			
Do high-use and mixed road user areas minimise conflict potential and speeds (e.g. near schools, local shopping centres, parklands and playgrounds, medical facilities)?	B			
Are activity centre active frontages removed from arterial roads (i.e. access controlled via service road, pedestrian movements across the arterials controlled)?	D			

Road Safety Planning Issue	Priority	Yes	No	Comment
Are activity centres planned to be free of internal traffic or with traffic at very low speeds?	C			
Do the locations proposed for schools allow for safe and convenient access by walking, cycle, bus and car?	D			
Do schools and community facilities feature: easy and direct access by cars and buses from arterial/ collector to avoid excessive traffic circulation in local streets? adequate off-street parking?	D			
Will public transport routes provide direct connections to all activity centres (without the need for pedestrians to cross busy roads)?	D			
<b>7. Minimise High-Severity Collisions On Arterial Roads</b>				
Are roadside hazards minimised? Work with streetscape designers to select vegetation that is flexible or will break on impact and encourage provision of underground services alongside transport routes. Street furniture should be breakable or impact absorbing. If these are not possible, encourage provision of safety barriers.	B			
Are speed limits compatible with the road function, standard and actual use?	A			
Is side-road and property access to arterial roads prevented or suitably controlled?	B			
Is kerbside parking prevented, restricted or suitably designed along the arterial corridor?	B			
Are public transport stops designed and located to maximise safety of passengers and other road users?	C			
<b>8. Minimise Crashes at Intersections by Controlling Access and Turning Movements</b>				
Are intersections designed to reduce opportunities for conflict and minimise speeds e.g. grade-separation, roundabouts, left-in/left-out? For example, road safety engineers may recommend designs where vehicle speeds are managed through intersection design.	A			
Are all railway crossings grade separated?	C			
<b>9. Minimise Exposure of Pedestrians and Cyclists to Vehicular Traffic</b>				
Are major pedestrian/cycle paths physically separated from traffic carrying roads (e.g. off-road path or Copenhagen type)?	B			
Are priority pedestrian/cycle crossings planned (e.g. grade separation) or road travel speed reduced to ≤ 30 km/h for at-grade crossings?	B			

Road Safety Planning Issue	Priority	Yes	No	Comment
<b>10. Provide Safer Site Access from Arterial/Collector Road Network</b>				
Are intersections designed to reduce opportunity for conflicts and minimise speeds from the development site, e.g. roundabouts, left-in/left-out?	A			
Is kerbside parking prevented, restricted or suitably designed along arterial/collector road network?	C			
Are safe and direct paths to the development provided for pedestrians and cyclists, and separated from other vehicles?	B			
<b>11. Encourage Safe On-Site Interactions</b>				
Does the layout ensure safe separation of vehicular and pedestrian movements?	A			
Are loading/unloading facilities separated from customer vehicle and pedestrian movements?	B			
Does the layout of off-street parking and internal roads encourage low speeds and minimise potential for intersection crashes?	B			
Is sufficient off-street parking incorporated into the design, or vehicle access discouraged?	C			

Source: Austroads (2015f).

## Appendix C Traffic Impact Assessment Report Structure

### C.1 Report Outline

As a guide for the organisation of a TIA report, Table C 1 provides an outline of the sample table of contents for the report and Table C 2 provides a list of suggested figures and tables for the report.

**Table C 1: Traffic impact assessment report**

<ul style="list-style-type: none"> <li>I. Introduction and Summary                             <ul style="list-style-type: none"> <li>A. Purpose of Report and Study Objectives</li> <li>B. Executive Summary                                     <ul style="list-style-type: none"> <li>1. Site location and study area</li> <li>2. Development description</li> <li>3. Types of studies undertaken (impacts, signal warrant, site access, etc.)</li> <li>4. Principal findings</li> <li>5. Conclusions</li> <li>6. Recommendations</li> </ul> </li> </ul> </li> </ul>
<ul style="list-style-type: none"> <li>II. Proposed Development (Site and Nearby)                             <ul style="list-style-type: none"> <li>A. Off-Site (or Background) Development</li> <li>B. Description of On-Site Development                                     <ul style="list-style-type: none"> <li>1. Land use and intensity</li> <li>2. Location</li> <li>3. Site plan</li> <li>4. Zoning</li> <li>5. Phasing and timing</li> </ul> </li> </ul> </li> </ul>
<ul style="list-style-type: none"> <li>III. Existing Area Conditions                             <ul style="list-style-type: none"> <li>A. Study Area                                     <ul style="list-style-type: none"> <li>1. Area of influence</li> <li>2. Area of significant transportation impact (may also be part of Chapter IV)</li> </ul> </li> <li>B. Study Area Land Use                                     <ul style="list-style-type: none"> <li>1. Existing land uses</li> <li>2. Existing zoning</li> <li>3. Anticipated future development</li> </ul> </li> <li>C. Site Accessibility                                     <ul style="list-style-type: none"> <li>1. Area roadway system   <ul style="list-style-type: none"> <li>a. existing</li> <li>b. future</li> </ul> </li> <li>2. Traffic volumes and conditions</li> <li>3. Transit service</li> <li>4. Pedestrians and bicyclists</li> <li>5. Existing relevant transportation system management programs</li> <li>6. Other as applicable</li> </ul> </li> </ul> </li> </ul>

- IV. Projected Traffic
  - A. Site Traffic (each horizon year)
    - 1. Trip generation
    - 2. Trip distribution
    - 3. Modal split
    - 4. Trip assignment
  - B. Through Traffic (each horizon year)
    - 1. Method projection
    - 2. Non-site traffic for anticipated development in study area
      - a. method of projections
      - b. trip generation
      - c. trip distribution
      - d. modal split
      - e. trip assignment
    - 3. Through traffic
    - 4. Estimated volumes
  - C. Total Traffic (each horizon year)
- V. Transportation Analysis
  - A. Site Access
  - B. Capacity and Level of Service
    - 1. Existing conditions
    - 2. Background conditions (existing plus growth) for each horizon year
    - 3. Total traffic (existing, background and site) for each horizon year
  - C. Transportation Safety
  - D. Traffic Signals
  - E. Site Circulation and Parking
- VI. Improvement Analysis
  - A. Improvements to Accommodate Existing Traffic
  - B. Improvements to Accommodate Background Traffic
  - C. Additional Improvements to Accommodate Site Traffic
  - D. Alternative Improvements
  - E. Status of Improvements Already Funded, Programmed, or Planned
  - F. Evaluation
- VII. Findings
  - A. Site Accessibility
  - B. Transportation Impacts
  - C. Need for Any Improvements
  - D. Compliance with Applicable Local Codes
- VIII. Recommendations
  - A. Site Access/Circulation Plan
  - B. Roadway Improvements
    - 1. On-site
    - 2. Off-site
    - 3. Phasing, if appropriate
  - C. Transit, Pedestrians and Bicycles
  - D. Transportation System Management /Transportation Demand Management Actions
    - 1. Off-site
    - 2. On-site operational
    - 3. On-site
  - E. Other
- IX. Conclusions

Source: Institute of Transportation Engineers (2010).

**Table C 2: Suggested figures and tables to be included in a traffic impact assessment report**

Item	Title	Description
Figure A	Site location	Area map showing site location.
Figure B	Study area	Map showing area of influence.
Figure C	Existing transportation system	Existing roadway system serving site. Should show all major streets, minor streets adjacent to site and site boundaries. Show also transit, bicycle and major pedestrian routes, if applicable, along with right-of-way widths and signal locations. In some cases, may be combined with Figure A.
Figure D	Existing and anticipated area development	Map at same scale as Figure H showing existing and anticipated land uses/developments in study area.
Figure E	Current daily traffic volumes	Recent or existing daily volumes on roads in study area. May be combined with Figure B or E. Include existing moving lanes if not show in Figure B.
Figure F	Existing peak-hour turning volumes	Current peak hour turning volumes at each location critical to site volumes access or serving major traffic volumes through study area. May be combined with Figure D. Also existing moving lanes if not shown in Figure B.
Figure G	Anticipated transportation system	Area transportation system map showing programmed and applicable planned roadway, transit, bikeway and pedestrian-way improvements affecting site access or traffic flow through the study area. May be combined with Figure B.
Table A or Figure H	Directional distribution of traffic	Map or table showing (by percentages) the portion of site traffic approaching and departing the area on each roadway; may differ by land use within multi-use development.
Table B	Estimated site traffic generation	Estimated peak hour (and daily if required) trips to be generated by each major component of the proposed development; must be shown separately for inbound and outbound directions.
Figure I	Site traffic	Map of anticipated study area roadway network showing peak hour turning volumes generated by site development.
Table C	Estimated trip generation for non-site development	Trips generated by off-site development within study area. Similar to Table B.
Figure J	Estimated non-site traffic	Map similar to Figure H showing peak hour turning volumes generated by off-site development within study area plus through horizon year traffic.
Figure K	Estimated total future traffic	Map similar to Figure G showing sum of traffic from Figures H and I.
Figure L or Table D	Projected levels of service	Levels of service computed for critical intersections in study area. Include existing, horizon year non-site and total horizon year (with site development) conditions.
Figure M or Table E	Recommended improvements	Map showing recommended off-site transportation improvements, site access points and on-site circulation and parking features, as appropriate. May require more than one figure. Table will describe improvements by location and type. If phasing of improvements is to be stipulated, this should also be shown on these or a separate figure or table.
Figure N or Table F	Study checklist	Checklist showing the required/optional elements of a transportation impact analysis report, whether or not they have been incorporated, and their locations in the report.

*Note: Additional figures and tables may be needed for studies and additional complexities, issues, or study years.*

*Source: Institute of Transportation Engineers (2010).*

## Appendix D Example of Traffic Generation Rates

The following traffic generation rates are taken from Roads and Maritime Services (2013) which updates the traffic generation rates in Roads and Traffic Authority (2002). It is provided for example only.

The NSW guide is currently the most comprehensive Australian reference on the subject. However, it is noted that the base data were collected many years ago and need to be updated with more recent data.

### D.1 Low Density Residential Flat Dwellings

Eleven survey were conducted in 2010, six with the Sydney urban area and five with regional NSW. The results of the survey were as follows:

- Rates
  - Daily vehicle trips = 10.7 per dwelling in Sydney, 7.4 per dwelling in regional areas.
  - Weekday average evening peak hour vehicle trips = 0.99 per dwelling in Sydney (maximum 1.39), 0.78 per dwelling in regional areas (maximum 0.90).
  - Weekday average morning peak hour vehicle trips = 0.95 per dwelling in Sydney (maximum 1.32), 0.71 per dwelling in regional areas (maximum 0.85).

(The above rates do not include trips made internal to the subdivision, which may add up to an additional 25%).

### D.2 High Density Residential Flat Dwellings

Ten surveys were conducted in 2012, eight within Sydney, and one each in the Hunter and Illawarra. All developments were (i) close to public transport, (ii) greater than six storeys and (iii) almost exclusively residential in nature. The weekday trip generation rates are shown in Table D 1.

**Table D 1: Weekday trip generation rates**

Weekday rates	Sydney average	Sydney range	Regional average	Regional range
AM peak (1 hour) vehicle trips per unit	0.19	0.07–0.32	0.53	0.39–0.67
AM peak (1 hour) vehicle trips per car space	0.15	0.09–0.29	0.35	0.32–0.37
AM peak (1 hour) vehicle trips per bedroom	0.09	0.03–0.13	0.21	0.20–0.22
PM peak (1 hour) vehicle trips per unit	0.15	0.06–0.41	0.32	0.22–0.42
PM peak (1 hour) vehicle trips per car space	0.12	0.05–0.28	0.26	0.11–0.40
PM peak (1 hour) vehicle trips per bedroom	0.07	0.03–0.17	0.15	0.07–0.22
Daily vehicle trips per unit	1.52	0.77–3.14	4.58	4.37–4.78
Daily vehicle trips per car space	1.34	0.56–2.16	3.22	2.26–4.18
Daily vehicle trips per bedroom	0.72	0.35–1.29	1.93	1.59–2.26

Source: Roads and Maritime Services (2013).

### D.3 Housing for Seniors

Ten surveys were conducted in 2009, five within the Sydney urban area and five in regional New South Wales. Summary trip generation rates were as follows:

- Weekday daily vehicle trips = 2.1 per dwelling.
- Weekday peak hour vehicle trips = 0.4 per dwelling.

(Note that morning site peak hour does not generally coincide with the network peak hour).

### D.4 Office Blocks

Ten surveys were conducted in 2010. Eight of the surveys were conducted within the Sydney urban area and one each in Newcastle and Wollongong. The Sydney sites provided a range of locations with two inner ring sites, four middle ring sites and two outer ring sites. Most had access to the rail network. Summary trip generation rates were as follows:

- Daily vehicle trips = 11 per 100 m<sup>2</sup> gross floor area.
- Morning peak hour vehicle trips = 1.6 per 100 m<sup>2</sup> gross floor area.
- Evening peak hour vehicle trips = 1.2 per 100 m<sup>2</sup> gross floor area.

### D.5 Business Parks and Industrial Estates

In 2012 eleven of these two types of sites were surveyed, four with the Sydney urban area, four with the Lower Hunter, one in the Illawarra and one in Dubbo. Summary vehicle trip generation rates are shown in Table D 2.

**Table D 2: Summary vehicle trip generation rates**

Weekday rates	Sydney average	Sydney range	Regional average	Regional range
AM peak (1 hour) vehicle trips per 100 m <sup>2</sup> of GFA	0.52	0.15–1.31	0.70	0.32–1.20
PM peak (1 hour) vehicle trips per 100 m <sup>2</sup> of GFA	0.56	0.16–1.50	0.78	0.39–1.30
Daily total vehicle trips	4.60	1.89–10.47	7.83	3.78–11.99

Source: *Roads and Maritime Services (2013)*.

## Appendix E Sample Rural Project – Quarry

This appendix presents an example drawn from Queensland Department of Main Roads (2006). All figures and tables in this appendix are sourced from that document.

It is intended to provide an understanding of the issues requiring consideration for rural developments. It is not intended to provide an exhaustive example of traffic analysis, although some analysis is provided for illustrative purposes.

The process steps are as follows:

Step 1: Development profile

Step 2: Pavement impact assessment

Step 3: Traffic operation assessment

Step 4: Safety review

Step 5: Environmental and other issues

Step 6: Impact mitigation.

Note that in presenting this example in the primary context of traffic management guidance, Step 2 has not been included in this appendix. Note also that cross-references to other sections within the source document have been removed where possible for clarity.

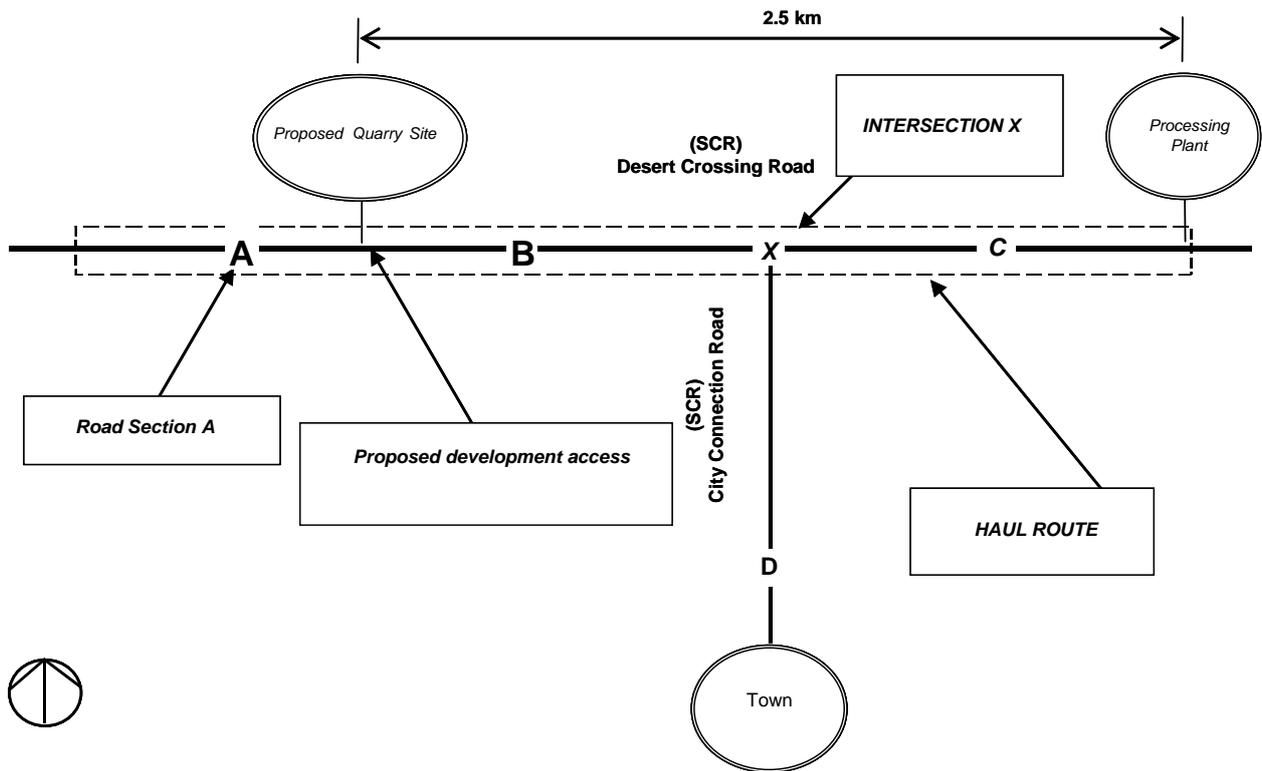
### E.1 Step 1: Development Profile

#### E.1.1 Development Details

The proposal is a new quarry to be located outside a large rural town as shown in Figure E 1. The figure identified road sections A, B, C and D and intersection X which are referred to later. An existing processing plant, which will receive the extracted material, is located 2.5 km to the east on the same State-Controlled Road (Desert Crossing Road).

- The quarry has an estimated output of 200 000 t/year.
- The development application was referred to Main Roads by the local government, as the quarry would have direct access to a state-controlled road (SCR). The planned size of the quarry exceeds identified referral thresholds. (Referral triggers are documented in Department of Infrastructure, Local Government and Planning 2007).
- Currently, the site is vacant and there are agricultural land uses adjacent.
- The development is proposed to have a single access onto Desert Crossing Road. The processing plant has an existing access direct to Desert Crossing Road.
- The quarry is proposed to operate in a single 6 am to 5 pm shift, six days per week, throughout the year (i.e. 312 days/year). Up to 25 staff will be present during a shift.
- Haulage vehicles will be 42.5 t GVM tri-axle semi-tippers with a tare (vehicle) mass of 16 t and net (payload) weight of 26.5 t.
- The proposed development will employ a local workforce, residing primarily in the town.
- The quarry is expected to become fully operational in the 2007 and has an estimated extraction life of 20 years.

Figure E 1: Locality map



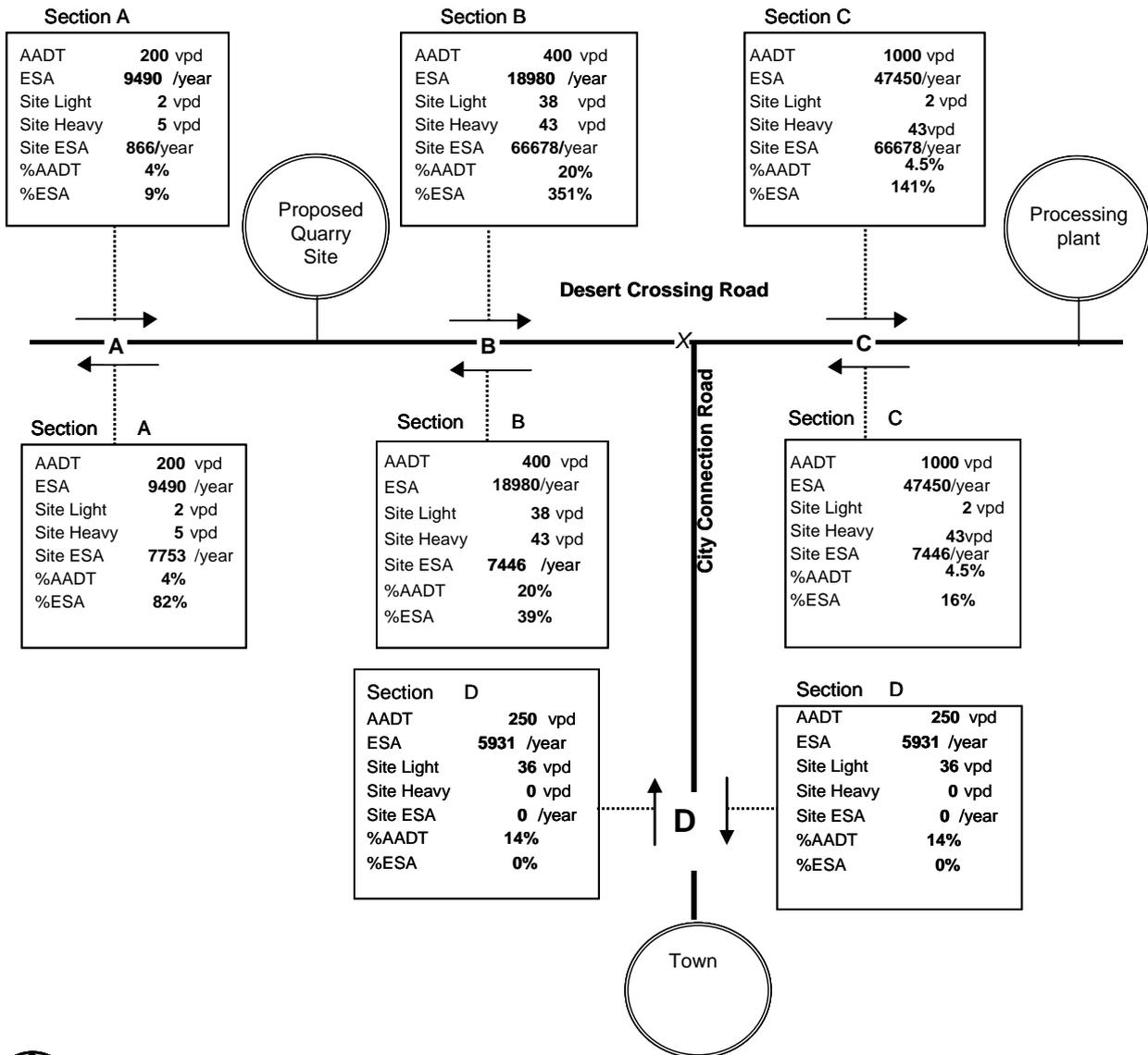
### E.1.2 Surrounding Road Network Details

- Desert Crossing Road is a SCR as is City Connection Road to the town. Both are low volume rural roads.
- Both roads have a 10 m pavement, comprising two 3.5 m lanes and 1.5 m sealed shoulders (the road forms were confirmed by site inspection).
- Existing annual average daily traffic (AADT) quantities provided by the Main Roads (MR) district office are shown in Figure E 2. Road sections A, B and C have 10% commercial vehicles while road section D has 5% commercial vehicles.
- The MR district office has advised that the traffic growth rate in the area is of the order of 2% linear per annum.

### E.1.3 Development Traffic Generation

The likely traffic profile generated by the proposal was based upon consideration of the operation and its traffic generation characteristics.

Figure E 2: Traffic volumes



Note: See text in this Appendix for explanation of how the site traffic is determined.

### E.1.4 Traffic Generation – Light Vehicles

- In this particular example, peak employee traffic has been estimated for a period of one hour. However, this may not be sufficient in some situations and estimates for periods of 15 minutes might be necessary where arrival or departure rates are more pronounced. Visitor movements have also been estimated.
- No reduction in trip making due to potential ride-sharing has been made. Options for operating a shuttle bus have been examined but found to be unviable. Some ride-sharing may occur and would be encouraged by the plant operator.
- A survey of a similar development was conducted by means of an automatic traffic counter to identify the traffic profile. Previous surveys of similar developments also support the assumptions adopted.

Traffic generation – light-vehicles	
<b>Employees</b>	25 staff per day x 2 trips/staff/day (1 in/1 out)
	= 50 light vehicle trips/day (A)
or	25 light-vehicle trips/hour (peak) (trips during shifts are unlikely)
<b>Visitors</b>	average of 15 visitors per day x 2 trips/visitor/day (1 in/1 out)
	= 30 light-vehicle trips/day (B)
	(it is unlikely that any of these trips would occur during the peak period)

**E.1.5 Traffic Generation – Heavy Commercial Vehicles**

- The anticipated annual profile of quarry extraction was examined and the design case identified. For the purposes of traffic operation, the peak operation (worst case scenario) should be considered, whereas for pavement impacts, the average case should be used. For the purposes of this example, it has been assumed that the peak demand is the same as the average demand.
- The quarry operator has forecast that March will be the peak month. Extraction is expected to be in the order of twice the average.

**E.1.6 Development Traffic Distribution**

The anticipated distribution of development traffic has been based upon the locations of potential product destinations and staff accommodation. This is shown in Table E 1.

**Table E 1: Traffic distribution**

Component	Percentage	Road section	Volume
Light vehicles	90%	D	72
	5%	C	4
	5%	A	4
	100%		80
Heavy commercial vehicles	90%	B and C	86
	10%	A	10
	100%		96

In accordance with this distribution, the daily site traffic volume is as shown in Figure E 2.

**E.1.7 Study Network Definition**

- All haul routes associated with the development will need to be assessed in accordance with Criterion 4 (in Chapter 3.2 of source document).
- To identify the spatial extent of investigation, information on existing traffic volumes and ESAs was obtained. In most cases, AADT and the percentage of commercial traffic will be available from the MR district office. Supplementary traffic counts may be required.

**Traffic operation**

- For traffic operation, assessment is required where the development traffic exceeds the thresholds set by Criteria 3 and 4.
- This is the case for road section A (Criterion 4), road section B (Criterion 3), road section C (Criterion 4) and road section D (Criterion 4).
- Intersection X also requires assessment (Criteria 3 and 4).

**Pavement impacts**

- Assessment of pavement impacts is required where development traffic generates an increase in ESAs equal to or greater than 5% (Criterion 2).
- As shown in Figure E 2, the development will generate an increase in ESAs equal to or greater than 5% on road sections A, B and C. Road section A extends for the full distance of the haul route to the west.

**Traffic generation – heavy commercial vehicles**

**Average demand** 200 000 t/year + (26.5 t/truck x 312 days/year)  
 24 loaded truck trips/day  
 (24 unloaded trips/day to the site/24 loaded trips/day from the site)  
 = 48 heavy commercial vehicle trips/day

**Peak demand (twice the average extraction)**

48 loaded truck trips/day  
 (48 unloaded trips/day to the site/48 loaded trips/day from the site)  
 = 96 heavy commercial vehicle trips/day

**Traffic generation – all vehicles**

80 light vehicle trips/day + 96 heavy commercial vehicle trips/day  
 (Total trips on segments A, B & C)  
 = 176 total vehicle trips/day.

Existing ESAs for each road section should be calculated, as shown below, by weighting the AADT in accordance with the proportion of existing commercial traffic.

**ESA calculation (road section B)**

AADT = 400 vpd eastbound  
 Commercial vehicle (CV) % = 10%  
 ESA:CV ratio = 1.3 (derived from MR Pavement Design Manual)  
 Existing ESA (Section B) = 400 vpd x 10% CV x 365 days/year x 1.3 ESA/CV  
 = 18 980 ESA/year

**E.1.8 Design Horizon**

- The design horizon for this project was identified as 2027, as the quarry has an estimated operating life based on identified yield of 20 years beyond initial opening in 2007.
- For the purposes of traffic operation, it is appropriate to limit the impact assessment to 10 years and therefore 2011 has been adopted for traffic operation assessment.

### E.1.9 On-site Aspects

- All servicing and parking will take place on-site, as there is ample space.

## E.2 Step 2: Pavement Impact Assessment

(Excluded from this appendix).

## E.3 Step 3: Traffic Operation Assessment

Following identification of the traffic profile of the development, discussions with the Main Roads District Office were convened to resolve what traffic operation assessment was required along the haul route on road section A. In this instance, the District Office limited the assessment to road sections B, C and D and intersection X. The analysis process for each is outlined below.

### E.3.1 Road Link Analysis

- Volumes on all sections of roads are within acceptable limits for the present road forms.
- Existing AADT volumes (2006 base year) were factored by the 2% linear annual growth rate for the 2017 analysis. The forecast link volumes without and with development are shown in Table E 2.
- Volumes on all road sections will continue to be acceptable with the existing road forms at 2017 with the development operational.
- No-overtaking-lane provision or four-lane upgrading will be required within the 2011 design horizon.

**Table E 2: Forecast link volumes**

Link	Existing AADT (2000)	2007		2017	
		No dev	With dev	No dev	With dev
Section A	400	408	422	488	502
Section B	800	816	978	976	1038
Section C	2000	2040	2130	2440	2530
Section D	500	510	582	610	682

### E.3.2 Intersection Analysis

- To determine the adequacy of intersection X, the site access and the processing plant access, the following have been considered:
  - intersection capacity
  - criteria for auxiliary turn lanes.
- Peak hour turning movement volumes with and without the development at the opening year (2007) and design year (2017) were forecast.
- SIDRA<sup>5</sup> analysis for operation of unsignalised intersection X is summarised in Table E 3. Degree of saturation and 95 percentile queue lengths are as shown. The critical degree of saturation for an unsignalised intersection of this form is 80%.

<sup>5</sup> SIDRA Solutions (<http://www.sidrasolutions.com/>) is a well-known provider of intersection analysis software.

**Table E 3: SIDRA analysis for intersection X**

Design case	DOS (%)	95%ile queue (m)	
		Right turn in	Right turn out
2000 No development	42	10	5
2000 With development	40	12	8
2010 No development	75	15	8
2010 With development	79	19	12

- Intersection X will continue to operate adequately in its existing unsignalised form to 2017 with the development operational.
- Rural turn-lane warrants were checked under projected traffic volumes to determine whether any upgrading to the existing form of intersection X is required. In this instance, the existing Austroads Type B right-turn configuration will need to be upgraded to a Type C form on site opening. With no development of the quarry, upgrading would not be required within the 2017 design horizon.
- Traffic operation at the proposed quarry access and the existing processing plant access was also examined using SIDRA. The degrees of saturation at 2017 with the development operational were calculated to be 40% and 50% respectively, which in both cases is acceptable. Rural turn-lane warrants were checked for both accesses and Austroads Type A layouts found to be required. The existing processing plant access has already been built to this standard and requires no further work.

#### **E.4 Step 4: Safety Review**

- Actual crash rates for road sections B, C and D and critical crash rates for the district were obtained from MR. As the actual crash rates were well below the critical crash rates, no amelioration is necessary.
- The safety issues checklist provided in Appendix B was used to check the safety aspects of the intersections and accesses associated with the proposed development. Pedestrian and cycle facilities are not present or needed on the low volume rural roads assessed.
- Discussions with MR indicated that no safety audit is required.
- No development works are required to ameliorate any existing safety deficiencies.

#### **E.5 Step 5: Environmental and Other Issues**

- No new transport corridors are planned in the vicinity. The existing reserve for Desert Crossing Road is adequate to accommodate four lanes on the southern side if and when necessary.
- The development will not generate significant night traffic and the adjacent agricultural land uses are not sensitive to the noise and vibration created by heavy commercial vehicle traffic that will be generated by day.
- There is no adjacent development that could be affected by headlight glare. On-site lighting will be oriented so as to avoid illuminating Desert Crossing Road.
- Detailed design of the proposed quarry access will need to include landscaping to present well to passing motorists and to replace existing vegetation removed and avoid erosion on Desert Crossing Road.
- Approval for the quarry access onto Desert Crossing Road is being sought as part of this application. The spacing between the proposed access and the nearest adjacent access is approximately 1.25 km. There are few access points along this section of road and it is not anticipated that the proposed access would interfere with others.

- The detailed design of the proposed quarry access and upgrading of intersection X to Austroads Type C configuration will need to allow for drainage continuity with the existing swale drains along each side of Desert Crossing Road.
- The quarry access will need to be sealed so as not to generate dust across Desert Crossing Road. The on-site design and operational procedures will need to minimise dust generation so as not to impact Desert Crossing Road.
- There is one structure over a creek along the haul route between the site and the processing plant on road section C. Its design has been verified to accommodate the proposed haulage vehicle fleet.
- An environmental impact statement (EIS) is being prepared as part of the development application. This EIS will examine the overall impact of the development.

## **E.6 Step 6: Impact Mitigation**

### **E.6.1 Impacts**

The RIA has identified that the following improvements are required as a result of the development:

- contribution toward increased routine maintenance on section A
- rehabilitation of the pavement on section B
- rehabilitation of the pavement on section C is brought forward from 2010 to 2008
- upgrading of intersection X to Austroads Type C at opening of the development
- construction of an Austroads Type A site access intersection to the development.

### **E.6.2 Costing/Contributions**

MR identified that section A has an annual routine maintenance allowance of \$50 000 (2006 dollars). With development, ESAs will increase by 9% and 82% eastbound and westbound respectively. The development therefore creates a need for a further \$22 750 per year ( $9\% \times \$50\,000/2 + 82\% \times \$50\,000/2$ ) for routine maintenance during its operational life. In this case, Main Roads and the developer agreed that the requirement for additional routine maintenance would be limited to the first 10 years of operation of the quarry.

After discussions with Main Roads, the developer agreed to pay half of the cost of pavement rehabilitation on section B. This section had no remaining pavement life but would have continued to operate effectively with minimal maintenance in the absence of the development. Using Main Roads unit rates, the full cost of rehabilitating the pavement on section B was estimated at \$1.25 million (in 2006 dollars). The developer therefore accepted responsibility for paying \$625 000.

MR advised that \$1.25 million (in 2010 dollars) was expected to be allocated through the RIP for rehabilitating the pavement on road section C in 2010. Using an outturn factor of 1.00/1.12 extracted from the RIP Guidelines, this is converted to \$1.12 million (in 2006 dollars). The cost of bringing this improvement forward from 2006 to 2008 is the responsibility of the developer. MR will need to ensure that the capital cost for the rehabilitation is available in 2008.

The developer paid for the whole cost of upgrading intersection X to an Austroads Type C form at year 2007 (\$475 000 in 2006 \$).

The developer paid for the cost of construction of the Type A access intersection to the quarry (\$150 000 in 2006 \$).

## Appendix F Sample Urban Project – Commercial /Industrial Development

The following example is taken verbatim from Queensland Department of Main Roads (2006). All figures and tables in the appendix are sourced from that document.

It is intended to provide an understanding of the aspects requiring consideration for urban development types. It is not intended to provide an exhaustive example of traffic analysis, although some analysis is provided for illustrative purposes.

The process steps are as follows:

Step 1: Development profile

Step 2: Pavement impact assessment

Step 3: Traffic operation assessment

Step 4: Safety review

Step 5: Environmental and other issues

Step 6: Impact mitigation.

Note that Step 2 is not required in this example. Note also that cross-references to other sections within the source document have been removed where possible for clarity.

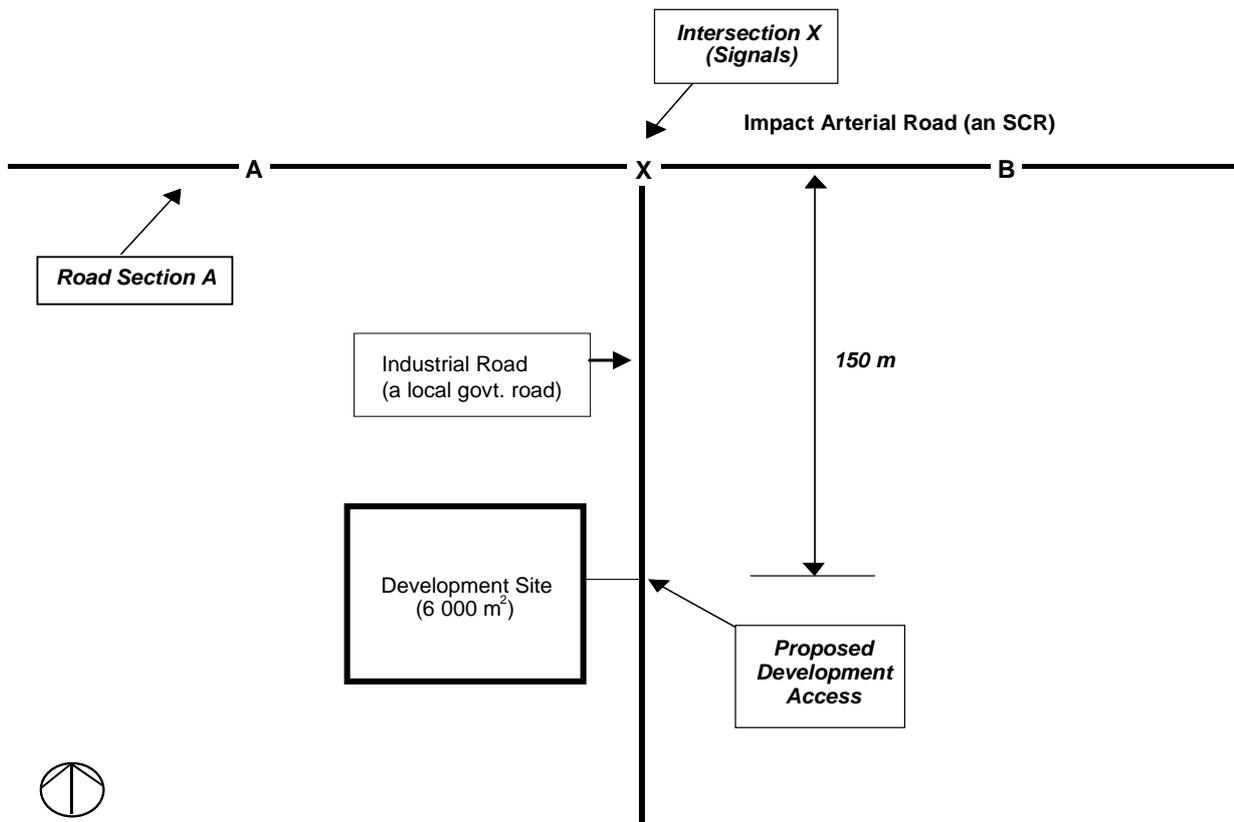
### F.1 Step 1: Development Profile

#### F.1.1 Development Details

- The proposal is for a light industry/office development within an urban environment on the fringe of a major city. A locality map is shown in Figure F 1.
- The proposed development is to have a gross floor area of 6000 m<sup>2</sup>.
- It is anticipated that staff will work a single shift between 6.30 am and 4.00 pm daily. The typical attendance will be 50 employees.
- The application was referred to Main Roads by the local government, as the planned development would access a local government road that intersects with a state-controlled road (SCR) within 200 metres.
- Currently, the site is vacant and is used by adjacent industry uses for parking.
- The development proposal is planned to be opened in 2007.

Access to the development will be obtained via an all-movements access to Industrial Road.

Figure F 1: Locality map

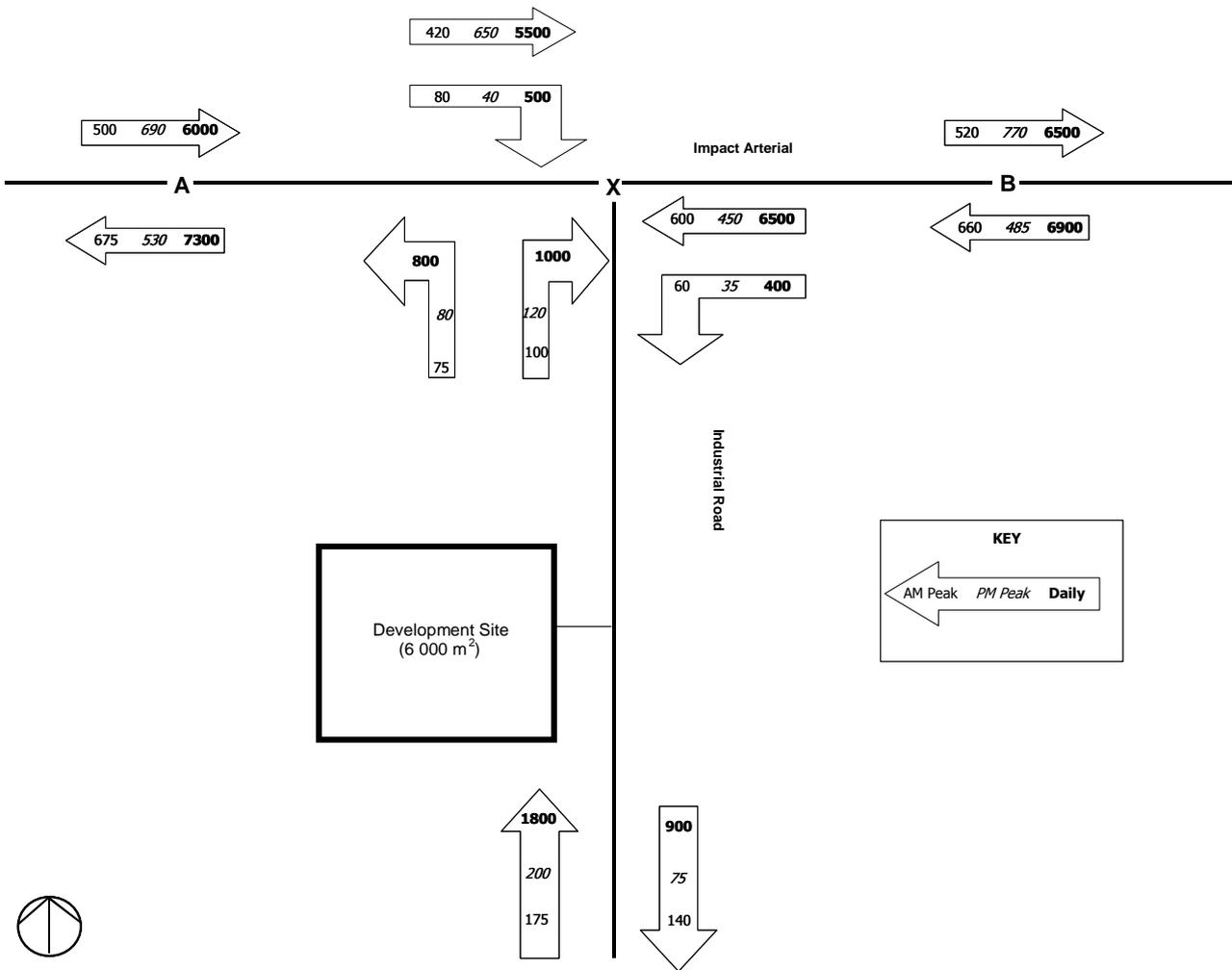


### F.1.2 Surrounding Road Network Details

- The site is located adjacent to a major local government road (Industrial Road) that intersects an SCR (Impact Arterial Road) approximately 150 m away.
- The intersection of Industrial Road and Impact Arterial Road is currently signalised.
- Traffic counts were conducted at the intersection to ascertain the existing peak hour and daily demand. The surveyed turning movements at the intersection are shown in Figure F 2.
- Historic traffic counts were reviewed to determine the profile of traffic growth. Growth assumptions were confirmed and agreed with Main Roads District officers prior to usage.

Base year and 10-year horizon traffic volumes at the intersection were generated for the scenario without the proposed development.

Figure F 2: Existing traffic volumes



### F.1.3 Development Traffic Generation

- Likely traffic volumes generated by the proposal were estimated using unit traffic generation rates extracted from surveys of similar developments. The source of any such traffic generation information utilised should be documented.
- Table F 1 shows the traffic generation based on a peak rate of one trip end per 100 m<sup>2</sup> and a daily rate of 10 trip ends per 100 m<sup>2</sup>.
- In this case, trip generation estimates based on gross floor area provide a reasonable estimate of development traffic.

Table F 1: Traffic generation (light industrial – 6000 m<sup>2</sup>)

Traffic generation characteristic	In	Out	Total
Daily trip ends	300	300	600
AM peak hour trip ends	45	15	60
PM peak hour trip ends	15	45	60

**Traffic generation calculation**

**Daily trips** = 6000 m<sup>2</sup> x 10 trip ends/100 m<sup>2</sup>  
 = 600 trip ends per day

**Peak hour trips** = 6000 m<sup>2</sup> x 1 trip end/100 m<sup>2</sup>  
 = 60 trip ends per hour

A direction distribution of 50% in/50% out was assumed for daily trips on the basis of similar surveys. For the peak-hour generation, a directional distribution of 75% in/25% out was utilised for the AM peak and reverse for the PM peak.

**F.1.4 Development Traffic Distribution**

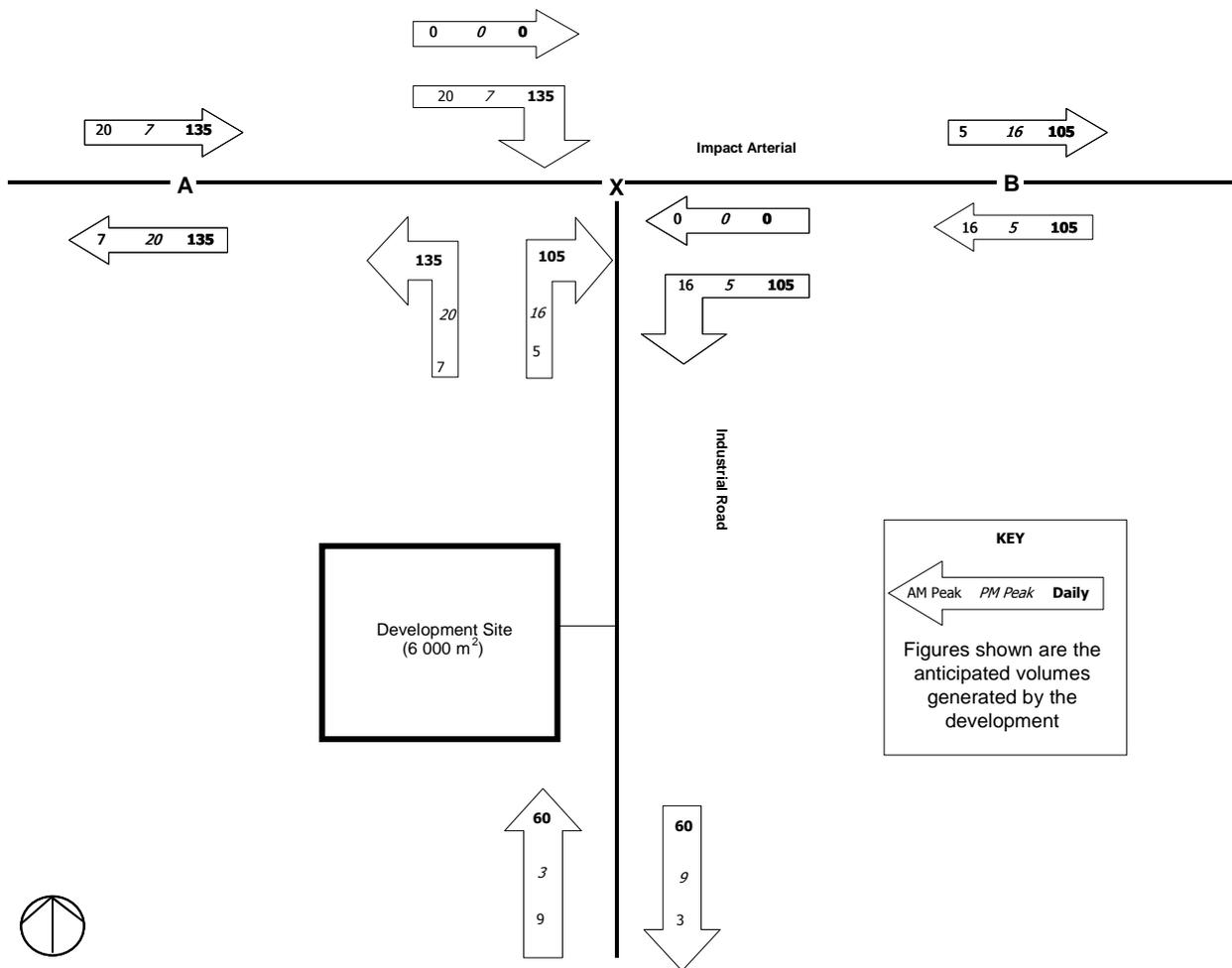
- Traffic generated by the proposed development was distributed in accordance with existing turning movement patterns at the intersection and residential development within the anticipated catchment (Table F 2).

**Table F 2: Traffic distribution**

Direction (to/from)	Percentage	Daily		AM peak		PM peak	
		In	Out	In	Out	In	Out
South	20%	60	60	9	3	3	9
East	35%	105	105	16	5	5	16
West	45%	135	135	20	7	7	20
<b>TOTAL</b>	<b>100%</b>	<b>300</b>	<b>300</b>	<b>45</b>	<b>15</b>	<b>15</b>	<b>45</b>

Development-generated traffic is shown in Figure F 3.

Figure F 3: Development-generated traffic

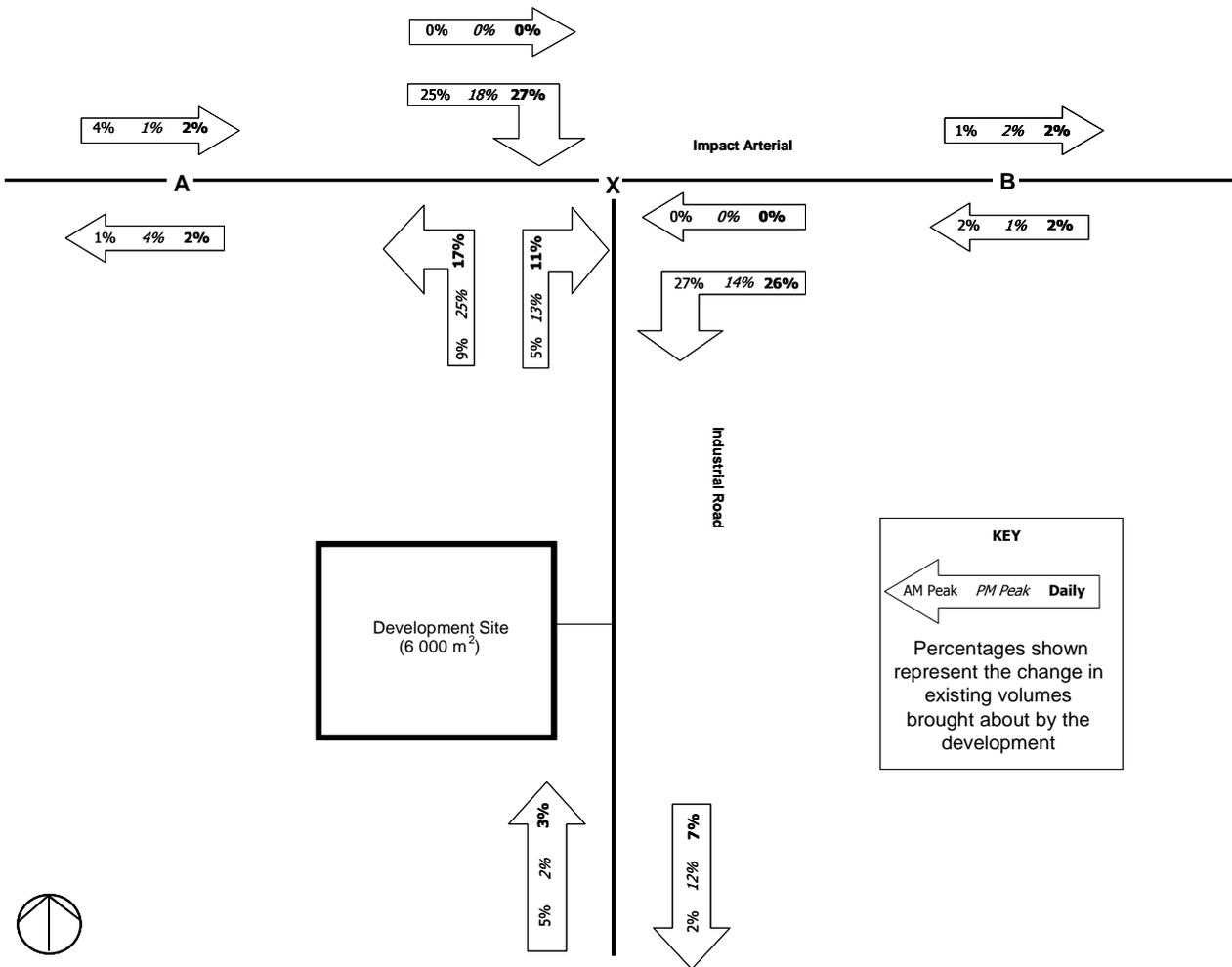


### F.1.5 Study Network Definition

#### Traffic operation

- The scope of investigation in this instance was limited to the intersection of the local government road and the SCR (Impact Arterial Road/Industrial Road).
- Figure F 4 shows the development traffic as percentages of existing turning movements. In all cases, the percentage is greater than 5% and assessment of the intersection is therefore required (see Criterion 3 in Section 3.2 of source document).
- With respect to road link volumes, development traffic on Impact Arterial Road east and west of Industrial Road is less than 5% of the existing flows and therefore assessment is not necessary.

Figure F 4: Percentage change generated by development



### F.1.6 Pavement Impacts

- Site-generated ESAs associated with heavy commercial vehicles were calculated to be less than 5% of the existing use on the SCR and therefore no assessment of pavement impacts was required.

### F.1.7 Design Horizon

- The development is anticipated to be completed and open by 2007. The horizon year is therefore 2017, 10 years after opening.

### F.1.8 On-site Aspects

- In this case Main Roads is not interested in on-site aspects, as they are not expected to affect operation of the remote intersection.
- On-site aspects will need to be covered for the local government assessment.

## F.2 Step 2: Pavement Impact Assessment

(Not required in this example)

### **F.3 Step 3: Traffic Operation Assessment**

- The traffic operation assessment prepared as part of the RIA needs to address the operation of the intersection of the local government road with the SCR (Impact Arterial Road/Industrial Road). The local government would also require an assessment of the operation of the points of access from the development to its road. This would generally be covered in the one assessment.
- No assessment of road link operation was required for this project, as the threshold set by Criterion 3 (in Section 3.2 of source document) was not exceeded for Impact Arterial Road.

#### **F.3.1 Intersection Analysis**

- Development traffic volumes at the Impact Arterial Road/Industrial Road intersection were produced by considering increases generated by the development using the assumptions regarding traffic generation and distribution discussed above.
- Intersection operation was tested using SIDRA.
- Analysis revealed that the intersection is currently operating at levels outside desirable limits of capacity during peak periods. With development, operation is marginally worse.

### **F.4 Step 4: Safety Review**

- A review of safety issues was undertaken including crash history at the intersection. No concerns were identified.
- Safety was not considered to be a major concern given that the types of vehicles generated by the proposal were not inconsistent with those currently using the intersection.

### **F.5 Step 5: Environmental and Other Issues**

- No other issues were determined to be relevant to the affected SCR or intersection.

### **F.6 Step 6: Impact Mitigation**

- It was identified that Roads Implementation Program funding has been committed for some minor intersection improvements.
- The development, in this instance, brought forward the timing for the intersection improvements by less than one year. As a result, capacity impacts were viewed as insignificant and no contribution sought.

# Commentary 1

The following commentary is drawn from the following sources:

- Western Australian Planning Commission (2006)
- Roads and Traffic Authority (n.d.)
- Department for Transport (2007)
- Scottish Executive (2006).

Note: The practitioner should be aware of statutory obligations and guidance on transport assessment that may apply in a given jurisdiction.

## C1.1 Transport Assessment and Traffic Impact Assessment

Section 4 of the Guide describes traffic impact assessment (TIA) procedures and refers to wider transport considerations required in the case of larger or more complex developments. Table C1 1 compares the general features of the two forms of appraisal.

**Table C1 1: TIAs and transport assessment compared**

	Traffic impact assessment	Transport assessment
<b>Modes considered</b>	Focus on car but others may be included.	All modes considered but initial emphasis on walk, cycle and public transport.
<b>Transport implications covered</b>	Comparison to similar developments.	Accessibility and mode split analysis.
<b>Impacts considered</b>	Road safety and traffic.	Wide criteria based on transport appraisal guidance.
<b>How are negative impacts addressed?</b>	Increase road capacity and add safety features.	Wider assessment. Travel plans. Financial incentives. Additional transport capacity if required.

Source: Scottish Executive (2006).

In the UK (Department for Transport 2007), transport assessment (TA) is defined as:

*A comprehensive and systematic process that sets out transport issues relating to a proposed development. It identifies what measures will be taken to deal with the anticipated transport impacts of the scheme and to improve accessibility and safety for all modes of travel, particularly for alternatives to the car such as walking, cycling and public transport.*

The TA processes that are followed as part of development control of major projects include (but are not limited to):

- road capacity issues and impacts, at the macro (system) level – a traffic impact study would be a component of the assessment as well
- accessibility (ability to be reached) by car, public transport, foot or bicycle
- ease of access: a more local examination of the ability of site approaches and entrances (location and design) to accommodate/provide adequately for various modes
- capacity issues for non-road modes (can the public transportation system handle the demand, what works would be required?)
- related to the foregoing: for major public facilities that are located on the basis of other policy decisions or criteria (e.g. airport, hospital or stadium), what infrastructure is required to service the development?

A TA requires consideration of all modes of transport and the full range of transport tasks – not just person movements, but also freight movements, local distribution and delivery of goods and services, and emergency services operations. A typical set of considerations and features would include:

- applicable to all forms of development, from individual developments to subdivisions and even structure plans, although the level of detail will be different
- assessment to consider all parts of the transport network where the development movement would be likely to have a material impact
- impacts to be assessed for year of (full) opening and 10 years after opening, (to identify whether the development would use up any spare capacity in the surrounding transport network, bringing forward the need for improvements)
- assessment of the likely parking demand compared with parking provision advised or required under the relevant regulations
- consideration of any nearby committed (but not yet built) developments and of any proposed or possible changes (by others) to the surrounding transport network
- assessment of the potential for development traffic to intrude into the surrounding area, particularly residential areas, and its likely impact on amenity
- thresholding for remedial measures at intersections should be based on acceptable delays including delay to pedestrians at intersections and mid-block crossings
- the adequacy of the site location, layout and access points to accommodate the level of expected movements (car, truck and public transport)
- assessment of impact of the development traffic on existing pedestrians, cyclists and public transport users
- assessment of the impact of the development on (or compatibility with) existing or proposed plans for public transport to or within the study area
- assessment of the accessibility of the site by non-car modes including links to bus stops, train stations, any new or improved services and detailed description of any proposed pedestrian/cycle facilities.

Estimation of internal and external movement by all modes is an integral part of the planning process – not just to estimate impacts to be compensated beyond the development site, but rather as part of the cyclic process of development planning to reach an optimal land use transport outcome.

The tools for analysing the movement implications and needs of the development involve a comprehensive travel demand forecasting process and a means by which various levels of diversion from car to other modes can be tested.

This TA clearly goes beyond a localised traffic impact assessment.

## **C1.2 Contents of a Full Transport Assessment**

Transport assessment involves three elements:

- analysis of the level of demand for movement to and within the site, by all modes  
In the iterative process, this may involve re-analysis with different input assumptions about land use type and intensity, layouts, and policy requirements
- the feasibility and effects of different strategies for the management of movement to and within the site
- impact assessment, including impacts in the full range of policy areas that are of concern to the government.

The level of detail needing to be addressed in a transport assessment may be influenced by the scale of the development; the significance of the development at a local, regional and state level; the relevance of any statutory planning requirements e.g. local environmental plan; the development control plan; design guidelines.

In more detail, common features of the transport assessment process are:

***Stage 1 – Assessing the travel characteristics of a development***

- the site and general characteristics
- measurement of accessibility to and from the site by all modes – present and future (under various internal and external land use scenarios)
- estimating the travel generated and likely modal split
- assessing effects on local transport.

***Stage 2 – Influencing travel to the development***

- choosing an accessible location
- scale of the development
- intensity of use
- effects of mixed-use developments
- the layout and design of the development
- promoting access on foot and bicycle
- pedestrian or bicycle access audits
- promoting public transport access
- access to rail services
- traffic impact assessment
- travel plans
- awareness raising and marketing
- behavioural change initiatives
- changing working practices to support the travel objectives.

***Stage 3 – Appraising and mitigating impacts***

- accessibility and integration impacts with the local community
- safety and security impacts
- environmental impacts
- highway and traffic impacts
- strategies for enhancing public transport.

The allocation of responsibility (funding and implementation) for mitigation works carries the same problems as in the simpler case of traffic impact studies. While transport assessments can be of considerable assistance in assessing and dealing with the transport impacts of new developments, it can be hard to identify and provide any off-site infrastructure or services required of the development and to ensure sustainable transport provision including integrated walking and cycling networks because of the following:

- New development is usually incremental, with several individual developments taking place in an area over a period of years.
- Transport to a new development adds only one more layer to already complex movement patterns. Though additional demands are created, they are hard to identify, and in particular to identify specific infrastructure or services related to particular developments.

It should be noted that the *Guidance on Transport Assessment* (Department for Transport 2007) was withdrawn in October 2014 and replaced by an online-only guide (Department for Communities and Local Government 2015), which seems to be aimed more at local or regional governmental planning bodies rather than developers.

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## Commentary 2

Many governments have recognised that policies and strategies for urban development need to be based on sustainable development principles for improving the environment, the economy and communities. In Australia, the National Strategy for Ecologically Sustainable Development, released in 1992, provides a foundation for sustainable development theory and practice. Austroads has also published a number of documents dealing with sustainability including:

- *Strategy for Ecologically Sustainable Development* (Austroads 1995)
- *Ecologically Sustainable Development 'Toolbox'* (Austroads 2000a)
- *Strategy for Ecologically Sustainable Development: Progress and Directions* (Austroads 2000d).

Much has been written on the subjects of integrated planning and sustainable development. Brindle and Lansdell (1999) points out that:

*Integrated planning does not mean only putting a development with the movement system it needs, or vice versa. It implies the expansion of land use and transport planning into the wider context of community needs, inter-dependencies and sustainable urban areas. It is thus essentially holistic.*

Brindle and Lansdell also describes the meaning of sustainability, suggesting that in practical terms it attempts to reduce resource depletion and environmental impacts of an activity, and has taken on meanings that refer to economic vitality and quality of life. Brindle and Lansdell further note that these three objectives are not always compatible even though policy statements attempt to progress all three, and concludes that integrated land use/transport planning, even if fully implemented, would not fully satisfy the needs of sustainable development.

The interest in sustainable development reflects an increasing awareness and concern in urban communities about the problems created by growth in car use and the resultant congestion. There is a realisation that it is neither feasible nor desirable to provide improved road capacity at a rate that would satisfy the ever-increasing demand. Demand can also be constrained by managing expectations. Apart from the quality of life for citizens who are dependent on cars for daily travel, the issues of poor air quality, greenhouse gas emissions, and reliance on non-renewable energy resources are of major concern. For example, transport accounts for about 17% of Australia's greenhouse gas emissions (Department of the Environment 2015). This contribution must be reduced if Australia is to meet its international commitments to help prevent interference with global climate systems.

In response to these issues governments are introducing planning policies and strategies aimed at reducing dependence on private car travel. Planning for sustainable development may focus on key aspects such as:

- managing urban growth through integrated land use, transport and environmental planning, including the definition of urban growth boundaries
- location and provision of affordable housing providing transport choice options
- activity centres as important transport nodes, closely integrated with public transport services
- provision of real choices for use of sustainable modes of transport including a substantial increase in public transport usage and encouragement of walking and cycling
- development and management of an arterial road system so that it meets stated transport and community objectives (e.g. safety and accessibility), in a way that considers the needs of all road users (e.g. freight, public transport, pedestrians and cyclists as well as motor vehicle users) as well as the communities through which the roads pass
- conservation of green wedges between corridors of urban growth
- coordination of transport modes to improve accessibility.

Sustainable development policies and travel demand management initiatives may have a significant impact on traffic management, particularly in inner areas of cities, and they need to be considered in the development of transport and traffic strategies.

Communities or suburbs which are planned and laid out in the following ways can lead to reductions in private car use and to improvements in the health of the local community and road users:

- encouragement of walking and cycling
- replacement of longer trips by shorter trips (by more local facilities)
- public transport that links residences with work, recreation and other attractions.

However, achievement of these benefits requires planning, policy implementation and the provision of alternative infrastructure and services. It is not sufficient to merely leave sections of road infrastructure off a plan, or not provide sufficient car parking on-site, with the expectation that people will walk, cycle or perhaps not travel so much. People need to travel to work, school, shops and recreational sites. Realistic assessments of trip generation are required. Unless consistent and positive action is taken to manage travel demand and provide non-car options, missing road links or insufficient vehicle access points (for example) will simply result in needless congestion, which also affects road-based public transport. In other words, the achievement of sustainable development objectives and travel demand management objectives requires the consistent application of stated policy and positive action to provide travel options; it cannot occur through a lack of investment in appropriate infrastructure.

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## Commentary 3

### C3.1 Functional Classification

In considering road classifications, it is necessary to differentiate between legal or administrative classifications, and functional classifications. Legal or administrative classifications are usually determined by national or state governments, as a means of allocating funds and identifying the authority responsible for the care and management of various parts of the road network.

Functional classification describes the road's traffic function; it involves the relative balance of:

- the traffic mobility function (or through traffic function)
- the amenity or access function.

A map showing the traffic functions of roads across a network is often referred to as a 'road hierarchy plan'. A 'road hierarchy' may be defined as the 'grading of roads according to increasing or decreasing importance of their traffic-carrying or other function' (Austroads 2015a). For the safety of road users a grading of roads, with many different mixes of movement function and access function should be avoided. Particularly in urban areas, unless these two functions are clearly separated by space, they conflict with each other and the mixture results in higher crash rates. While this separation of functions cannot always be achieved on existing roads, the more closely it is achieved the safer a road will be.

### C3.2 Networks for Specific Road User Groups

It has become more and more evident that the transport network is really a 'network of networks' that is required to deliver high levels of performance to users with competing needs but with the same overall goal of moving people or goods from one place to another as efficiently, safely and sustainably as possible (Austroads 2009e).

The majority of all urban roads and streets are accessible by all types of vehicles and road users, except that:

- urban freeways are typically restricted to motor vehicles which are capable of travelling at higher speeds
- local streets are typically not designed to accommodate the largest freight vehicles and the largest buses.

Within local areas and along strategic routes, networks of off-road cycling and walking paths are provided in many cities. Again within local areas, streets can be laid out in highly connective networks for pedestrians and cyclists, while having some sections of road closed off to motor vehicles. For example a rectangular grid of local streets can be created where motor vehicles encounter only T-intersections; the fourth leg of all 'crossroads' is a section of park accessible only by pedestrians and cyclists.

A further way to assist particular road user groups is to allocate road space or give preference to them on the general road network. This commences by planning a user group-specific network superimposed onto existing roads. The aim of these networks is to assist the movement of these specific road user groups. Examples include:

- Networks of bicycle lanes, so that cyclists have their own space. Routes within the network may be on arterial roads or higher order local streets, such as collector roads. Although typically full time, they may be part time during clearway hours on arterial roads.
- Bus and tram lanes, either full-time or part-time, to let these vehicles move past queues of traffic and thereby reduce their travel time variability as well as their total journey time. These lanes need not be provided as interconnecting networks.

More broadly across an urban area, the arterial road network can be split into sub-categories, with the more major or strategic routes designated as the principal freight network or other type of preferential network. This network of roads is then managed to increase the priority of the identified user group (e.g. with traffic signal timing assisting truck movement) and the features along the road designed to accommodate larger vehicles.

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## Commentary 4

Effective planning, development and management of an interconnected network of urban arterial roads can assist in protecting the amenity of local areas. For example, a local street might be carrying an unacceptable volume of traffic, or an undesirable proportion of heavy vehicles, or simply 'intruding' extraneous traffic. These outcomes all result from a deficiency in the nature of the local street and arterial road network, and the location of traffic generators in relation to the network.

The *Guide to Traffic Management Part 8: Local Area Traffic Management* (Austroads 2008a) lists common contributors to higher traffic volumes and intruding traffic in local areas as:

- Under-provision of traffic routes – This results in larger local areas and the greater number of trips generated results in higher volumes on some local streets.
- Arterial road congestion – Especially in networks with grids of local streets, congestion does not have to be severe for the alternative routes via local streets to become attractive.
- External connectivity – If two local street connections to the arterial road network, on opposite or adjacent sides of a local traffic area, provide an easy travel path through the local area, these connections will lead to higher volumes on the connecting local streets.
- Internal connectivity – Local street networks with numerous alternative internal routes will spread traffic across many local streets. This tends to increase the average exposure to traffic per household.
- Excessive development density and inappropriate location of traffic generators – The greater the development of a block of land (even with units instead of a detached house and garden), the greater the traffic generation. Community facilities and employment locations generate more traffic. Where these are desirable, they need to be located where roads of suitable traffic function can take the traffic.

The under-provision of arterial roads in developing urban areas (e.g. on the urban fringe or in growth corridors) can come in several forms:

- arterial roads spaced too far apart; that is, too few arterials within a given area
- missing links in the arterial road network, typically where freeways, railways, rivers and other constraints are relatively expensive to bridge
- inadequate road width and an insufficient number of traffic lanes
- inadequate control of vehicular access.

The first two deficiencies lead to:

- larger local areas, so that even where all traffic within the local area is locally generated, some local streets will have excessive traffic volumes and experience poor amenity
- larger volumes of turning traffic at those arterial/arterial intersections which do exist, leading to severe delays for turning traffic and through traffic
- short-cutting by through traffic on local streets where the local street network is at all susceptible to this
- difficulty in providing bus services within reasonable walking distance of all properties, or if internal links are suitable for bus routes they risk becoming through traffic short cuts
- some local streets (e.g. those described as collector roads) acting as de facto arterial roads through necessity; this is not a satisfactory option as these streets typically have direct frontage driveway access, with its lower levels of safety under heavy traffic volumes
- longer trips on the arterial roads to get around gaps in the network.

It is therefore most important for both local amenity and efficiency of the arterial roads that, at the network planning and subdivision approval stages, arterial road networks are developed having satisfactory spacing, adequate capacity and interconnection without missing links. The spacing and size of arterial roads depends on the intensity of development. In areas of more intense development, more arterial links are likely to be needed. Brindle (2001) points out that in order to provide bus routes that all households can reach easily, the grid should be at 800 m spacings. Some state guidelines recommend the spacing of arterial roads to be no more than 1 km to 1.5 km.

*Arterial road congestion* can be the prompt for external through traffic to use local streets. In areas with grid local street systems, this congestion does not have to be severe for the alternative short cut paths through the local area to become attractive as a way of avoiding delays. Local streets intersecting with arterials near traffic signals are especially vulnerable to through traffic.

*External connectivity* describes the extent to which a vehicle path through a network provides a connection between any given points, compared with alternative paths. When vehicle paths through the local street network have equal or higher connectivity than the alternative routes using the major road system, they will attract through (non-local) traffic. These paths through a connective local street system may be attractive to through traffic because they are shorter or faster than the alternative arterial routes, or they may simply be preferred because they involve fewer stops ('dodging the lights') or provide opportunities to 'jump the queue' at congestion points on the major road system.

Some local street systems have been planned deliberately to create low connectivity paths that are not attractive to through traffic, e.g. with hierarchical street networks including loops and cul-de-sac. More recent planning philosophies have sought to create '(road vehicle) permeable' local networks, e.g. with a return to a grid network of local streets with frequent connections to arterial roads. This results in high levels of *internal connectivity*. This in turn can lead to short cutting through traffic along connective vehicle paths and a greater exposure to higher levels of traffic for more households. Such problems should preferably be anticipated and dealt with at the network planning stage rather than left to be dealt with by local area traffic management techniques. Networks that are permeable for pedestrian and cycle movement, and which provide adequately for local traffic circulation, do not need to have high external connectivity for motor traffic.

In planning and designing arterial roads and local traffic areas, there should be:

- high levels of connectivity for vehicles at the arterial road scale, through the provision of an interconnected arterial road network at sufficiently close spacing in two perpendicular directions, with no missing links
- low levels of connectivity for motor vehicles at the local street scale; within a local traffic area, there should be adequate links for vehicle circulation without high levels of connectivity which encourage short trips to be made by car and expose more households to more traffic
- high levels of connectivity for pedestrians and cyclists at the local street scale; local traffic areas should be easy to walk and cycle through.

The *location of traffic generating developments* that often generate substantial volumes of traffic is critical to the operation and amenity of local street systems and arterial roads alike. The impact of such developments must be assessed at the planning stage to ensure that arterial roads serving the development (e.g. a regional shopping centre) can cope with the increased demand and that local streets are not used as access routes to the development.

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## Commentary 5

### C5.1 Process

Major developments such as residential suburbs or sub-divisions, or regional shopping centres will normally require the following, or a similar process to be used:

- Collect all available traffic data for the affected area of the network and plot existing annual average daily traffic (AADT) volumes onto a map including turning volumes at all major intersections. This may require conversion of shorter-term traffic counts to AADT estimates using factors derived from existing data (refer to the *Guide to Traffic Management Part 3* (Austroads 2013b)).
- Determine a traffic growth rate for roads in the area, using historical data for rural areas, or population growth estimates and traffic modelling for urban areas. If sufficient data is not available rates from similar roads in the region might be used.
- Use growth rates to establish estimated AADTs (without the development) for the year of initial opening, the years in which subsequent stages may open, and an appropriate design year. Adjust the AADTs for each stage accounting for any major transport infrastructure improvements and any other major developments that will occur in the area during the assessment period.
- Estimate the traffic generated by the development for the various stages, adjusting for linked trips, those trips that are new to the network and those that are undiverted drop-in trips (see below).
- Assume a distribution of development traffic to the network and plot these volumes onto a map as a record of the likely impact of the development as a basis for allocating responsibilities between the developer and the road agency.
- Add the estimates of traffic generated by the development to the estimates of traffic (without development) to obtain plots of design AADT volumes for each stage of the development.
- Convert the AADT estimates for the affected network into peak-hour design volumes for each direction of flow using appropriate peak-hour factors and directional splits.

It will also be necessary to establish the numbers of heavy commercial vehicles for all links and turning movements so that the effect of these vehicles can be included in traffic analysis.

### C5.2 Existing Traffic Data

The satisfactory assessment of the impact of developments requires detailed data relating to existing traffic on the network. It is usual to acquire the following data for all roads in the study area that are likely to be affected by the generated traffic:

- daily traffic volumes
- profile of daily traffic volumes to establish variations throughout the week
- profile of hourly volumes of traffic for the days when development traffic generation is expected to peak
- traffic growth rates
- the daily and peak-hour volumes of heavy vehicles
- anticipated pedestrian and cyclist traffic flows.

It is important to ensure that the existing data collected is adequate to determine the various times at which development traffic is expected to peak. This is necessary so that critical combined peak periods for normal road traffic plus growth plus development traffic can be established. For some developments the peak traffic generated by the development may coincide with peak recreational flows on the surrounding road network. In these cases data will be required for the normal weekday situation as well as recreational periods.

### C5.3 Design Year

The selection of a design year is a key decision in the design of roads and the same applies to developments. It is common for important roads to assume a design year some 20 years beyond their opening date. Whilst this may be practicable for rural roads it is often not feasible in urban areas where existing arterial roads operate close to capacity or have limited potential to accommodate traffic growth, and new roads may attract trips from other parts of the network or attract new trips through induced demand.

The design year is particularly important for traffic operation assessment and any road safety review, particularly for large developments where the design year should desirably be 10 years after opening. For a large staged development the design year may be in the range of 10 to 20 years after opening of the final stage. Where assessment of individual stages is undertaken, base flows for successive stages should include the previous stages' traffic generation. Where staging is over a period exceeding five years it is preferable to reassess traffic impact closer to the time of implementation when other influences can be considered with greater certainty.

### C5.4 Traffic Growth and Future Traffic

For existing roads in rural areas and roads on the fringes of cities, historical traffic data can be used to determine an underlying growth rate, which can then be used to estimate future traffic volumes for key times in the development (e.g. at opening, in the design year or at any intermediate stage). This approach may also be applied to urban roads that are not likely to have their traffic flows influenced by changes in land use or road network changes (e.g. new roads or capacity improvements).

Traffic growth and future traffic volume estimates for roads that are likely to be influenced by changes to land use or the road network should be determined through the use of appropriate traffic modelling techniques (refer to the *Guide to Traffic Management Part 3* (Austroads 2013b)). The outputs from these models cannot be taken at face value and need to be calibrated against existing traffic flows.

Because modelling techniques have limitations on their ability to accurately predict future volume, it is usual to provide a range of possible volumes for the roads around the development. These volumes can be used to perform a sensitivity analysis of design volumes where a range of peak hour design volumes are analysed. The peak hour design volumes would be based on various assumptions as to the peak-hour volume/24-hour volume ratio, and the directional split of traffic using the road.

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## Commentary 6

It is recognised that rates may change between jurisdictions and locations within jurisdictions and for this reason practitioners should obtain information from local sources wherever practicable. Generation rates may also vary within each development category and therefore practitioners should not assume that a single rate 'fits all' for any particular type of land use but should justify rates based on information from other sources, for example, the development industry.

Developments also generate public transport trips and depending on the location of the development (e.g. congested inner city area) public transport may be required to accommodate a large proportion of the transport demand. This in turn will affect the traffic generation rates used for other modes, especially the private car, and will influence the extent of parking required.

Trip generation data for a variety of land uses is available from a number of sources including:

- Roads and Traffic Authority (2002) with relevant updated trip generation rates derived from more recent surveys (Roads and Maritime Services 2013)
- Institute of Transportation Engineers (2012) – comprehensive data collation, from USA, which may need to be modified to suit Australian conditions
- State, territory and local government databases
- databases or reports from traffic and transportation consultants and surveyors.

Roads and Traffic Authority (2002) (with data updates from Roads and Maritime Services 2013) is currently the most comprehensive Australian reference on traffic generation. It is widely recognised that traffic generation data is lacking in Australia (Mousavi, Bunker & Lee 2012). Indeed, the requirement for continuously updated traffic generation surveys must not be understated.

In New Zealand, a database has been established (Clark 2007), to capture traffic and parking generation rates for developments in New Zealand and Australia. The organisation maintaining this database is called the Trips Database Bureau (TDB). The TDB manages a repository of data on surveyed trips, parking and travel related to all land uses, collated from a variety of public and private sources, and available for sharing amongst professional engineers and planners.

In the UK, the main source of trip rate information is the TRICS database (TRICS Consortium n.d.), which provides a wide variety of data across many land uses, and contains some multi-modal trip rate information. Research is under way in New Zealand to correlate the NZ and UK data on trips and parking (NZ Transport Agency 2009). However, the relevance of transferred trip rates and models is still an active area of academic research (see for example: Everett 2009; Mwakalonge, Waller & Perkins 2012, Holguín-Veras et al. 2013).

The TDB has strong ties to both the TRICS consortium and the ITE.

The level of detail provided in the sources listed above varies from raw data, relationships between amount of traffic generated and the type and size of land use, to rates only. Some references contain other information such as parking demand data and/or rates, data collection methods and guidance on use of data.

The most reliable source of trip generation data will be survey data from the actual development (only possible where an existing development is being changed or enlarged) or a similar one in a similar location – preferably in close proximity. However, it may be appropriate to collect data from similar developments and to modify it to allow for differences in attributes between the surveyed and proposed developments, such as size, location, and minor differences in the mix of uses (e.g. business types).

Alternatively, a survey of a similar existing development may be conducted, so long as the comparison is appropriate. Note that when comparing a commercial development in a city with a similar development in a regional town, the traffic generation rates will typically be lower in the latter case, as the business is likely to be operating at a lower activity level per unit of floor area.

Figure C6 1 is an example of the format for traffic generation data that can be collected to obtain rates for a proposed development. Raw data are provided together with a description to allow appropriate use of the information.

Figure C6 1: Development traffic generation data

Use: Shopping Centre  
 Location: Shopping Central  
 Description of Development: GFA 65 000 m<sup>2</sup>  
 GLA 60 000 m<sup>2</sup>  
 Description of Surrounds: CBD  
 Day of Survey: Friday, 3 October 1998

CENTRAL SHOPPING CENTRE - TRAFFIC GENERATION						
TIME (1/4hr commencing	15 MINUTE GENERATION		TOTAL	HOURLY GENERATION	PARKED VEHICLES	OCCUPANCY
	IN	OUT				
700	35	37	72		30	2%
715	41	29	70		42	2%
730	61	10	71		93	5%
745	102	32	134	347	163	8%
800	94	39	133	408	218	11%
815	118	36	154	492	300	15%
830	156	47	203	624	409	20%
845	206	41	247	737	574	29%
900	175	59	234	838	690	35%
915	198	62	260	944	826	41%
930	231	78	309	1050	979	49%
945	225	101	326	1129	1103	55%
1000	215	127	342	1237	1191	60%
1015	174	105	279	1256	1260	63%
1030	201	134	335	1282	1327	66%
1045	176	136	312	1268	1367	68%
1100	122	125	247	1173	1364	68%
1115	229	171	400	1294	1422	71%
1130	175	153	328	1287	1444	72%
1145	225	172	397	1372	1497	75%
1200	241	261	502	1627	1477	74%
1215	166	167	333	1560	1476	74%
1230	180	178	358	1590	1478	74%
1245	197	214	411	1604	1461	73%
1300	176	224	400	1502	1413	71%
1315	128	174	302	1471	1367	68%
1330	176	198	374	1487	1345	67%
1345	174	185	359	1435	1334	67%
1400	153	250	403	1438	1237	62%
1415	169	209	378	1514	1197	60%
1430	169	204	373	1513	1162	58%
1445	154	162	316	1470	1154	58%
1500	153	232	385	1452	1075	54%
1515	106	185	291	1365	996	50%
1530	131	160	291	1283	967	48%
1545	131	165	296	1263	933	47%
1600	131	148	279	1157	916	46%
1615	159	200	359	1225	875	44%
1630	125	204	329	1263	796	40%
1645	110	196	306	1273	710	36%
1700	118	187	305	1299	641	32%
1715	102	199	301	1241	544	27%
1730	126	175	301	1213	495	25%
1745	116	180	296	1203	431	22%
<b>TOTAL</b>	<b>6750</b>	<b>6351</b>	<b>13101</b>			
<b>PEAK PARKING ACCUMULATION</b>					<b>1497</b>	<b>75%</b>
<b>PEAK HOUR TRAFFIC GENERATION</b>				<b>162</b>		
<b>TOTAL SPACES AVAILABLE</b>						<b>2000</b>
<b>AVERAGE OCCUPANCY</b>						<b>47%</b>

Source: Queensland Department of Main Roads (2006).

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## Commentary 7

The computation of traffic generation is based on unit rates that are applied to a particular class of development on the basis of the number of units, the gross floor area or in some cases the site area.

Appendix D of the Guide provides an example of typical traffic generation rates for various types of development that can be used to estimate daily and peak-hourly traffic flows generated by such developments. It is emphasised that these rates are average rates and that:

- variations from the average may occur for particular sites
- they are adequate to enable comparisons between the traffic generation potential of various land use types enabling a rough assessment of the traffic implications of land use zoning
- departures from these rates for individual development proposals may be adopted in which case such departure should be justified.

Traffic generation rates provide a mechanism for estimating the traffic volume generated by developments. However, it is also important to gain an understanding through observation or experience, of the composition (classes of vehicles) and the hourly distribution of the traffic generated by different types of developments. In developments where a variety of different uses is proposed, such as a regional shopping centre, the peak-hourly movements associated with different businesses and attractions within the complex may occur at different times of the day. In these cases the peak traffic flows for the overall development are not simply the sum of the flows for the individual businesses, but could be substantially less.

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## Commentary 8

Another factor that serves to reduce the apparent impact of developments is the concept of linked trips. Estimating the number of linked trips that result from a specific development is still a subject of academic interest (Millard-Ball 2015) and there are certainly no hard and fast rules that can be applied.

Traffic generation data for movements into and out of certain types of development are available, as outlined in Section 4.4.5 and Appendix D. However, a percentage of the traffic generated by or attracted to a development will be present on the road network as part of the existing traffic volume. There is therefore a need to understand and be able to estimate how much of the generated traffic is new and how much is already on the road network prior to opening of the development. Historically, traffic impact assessments conservatively assumed that all generated traffic was new. More recently, 'discounts' have been applied to generated traffic to account for the 'drop-in' component, which is not new traffic to the network.

In this Guide, a trip is defined as a one-way vehicular movement from one point to another excluding the return journey. Therefore, a return trip to/from a land use is counted as two trips.

Trips can be broadly categorised into the following types:

- A linked trip is a journey where there is a chain of stops from origin to ultimate destination. A trip from home to work with stops at school and the post office comprises three linked trips; home to school, school to post office, and post office to work.
- An unlinked trip is a journey with no intermediate stops.

For the purposes of a traffic impact assessment, the following three types of trips are commonly used:

- New trip – in traffic impact studies, unlinked trips are generally referred to as new trips. These are trips attracted to the development and without the development would not have been made, hence they constitute a new trip.

- Diverted drop-in trips – a linked trip from an origin to a destination that has made a significant network diversion to use the new development.
- Undiverted drop-in trips – a linked trip from an origin to a destination that previously passed the development site. It is also referred to as a pass-by trip and the new development is an intermediate stop on a trip that is made from an origin to a destination.

The diverted and undiverted drop-in trips are considered to be trips that are already part of the existing flows on the road network. The treatment of the different trip types varies with the level of assessment. Hallam (1988) provides a reasoned basis for separating assessment into three levels:

- regional assessment – consideration of the impact of a development in the context of the total urban area
- local assessment – consideration of the effect of a development over a substantial area focussed on the development
- access level – micro-level assessment.

At the regional level, insertion of a new development could be considered to only increase travel by the new trips proportion of generation. Diverted and undiverted drop-in trips would already be on the network.

At a local level, both the new trips and diverted drop-in trips are introduced into the area and represent additional trips on the local network. This local network may contain roads of regional significance. The undiverted drop-in trips to developments on roads of regional significance can be regarded as already on the local network. It is important that these trips are considered. They must be re-routed from movements past the development to movements into and out of the development. For every two-development trips assigned as undiverted drop-in trips (one in/one out), one through trip should be removed from passing traffic.

Information on trip segmentation relating to the proposed development must be acquired from various sources and considered in developing traffic estimates. Trip segmentation is a term that means the proportions of new, diverted drop-in and undiverted drop-in trips that are generated by the type of development.

A typical example of the segmentation of traffic generation for shopping centres and fast food outlets is shown in Table C8 1.

**Table C8 1: Segmentation of traffic generation for shopping centres**

Development	Trip segmentation		
	New (%)	Diverted drop In (%)	Undiverted drop in (%)
Shopping centres > 20 000 m <sup>2</sup>	63	18	19
Shopping centres 3 000 m <sup>2</sup> – 20 000 m <sup>2</sup>	50	22	28
Shopping centres < 3 000 m <sup>2</sup>	50	32	18
Fast food outlets	40	25	35

Source: Queensland Department of Main Roads (2006).

The distribution of generated traffic to the road network is briefly discussed in Section 4.4.7. The generated traffic determined by generation rates, the application of trip segmentation percentages and its impact on existing flows is applied in assigning the generated traffic to the affected network.

The generated traffic is 'laid over' existing traffic flows to determine link volumes (mid-block) and intersection movements for the road network with the development operating.

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## Commentary 9

Level of Service (LOS) is defined in terms of service measures such as speed and travel time, freedom to manoeuvre, traffic interruptions, comfort and convenience. The practical application of LOS to different road environments takes into account factors such as volume/capacity ratios, terrain types, proportion of heavy vehicles and road gradients. For a comprehensive account of capacity and LOS refer to the *Guide to Traffic Management Part 3* (Austroads 2013b) and Transportation Research Board (2010).

Each of the six LOS represents a range of operating conditions and the driver's perception of those conditions, and can generally be described as:

### **LOS A**

Level of service A is a condition of free flow in which individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high, and the general level of comfort and convenience provided is excellent.

### **LOS B**

Level of service B is in the zone of stable flow and drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream, although the general level of comfort and convenience is a little less than with level of service A.

### **LOS C**

Level of service C is also in the zone of stable flow, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level.

### **LOS D**

Level of service D is close to the limit of stable flow and is approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor, and small increases in traffic flow will generally cause operational problems.

### **LOS E**

Level of service E occurs when traffic volumes are at or close to capacity, and there is virtually no freedom to select their desired speeds and to manoeuvre within the traffic stream. Flow is unstable and minor disturbances within the traffic stream will cause flow breakdown.

### **LOS F**

Level of service F is in the zone of forced flow. With it, the amount of traffic approaching the point under consideration exceeds that which can pass it. Flow breakdown occurs, and queuing and delays result.

Road agencies generally prefer to design new rural road projects for LOS A or B at opening and LOS C or D in the design year. However, some rural projects and most urban projects will have practical and financial limits on the extent of work that can be achieved and consequently the performance criteria will have to be negotiated throughout the traffic analysis process. In this regard an analysis of the existing LOS on the road network provides a useful benchmark by which to assess changes as a result of development.

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Austrroads Guide to Traffic Management consists of 13 parts and provides comprehensive traffic management guidance for practitioners involved in traffic engineering, road design, town planning and road safety.

**Guide to Traffic Management Part 12: Traffic Impacts of Developments** is concerned with identifying and managing road system impacts arising from land use developments. Part 12 provides guidance for planners and engineers associated with the design, development and management of a variety of land use developments. It aims to ensure consistency in the assessment and treatment of traffic impacts, including addressing the needs of all road users and effects on the broader community.

## Guide to Traffic Management Part 12



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