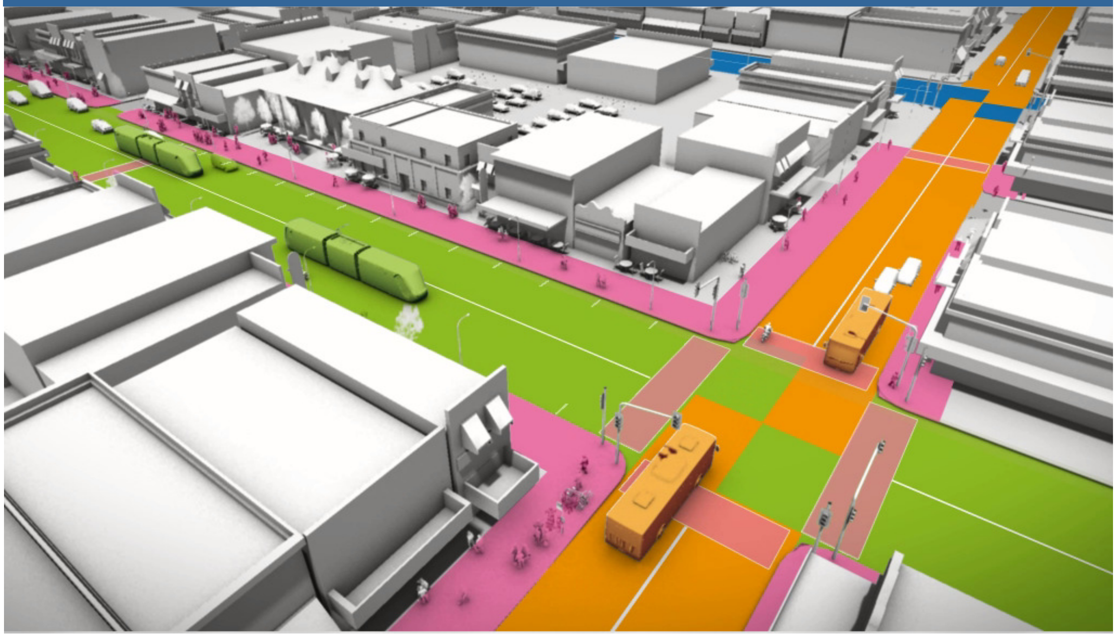
SmartRoads Guidelines

February 2015



ENGINEERING EXCELLENCE AWARDS
ENGINEERS AUSTRALIA
AWARD RECIPIENT VICTORIA 2011

Version Control

Version number	Purpose / Changes	Author	Date
1	Initial release of SmartRoads Guidelines in accessible format for VicRoads website.	VicRoads Network Policy and Standards	

Contents

1 SMARTROADS CONTEXT

1.1 Setting the scene – Melbourne and Victoria

Melbourne's population is predicted to rise to around 7.7 million by 2051, having surpassed 4 million in 2011. This has significant implications for transport and liveability across the city, as well as having an impact on state and national productivity. Clearly, the existing road network cannot accommodate this rate of growth if current private car trip patterns continue.

Currently, around 85% of public transport service kilometres use the road network, and the trend in patronage has increased on all road based public transport modes over the past ten years. For example, the number of trips taken on Melbourne's trams increased by 44% between 2002-03 and 2012-13. Bus services also increased over the same period by 37%, particularly since the roll out of significant bus improvements such as SmartBus and DART (Doncaster Area Rapid Transit). Though good operating conditions is key to the continued growth of these modes so is improving access for those using the metropolitan train network (83% increase 2002-03 to 2012-13), from walking to park and ride.

At the same time, the use of walking and cycling for transport is increasing, with bicycle use up 48% (2006-07 to 2012-13) in Melbourne's inner suburbs, and up 55% in Melbourne's middle suburbs over the same time period. The number of people walking to work in Melbourne increased by 50% between 2001 and 2011, with walkers in 2011 accounting for 3.4% of all trips to work.

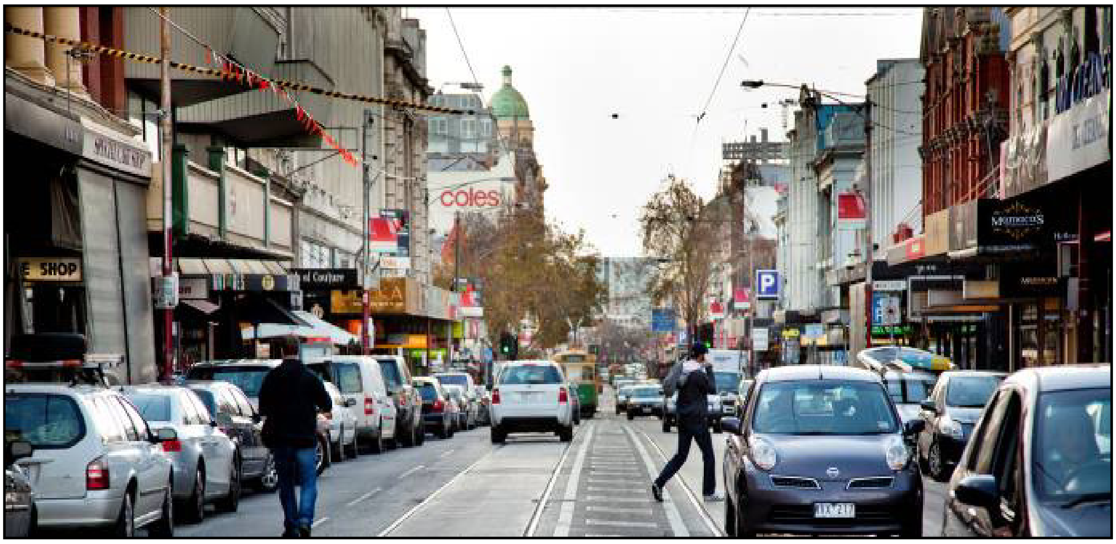
Evidently, while private vehicles remain the most popular way to travel, this behaviour is changing as factors such as congestion, fuel costs and health encourage people towards more active, efficient or affordable transport modes. To accommodate our growing population we need to cater better for public transport, walking and cycling, without losing sight of the importance of private vehicle use for some trips, and the need to cater for freight across the arterial road network.

Though regional cities and country communities might not face the same levels of traffic congestion, they do play a key role in driving growth and prosperity in Victoria. There is a need to maintain good connections across the state and deliver good planning outcomes in these communities. Melbourne will not retain its status as one of the world's most liveable cities unless regional and rural Victoria is also growing and prospering.

1.2 Activity centres

Activity centres are vibrant hubs where people shop, work, meet, relax and increasingly, live. Larger centres in particular are generally well serviced by public transport and provide multifunctional clusters of activity. This clustering enables planning for more efficient transport options that avoid the kind of increase in congestion that could otherwise inhibit liveability and detract from the character of the area. There is also considerable evidence about the productivity benefits of clustering economic activities into areas that are densely populated and have existing activity[1], with greater benefits accruing in the larger more dense areas. Therefore, it is important that the operation and planning of the transport network is concerned with delivering wider community goals rather than being an entity in its own right.

Activity centres differ in size and function. More information on each type of centre can be found in *Plan Melbourne* on the Department of Transport, Planning and Local Infrastructure (DTPLI) website.



[1] Towards an integrated and sustainable transport future: a new legislative framework for transport in Victoria

1.3 Integrating transport with land use planning

To create the best possible transport solutions for Victoria's and Melbourne's communities, we need to draw together the planning for transport and land use. This applies particularly to activity centres, which bring together retail, employment, and recreational activities. This high density of activity creates a high level of transport demand, including the need for freight access within the area. We need to facilitate planning to ensure that this demand is met in the most efficient and sustainable way.

Similarly, we need to ensure that transport is integrated into new developments to facilitate access to activities and promote the community's interactions with services, with employment and recreation opportunities, and ultimately with each other. When properly managed, traffic can be part of the dynamic, vibrant energy of a successful activity centre. At the same time, we need sound planning and operation of transport around freight hubs to ensure the more efficient movement of goods and to minimise the intrusion of heavy vehicles into places where they are not suited.

We need a structured framework involving all our stakeholders that enables decisions about all transport modes to be made in a way that ensures that they support the surrounding land use. '***SmartRoads***' provides this.

The SmartRoads framework enables decisions about all transport modes to be made in a way that ensures they support the surrounding land use. SmartRoads is part of the process of creating and enhancing all types of activity centres and key strategic land uses by facilitating access to the area and by managing the kinds of traffic within it. This may include:

- providing priority for cyclists to the area
- providing priority for public transport to access an activity centre, while ensuring that buses and trams don't intrude on the public space

- providing more frequent opportunities to cross roads in pedestrian priority areas
- providing alternative routes for general traffic and freight on through journeys to maximise mobility while minimising the presence of these vehicles in retail and leisure zones.

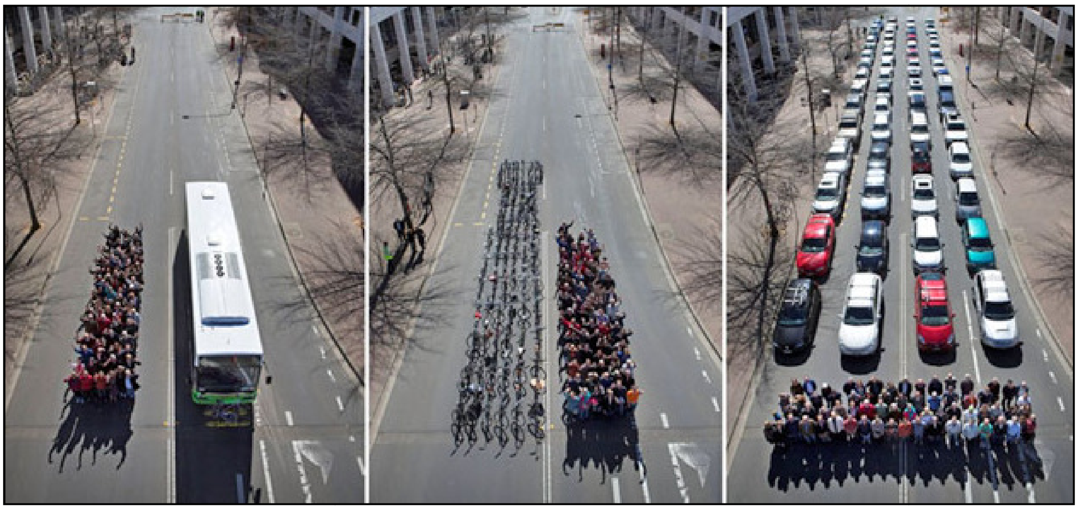
1.4 The art of transport and traffic engineering

Transport and traffic engineering can at times be just as much art as science. For example, in cases where little or no data is available or modelling has limitations, expertise, local knowledge and judgement need to take over.

SmartRoads provides a transparent way for decisions to be made in these situations, as well as facilitating decisions that are based on detailed, high-quality data, modelling and information. By drawing all stakeholders together and providing them with a shared language, the process shows participants how trade-offs are being made both between modes and across the network and enables all views to be captured. This consistent, transparent decision-making process can be just as important as the decision itself, because it ensures that all participants understand the final outcome – even in cases where it isn’t their preferred option. The associated SmartRoads tools can visually display the outcome of interventions that have traditionally been difficult to visually display, such as modal trade-offs and wider network effects.

1.5 Delivering on the Transport Integration Act

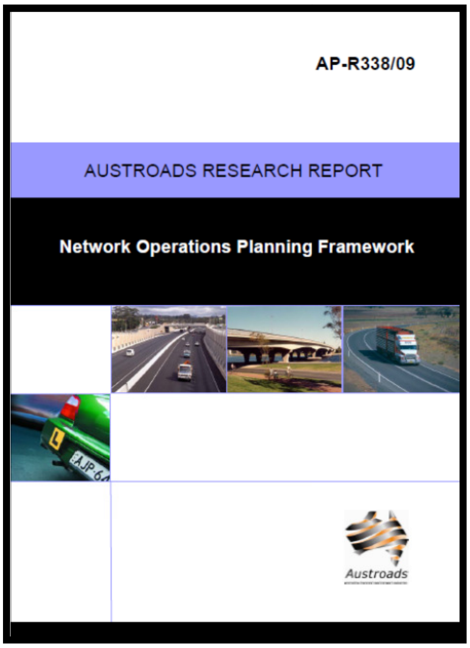
The *Transport Integration Act* sets out a vision for Victoria’s transport system that supports a city that is inclusive, prosperous, safe and green, using careful planning to maximise opportunities and reduce risks. The Act impacts on both the transport and place function of roads. All Victorian transport planning and management needs to have regard to the six key objectives of the Act, which are: environmental sustainability, economic prosperity, safety, integration of land use and transport planning; and efficiency, coordination and reliability.

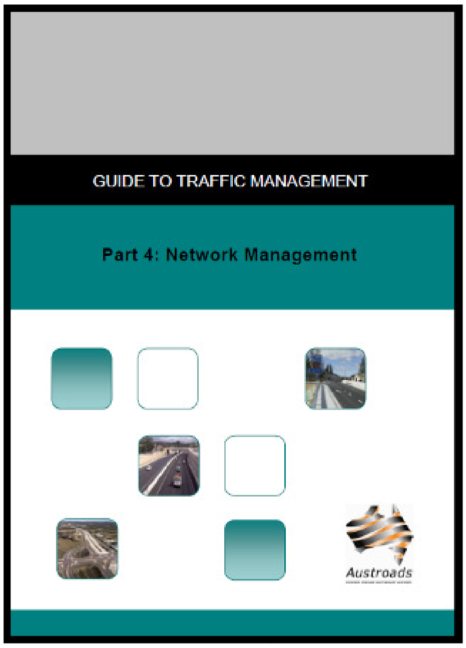


SmartRoads forms a key component of VicRoads' response to the *Transport Integration Act*. More information on the Act is provided in Section 3.1.

1.6 Austroads

For some years, Austroads has been setting broad policy on network operation planning, as documented in its *Network Operations Planning Framework* (2009) and in the *Austroads Guide to Traffic Management Part 4: Network Management* (2009). SmartRoads has been developed by VicRoads in response to the broad directions set by Austroads and has become Victoria's practical application of the Austroads framework.





1.7 Research context

As well as the Austroads documents mentioned above, SmartRoads draws on the Victorian Auditor General's 2013 report '*Managing Traffic Congestion'*, Victorian Competition and Efficiency Commission's 2006 report *Making the Right Choices: Options for Managing Transport Congestion* and the European Conference of Ministers of Transport's 2007 report *Managing Urban Traffic Congestion*. Its objectives are also informed by those set for state road authorities by the Australian Transport Council in 2008.

These reports draw similar conclusions about the importance of safety, efficiency, economic prosperity, and environmental sustainability. All emphasise the importance of drawing together the planning processes for transport and land use.

SmartRoads identifies five broad objectives, which set the direction for the best management of the road network, with a number of strategies which are used to achieve these. These are described in detail in Section 3.2.

1.8 VicRoads Strategic Directions

VicRoads Strategic Directions 2012-2014 has four key objectives: to operate and maintain the road system to help our customers travel easily and reliably; to develop the road system to improve connections between places that are important to VicRoads' customers; to improve road safety; and to make the road system more environmentally sustainable. The SmartRoads concepts and methods flow across all four of these objectives and are a key component of VicRoads' plan to deliver on its strategic directions.

2 SMARTROADS FRAMEWORK OVERVIEW

2.1 The framework

VicRoads has developed a network operations planning framework commonly referred to as SmartRoads. The framework consists of several core elements as shown in the chart below.

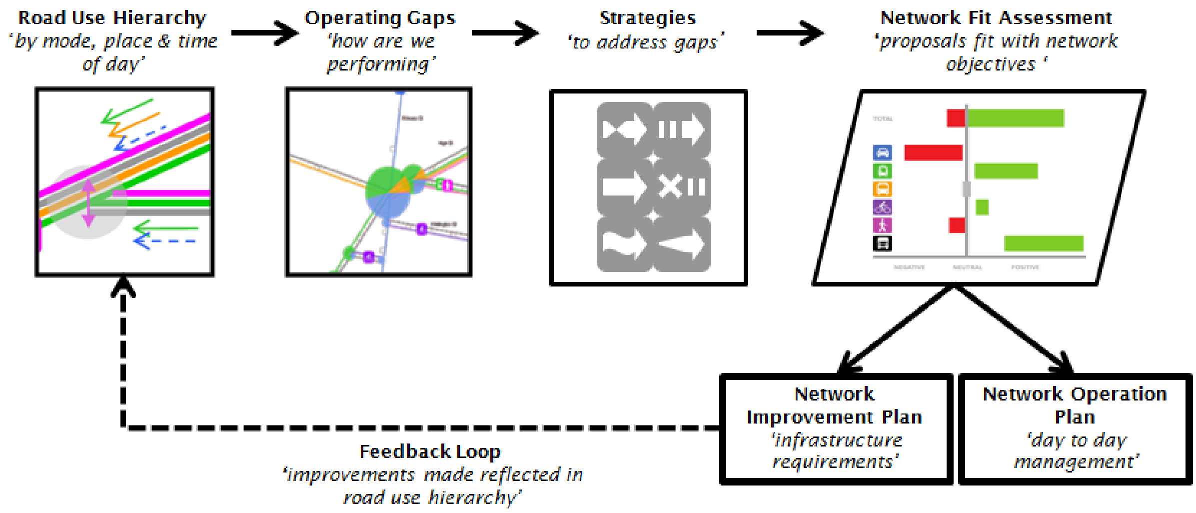


Figure 1 - SmartRoads framework

2.2 Road use hierarchy (Section 4)

The road use hierarchy is made up of the **strategic road use** and the **relative priorities** for each transport mode by mode, place and time of day. It represents a shared vision with stakeholders for how the road network needs to be managed rather than the current operating conditions – *'our agreed aspirational goal'*. It is a high-level strategic document, which has been endorsed by state and local government and influences everything from the day-to-day management of the network through to longer-term planning for major improvements.

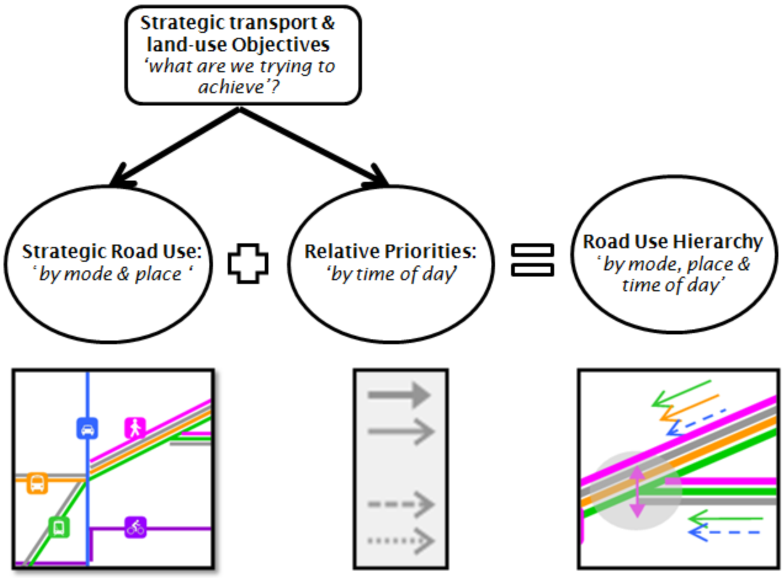


Figure 2 - Forming the road use hierarchy

2.2.1 Strategic road use

The strategic road use allocates priority by mode and by place, recognising the relationship between the transport network and the place it is interacting with. It is represented as a map of Melbourne and regional towns/cities showing the modes that have the highest priority on each route across the whole day and has been developed by VicRoads in collaboration with state and local government, transport operators and other relevant stakeholders.

2.2.2 Relative priorities

Relative priority is allocated as one of five levels of encouragement which change for different periods of the day depending on travel demand and surrounding activity. There are four key time periods: morning peak, high off peak, evening peak, and off peak. Changing the encouragement given to modes based on place and time can assist in resolving competing demands for road space.

Relative priority is represented as a level of encouragement given to each mode, represented as an arrow, indicating the extent to which a mode is encouraged based on place and time:

Strongly encourage movement

Encourage movement

No specific encouragement

Encourage local access only

Local access only

One of these five levels of encouragement is assigned to each mode depending on the features of the location – for example, an activity centre, a strip shopping centre, or a road included in the principal public transport network (PPTN).

The priorities are determined on the basis of a set of rules which are summarised in tables of priority arrows for each mode by time and place. Like the strategic road use, the relative priorities have been developed in consultation with other government agencies and relevant stakeholders

2.3 Operating gaps (Section 5.2)

A method of describing the gap between the favoured performance (aspirational) of the network and its actual performance. This enables us to objectively assess the current performance and therefore to focus on the areas of greatest need across the network. It also enables us to test the impact of proposed changes, to ensure they fit with the strategic intent of the road use hierarchy. The operating gap takes into account:

- how well each mode is operating at a given location (current level of service);

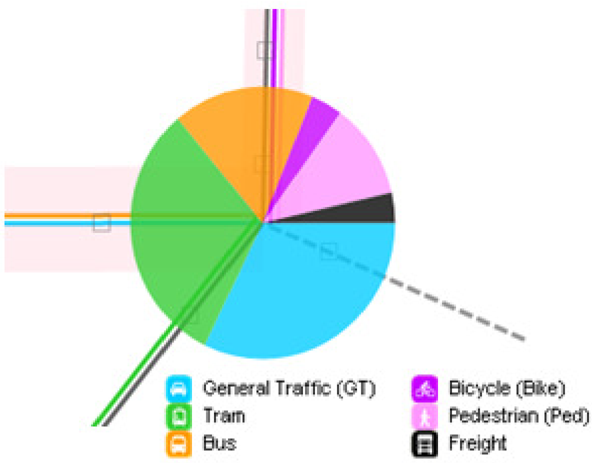


Figure 3 - Operating gap example

- how well the network should be operating (relative level of service);
- the priority assigned to different modes by the RUH, based on government policies and objectives (relative priority);
- how many people or goods the mode can transport (relative efficiency); and
- the future growth predicted for a mode (mode shift factor).

This provides a rich analysis of deficiencies on the road network and enables initiatives to be targeted to achieve the greatest strategic benefit.

The operating gap enables us to capture the complexity of the issues on the network and test possible responses. This is done through the use of the network fit assessment tool (the NFA Tool) which can be used to convert raw data into a more sophisticated assessment of the network.

2.4 Network strategies (Section 6)

Network strategies are developed to guide the process of identifying solutions to address the gaps on the network. While the road use hierarchy provides information about the level of priority given to each mode, the strategies provide additional guidance on the kinds of treatments that could be used to achieve the preferred level of priority. Network strategies generally focus on sub-networks rather than specific sites, for example a local government area or a strategically important corridor.

2.5 Network fit assessment (Section 7)

The network fit assessment (NFA) process is used to determine whether a change to the operation of a road – from modifications to signal timing through to the construction of a new freeway - supports the intent of the road use hierarchy. The assessment is conducted in a workshop to ensure that the process is transparent and that all stakeholders understand the results and the trade-offs between transport modes that may be involved.

The outputs of the SmartRoads NFA Tool include simple graphical representations of the impact of a proposal, as shown in Figure 4. The green and red dots on the map represent the sum of the positive and negative impacts of all modes on that particular location. The bar graph in the bottom right-hand corner shows the range from the worst-case impact to the best-case impact for each mode under consideration. These types of outputs bring key decision-makers, who may not be transport engineers, along on the journey of understanding the potential impacts of a proposal on the transport network.

The NFA process can also be used for post-delivery assessments to determine the effectiveness of the treatment in addressing any operational deficiencies. The post-assessment will also raise any fine tuning that needs to be carried out.

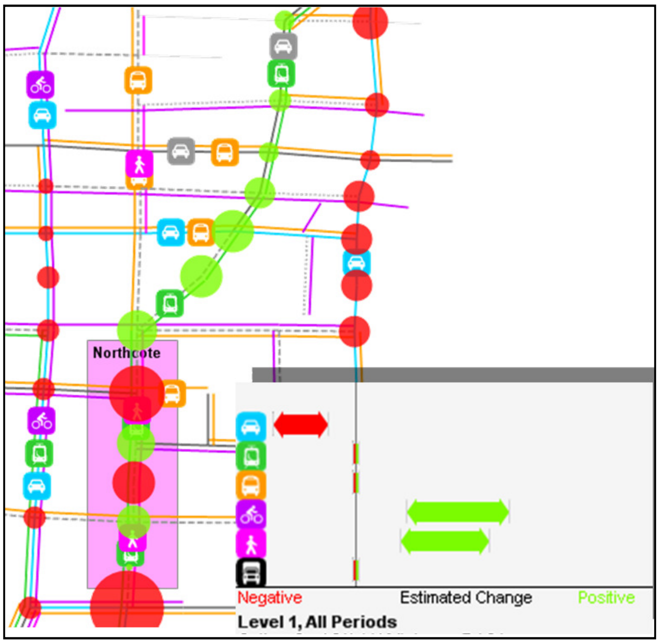


Figure 4 - Example of Network Fit Assessment Tool output

It is important to recognise that the NFA process is assessing the operational impacts, thus it doesn't assess the safety merits of the project. These are determined through a separate process.

2.6 Network Operating Plan and Network Improvement Plan (Section 8)

The final outputs of the SmartRoads process are the Network Operating Plan (NOP) and the Network Improvement Plan (NIP).

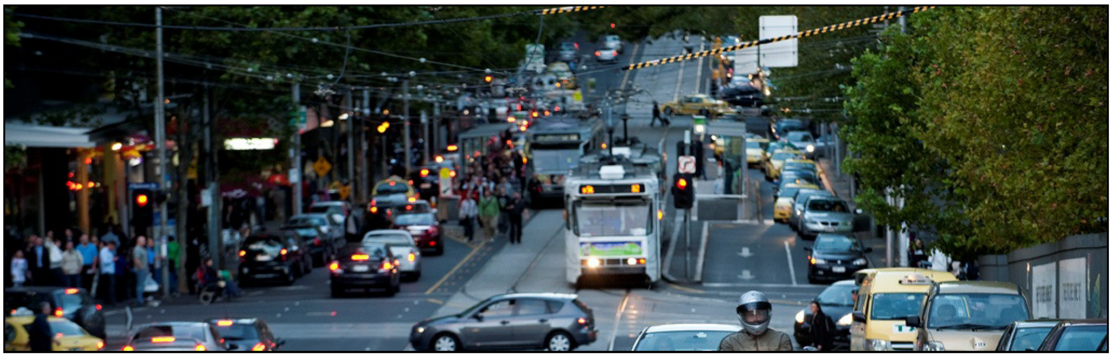
The NOP and NIP emerge from the strategic intent and operational objectives of the road use hierarchy, the existing and future operating gaps and the network strategies. The two plans then provide the focus for the two different timeframes for managing the network.

- The **NOP** is concerned with optimising the current day-to-day operation of the existing network in line with the RUH and network strategies.
- The **NIP** sets out possible future projects to improve the operational performance of the network; this may include a priority list.

3 KEY OBJECTIVES FOR SMARTROADS

3.1 Introduction

People are drawn to vibrant, busy cities by the range of activities and opportunities they offer. However, as more people choose to live, work and connect with each other around these activities, traffic congestion can become a problem. Successful cities strike the right balance between hosting an array of activities on the one hand and providing a transport system that works well enough to move everybody around on the other.



The *Transport Integration Act* sets out the way that Melbourne will achieve this balance. Its six 'transport system objectives' suggest a dynamic, prosperous city which uses careful planning to maximise opportunities and reduce risks. As SmartRoads forms a key component of VicRoads' response to the objectives and decision-making principles set down in the Act, they are summarised in Table 1 in point form.

Table 1 - TIA transport system objectives

TIA transport system objectives

Social and economic inclusion

- Enabling people to access opportunities for social and economic wellbeing
- Minimising barriers to access
- Providing support for those who find it difficult to use the transport system.

Economic prosperity

- Providing efficient access for people and goods to places of employment, markets and services
- Increasing efficiency by reducing costs and improving timelines
- Fostering competition by providing access to markets and facilitating investment in Victoria.

Environmental sustainability

- Protecting, conserving and improving the natural environment
- Avoiding, minimising and offsetting harm to the local and global environment, including through transport-related emissions and pollutants and the loss of biodiversity
- Promoting forms of transport and forms of energy and transport technologies which have the least impact on the natural environment
- Improving environmental performance of all forms of transport.

Integration of transport and land use

Facilitate access to social and economic opportunities, especially:

- Maximising access to residences, employment, markets, services and recreation
- Planning and developing the transport system more effectively
- Reducing the need for private motor vehicle transport and the extent of travel
- Facilitating greater mobility within local communities.

Transport system and land use planning should be aligned, complementary and supportive to ensure that:

- Transport decisions are made having regard to their current and future impact on land use
- Land use decisions are made having regard for the current and future development and

operation of the transport system
- Transport supports changing land use

The transport system should improve the amenity of local communities and minimise impacts on adjacent land uses.

Efficiency, coordination and reliability

Facilitate the network-wide efficient, co-ordinated and reliable movement of people and goods at all times. It should also:
- Balance efficiency across the network to optimise the network capacity of all modes of transport and reduce journey times
- Maximise the efficient use of resources
- Facilitate integrated and seamless travel within and between modes
  - Provide predictable and reliable services and journey times and minimise any inconvenience caused by disruptions to the transport system.

Safety, health and wellbeing
- Seek to continually improve its safety performance through safe infrastructure, safe forms of transport and safe user behaviour
- Avoid and minimise the risk of harm arising from use of the system
- Promote forms of transport and forms of energy which have the greatest benefit for, and least negative impact on, health and wellbeing.

TIA decision-making principles

Integrated decision-making
- Achievement of wider government objectives
- Need for co-ordination between all levels of government and government agencies, and with the private sector

Triple bottom line assessment
- Regard to be given to all the economic, social and environmental costs and benefits

Equity between people
- Equity between people irrespective of:
  - Personal attributes including age, physical ability, ethnicity, culture or gender, or their financial situation
  - Location including growth, urban, regional, rural or remote areas
- Equity between generations by not compromising the ability of future generations to meet their own needs

The transport system user perspective
- Understand user requirements, including information needs
- Enhance useability of the transport system and the quality of the experience of the transport system

The precautionary principle
- If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation
- Decision-making should be guided by:
  - A careful evaluation to avoid serious or irreversible damage to the environment wherever practicable;
  - An assessment of the risk-weighted consequences of various options

Stakeholder engagement and community participation
- Taking into account the interests of stakeholders, including transport system users and members of the local community
- Adopting appropriate processes for stakeholder engagement

Transparency
- Give members of the public access to reliable and relevant information in appropriate forms to facilitate a good understanding of transport issues and the process by which decisions are made.

3.2 SmartRoads objectives and strategies

SmartRoads has developed five key objectives and corresponding strategies which set the direction for the best management of the road network in Victoria. They shape how each of the elements in the framework is applied from designating the Road Use Hierarchy through to applying network strategies. Each of the objectives aligns directly with the requirements of the *Transport Integration Act* and are influenced by a range of national and international research as outlined in Section 1.7.

3.2.1 Objective 1: reduce the amount of travel by integrating transport with land use and supporting the function of activity centres

Strategy 1.1: *Encourage general traffic to use arterial roads that avoid significant conflicts with abutting land use.*

Hubs of retail, social and community activity such as strip shopping centres and activity centres are an important part of the fabric of a successful and liveable city. These centres enable people to access a range of services and activities quickly and easily by bringing them together into one place. Planning good alternate routes for general traffic not needing to access the activity centre provides opportunities to improve priority for walking, cycling and public transport within and into the area. Where possible, motor vehicles are encouraged to use designated *preferred traffic routes* that avoid these areas. Where this is not possible, through traffic demand is spread across available arterial roads to minimise the impact on activity centres. SmartRoads will set the priorities on these arterials to reflect the importance of the activity centre they are passing through. For example Ballarat Rd and Moore St around the Footscray Metropolitan Activity Centre have been designated as *Preferred Traffic Routes*, once there is no conflict these routes revert back to traffic routes (grey).

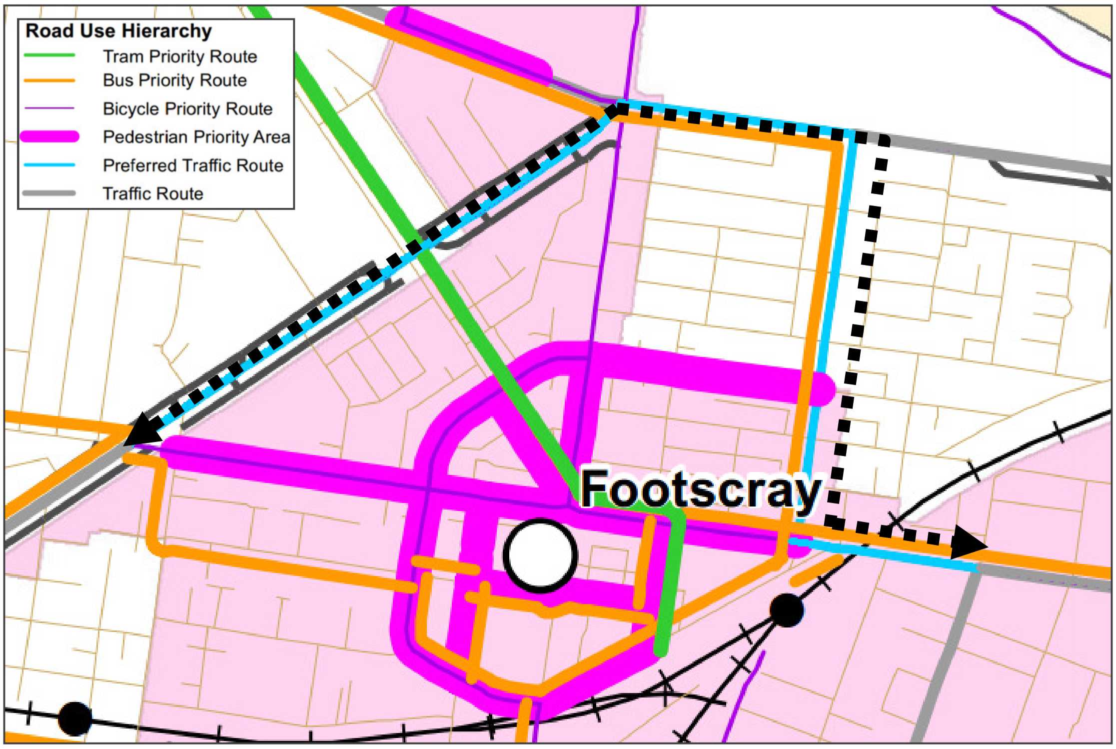


Figure 5 - Strategic Road Use map: Footscray Activity Centre

Strategy 1.2: *Provide better access to activity centres and job opportunities via public transport.*

The Principal Public Transport Network (PPTN) consists of core network of strategic on-road public transport routes providing access to key destinations such as the expanded central city, metropolitan activity centres, national employment clusters, state significant industrial precincts and health and education precincts.

In addition to encouraging public transport on all routes on the principal public transport network (PPTN), SmartRoads gives particular priority to routes that connect and support activity centres, where:

- There are more than 80 two-way (40 each way) tram or bus services a day connecting two activity centres; or
- There are more than 60 two-way (30 each way) tram or bus services a day connecting three or more activity centres.

Strategy 1.3: *Provide better access to activity centres and job opportunities via walking.*

Walking is an important element of the land use strategy which aims to reduce the reliance on cars and promote activity centres as places where people can live, work and connect. Pedestrian volumes are usually higher in these areas as there is concentration of employment, shops, schools and good access to public transport.

Encouraging pedestrian movement around activity centres usually involves the provision of more frequent and convenient and safe crossing locations, reduced waiting times at traffic signals, and pleasant, comfortable walking paths to and through the centre. Key desire lines into and through activity centres will be highlighted as part of the principal pedestrian network (PPN) in the network operating plans (NOPs). Along the PPN where active frontages exist for at least 200 metres on both sides of a street, there will be a higher demand for crossings and interaction; these areas will be designated as *pedestrian priority areas* to reinforce the need for higher levels of priority for pedestrians.

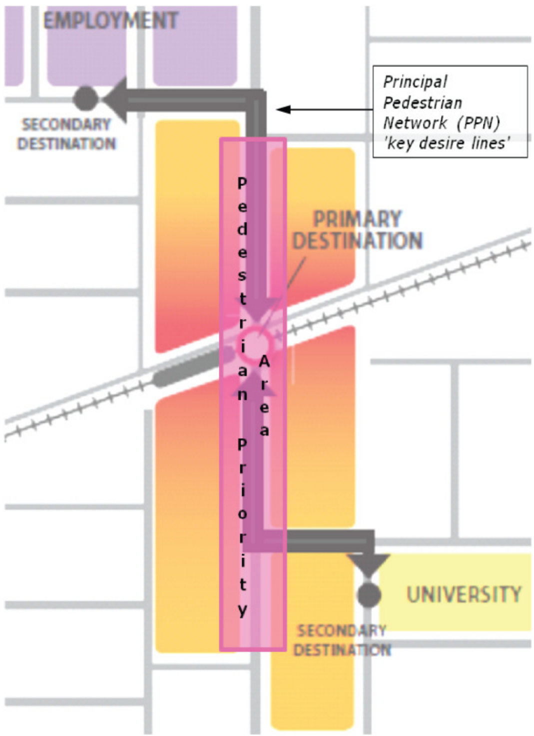


Figure 6 - Designating pedestrian priority

In some cases, public transport and pedestrians have competing demands on arterial roads through pedestrian priority areas. The difficulty is that pedestrian priority includes frequent crossings, but these can slow trams and buses down. Careful consideration needs to be given to solutions that support pedestrian access and mobility, together with public transport mobility, taking into account the time of day demands for each mode.

Strategy 1.4: *Provide better access to activity centres and job opportunities via bicycle.*

Cycling is a practical mode of transport for many kinds of trips. Key routes on the principal bicycle network (PBN) that provide people of differing ability with a good connection to activity centres are designated as bicycle priority routes. The aim is to attract less frequent or less confident cyclists to riding for transport, making this a 'front-of mind' mode for a range of trips. The bicycle priority routes are assigned according to how well they can be separated from other traffic, their directness and their proximity to an activity centre or strategic land-use.

The criteria used to identify bicycle priority routes is summarised below:

Priority check

1. Connection to key destination.
2. Directness of route to key destination.
3. Potential to provide for varying levels of cycling experience (from novice to experienced cyclists).

Network check

4. Sufficient supply of priority routes into key destinations.
5. Linkages between priority routes.
6. Unnecessary duplication of routes.

Improvements to bike paths, lanes and crossing points will be targeted towards these bicycle priority routes as they enable people to confidently ride to their local activity centre.

Strategy 1.5: *Ensure that transport and land use are mutually supportive.*

By thinking about the travel that will be generated by new development, particularly major developments such as hospitals, subdivisions and retail centres, right from the start of the planning process, we can ensure that the increase in travel does not translate to an increase in congestion. This may involve planning for public transport improvements or dedicated pedestrian and bike facilities, as well as thinking carefully about the distribution of private and other vehicles across the surrounding local and arterial road network. This two-pronged approach to shaping our city will ensure that people can move freely across metropolitan areas and access the benefits that cities provide its citizens.

This approach also has a role to play in refining the transport arrangements for existing facilities. Considering the ways that the transport system and the surrounding land use impact on each other can lead us to solutions that promote mobility without detracting from the safety, comfort and atmosphere of the community. It also recognises the non-transport function of roads as places, which may be used for example for community activities, as retail zones, or for outdoor café spaces.

To ensure transport and land-use are mutually supportive, all projects or proposals that:

- add noticeable delays to general traffic or freight vehicles, or
- impact on the operation of public transport, or
- change the access or amenity for pedestrians in an activity centre or along the PPN, or
- change the access, separation or amenity for bicycles on the PBN

need to be tested against the objectives embedded into the road use hierarchy. This testing is referred to as a network fit assessment (NFA).

3.2.2 Objective 2: Encourage modes that use road space more efficiently

Strategy 2.1: *Prioritise public transport on the road network.*

In addition to the priority given to public transport that connects activity centres outlined under objective 1, bus and tram priority routes will also be assigned on the PPTN where they:

- are existing SmartBus routes
- form part of Melbourne's orbital (or proposed premium) bus network or
- have more than 150 two-way services a day.

The remaining PPTN will still have a level of priority, albeit lower than for designated bus priority routes.

Strategy 2.2: *Improve the reliability of on-road public transport.*

Predictable journey times are important to commuters – they enable users to plan their time and enable the network to be operated more efficiently. Measures such as providing priority at traffic lights not only reduce travel times, they also make travel times more predictable. These and other measures will be targeted towards bus and tram priority routes.

Strategy 2.3: *Promote greater use of public transport.*

Frequent, well-patronised public transport services are an important response to population growth and the corresponding increase in transport demand, because they are particularly efficient modes. On designated routes, measures to improve the travel times and reliability of trams and buses will ensure that these modes are the most reliable way to travel the route, which in turn will make public transport more appealing.

3.2.3 Objective 3: Encourage healthier and more environmentally sustainable modes

Strategy 3.1: *Provide bicycle routes that link to key destinations and cater for differing levels of rider ability.*

Bicycles are an increasingly important mode of transport, both because they provide significant health benefits and because they reduce the pressure on roadspace by taking cars off the road. The principal bicycle network (PBN) is a network of cycle routes that provide access to key destinations across Melbourne. As outlined in strategy 2 under objective 1, routes which connect to activity centres are given the highest priority. However, the remaining routes on the PBN are still given encouragement in the road use hierarchy to ensure that cyclists have safe, comfortable facilities, which will also attract more people to cycling for transport and broaden the demographic of those using this mode. The needs of cyclists will also be prioritised when evaluating new transport improvements and new developments.

Strategy 3.2: *Reduce conflicts and risks for cyclists.*

To get people cycling, bicycle priority routes need to allow for separation from other traffic. This ensures that the stress on cyclists is reduced and greater numbers of people are encouraged to use this mode for transport.

Strategy 3.3: *Prioritise walking on the Principal Pedestrian Network (PPN).*

In addition to the pedestrian priority areas provided in activity centres, to encourage walking as a viable transport alternative, key walking routes leading into activity centres, forming the PPN, will be given priority.

Strategy 3.4: *Reduce conflicts and risks for pedestrians.*

Priority will be given to ensuring that there are adequate safe crossing facilities for pedestrians in their priority areas. Pedestrian paths and crossings will also be taken into account when planning new developments and considering changes to the transport system. These means will make certain that pedestrians are comfortable on their journeys, ensuring that negative experiences do not deter those who might consider using walking for transport.

Strategy 3.5: *Where practical set mode targets specific to an area.*

To measure how we are performing in people using sustainable modes for transport it is appropriate to set agreed mode share targets. These should be specific to an activity centre or sub network rather than at a metropolitan or state level.

3.2.4 Objective 4: Improve the efficiency of the movement of both people and goods on our road network

Strategy 4.1: *Provide priority to optimise the movement of people rather than vehicles.*

In general, SmartRoads gives priority to initiatives that enable the greatest number of people to be moved along a route, rather than the greatest number of vehicles. For example, a bus can hold 50 people, whereas the amount of roadspace used by a bus can only accommodate 2.5 cars which equates to 10 people. This approach ensures that the use of the road is as efficient as possible. At the moment, Melbourne has one of the lowest car occupancy rates of any city in the world (1.2 people per vehicle). Improving the efficiency of the movement of people is a key step to managing the increasing demands placed on the road system. This can be done for example through the more efficient operation of traffic signals and traffic lanes, and better information for road users to enable them to make smarter travel choices.

Strategy 4.2: *Optimise the network capacity for all modes of transport and reduce journey times.*

It is not possible to cater for all modes of transport on the same route at the same time, but by balancing the needs of all road users across the network and across the day, the road use hierarchy is able to cater for most travel demand. By making carefully considered trade-offs, the road use hierarchy ensures that the movements which are most important to the community get the greatest encouragement.

Strategy 4.3: *Arterial Roads are preferred over local roads for interregional travel while local roads have a key access function.*

Arterial roads are, by definition, the nominated traffic routes for longer distance travel. However, the local road network provides the transport connections to deliver access between destinations and the arterial road network and has a part to play in the overall transport network. Key local roads will be nominated by agreement with council as:

- Local Primary Access Route: Provides access routes to/from local destinations; may also act as circulation routes and a gateway into the activity centre. Most likely will have controlled intersections.

- Local Secondary Access Route: Collects and distributes between local primary access routes. May have controlled intersections.

- Local Destination Route: Predominantly local access to abutting properties or shared spaces within activity centres with low levels of traffic and restricted access. Unlikely to have controlled intersections.

Strategy 4.4: *Provide priority on the Principal Freight Network and connections to freight activity centres.*

The principal freight network (PFN) sets out the preferred routes for freight across the state and generally links the freight terminal network and freight activity centres. SmartRoads gives greatest encouragement to freight on the PFN routes, and also on arterial roads connecting key freight centres that may not be on the PFN.

Strategy 4.5: *Encourage freight to make greater use of the spare capacity available during inter-peak and off peak times.*

To promote the most efficient movement of goods, freight will be given greatest encouragement during inter-peak and off peak periods, when lower traffic volumes ensure that transit times are both faster and more reliable. As the requirements of heavy vehicles are potentially in conflict with the needs of other road users within activity centres, freight will not be encouraged to use arterial roads through these centres at times when other activity is greatest. To facilitate this, freight will be given greater encouragement on the preferred traffic routes outside activity centres during inter-peak periods.

Strategy 4.6: *Facilitate freight movement and access on the arterial road network.*

To ensure that local residential areas are safe and comfortable places to live, arterial roads are always preferred over local roads for freight vehicles. Heavy vehicle movements can impact on the amenity of activity centres; however, these areas can also generate freight movements. Freight will be encouraged to use the arterial network to access locations for making deliveries around and into these areas. In instances where truck restrictions are in place on arterial roads, an alternative route will be identified on the arterial road network.

Strategy 4.7: *Recognise traffic routes linking key destinations.*

A core network of strategic traffic routes is required to provide access to key destinations such as the expanded central city, metropolitan activity centres, national employment clusters, state significant industrial precincts, health and education precincts and transport gateways, such as the Port of Melbourne or metropolitan freight terminals. These traffic routes will be highlighted as part of the principal traffic flow network (PTFN) to reflect their importance.

Strategy 4.8: *Ensure that overall network efficiency for all modes is considered in real time.*

It is important to ensure that traffic management such as responding to incidents on the road network, planned or unplanned lane closures, and plans for works and events give consideration to all modes in accordance with the relevant network operating plans, without overlooking modes such as cycling and walking.

3.2.5 Objective 5: Where new infrastructure is required, target investment towards those projects that provide the most sustainable long-term capacity improvements

Strategy 5.1: *Collect accurate data on congestion to inform decision-making and ensure that priority is given to projects that improve efficiency across all modes on the whole network.*

Understanding congestion across the whole network is fundamental to ensuring that road improvement projects will improve overall transport efficiency. Ensuring optimal person throughput across multiple modes will have a greater impact on congestion than targeting one mode or adding capacity alone. This can only be done with a base of accurate data that assists in identifying problems and testing solutions. The data can be used to conduct a thorough, robust analysis of proposed projects.

Strategy 5.2: *Ensure that VicRoads, other State governments partners, local councils and stakeholders work together to identify and implement the best multi-modal improvements.*

Cooperation between government agencies is a key element of SmartRoads as it enables all aspects of the transport context to be considered together. The relationship between transport and land use planning is important in congestion management and will be central to the consideration of all future projects. Similarly, SmartRoads enables road projects to be assessed for their impact on all transport modes, and this process enables multi-modal solutions to be identified (see network fit assessment in Section 7). This applies to new transport projects and also to the consideration of new developments and their integration with the transport system.

Strategy 5.3: *Assess the projected travel patterns and demand that will be created by the project.*

As part of improving the efficiency of the transport system on a network-wide basis, the impacts of any proposal must be carefully considered. It may be that the project improves flow for one particular mode but may eventually cause delays for other modes. These issues will be considered from the outset in planning road improvements.

Strategy 5.4: *Ensure that network operation is part of project planning.*

To preserve the productivity benefits of any new investment in road capacity, it is important to ensure that there is a plan for the future management of the new infrastructure developed at the same time as the project is designed. The management of surrounding routes will also be considered, to address any adverse impacts and utilise any opportunities created by the project. This process will ensure that the new structure provides benefits well into the future.

3.3 TIA decision-making principles

As noted, the *Transport Integration Act* sets out six transport system objectives and seven decision-making principles. The previous section outlined SmartRoads' five objectives and showed how they respond to those of the Act. SmartRoads also fits with the decision-making principles outlined in the Act, in particular the following six of the seven principles:

- integrated decision-making
- triple-bottom-line assessment
- the transport system user perspective
- the precautionary principle
- stakeholder engagement and community participation
- transparency.

The SmartRoads framework was set up in consultation with key stakeholders and is designed to integrate transport and land use decisions. The road use hierarchy was created in a series of workshops attended by stakeholders, and the same workshop system is used both to further develop the road use hierarchy, for example in growth corridors. This ensures that all relevant parties are involved in decisions, so they capture the perspectives of all road users, engage stakeholders and are transparent.

3.4 Use of workshops in SmartRoads

SmartRoads provides a common language which enables transport professionals, land use professionals and user groups to work within the same process.

The process begins with stakeholders agreeing on the five objectives set out above. This agreement creates an environment where decisions can be made in accordance with the SmartRoads framework in a way that is inclusive and transparent.

The traditional process where proposals would be passed from one decision-maker to another for approval could result in proposals being returned, rejected

and submitted again, wasting time and creating adversarial relationships. The workshop process brings all stakeholders together and facilitates a discussion about the decision that results in a shared understanding of the trade-offs that need to be made. When it is decided that a proposal needs revising, the proponent leaves the workshop with a sound understanding of the views of all involved and clear direction for the revision required. This process leads to better decisions and better integration between decision makers across all levels of government and beyond to the community.

Good facilitation is an important part of an effective workshop, to ensure that all participants are brought in to the discussion, all views are captured, and the process is balanced. Tips on facilitating a workshop are provided in Section 7.4.1.

3.5 Stakeholders

VicRoads has consulted with key stakeholders from SmartRoads' inception. This has ensured that the framework represents a vision for Melbourne that is supported by local councils, the Department of Transport Planning and Local Infrastructure and other groups such as Royal Automobile Club of Victoria (RACV) and Bicycle Network. The Department of Transport Planning and Local Infrastructure represents public transport, walking and ensures that liveability and a sense of place are part of the conversation, while local councils bring community views to the discussion.

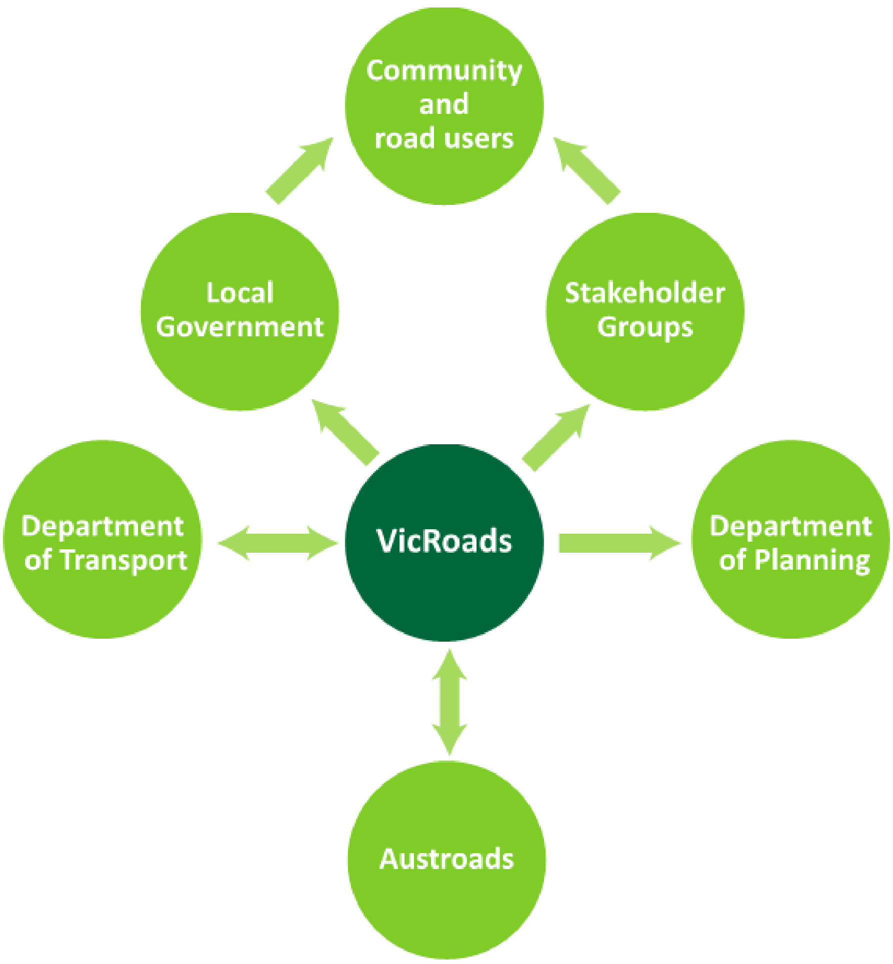


Figure 7 - Working with stakeholders

4 SMARTROADS ROAD USE HIERARCHY

The road use hierarchy has been endorsed by local and state government and comprises the strategic road use and relative priorities for each transport mode by mode, place and time of day. The diagram below illustrates how these two elements make up the road use hierarchy.

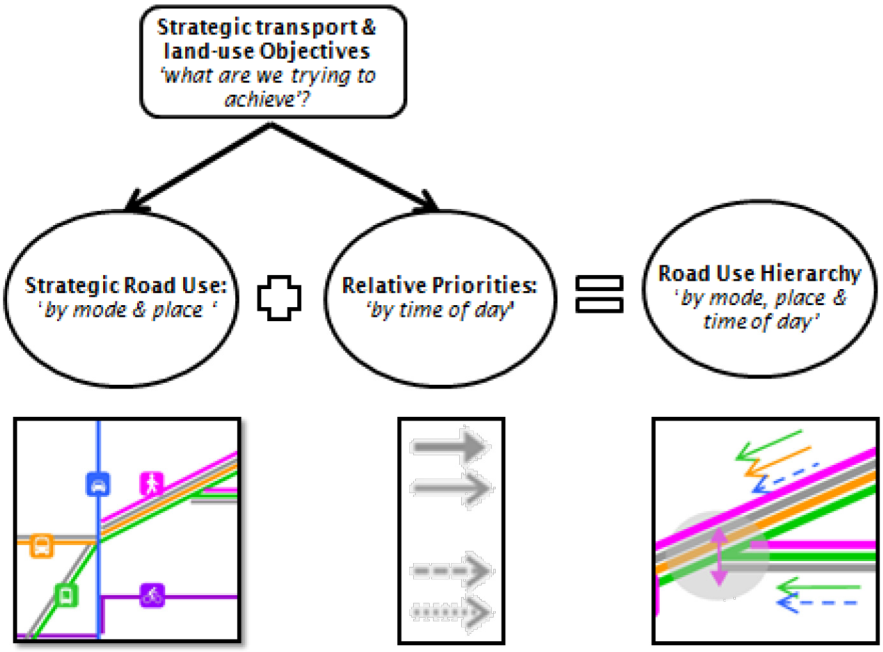


Figure 8 - Forming the road use hierarchy

The **strategic road use** allocates priority by mode and place, recognising the relationship between the transport network and the place it is supporting. It is represented as a map of Melbourne and regional towns/cities showing the modes that have the highest priority on each route across the whole day. The illustration below has been taken from the Melbourne strategic road use map.

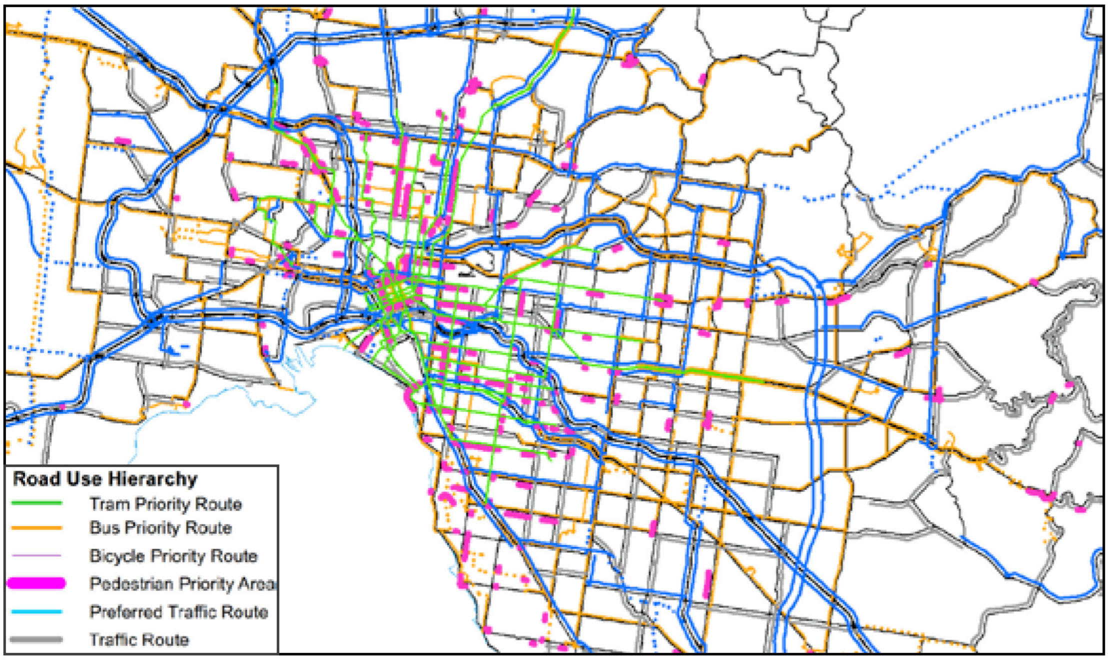


Figure 9 - Strategic road use map for Melbourne

map shows, there is competition for road space and for priority between different modes on a number of the same routes. To resolve those competing demands, a set of relative priority rules is applied, summarised as a set of tables of arrows which are explained in detail below (see Section 4.4). These rules recognise that transport patterns change at different times of the day, particularly in and around activity centres, and are used to help to establish the hierarchy of modes at any given location.

Traditional road hierarchies have classified roads according to their function, for example freeways, arterial roads and local roads, usually resulting in private cars getting most of the operational priority. Instead, the SmartRoads hierarchy ranks each of the modes on each road in relation to each other. These relative priorities are influenced by the place the road runs through and the time of day under consideration and are essential in resolving competing demands for road space. Using place and time of day to set the hierarchy allows planners and engineers more flexibility and to apply a pragmatic approach in their decision making

The road use hierarchy represents a shared vision for how the road network needs to be managed rather than the current operating conditions.

4.1 Strategic road use map

The strategic road use allocates priority by mode and place. It uses place as a fundamental starting point for transport planning, by allocating priority to various modes based on the place they are supporting or travelling through. The strategic road use is strongly influenced by the government's designated activity centres, from the Metropolitan Activity Centres through to neighbourhood centres. It comprises priority routes for each mode and is represented as a map of Melbourne (or of the regional towns or cities under consideration) showing the modes that have the highest priority on each route across the whole day. The road use hierarchy, by contrast, is specific to one of four time periods. The strategic road use was developed in consultation with key state government agencies, local government and transport stakeholders and takes a number of government planning strategies into consideration, including principal networks as described below.

4.1.1 Development of the strategic road use

All strategic road use maps are developed in a series of workshops, usually focussed on one municipality. Participants include council traffic and planning officers, VicRoads traffic and planning officers and public transport managers. They use all available traffic and land use data and draw on the experience of the participants to prepare the map based on the six SmartRoads goals. When SmartRoads was being

developed, strategic road use maps were produced for each local government area in Melbourne and then joined to form an overall map of the metropolitan area.

Strategic road use maps are now developed as required in workshops involving all relevant stakeholders. This process is described in Section 9.3.2. Maps may be produced for new or redeveloped activity centres, for growth corridors in Melbourne or for regional cities in Victoria. They are living documents, which need to be reviewed as land use, travel patterns or road network conditions change.

4.1.2 Principal networks and priority routes

The SmartRoads road use hierarchy includes priority routes and preferred routes which have been determined in consultation with key stakeholders. These are: *bus priority routes, tram priority routes, preferred traffic routes, bicycle priority routes and pedestrian priority areas*. At the same time, the hierarchy draws on the principal transport networks, which have been developed to focus attention on important corridors for selected modes, taking into account the state and local planning policy frameworks. The networks identified to date are the principal public transport network, the principal traffic flow network, the principal freight network, the principal bicycle network and the principal pedestrian network.

In general, the preferred and priority routes on the road use hierarchy will encourage a given mode on its principal network, in recognition of its strategic importance. The road use hierarchy is also influenced by operational factors such as the number of services and facilities and the importance of the link in supporting the activity centres.

The road use hierarchy identifies how individual intersections and links should operate to support the broader land use and transport objectives. It provides a practical guide for the traffic and transport managers and operators to take into account these objectives when making decisions either on the day-to-day operations or planning for future network improvements. This is reflected in the definitions of the priority and preferred routes which form part of the framework.

4.1.3 SmartRoads preferred/priority routes and area definitions

- **Tram priority route** Trams are a high priority mode along routes that frequently link key destinations/activities.

- **Bus priority route** Buses are a high priority mode along routes that frequently link key destinations/activities.

- **Bicycle priority route** Promote and reduce conflict along key cycling routes linking to activity centres and key destinations.

- **Pedestrian priority area** Pedestrians are a high priority where there is a considerable area of high pedestrian activity.

- **Preferred traffic routes*** General traffic is encouraged to use these routes to avoid significant conflicts. PTRs are used both at a local scale (for example, to bypass an activity centre) and also at a metropolitan / regional scale, where they form continuous routes for longer distance travel, avoiding a number of activity centres (for example, the freeway network).

*Heavy freight is incorporated into preferred traffic routes; the principal traffic flow network includes all routes identified as part of the metropolitan Principal Freight Network in *Victoria: The Freight State*.

4.1.4 SmartRoads other routes definitions

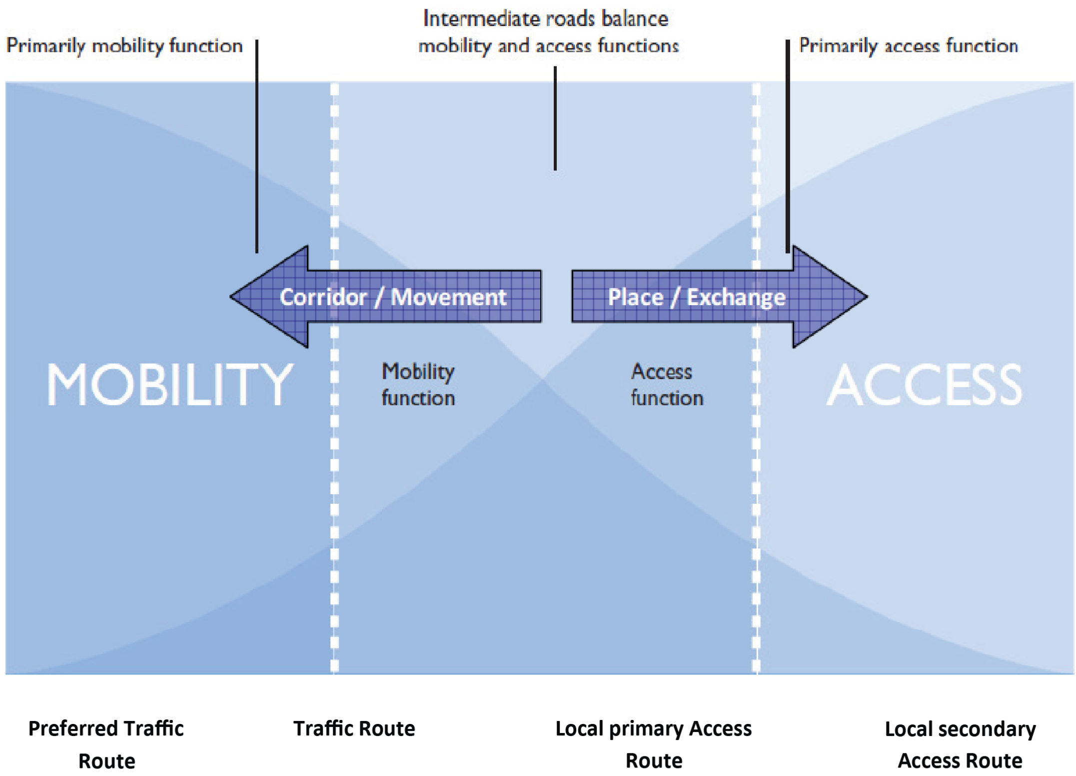
- **Traffic routes** represent the remaining arterial road network that are not designated as Preferred Traffic Routes; therefore, they are the main roads that link activity centres and cater for the mobility needs of people and goods across the metropolitan and regional area.

- **Local primary access routes** provide the main connection between traffic routes and the abutting land use; they may provide circulation routes within the local network and activity centre, therefore; may have a limited mobility function for localised traffic.

- **Secondary access routes** have a greater emphasis on access rather than mobility. These routes provide connections between the local networks and provide access directly to the end destinations.

4.1.5 Access and mobility

There is a particular relationship between mobility for motorised modes and access for all road users, as in general, roads with a strong mobility function and limited access do not enhance place particularly well, while roads with a strong access function may be an important part of the surrounding place but do not provide well for mobility. This relationship is represented on the chart below, with the SmartRoads traffic and access routes shown in their approximate places on the mobility–access continuum.



[2]

4.2 Relative priority

4.2.1 Priority by time of day

The road use hierarchy is the combination of the strategic road use and the relative priorities, which are allocated to each mode in the four key time periods.

Relative priority is allocated as one of five levels of encouragement which change for different periods of the day depending on travel demand and surrounding activity. For example, morning and evening peak periods are the most critical for commuters, whether they are in cars, on trams or buses, or on bicycles, while activity centres often have a higher demand for walking and cycling during the high off peak (10am-3pm) and the afternoon peak (3pm-7pm). Encouragement can also be assigned for peak holiday periods, for weekends or for major events. Changing the encouragement given to modes based on place and time can assist in resolving competing demands for road space.

SmartRoads' four key time periods

AMP morning peak (approx. 6am–10am)

HOP high off-peak (between morning and evening peak, approx. 10am–3pm)

PMP evening peak (approx. 3pm–7pm)

OP off-peak (evening after peak hour, approx. 7pm–6am)

[2] Adopted from network and corridor planning practice note (NSW Roads and Traffic Authority, November 2008)

4.3 Levels of encouragement

Relative priority is represented as a level of encouragement given to each mode. The terms 'priority' and 'encouragement' are therefore often used interchangeably. The level of encouragement given to each mode is represented as an arrow, indicating the extent to which a mode is encouraged based on place and time.

- Strongly encourage movement
- Encourage movement
- No specific encouragement
- Encourage local access only
- Local access only

One of these five levels of encouragement is assigned to each mode depending on the features of the location – for example, an activity centre, a strip shopping centre, or a road included in the principal public transport network.

A good example of this is freight vehicles making deliveries into a larger activity centre. Ideally we would encourage freight vehicles to make deliveries in the high off peak when there is spare capacity on the arterial network. At the same time, we do not want to encourage freight vehicles to drive through the activity centre if it is not its destination. The priority for freight within an activity centre in this scenario would generally show *encourage local access only*.

The levels of encouragement assigned are reflected in the network operating gaps.

4.4 Priority relative to other modes

Where there are multiple priority modes on a route, we need to think about how to resolve the competing demands for priority by each mode. In some cases, the capacity of the arterial road will allow similar priority to be given to more than one mode – for example, many freeways and duplicated arterials can accommodate multiple priority modes. However, in many cases *relative* priority will need to be assigned; that is, each mode will need to be given a level of encouragement in relation to the others. This means addressing questions such as: do buses or trams have greater priority at this location? Do cars or buses have greater priority? In this way, a hierarchy of priority can be developed for each location.

The following general rules have been adopted to determine the relative priorities between transport modes:

- A transport mode on its priority/preferred route or area (e.g. buses on a bus priority route, general traffic on a preferred traffic route), will be **strongly encouraged** at all times, *except*:
    - the mode will be **encouraged** within activity centres at times when there is significant activity surrounding the road, such as retail activity, people accessing leisure or entertainment zones, etc.
    - pedestrian priority is lower at times when there is limited surrounding activity.
- A transport mode not on its priority/preferred route or area will have **no specific encouragement** over other modes, *except:*
    - the mode is **encouraged** on its principal networks (e.g. bicycles on the principal bicycle network, trams and buses on the principal public transport network).
    - Pedestrians are **encouraged** within larger activity centres covering a network of roads.
    - General traffic is given a lower priority on local access routes.
    - General traffic is given a lower priority within activity centres when there are times of significant activity (e.g. high off peak in a strip shopping centre).
    - Freight is given a higher priority on a preferred traffic route.
    - Freight is given higher priority on the principal freight network *outside* the peak periods.

These general rules have been used to detail relative priorities for each transport mode by time and place. These levels are set out in easy-to-read tables with place across the top and time down the side. Activity centres are rated against a scale of place significance as set out in Table 2 below.

Table 2 - Place significance

Place Significance				
1. Very Low	**2. Low**	**3. Moderate**	**4. High**	**5. Very High**
Non-sensitive land-use e.g. Industrial	Residential	Small to medium activity centres (including neighbourhood centres) and strip shopping centres	Larger activity centres & key city destinations	Metropolitan Activity Centres and the Expanded Central City
Outside of Activity Area		In Activity Area		
		Previously referred to as Major Activity Area (MAA) and Strip Shopping Area (SSA)	Previously referred to as Principal Activity Area (PAA)	Previously referred to as Central Activity Area (CAA)

Road Use Hierarchy maps currently identify places on the basis of definitions established prior to the adoption of Plan Melbourne. This will not impact on the operation of SmartRoads, as there is a strong alignment with new place definitions as outlined in Table 2 above.

Buses will be discussed in some detail to illustrate the relationship between the rules and the tables of relative encouragement arrows. The tables for all other modes follow.

4.4.1 Bus priorities

The table below sets out the levels of encouragement for buses.

		Place Significance				
Route	**Time of day**	1. Very Low	2. Low	3. Moderate	4. High	5. Very High
On Bus Priority Route	AMP	Strongly encourage movement	Strongly encourage movement	Strongly encourage movement	Encourage movement	Encourage movement
	HOP	Strongly encourage movement	Strongly encourage movement	Encourage movement	Encourage movement	Encourage movement
	PMP	Strongly encourage movement	Strongly encourage movement	Encourage movement	Encourage movement	Encourage movement
	OP	Strongly encourage movement	Strongly encourage movement	Encourage movement	Encourage movement	Encourage movement
On PPTN[1, a]	All times	Encourage movement	Encourage movement	Encourage movement	Encourage movement	Encourage movement

[a] *Not on Bus Priority Route but on PPTN*

As the above table indicates, buses are always strongly encouraged in the morning peak on bus priority routes, except in larger activity centres (place significance 4 & 5) because of the higher demands from pedestrians (see pedestrian priorities in Section 4.4.3). They are encouraged in activity centres (place significance 3 to 5) at all other times of the day, but strongly encouraged outside of activity centres (place significance 1 & 2), where conflicts with other modes such as cycling and walking are less likely. Where a bus route is on a principal network (PPTN) but not a priority route, buses are encouraged at all times. At all other locations they are given no specific encouragement.

4.4.2 Tram priorities

		Place Significance				
Route	**Time of day**	1. Very Low	2. Low	3. Moderate	4. High	5. Very High
On Tram Priority Route	AMP	Strongly encourage movement	Strongly encourage movement	Strongly encourage movement	Encourage movement	Encourage movement
	HOP	Strongly encourage movement	Strongly encourage movement	Encourage movement	Encourage movement	Encourage movement
	PMP	Strongly encourage movement	Strongly encourage movement	Encourage movement	Encourage movement	Encourage movement
	OP	Strongly encourage movement	Strongly encourage movement	Encourage movement	Encourage movement	Encourage movement

4.4.3 Pedestrian priorities

		Place Significance				
Route	**Time of day**	1. Very Low	2. Low	3. Moderate	4. High	5. Very High
In Pedestrian Priority Areas	AMP	No specific encouragement	No specific encouragement	No specific encouragement	Encourage movement	Strongly encourage movement
	HOP	No specific encouragement	No specific encouragement	Strongly encourage movement	Strongly encourage movement	Strongly encourage movement
	PMP	No specific encouragement	No specific encouragement	Encourage movement	Strongly encourage movement	Strongly encourage movement
	OP	No specific encouragement	No specific encouragement	No specific encouragement	Encourage movement	Encourage movement
On PPN[2, b]	All times	Encourage movement	Encourage movement	Encourage movement	Encourage movement	Encourage movement

[b] *Not in Pedestrian Priority Areas but on PPN or within larger activity centres or Metropolitan Activity Centres*

4.4.4 Bicycle priorities

Route	Time of day	1. Very low	2. Low	3. Moderate	4. High	5. Very High
		Place Significance				
On Bicycle Priority Route	AMP	Strongly encourage movement	Strongly encourage movement	Encourage movement	Encourage movement	Encourage movement
	HOP	Strongly encourage movement	Strongly encourage movement	Encourage movement	Encourage movement	Encourage movement
	PMP	Strongly encourage movement	Strongly encourage movement	Encourage movement	Encourage movement	Encourage movement
	OP	Strongly encourage movement	Strongly encourage movement	Encourage movement	Encourage movement	Encourage movement
On PBN[3, c]	All times	Encourage movement	Encourage movement	Encourage movement	Encourage movement	Encourage movement

[c] *Not on Bicycle Priority Route but on PBN*

4.4.5 General traffic priorities

Route	Time of day	1. Very Low	2. Low	3. Moderate	4. High	5. Very High
		Place Significance				
On Preferred Traffic Route (PTR)[4]	AMP	Strongly encourage movement	Strongly encourage movement	Encourage movement	Encourage movement	Encourage movement
	HOP	Strongly encourage movement	Strongly encourage movement	Encourage movement	Encourage movement	Encourage movement
	PMP	Strongly encourage movement	Strongly encourage movement	Encourage movement	Encourage movement	Encourage movement
	OP	Strongly encourage movement	Strongly encourage movement	Encourage movement	Encourage movement	Encourage movement
On Principal Traffic Flow Network (PTFN)[5, d]	AMP	Encourage movement	Encourage movement	Encourage movement	No specific encouragement	No specific encouragement
	HOP	Encourage movement	Encourage movement	No specific encouragement	No specific encouragement	No specific encouragement
	PMP	Encourage movement	Encourage movement	Encourage movement	No specific encouragement	No specific encouragement
	OP	Encourage movement	Encourage movement	Encourage movement	Encourage movement	Encourage movement
On Traffic Route	AMP	No specific encouragement	No specific encouragement	No specific encouragement	Encourage local access only	Encourage local access only
	HOP	No specific encouragement	No specific encouragement	Encourage local access only	Encourage local access only	Encourage local access only
	PMP	No specific encouragement	No specific encouragement	No specific encouragement	Encourage local access only	Encourage local access only
	OP	No specific encouragement	No specific encouragement	No specific encouragement	No specific encouragement	No specific encouragement
On Local Primary Access[6]	All times	Encourage local access only	Encourage local access only	Encourage local access only	Encourage local access only	Encourage local access only
On Local Secondary Access[7]	All times	Local access only	Local access only	Local access only	Local access only	Local access only

[d] *Not on Preferred Traffic Route but on PTFN*

4.4.6 Freight priorities

Time of day	Route Significance		Place Significance		
	On PFN[9] & PTR[4]	On PFN or PTR	In Activity Centre		Outside Activity Centre
			On PTFN[5]	Not on PTFN[5]	On PTFN[5]
AMP	Strongly encourage movement	Encourage movement	No specific encouragement	Encourage local access only	Encourage movement
HOP	Strongly encourage movement	Strongly encourage movement	No specific encouragement	Encourage local access only	Encourage movement
PMP	Strongly encourage movement	Encourage movement	No specific encouragement	Encourage local access only	Encourage movement
OP	Strongly encourage movement	Strongly encourage movement	Encourage movement	No specific encouragement	Encourage movement

1. Principal Public Transport Network, 2. Principal Pedestrian Network, 3. Principal Bicycle Network, 4. Preferred Traffic Route, 5. Principal Traffic Flow Network, 6. Local Primary Access Route, 7. Local Secondary Access Route, 8. Activity Centre, 9. Principal Freight Network

4.5 Road use hierarchy by mode, by place and by time of day

The road use hierarchy comprises the strategic road use and the relative priorities. It shows where individual modes are encouraged across the network and how much they are encouraged relative to each other. The road use hierarchy maps provide an easy way to find information about the encouragement assigned on any given route, across any given network, or at any given intersection, at a certain time period.

An example of a road use hierarchy map is provided in Figure 10 from the Network Fit Assessment Tool. Note the arrows at the intersection indicating the priority assigned to each mode.

AM Peak

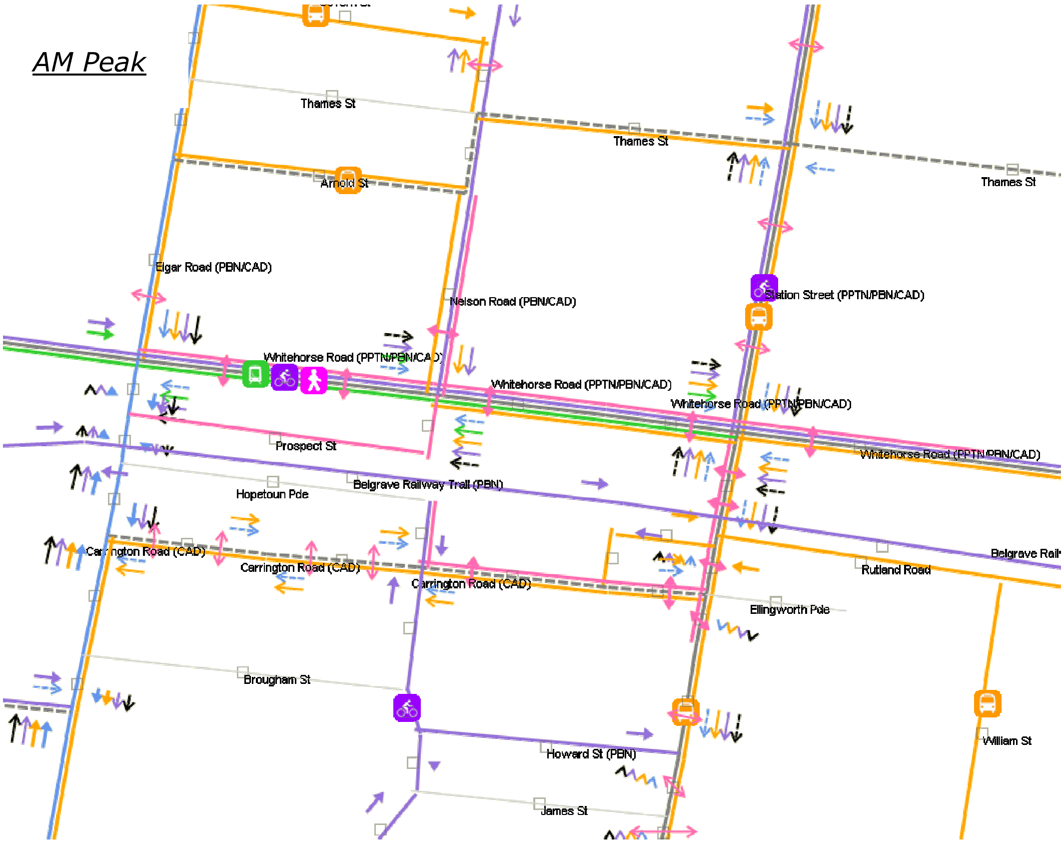


Figure 10 - Example of relative priorities – AM Peak (from Network Fit Assessment Tool)

4.6 Components of the road use hierarchy: links, intersections and approaches

To represent the complicated interactions of a city’s road network, the RUH is formed by two distinctive parts: intersections, and the links between them. In general, intersections are the primary control points for the management of an urban road network. They are the sites where transport links meet and can be controlled (stopped, progressed, slowed etc), as such they become the key decision points on the network. When people reach these decision points on the network what movement are we encouraging? Figure 11 below illustrates two key decision points for general traffic travelling from east to north (vice-versa) through the Geelong CBD – what route do we want to encourage people to use?

Figure 11 - Example of decision points on the network

We use the term link to mean the section of road between two such control points. We also need a way to distinguish the two opposing flows on the link – for example southbound vs northbound. We refer to each of these as a link approach. This enables us to specify different priorities for traffic depending on its context – for example, buses travelling towards an activity centre may be given a different priority to those travelling away from the activity centre. This system provides a simple way of representing the network and the numerous points that affect its operation.

As a further simplification, rather than showing the operating performance (or levels of service) for each mode by link and by intersection, an overall operating performance is provided for the link approach.

As the link approach represents the performance for each mode at a certain time, it makes sense to show the level of encouragement assigned for each mode by time period. Therefore, the link approach represents:

- the direction of travel, and
- the level of encouragement assigned for each mode by time period, both along the link and through the intersection.

In Figure 12 below, Link A is the section of road between Intersections 1 and 2. Link Approach A.1 refers to the lane(s) on Link A travelling towards Intersection 1, while Link Approach A.2 refers to those lane(s) on Link A travelling towards Intersection 2.

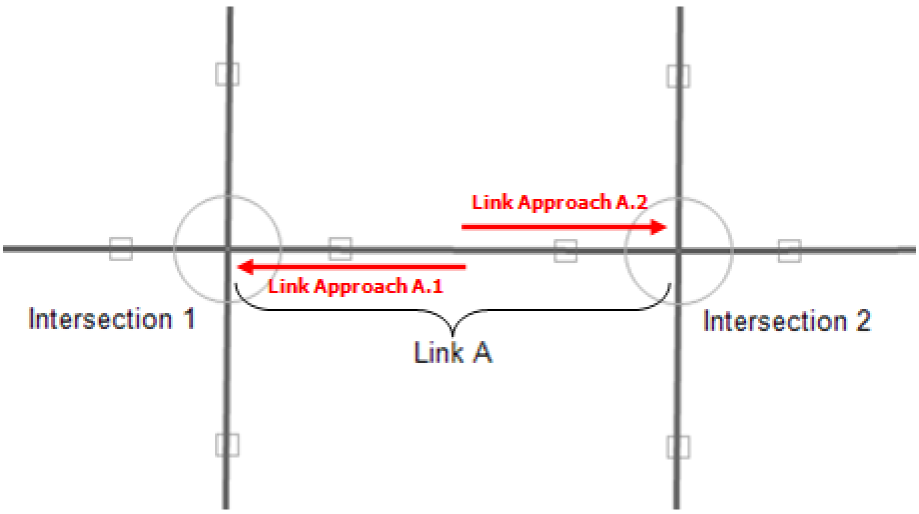


Figure 12 - Link and approach example

Figure 13 below illustrates how the level of encouragement would be shown within the Network Fit Assessment (NFA) Tool:

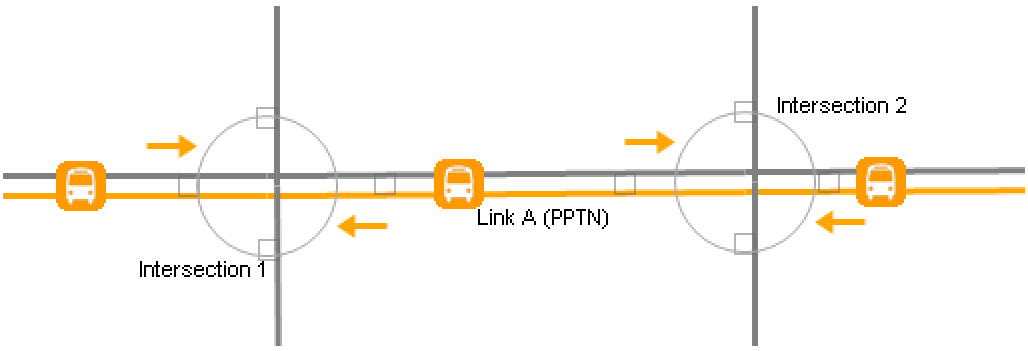


Figure 13 - Show priorities

This relatively simple system does not capture the difference between levels of service for different movements at an intersection, for example, vehicles turning right may have a different level of service to those travelling through. However, a number of site visits undertaken during the development of SmartRoads found that the dominant movement on the approach to an intersection generally dictates the level of service for all vehicles travelling along the link approach. For example, if the dominant movement for general traffic approaching an intersection is the through movement, it is likely that in peak periods the through lanes will block the right-turn lane. Thus any improvement to the through movement will benefit the right-turn movement. For this reason it is considered that representing a level of service for each individual movement would require a lot of work and interpretation without providing significant difference to the end result.

4.7 Mapping the road use hierarchy onto the network

An example road use hierarchy map for Box Hill in the high off peak is shown in Figure 14 below. You can see the encouragement arrows on the link approach to each intersection.

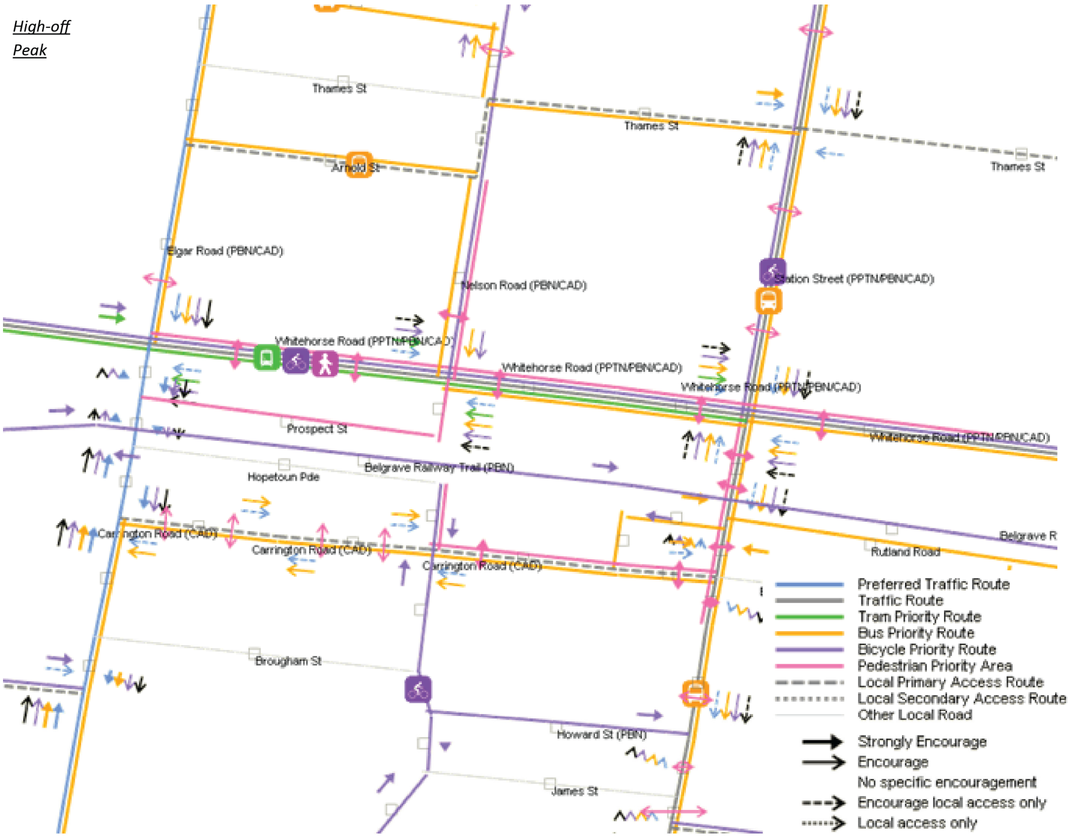


Figure 14 - Example relative priorities for Box Hill (High-off Peak)

As Box Hill is a Metropolitan Activity Centre, the road use hierarchy for the area involves a large number of competing priorities between transport modes. For example, on Whitehorse Road eastbound approach to Nelson Road, we can see that the priorities have been allocated in accordance with the relative priority tables previously provided:

- general traffic is *encourage local access only* as Whitehorse Road is a traffic route (not a preferred traffic route) through a Metropolitan Activity Centre
- freight is *encourage local access only* because this section of Whitehorse Road is not a preferred traffic route and travels through a Metropolitan Activity Centre (recalling that this map is for the high off peak period)
- trams are *encouraged* as Whitehorse Road is a tram priority route through a Metropolitan Activity Centre

- bicycles are *encouraged* as Whitehorse Road is a bicycle priority route through a Metropolitan Activity Centre
- pedestrians are *strongly encouraged* across Whitehorse Road because it is within a Metropolitan Activity Centre in the high off peak period.

Finally, the priority given to general traffic and freight on a link approach is influenced by the link that it feeds into. Where the destination link priority is less than the feeder link priority then the feeder link priority is reduced one level. For example, if the general traffic and freight priorities leading into a link are *encourage local access only*. Using the relative priority tables, we know that the priority for general traffic on a traffic route outside of activity centres is *no specific priority*. However, the destination link priority is *encourage local access only*, so the resulting priority for the link approaches leading into link A would be one level lower than *no specific priority*, i.e. *encourage local access only*.

4.8 Case study: Burke Road, Camberwell Junction

Larger activity centres such as Camberwell Junction, with shops, services and cafes on both sides of Burke Road, present a particular challenge because there are usually major conflicts between all modes and with the liveability of the area.

To resolve these conflicts, the SmartRoads goals are applied to:

- encourage through traffic to use routes other than Burke Road
- ensure good public transport services to the area
- encourage good bicycle access to the area
- encourage walking to and from the area
- facilitate good pedestrian access and mobility within the area

- encourage the use of designated local access routes to better manage the interface between the local and arterial roads to serve the access needs of the activity centre.

The map below (Figure 15) shows how these concepts have been implemented in the strategic road use for Camberwell Junction.

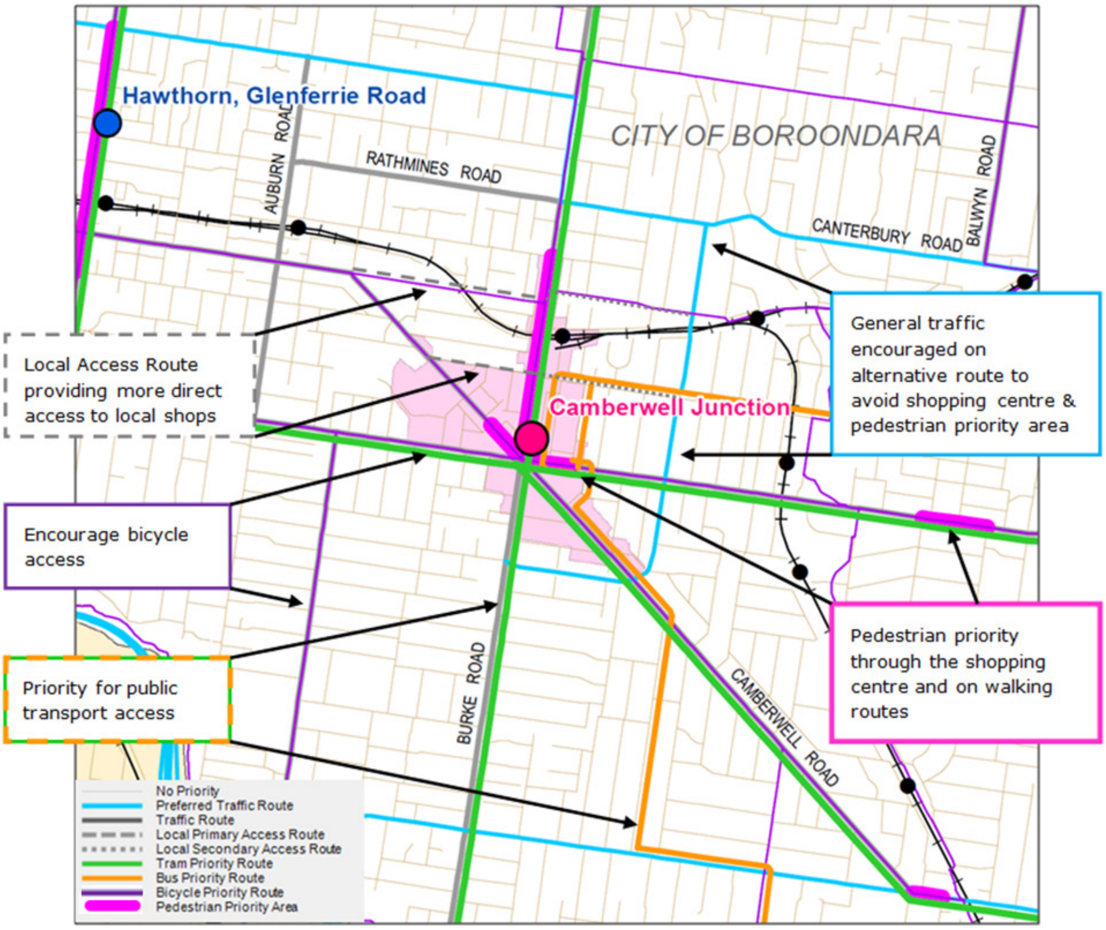


Figure 15 - Case study Camberwell

5 MEASURING NETWORK PERFORMANCE

5.1 Measuring against the plan

The road use hierarchy is a strategic plan that has been developed collaboratively and provides a shared vision for how the road network needs to be managed, in order to deliver on the agreed strategic objectives. When it comes to network operations, it is essential to measure the performance of each mode against this strategic plan: '*if we don't measure it, we can't manage it*'. By providing a method to do this, SmartRoads is simultaneously strategic and operational.

This not only allows a better understanding of how the network is performing, but also provides an insight into the size of the gap between how each mode operates now and how it needs to operate in the future. The features inherent in the SmartRoads framework – such as the future transport perspective and support for activity centres - allow us to be more objective when assessing proposed changes to the transport network.

It's often possible to see how well a road is working by looking at the traffic congestion, measured perhaps by how many traffic signal cycles it takes for a car or truck to get through an intersection. But we need a different way of measuring how well a road is operating for buses, trams, pedestrians and for cyclists, for whom intersection delay may not be as significant as features such as the reliability of the bus/tram service for commuters, frequent safe crossing opportunities for walkers or a separated path for cyclists. To compare how well a road is working for all modes, and make trade-offs between them, SmartRoads uses the concept of 'level of service' to assess the operation of the road network.

To ensure that level of service data can be easily interpreted for decision-making, it is incorporated into an operating gap. The SmartRoads operating gap factors in all of the elements of SmartRoads and presents them as a simple scale that can be used to identify network issues and to test solutions. The operating gap can be used to identify opportunities to make improvements across several modes at the same location. It can also be used to compare the relative needs of each road user group and to target locations or areas with the greatest overall operational need.

The use of this method of analysis enables us to quantify the qualitative experience of travel, and this enables us to measure the actual performance of a road against the preferred performance. It also provides a basis for a quantitative analysis of the impact of proposed road improvements on all modes of transport.

5.2 Operating gap

The level of service (LOS) is the basis of the operating gap, which enables us to capture the complexity of the issues on the network and test possible solutions. This is done through the use of the Network Fit Assessment Tool (the NFA Tool) which can be used to convert raw data into a more sophisticated assessment of the network. To reflect the SmartRoads objectives in the operating gap a mode's current LOS is factored by: the level of encouragement given (relative priority); how many people/ goods are transported (relative efficiency); and the planned mode shift (mode shift factor).

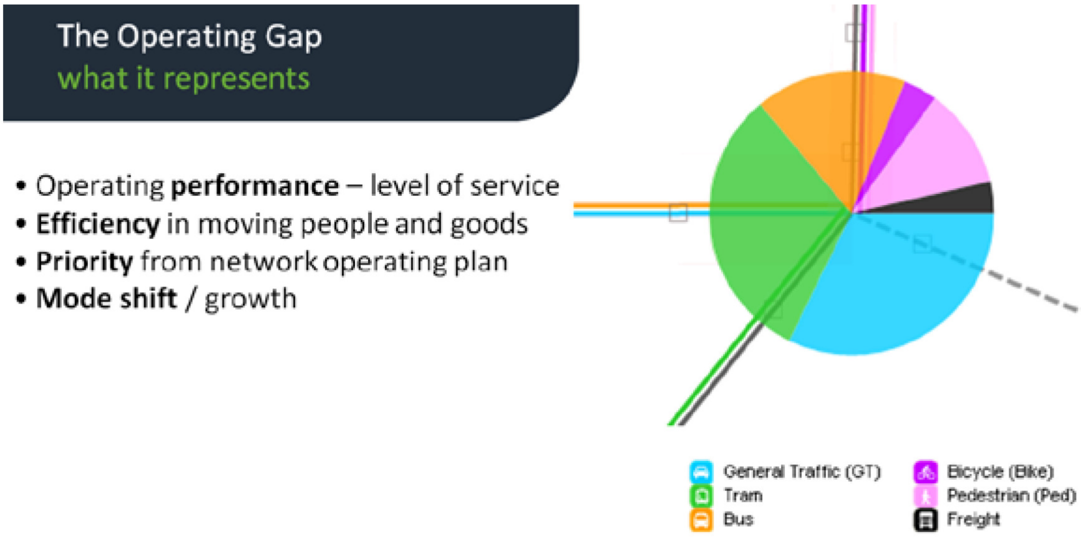


Figure 16 - The operating gap

The NFA Tool graphically represents operating gaps as pie charts on a map of the network – either for each link approach or combined for each intersection (sum of operating gaps for each approach). The pies convey the following key pieces of information:

- the size of the pie represents the size of the operating gap i.e. the smaller the pie, the better the operation,
- while the portion size of the pie illustrates how much of the gap is made up of the deficiency in the particular mode, for example: the operating gap above shows that deficiencies in Public Transport (tram/bus) operations make up half of the issues at this location,
- from an overall network perspective many operating gaps illustrate where on the network there are the worst performance deficiencies are and how these deficiencies might vary across time of day.

When using the network fit assessment tool it automatically applies the three factors to the existing level of service to calculate the operating gap. Each of these components of the operating gap is explained in detail in the following sections.

It is noted that the NFA Tool does show another factor called Period Weighting, however this is not currently in use pending further research.

5.2.1 Operating gap example

The map (Figure 17) below has been extracted from the NFA Tool for the morning peak period in the Box Hill Metropolitan Activity Centre. The largest operating gap on the network in this area is the Station Street and Whitehorse Road intersection (inside red dotted circle). Looking at how the gap is made up, we can see that the issues at this intersection are centred around pedestrian (pink) and bus (orange) deficiencies. The operational issues for other modes are also shown: general traffic (blue); trams (green); bicycles (purple); and freight (black). You can see that the portions of the gap in these colours are considerably smaller, reflecting the fact that the issues for these modes are less significant. Of interest the NFA

Tool can show the gaps either as a summed total of all the approaches for the intersection (as shown) or by individual approach – in this example there would be an operating gap for each of the four legs to the Station St and Whitehorse Rd intersection.

Figure 17 - Operating gap example (Box Hill)- AM Peak

5.3 Level of service

In the past, measurement of road performance has generally focussed on motor vehicle traffic speed and delay. As outlined in Section 3, the *Transport Integration Act* requires a much broader set of criteria to be applied to the road network, including consideration of all transport modes, mobility, access and environmental factors.

While LOS is most commonly used to analyse highways by categorising traffic flow with corresponding driving conditions, over recent years, there has been a steady increase in the application of LOS to other transport elements such as public transport, walking and cycling[3]. LOS can refer to the speed, reliability, convenience, comfort and security of transportation facilities and services as experienced by the users.

Though SmartRoads adopts the level of service concept in measuring performance of the network, the criteria used by SmartRoads are unique in that they focus on the user of each mode rather than the application of technical

[3] The Transportation Research Board in the US and the Victoria Transport Policy Institute in Canada have both produced significant pieces of work that have advanced the idea of applying a multi-modal level of service concept. Austroads has also commenced a project looking at LOS across the various transport modes.

operational algorithms. The broad approach to defining SmartRoads levels of service is set out in Table 3 below.

Table 3 - Defining level of service

Level of Service	Definition
A	Best operating conditions
B	Good operating conditions
C	Fair operating conditions
D	Poor operating conditions
E	Unsatisfactory operating conditions
F	Worst possible operating conditions

5.4 Defining LOS by mode

Definitions for LOS have been further developed for each transport mode based on the operating objectives for that mode (see Table 4 below).

Table 4 - Defining LOS by mode

Transport type	Approach to LOS Definition
Pedestrians	• Use crossing opportunities and wait time
Bicycles	• Use separation and visibility
Trams & buses	• Use travel speed and variability in tram speed (excluding boarding times) and/or • Use delays and variability in delays (excluding boarding times)
General traffic & freight	• Use travel speed and variability in travel speed and/or • Use delays and variability in delays

Table 5 summarises the SmartRoads definitions for each mode's level of service, the detailed description of level of service for each mode, including travel speeds associated with each level, are provided in Section 10.

Table 5 - LOS descriptions

reducing performance

Level of Service				
A	No delay. No variability.	Opportunities to cross align with key desire lines. No wait times.	Dedicated minimum 3.0m off road path, grade separated.	No delay. No variability.
B	Operating speed between 60 –80% of the posted speed limit.	Opportunities to cross close to key desire lines. Small to moderate wait times.	Dedicated minimum 2.0m kerb side lane, separated by parking and/or hard separator.	Operating speed between 60 –80% of the posted speed limit.
C	Operating speed between 40 – 60% of the posted speed limit.	Opportunities to cross within reasonable distance of key desire lines. Moderate wait times.	Dedicated 1.7m to 2.0m bicycle lane marked on the carriageway.	Operating speed between 40 – 60% of the posted speed limit.
D	Operating speed between 20 – 40% of the posted speed limit.	Opportunities to cross not close to key desire lines. Moderate to long wait times.	Kerbside bicycle lane, 1.2m to 1.5m.	Operating speed between 20 – 40% of the posted speed limit.
E	Operating speed between 10 – 20% of the posted speed limit.	Opportunities to cross are an unreasonable distance from key desire lines. Long wait times.	Kerbside 1m bicycle lane or Bus Lane.	Operating speed between 10 – 20% of the posted speed limit.
F	Operating speed is less than 10% of the posted speed limit.	No opportunities to cross. Excessive wait times.	Wide kerbside lane marking or nothing. Shared lane with traffic.	Operating speed less than 10% of the posted speed limit.

5.5 Measuring level of service

The SmartRoads LOS criteria provides high-level descriptions. This allows a range of data sources to be used to measure LOS, from simple visual observations through to more precise measurements of travel time or delay. It is therefore possible to start with any available data, and add to it when more precise data becomes available. SmartRoads is flexible in the type of data that can be used to measure level of service and can accommodate and meaningfully compare different kinds of data at different locations. A finer grain LOS is presented in Section 10.

5.6 Quantifying level of service

Adopting LOS A as the ideal operating state (i.e. there is no deficiency), a VicRoads/Denmark St (Kew) numerical value can be assigned to each LOS as shown in Table 6.

As the difference between levels of service is considerable, a finer-grained structure is adopted to capture any smaller benefits or disbenefits that may occur to the modes (Table 7).

LOS	Value
A	0
B	1
C	2
D	3
E	4
F	5

Table 6 - Quantifying LOS (simple)

LOS	Value
A	0
A-	0.33
B+	0.67
B	1
B-	1.33
C+	1.67
C	2
C-	2.33
D+	2.67
D	3
D-	3.33
E+	3.67
E	4
E-	4.33
F+	4.67
F	5

Table 7 - Quantifying LOS (finer grain)

To reiterate, the NFA Tool uses the numerical value for LOS and factors it by the relative **efficiency** factor, the relative **priority** factor, and the **mode shift** factor, to generate network operating gaps, which are used in the network fit assessment process.

5.7 Relative efficiency factor (REF)

When assessing how well a given road or intersection works for each mode of transport, it is important to take into account the difference in the number of people and goods being moved by each mode, the economic value of delay to each person or unit of goods carried. By quantifying this at the site under consideration, the relative efficiency of each mode can be considered as part of the operating gap. This is termed the **relative efficiency factor.** For the REF to be relative it needs to relate to a base case.

The efficiency of the mode is calculated as the number of vehicles multiplied by the number of occupants (to give the person throughput). This is then multiplied by the time value for that mode (based on the Austroads delay cost[4]). This is then related to a base case. SmartRoads adopts a time value of $40,000 as the base for calculating the REF for each mode. The base case was developed using the maximum typical volume for a freeway traffic lane of 2,000 vehicles per hour, see Section 5.7.1 below for further explanation of how the base case is calculated.

The REF is calculated in this way for any mode, and then compared to the base case value of $40,000 – see Section 5.7.2 *'Calculating the relative efficiency factor'*. It is important to recognise that the attributes used in the base case calculation are not important; the base case is only needed to create a point of reference (i.e. REF = 1.0) in which to measure the difference of each mode's REF to the base case and then comparing each mode's difference, this includes general traffic.

The inclusion of the Austroads value is important because it brings the relative economic value of each user class into the efficiency calculation. The standard value for commuters is $13.50 per hour. This value is given to trams, buses, pedestrians and bicycles. The value for cars is slightly higher to account for the proportion of vehicles under 3 tonnes used for commercial purposes such as courier vehicles, delivery vans etc (as opposed to cars used just for commuting to work). Freight vehicles have a higher economic value $40.50 to account for the value goods being carried. To summarise:

- General traffic time value per person: $16.60
- All other 'people-moving' modes time value per person: $13.50
- Freight time value per vehicle: $40.50.

5.7.1 REF base case

The base case is calculated by multiplying 1.2 occupants per vehicle (Melbourne average) by 2,000 vehicles equalling 2,400 people. We multiply this by the Austroads value for this user class which is $16.60, giving an efficiency value of $40,000. The time value of $40,000 is then equated to a factor of 1 to become the base case against which all modes, including general traffic, will be measured. This is illustrated below.

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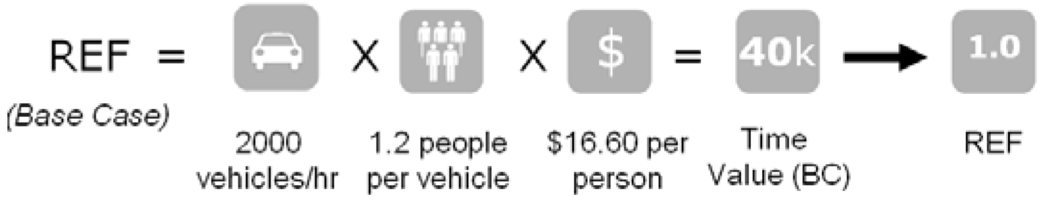
[4] The time values are taken from the *Austroads Guide to project Evaluation Part 4: Project Evaluation Data* (Austroads 2010).



5.7.2 Calculating the relative efficiency factor (REF)

The following two examples show how the REF for each mode is calculated against the base case. In both examples we are focussing on the same approach to an intersection.

Example 1: tram

- 20 trams per hour
- 100 passengers per tram[5]
- Time value per tram passenger: $13.50

The REF for the tram on this approach is 0.68.

Example 2: general traffic

- 800 vehicles per hour
- 1.2 people per vehicle
- Time value per general traffic passenger: $16.60

The REF for general traffic is 0.39.

We can see that while the efficiency of the trams is less than the base case (1.0), it is greater than the efficiency of a lane of cars on an arterial road, which matches our expectation as the person throughput is greater on trams.

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[5] SmartRoads assumes the following occupancy rates for each mode — general traffic: 1.2 people per vehicle; trams: 100 people per vehicle; buses: 50 people per vehicle; bicycles: 1 person per bicycle; freight: 1 person per vehicle. Different values can be specified in the tool if required for specific purposes.

5.8 Mode shift factor (MSF)

SmartRoads is a key part of Victoria's strategic planning for how we need the transport network to operate in the future. To meet the challenges of limited capacity on the network and increasing levels of congestion, there will need to be a shift towards more sustainable and efficient transport modes. The road use hierarchy gives increased priority to these modes and assumes that this will influence future mode share. For this reason, the operating gap calculation includes an assumption that the number of people travelling via sustainable modes will continue to grow faster than those in general traffic.

To determine an appropriate mode shift factor, historical data and transport forecasts for Melbourne have been reviewed. Over the past 5-10 years in inner Melbourne, growth rates for transport modes other than private cars have been around 5-6% per year. Private cars have actually decreased slightly. To reflect this, a growth rate of 5% per year over 10 years has been built in to the operating gap for the person throughput of all modes other than general traffic. (This is a factor of 1.6.) This provides a balance between guiding the network to how we need it to operate on the one hand, and the political and economic realities of transport and land-use development on the other.

We also know that the freight task is forecasted to double over the next 20 years. To balance the needs of both the growing freight task and the growing demand for public transport, walking and cycling, the same mode shift factor is applied to all of these modes.

5.9 Period weighting factor

In calculating the operating gap for each of the four key time periods, it is recognised that not all time periods are the same length or have the same strategic value, therefore the operating gap for each time period may need to be factored to account for this. Additional research will need to be done in the future to determine possible weightings for each period, but at this stage the weightings for each period are assumed to be equal and are set to a value of 1.

5.10 Relative priority factor (RPF)

Relative priorities are represented by the level of encouragement given:

Strongly encourage movement

Encourage movement

No specific encouragement

Encourage local access only

Local access only

To ensure that the relative priorities are captured in the operating gap, it includes a relative priority factor (RPF). The RPF converts the priority given to each mode, represented by arrows, to a numerical value (Table 8).

	Relative Priority (RP)	RPF
	Strongly encourage	**2**
	Encourage	**1.5**
	No specific encouragement	**1**
	Encourage local access only	**0.5**
	Local access only	**0.33**

Table 8 - Quantifying RPF

The NFA Tool automatically applies the relative priority factor but an explanation of the basis for the numerical values is provided below.

5.10.1 Relative priority factor technical background

These values will continue to be tested with road users and the community, and may alter over time or based on government policy objectives. Over the last 2 years, these RPFs have been used to evaluate trade-offs between road users in over 350 project proposals across the Melbourne Metropolitan area, and have proven to result in decisions that have generally been accepted by stakeholders as a fair balancing of priorities on the road network.

In planning for how the network needs to operate in the future, it is not desirable or realistic to plan for all modes to operate at a level of service A regardless of land use and at all time periods. For example, in a pedestrian priority area within an activity centre, it would be inappropriate to plan for a level of service of A for both general traffic (free flow conditions) and pedestrians (many crossing opportunities). Not only are the two modes in conflict with each other, but the resulting conditions would not be conducive to the broader placemaking objectives of the activity centre. The assignment of relative priority balances the competing needs of transport modes by both place and time of day.

The relative priority factor (RPF) assigns a numerical factor based on the level of encouragement given to each mode. The term 'relative priority' captures the fact that the priority given to a particular mode is in relation to the priority assigned to other modes using the road. For example, if trams are 'strongly encouraged' and general traffic is 'encouraged' along a road, we know that trams are encouraged more than cars during that time of day.

The NFA Tool carries out four basic steps to determine the relative priority factor to be applied to the operating gap:

1. Find the relative LOS for the mode on the road use hierarchy.
2. Quantify the relative LOS.
3. Set a baseline for comparison of the LOS value.
4. Calculate the relative priority factor.

Step 1: Find the relative LOS for the mode on the road use hierarchy

Relative level of service refers to the level of service that corresponds to the encouragement assigned to the mode (by the road use hierarchy).

The level of encouragement given to each mode is based on that mode's **relative priority.** We can draw a correlation between these relative priorities and the SmartRoads level of service definitions to give **relative LOS**. This enables the relative priorities to be quantified in a way that is consistent with the objectives of the road use hierarchy.

In general, a level of service A can be adopted as the best outcome when we are strongly encouraging a movement, D when we want to encourage local access only and a level of service E as an unacceptable outcome. The correlation between the relative priority and LOS is shown below.

Relative Priority (RP)	Relative LOS
Strongly encourage	**A**
Encourage	**B**
No specific encouragement	**C**
Encourage local access only	**D**
Local access only	**D-**
No priority	**E**

Step 2: Quantify the relative LOS

Using the same methodology that is used to assign values to the level of service for each mode, the tool can simply use the same values for the relative LOS:

Relative Priority (RP)	Relative LOS	LOS values
Strongly encourage	A	**0**
Encourage	B	**1**
No specific encouragement	C	**2**
Encourage local access only	D	**3**
Local access only	D-	**3.33**
No priority	E	**4**

Step 3: Determine a baseline for comparison of the LOS value

The natural baseline for the relative priorities is 'no specific encouragement'. However, a baseline for calculating the RPF needs to equal 1. To make the relative LOS value for C equal 1, the tool divides the LOS values by 2. It then divides all the LOS values by 2, to ensure they remain consistent.

Relative Priority (RP)	Relative LOS	LOS values	Baseline Values (÷2)
Strongly encourage	A	0	**0**
Encourage	B	1	**0.5**
No specific encouragement	C	2	**1**
Encourage local access only	D	3	**1.5**
Local access only	D-	3.33	**1.67**
No priority	E	4	**2**

Step 4: Calculate the relative priority factor

To establish a RPF that weights the value in favour of greater priority, the baseline values need to be 'reversed' so that a relative LOS of A gives the highest RPF. To achieve this, the baseline value for 'no priority' is deemed to have an RPF of 0 and the remaining new baseline values are calculated as the difference between the baseline value for 'no priority' and the baseline value for each of the other priorities.

The table below shows the RPFs for each relative priority – see example under table for practical application.

Relative Priority (RP)	Relative LOS	LOS values	Baseline Values (÷2)	RPF
Strongly encourage	A	0	0	**2**
Encourage	B	1	0.5	**1.5**
No specific encouragement	C	2	1	**1**
Encourage local access only	D	3	1.5	**0.5**
Local access only	D-	3.33	1.67	**.33**
No priority	E	4	2	**0**

For example:

Bus Priority Route, morning peak (AMP), outside an activity centre (place significance 2).

		Place Significance				
Route	**Time of day**	1. Very Low	2. Low	3. Moderate	4. High	5. Very High
On Bus Priority Route	AMP	Strongly encourage movement	Strongly encourage movement	Strongly encourage movement	Encourage movement	Encourage movement
	HOP	Strongly encourage movement	Strongly encourage movement	Encourage movement	Encourage movement	Encourage movement
	PMP	Strongly encourage movement	Strongly encourage movement	Encourage movement	Encourage movement	Encourage movement
	OP	Strongly encourage movement	Strongly encourage movement	Encourage movement	Encourage movement	Encourage movement
On PPTN[1, a]	All times	Encourage movement	Encourage movement	Encourage movement	Encourage movement	Encourage movement

[1]*Principal Public Transport Network*

[a] *Not on Bus Priority Route but on PPTN*

Bus services along this particular road are strongly encouraged, so:

- the relative level of service would be LOS A (LOS value = 0)
- the LOS value converted to the baseline value would be 0 (0/2=0)
- to get the relative priority factor (RPF) the difference between the no priority LOS baseline value (LOS E = 2) and the relative LOS baseline value (LOS A = 0) is calculated: 2 – 0 = 2, therefore
- the RPF applied to bus services along this road is 2.

5.11 Considering relative LOS in operating gap

To ensure our attention is focused on the most needy parts of network, a relative LOS factor is used. The table below sets out the relative LOS factor values, which are found simply by looking up the value corresponding to the relative LOS and the current LOS. These values are the result of the relationship between the current LOS and the relative LOS being calculated differently to reflect whether the current LOS is **better than, equal to** or **worse than** the relative LOS.

			Current LOS						
LOS			A	B	C	D	D-	E	F
Relative LOS	RPF	LOS Value	0	1	2	3	3.33	4	5
A	2	0	*0*	*3.0*	*5.0*	*7.0*	*7.7*	*9.0*	*11.0*
B	1.5	1	*0*	*1*	*2.5*	*4.0*	*4.5*	*5.5*	*7.0*
C	1	2	*0*	*0.5*	*1*	*2.0*	*2.33*	*3.0*	*4.0*
D	0.5	3	*0*	*0.33*	*0.67*	*1*	*1.17*	*1.5*	*2.0*
D-	0.33	3.33	*0*	*0.3*	*0.6*	*0.9*	*1*	*1.22*	*1.55*

The following four principles have been set to reflect the relationship. To include these principles in the operating gap calculation a function argument is applied.

- If current LOS = A, then the function should return a value of 0, i.e. there is no gap in the mode's level of service.
- If current LOS = relative LOS then the function should return a value of 1.
- The function should give greater weighting when current LOS is worse than relative LOS.
- The function should give less weighting when current LOS is better than relative LOS.

The following three functions can be applied dependant on whether the current LOS is **better, equal** or **worse** than the relative LOS:

- If the current LOS is **better** than the relative LOS then**:**

$$LOS_{current} / LOS_{relative}$$

- If current LOS is **worse** than the relative LOS then:

$$1 + (LOS_{current} - LOS_{relative}) \times RPF$$

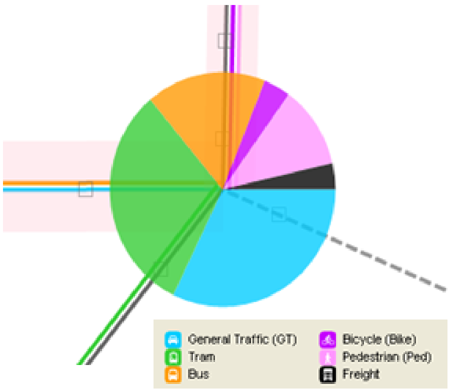
- If the current LOS is **equal** to the relative LOS then 1 is returned**:**

as either of the calculations performed will both equal 1

5.12 How the tool performs the operating gap calculation

As discussed, the basic components that make up the operating gap (OG) calculation for each location are:

- the mode's level of service (LOS)
- the priority assigned by the road use hierarchy (RPF) - considering relative LOS
- the efficiency of the mode in transporting people and goods (REF)
- the period weighting (PW)
- accounting for mode shift towards more sustainable transport modes and the growth in Victoria's freight task (MSF).

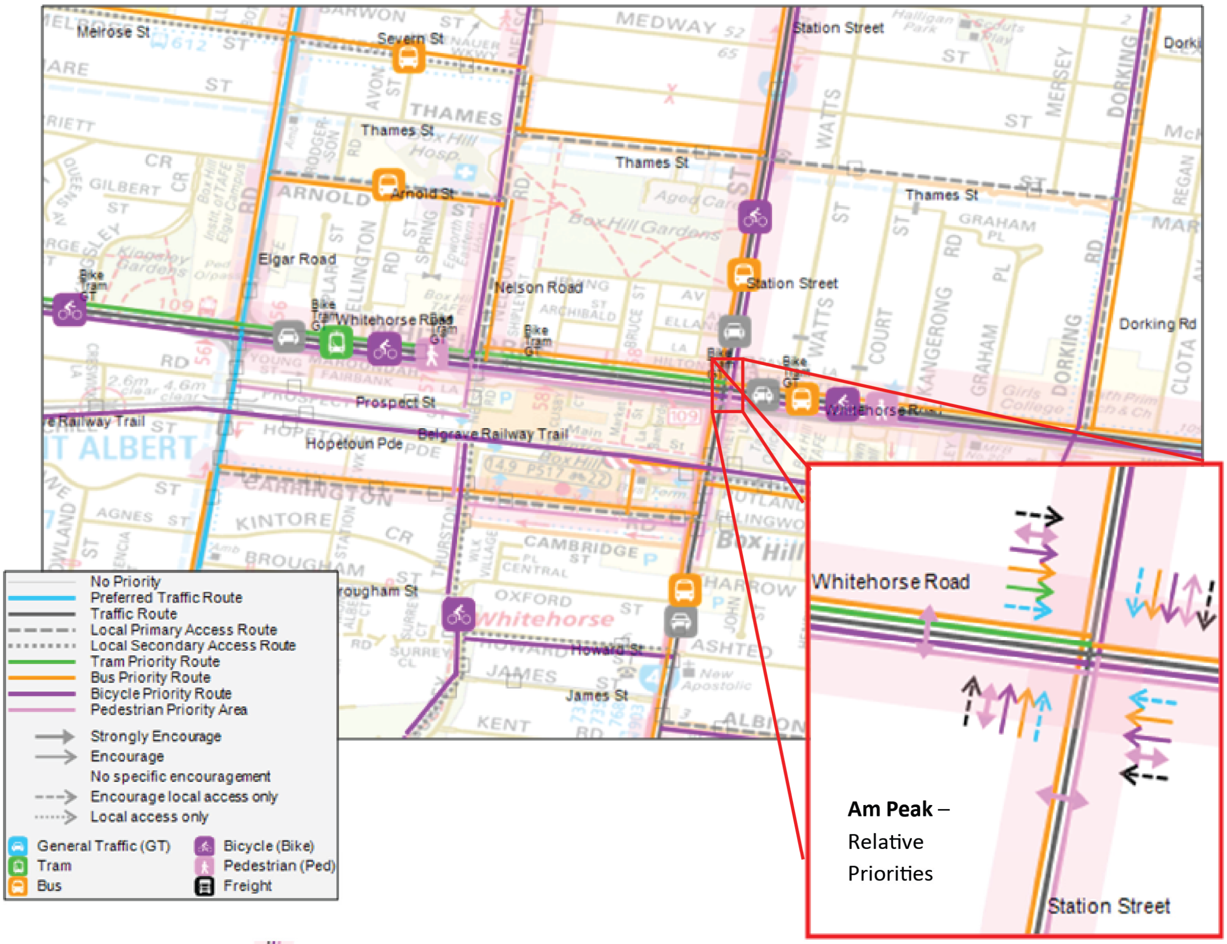


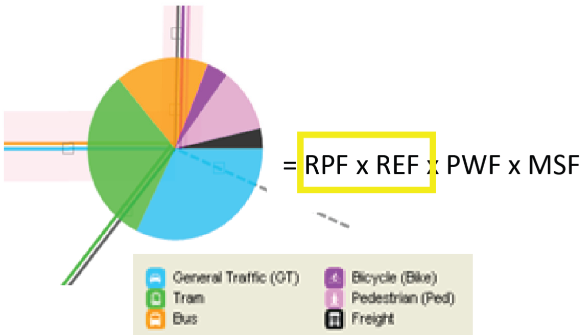
$$OG = RPF \times REF \times PW \times MSF$$

5.12.1 Example – calculating the operating gap

Box Hill Metropolitan Activity Centre– Station Street and Whitehorse Road in the morning peak, south approach.

The map below shows the priority road use for the network surrounding Box Hill Metropolitan Activity Centre. The AM peak relative priorities for the intersection of Station Street and Whitehorse Road are shown in the red box (bottom right). The relative priorities show that pedestrians are strongly encouraged (except on the east approach where they are encouraged), buses and bicycles are encouraged, and general traffic and freight are only encouraged for local access –these modes are encouraged to use either Elgar Road to the west or Middleborough Road (not shown) to the east.





Determine current LOS

After undertaking a site observation for the south approach a current LOS and volume was recorded for each mode:

- buses were LOS B and existing volumes are 35 buses per hour
- pedestrians were LOS E and existing volumes are 300 pedestrians per hour
- bicycles were LOS A and existing volumes are 100 bicycles an hour.
- general traffic was LOS C and existing volumes are 650 vehicles per hour (through movement).

Using the table below each current LOS is quantified.

Current LOS	LOS values
A	0
B	1
C	2
D	3
D-	3.33
E	4

What is the Relative LOS

The AM peak relative priorities for each mode (Station Street, south approach) are shown below:

Strongly encourage

Encourage

Encourage

Encourage local access only

The table below shows the relative priorities, the corresponding relative LOS, values and relative priority factor (RPF) that would be applied by the NFA Tool.

Relative Priority (RP)	Relative LOS	LOS value	RPF
Strongly encourage	A	0	2
Encourage	B	1	1.5
No specific encouragement	C	2	1
Encourage local access only	D	3	0.5
Local access only	D-	3.33	0.33
No priority	E	4	

Considering Relative LOS

While the LOS for each mode can be easily found in the look-up table once the relative and current LOS have been identified, the full mathematical calculation used to derive each one is shown below for those who are interested.

The current LOS is **worse than** the relative LOS, therefore:

$1 + (LOS_{current} - LOS_{relative}) \times RPF$ $\quad$ $1 + (4-0) \times 2 = \mathbf{9}$

The current LOS is **equal to** relative LOS, therefore:

either $LOS_{current} / LOS_{relative}$ or $1 + (LOS_{current} - LOS_{relative}) \times RPF$

$1/1 = \mathbf{1}$ or $1+(1-1)\times1.5 = \mathbf{1}$

The current LOS is **better than** the relative LOS, therefore:

$LOS_{current} / LOS_{relative}$

$0/1 = \mathbf{0}$

The current LOS is **better than** the relative LOS, therefore:

$LOS_{current} / LOS_{relative}$

$2/3 = \mathbf{0.67}$

Relative efficiency factor (REF)

REF = 300 pedestrians x $13.50 = $4050/$40k = **0.10**

REF = 35 buses x 50 persons per bus x $13.50 = $23625/40k = **0.59**

REF = 100 cyclists x $13.50 = $1350/40k = **0.03**

REF = 650 cars x 1.2 persons per car x $16.60 = $12948/40k = **0.32**

Period weighting factor (PWF)

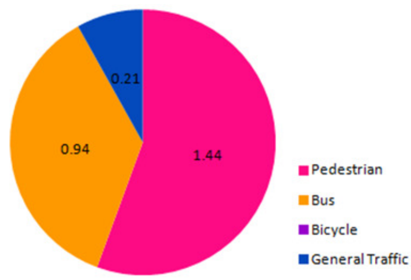
Until further research is undertaken with regards to the PWF, 1 will be applied to all equations.

Mode shift factor (MSF)

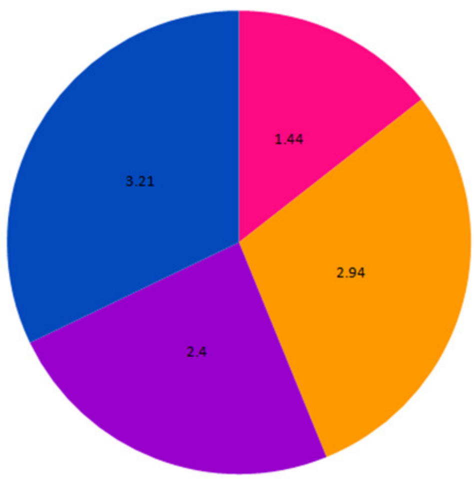
A mode shift factor of **1.6** is applied to all modes other than general traffic to account for growth of 5% over 10 years.

Mode	RPF x	REF x	PW x	MSF =	OG
Pedestrians	9	0.1	1	1.6	**1.44**
Buses	1	0.59	1	1.6	**0.94**
Bicycles	0	0.03	1	1.6	**0**
General traffic	0.67	0.32	1	1	**0.21**

Resultant operating gap from calculation above



The operating gap for a different intersection in Box Hill



In looking at the two operating gaps above you can see that the bottom gap is approximately 3 times the size of the top gap. While the first gap is less of an overall issue from a whole network perspective, there are still pedestrian and bus issues at this location that can be addressed. The second gap is a greater issue from a network perspective, however it requires a more detailed response due to the contribution made by each of the four modes. In identifying a solution, the impact on all modes will need to be considered. For example, if improvements are made to bicycle facilities, will that have a detrimental effect on moving people by other modes?

Summary

The operating gap can be used in a number of ways - to better inform our decision-making; to identify problems; to evaluate potential solutions; and to track trends. It enables us to identify those modes, time periods and locations where there are the greatest gaps in operating performance. It also enables us to compare the estimated operational changes resulting from potential solutions with the current operation. At the highest level, the operating gap is able to represent the operation of the whole of Melbourne and how it is changing annually. At the lowest level, it is used to assess the post-implementation performance of an individual project.

6 NETWORK STRATEGIES

6.1 Introduction

The road use hierarchy indicates the level of encouragement we are aiming to give each mode, by place and by time of day. To provide guidance on how these encouragement levels should be implemented, network strategies are devised. They form the final layer in guiding the development and content of the network operating plan and network improvement plan. At the time of writing, they are still in development and have not yet been recorded for most of metropolitan Melbourne. However, it is anticipated that they will be formulated in future road use hierarchy development workshops.

Network strategies are essentially parameters providing guidance to engineers and planners in developing operational and infrastructure solutions. They do not specify particular solutions. This allows transport and planning professionals to be creative, innovative and responsive in developing ideas and solutions for an ever evolving city. It also recognises that existing resources such as Austroads and various traffic engineering manuals will continue to play a significant role in assisting in identifying the best solutions.

Because network strategies indicate how the network needs to operate, rather than outlining detailed treatments, there is scope for different options to be identified to achieve the agreed objectives for the network. It is accepted that there is no single or simple solution to congestion and in fact certain levels congestion can be tolerated depending on the place and time of day. Network strategies are basically aiming to:

- prevent congestion from occurring;
- manage congestion if it does occur; or the last step
- provide infrastructure improvements to address it.

Such strategies can encourage the travel behaviours we need through a number of 'stick and carrot' measures. For example: a certain level of congestion could be tolerated on a Traffic Route while measures are installed on a Preferred Traffic Route to reduce congestion.

The application of network strategies is part of a paradigm shift away from rule-based decision-making to principle-based decision-making, which is in line with the *Transport Integration Act*.

When discussing strategies in a workshop as part of the road use hierarchy development two important questions need to considered:

- What are we trying to achieve for each mode? - *as depicted in the road use hierarchy*
- How are we going to go about implementing it? – *the network strategies we are going to utilise*

Using the workshop format allows stakeholders from various backgrounds to be involved in decisions about solutions on the network. This in turn provides for a more objective process at a future time when implementing specific solutions, because the discussion can always be taken back to ensuring we are delivering within the agreed parameters for operating the network.

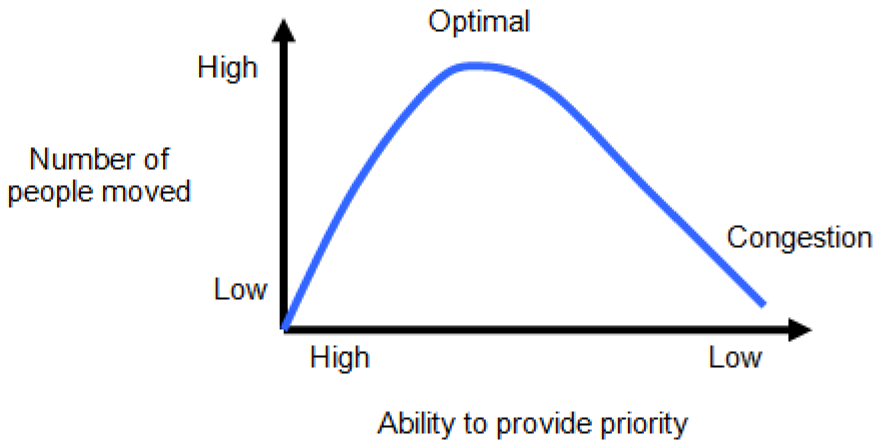
6.2 Determining sub-networks

In general, we can assume that the road use hierarchy and operating gaps are available for all of metropolitan Melbourne. Given the size and complexity of the Melbourne's road network and the number of stakeholders involved, to make the task of operating the network more manageable, we break it down into sub-networks.

To define a sub-network the following guidance is given:

- A sub-network boundary could be a natural or man-made barrier to movement that constrains transport capacity, such as freeways, railway lines, rivers and key land-use areas (such as industrial or residential precincts).
- Municipal boundaries should only be used if they act as a constraint, not because they are seen as a simple 'line in the sand'.
- Do existing operating gaps indicate any key inter-relationships on the network? For example, if we were to reduce an operating gap along a north-south route, would it subsequently increase the operating gaps along an intersecting east-west route?
- Are there parallel routes facilitating mobility in the same direction, for example a freeway providing for general traffic and freight, and an arterial road providing for public transport, bicycles and pedestrians?
- Are there any key public transport hubs? How far do the bus and/or tram priority routes extend from the hub? The sub-network should capture key routes into and out of the hub.
- Activity centre boundaries should be considered, together with the immediate supporting road network, including any preferred traffic routes designated to avoid conflict with activity centre land uses.
- Linkages with pedestrian priority areas such as railway stations or major destinations should be considered, as should key parts of the principal pedestrian network - include at least 1.5km around the activity centre.
- Key bicycle priority routes into activity centres should be taken into account.

Alternatively, a sub-network could be based along a regionally strategic corridor, for example the Monash Freeway (M1) and its inter-connecting arterial network. In setting network strategies for a corridor it is important to understand how the 'network fundamental diagram' (shown below) applies. The diagram indicates that, basically, a road operates in three distinctive states: free-flow, optimal flow and congestion. Importantly, increasing congestion can affect a number of different modes because the ability to provide priority to any mode is lost as both the time and space are no longer available.



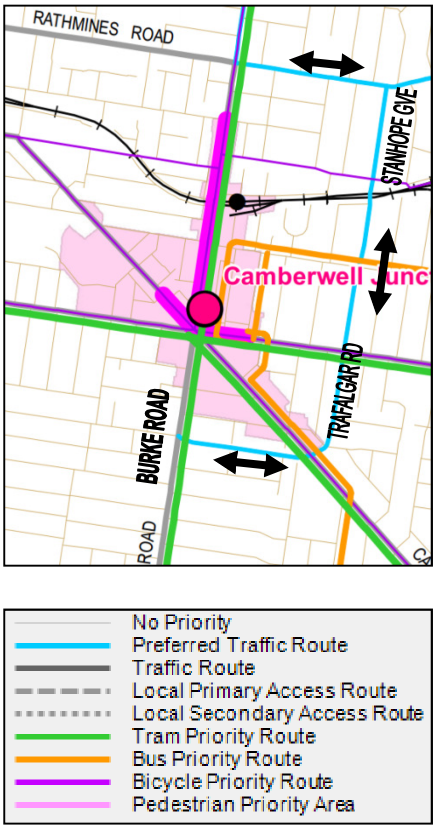
To understand the relationship between our ability to provide priority to any given mode and changes in congestion, we can imagine a bus travelling north arriving at the back of a 500-metre queue of traffic. It would be difficult to clear the traffic queue to enable the bus to get through the signals because the time needed would grossly affect other modes travelling east/west. However, if the north-south road were operating optimally and the queue was 100 metres, we would have sufficient time and space to clear the queue to allow the bus to proceed.

Building on this example, imagine that the bus service connects to the city via the freeway; the on-ramps to the freeway are metered and can cause long queues onto the surrounding arterial roads. The ramp metering is essential to keep the freeway operating in its optimal condition. With a road use hierarchy in place designating bus priority and preferred traffic routes for the network, how would an operations engineer decide what queue lengths are acceptable on the arterial; or a transport engineer know whether reliability or travel time are more important to the bus service; or a transport planner know that additional capacity needs to be built in the future? Strategies are designed to assist in addressing these kinds of issues.

6.3 Bringing it all together: Camberwell

We can generally identify a number of different treatments for any given location when addressing congestion. As each treatment will have its own set of positive and negative impacts on each transport mode, agreed network strategies play an important role in choosing between options. This is particularly beneficial when setting up operational plans for traffic signals. Having strategies in place communicates the stakeholders' objectives for the area to the people developing the solutions that are planned to be implemented.

Taking the example of Camberwell activity centre (shown over page), the strategic road use map shows the north/south road to the east of Burke Road is designated as a preferred traffic route (blue) to encourage general traffic away from the potential conflicts along this core street with pedestrians (pink) and public transport (green & orange). As you could imagine a number of different treatments could be implemented that align with this map.



Using public transport as example, the following scenarios could be developed by engineers to improve the level of service (reducing the operating gaps) for trams north/south along Burke Road:

- Scenario 1: peak hour clearways and extended signal phases when trams (north/south) are within a certain distance of the signals to allow better clearance.

- Scenario 2: restrict the number of cars going into the pedestrian priority area and give more signal priority and road space to general traffic on the preferred traffic route.

Each of these scenarios would have different impacts on the operating gaps on the network. For example, giving more signal time to trams travelling north/south could adversely impact on trams travelling east/west and may in fact increase the operating gaps on the network. Returning to the concept of 'prevent – manage – provide' outlined above, these scenarios can be evaluated as follows:

- Scenario 1 is a strategy of manage and provide i.e. provide extra capacity via clearways in the peak periods and manage the limited road space to give extra signal time to trams.

- Scenario 2 is a strategy of prevent and manage i.e. prevent conflicts by directing general traffic away from the key pedestrian priority area of Camberwell and manage the existing road network to encourage general traffic to use the preferred route to the east.

Scenario 2 involves increased use of side streets such as Stanhope Grove and Trafalgar Road (right) which are not at this stage adequate to cater for significant traffic volumes. This would need to be considered when developing the network strategies to ensure that they can be implemented on the ground.

Figure 18 - Trafalgar Rd (Camberwell)

Any network strategies that have been identified for this activity centre can be used to properly evaluate these options. Beyond operational considerations, other key factors such as liveability, accessibility and road safety need to be taken into account when operating a network.

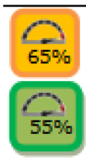
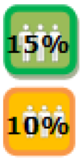
6.4 Types of strategies

A number of broad operational strategies have been identified for each mode.

6.4.1 General traffic and freight

	Restrict throughput			Maximise output
	Increase throughput			Minimise input
	Traffic gate 'store and release'			Encourage change in route
	Maximum queue allowable			Increase capacity
	Minimise queuing			Reduce capacity
	Smooth flow 'reduce stop starts'			Smoother merging

6.4.2 Public transport

	Improve Reliability '*meet the timetable - every time*'			Increase operating speed as a percentage of posted speed (excl. boarding's)
	Agreed mode shift target e.g. 15%			

6.4.3 Bicycles

- Increase on-road separation.
- Reduce conflicts with public transport.
- Increase visibility – line markings, Vibraline etc.
- Agreed mode shift target.
- Managing posted speed (general traffic).
- Off-road / fully separated facility.
- Reduce conflicts with pedestrians.
- Intersection priority.
- Crossing opportunities.
- Traffic calming measures.

6.4.4 Pedestrians

- Reduce delays for crossing.
- Reduce conflicts with other modes.
- Increase space available.
- Create legitimate crossing opportunities.
- Increase amenity.

7 ASSESSING NETWORK CHANGES

7.1 Introduction

VicRoads is committed to using SmartRoads to inform all decisions that affect the planning, development and operation of the arterial road network. This is usually done through a process known as a network fit assessment (NFA). This process has been developed to enable proposals to be assessed against the road use hierarchy. It provides decision-makers with information to better understand the trade-offs between transport modes within a network context, and to identify areas and/or modes that may require mitigating action as part of the proposal's implementation. In simple terms, the NFA indicates whether the operating gaps on the network would improve or worsen as a result of implementing a strategy or proposal.

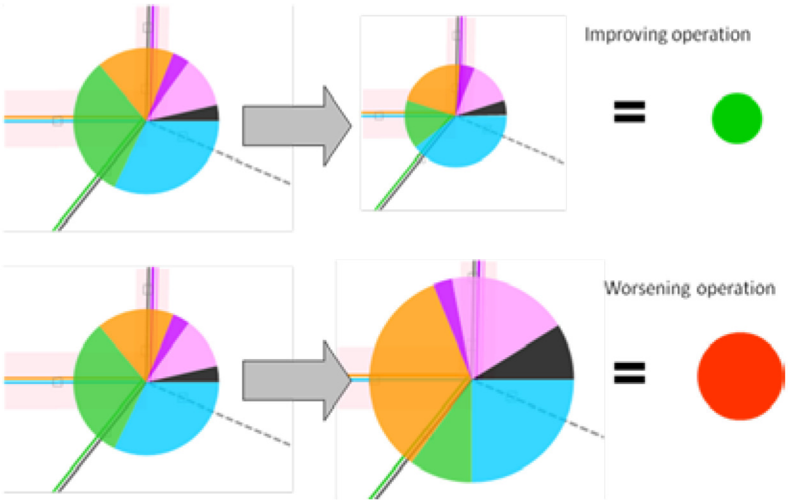


Figure 19 – '*What is the impact on operations as a result of implementing the project'*

The process enables a proposal to be reviewed and refined all the way from the development stages through to detailed planning. It recognises that transport planning, traffic analysis and modelling are not exact sciences. As such, a risk-based approach has been adopted which covers a range of outcomes, to reflect the quality of data, the information available and the views and advice of professionals.

A network fit assessment considers all intersections and links which are likely to be impacted by the proposal, as agreed by workshop stakeholders. Each transport mode is assessed on each midblock/intersection approach. This includes trams, buses, freight, bicycles, pedestrians and general traffic. The individual assessments are summed for each mode; a range of expected outcomes is produced from this summation to indicate the worst to best case scenarios (see Figure 20). A wide bar indicates a high degree of uncertainty regarding the proposal's impact on the network. Greater certainty can be

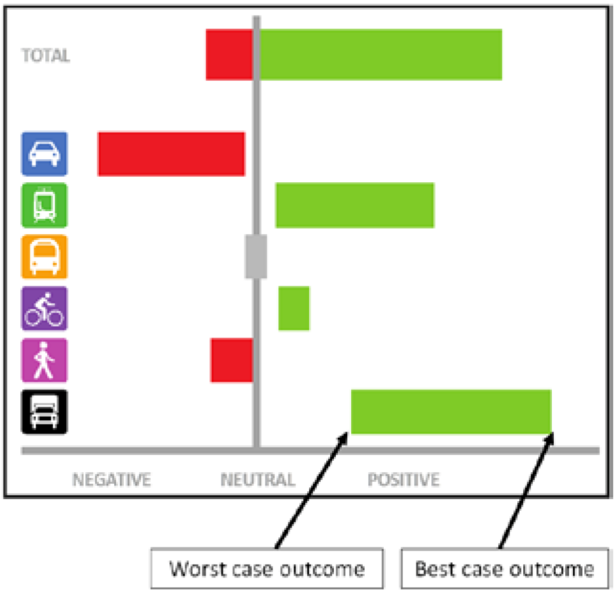


Figure 20 - NFA outcomes

achieved by improving the quality of analysis, using modelling, or possibly through further investigation, to reduce the range between outcomes.

NFAs are conducted in a workshop environment that brings engineers, planners and other experts together, and enables them to use a shared language to reach agreement. The workshop format facilitates consensus and ensures that the results have credibility with all interested parties.

The workshops must be attended by a NFA facilitator and operator (these roles can be filled by the same person) and representatives from all relevant parties, including the project proponent, VicRoads signals operations and VicRoads traffic operations.

7.2 Network fit assessment workshop roles

Each attendee at a NFA workshop has an important role to play in the success of the outcome. These roles are summarised here and should be kept in mind when considering how you might organise and facilitate a workshop.

Project proponent

- Provides background information, scope and objectives of project to all attendees.
- Presents any traffic analysis undertaken.

NFA facilitator

- Provides clear direction and advice on undertaking the assessment.
- Facilitates the workshop (see section on the facilitation process).
- Instructs NFA Tool operator on what to capture/record in the NFA Tool during workshop.

NFA Tool operator

- Responsible for entering all information/data/comments discussed at workshop into the network fit assessment tool.
- Generates and distributes the NFA report to all workshop attendees.

VicRoads traffic & transport operational representatives

- Provide advice on various traffic operational requirements from key perspectives, such as: VicRoads, council, community, road safety, etc.
- Provide advice on current traffic conditions.

VicRoads signals representatives

- Provide advice on signal operations within the scoped network.

Key stakeholders

- Depending on the proposal's scope, key stakeholders may need to be involved in the workshop, such as: officers from Council, Public Transport Victoria or representatives from public transport operators or road user groups, such as Yarra Trams and Bicycle Network.

The network fit assessment process has a number benefits for project proponents:

- It enables more effective decision-making for transport and land use objectives within activity centres, for example when reallocation of road space is considered.
- It enables more informed decision-making, for example when trading off one mode against another.
- It provides a comprehensive yet simple analysis of the impact of proposals associated with land use development.
- It provides a shared language that can be used by all stakeholders to achieve agreement on what the objectives for a proposal are.

7.3 The network fit assessment process

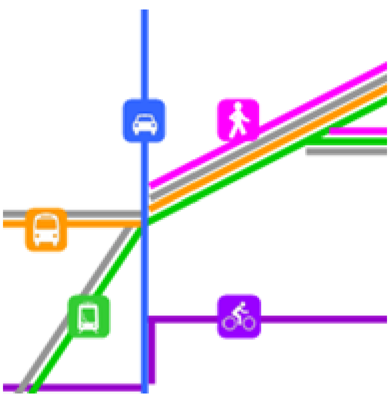
The network fit assessment (NFA) process can be carried out at three different levels:

- Rapid appraisal checklist.
- NFA level 1.
- NFA level 2.

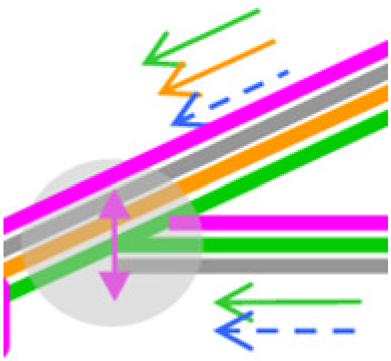
A rapid appraisal is a simple, fast process that must be conducted on any proposal that could affect the operation of the network to determine the need for any further assessment. If further assessment is required, it will be done at one of two levels:

- **Level 1** – determines the proposal's likelihood of supporting the intent of the strategic road use;
- **Level 2** – determines the proposal's fit with the road use hierarchy.

NFA level 1 - strategic road use

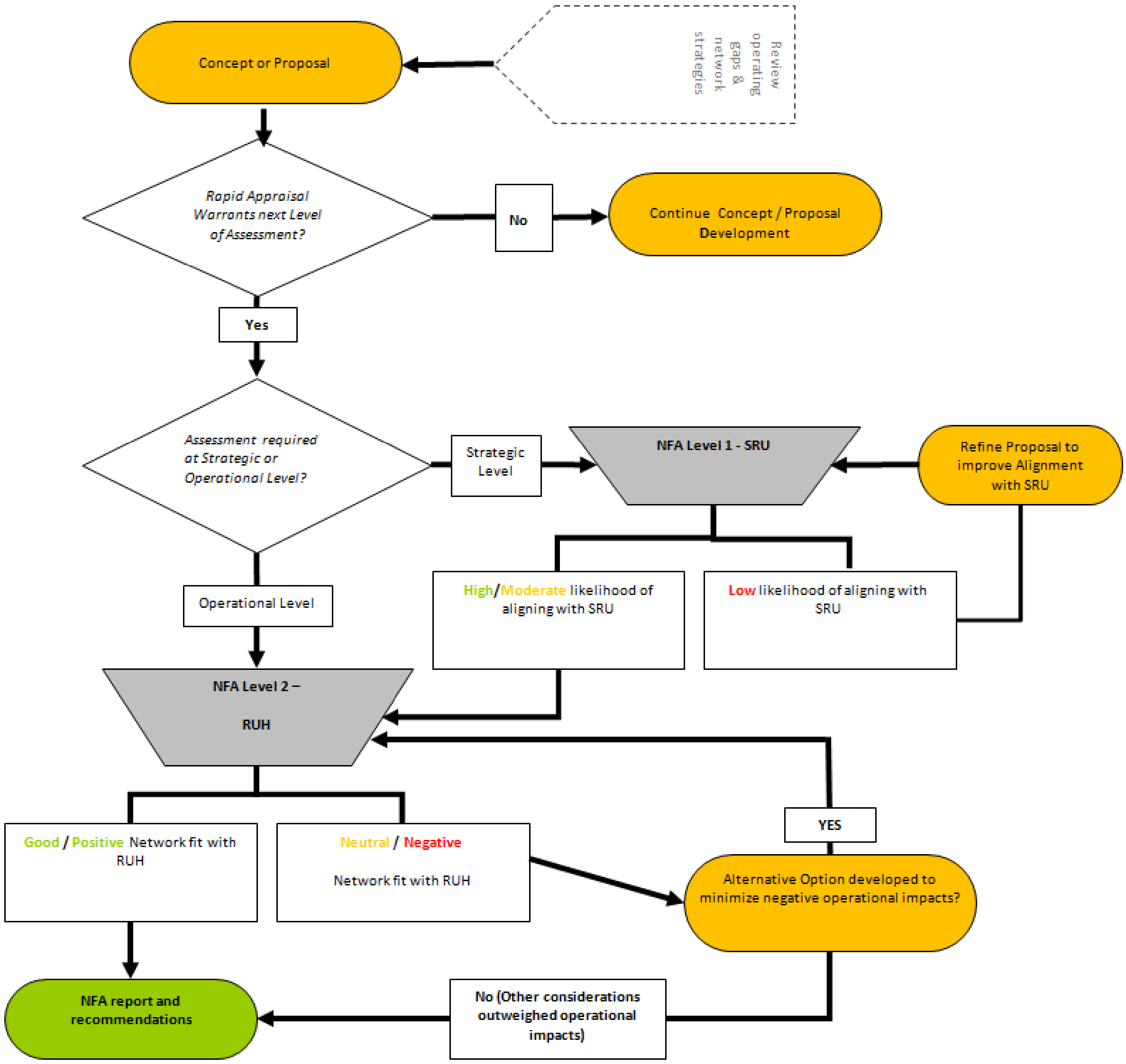


NFA level 2 - road use hierarchy



Network fit assessment process — flow chart

The network fit assessment process is represented in the flow chart below. The rapid appraisal is used at a very early stage, and the criteria for determining the need for a level 1 or level 2 assessment are shown in the diamonds on the chart. The chart also shows where it may be appropriate to refine or review a proposal, and at what stage a proposal can be further developed based on the network fit score that has been achieved.



7.3.1 Rapid Appraisal

A rapid appraisal is used to determine whether a proposed change will require a more detailed assessment. The checklist asks whether the change could have a significant impact on any particular road users.

A rapid appraisal is undertaken early on in the development phase of a project. Where the proposal requires approval from a responsible authority it can be done once submitted, by the authority. **If any item on the list is checked, then the next level of assessment is required.** The following table below displays the rapid appraisal checklist.

Item	Description	✓
VPP	Does it meet the referral requirements of Clause 52.36 *'Integrated Public Transport Planning'* - Victorian Planning Provisions (VPP)?	☐
TIAR	Is a Transport Impact Assessment Report required by VicRoads?	☐
General traffic & freight	Proposal will add traffic/freight volumes on a specific approach by more than 10%	☐
General traffic & freight	Proposal will add noticeable delays to general traffic or trucks/freight	☐
Trams	Proposal will impact (+ or -10%) on the operation of trams	☐
Buses	Proposal will impact (+ or -10%) on the operation of buses	☐
Pedestrians	Proposal changes access or amenity for pedestrians in an activity centre or Pedestrian Priority Area	☐
Bicycles	Proposal changes access, separation or amenity for bicycles on the PBN and/or a Bicycle Priority Route	☐

7.3.2 Level 1 network fit assessment

Introduction

A level 1 assessment provides a simple way to establish whether a concept is likely to support the intent of the strategic road use (SRU).

It uses the methodology described in this section to determine whether the proposal has a high, moderate or low likelihood of supporting the intent of the strategic road use, based on the score ranges identified in the table below.

NFA level 1 result	Total score range
High likelihood of supporting the intent of the strategic road use	*All modes have a score range that is neutral or positive, with at least 1 mode having a score range that is wholly positive*
Moderate likelihood of supporting the intent of the strategic road use	*There are more modes with a positive score range than a negative score range*
Low likelihood of supporting the intent of the strategic road use	*Any other result*

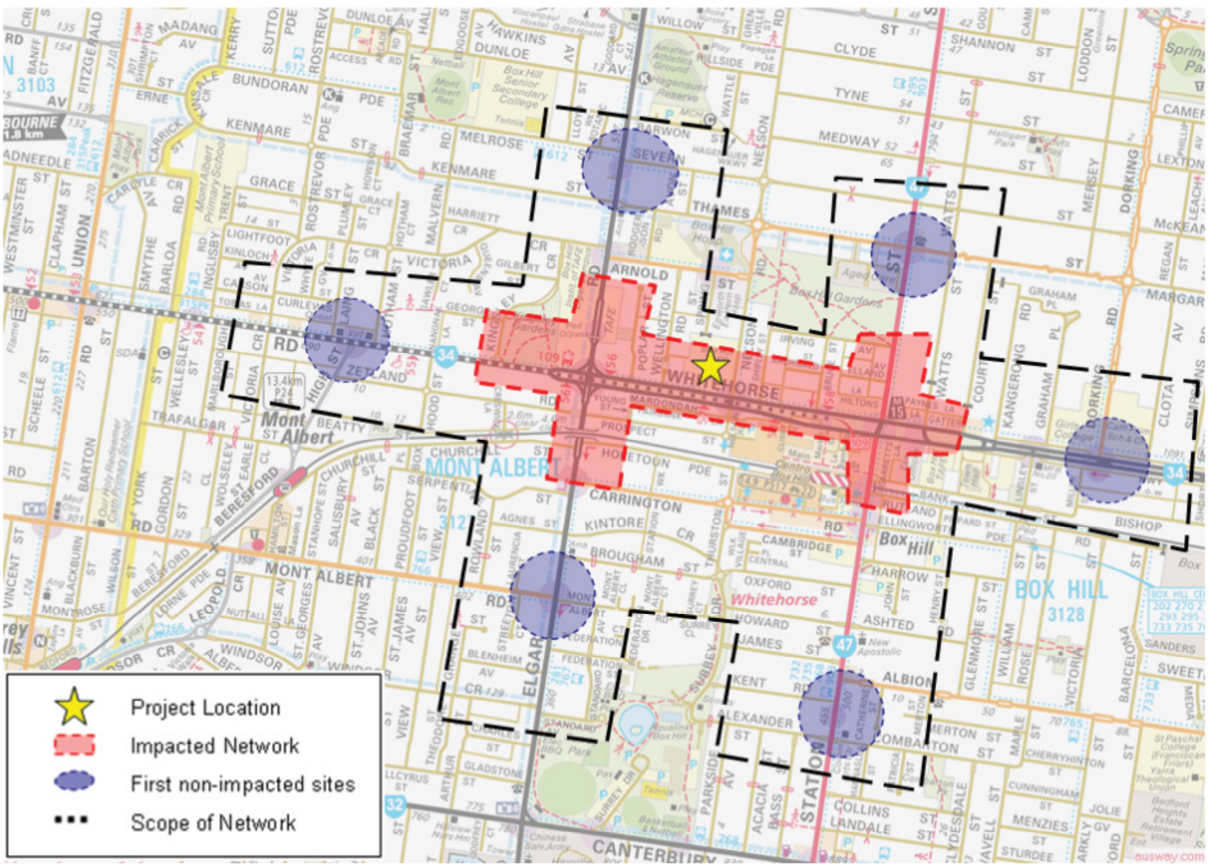
Methodology

1. Define scope of the network.
2. Conduct assessments.
3. NFA Tool calculations – the tool applies factors and numerical values then determines network fit score range.

Step 1— Define scope of the network

The scope of the network to be tested is determined on a case-by-case basis to ensure that all impacted sections of the road network are captured. The impacted network consists of all arterial roads and local roads designated in the SRU that are likely to be affected by the proposal. At a minimum it should include at least one controlled intersection beyond the subject link or intersection. A conservative approach needs to be adopted in scoping the impacted network, which can then be refined through further discussion with VicRoads traffic and signals operation teams.

Generally the workshop group would start from the nearest impacted location and move out, each time asking the six mode-related questions from the rapid appraisal checklist. Once a site does not meet any of the criteria, it will form a boundary of the scoped network. It is important to recognise that the scoping task is iterative. As we go through the assessment process it may be necessary to undertake further mitigating works at other locations to gain an improved fit with the network objectives. The diagram below shows an example of what might be included in a network scope.



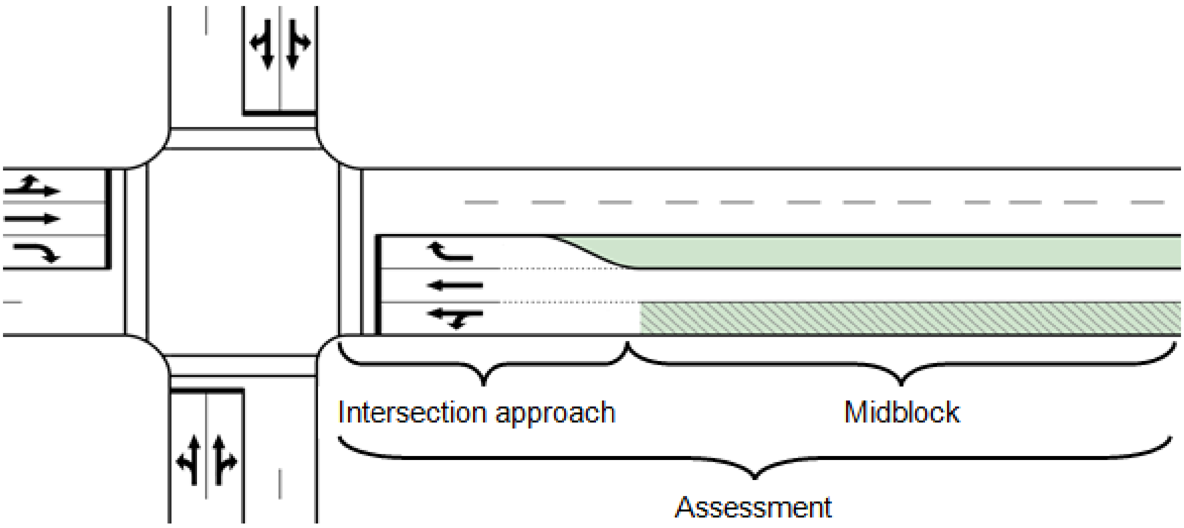
Step 2— Conduct assessments

Using the NFA Tool, the workshop will assess the proposal's impact on each mode by intersection approach. For a NFA level 1, the impact on a mode is rated as simply ***positive, neutral*** or ***negative***. The table below provides 'rule of thumb' guidance in applying the levels of impact.

Mode	Level of Impact		
	Negative	**Neutral**	**Positive**
General traffic	Noticeable increase	Barely register	Noticeable increase
Trams	>10%	0-10%	>10%
Buses	>10%	0-10%	>10%
Bicycles	Major to moderate	Minor	Major to moderate
Pedestrians	Major to moderate	Minor	Major to moderate
Freight	Noticeable increase	Barely register	Noticeable increase

'Rule of thumb' guidance in applying the level of impact

It is important to understand that the assessment is concerned with both the intersection approach and the midblock conditions, as illustrated below.



After determining the level of impact, a simple confidence level is assigned in the NFA Tool to reflect the group's confidence in the impact occurring. The workshop can nominate high, medium or low confidence, as set out in the table below.

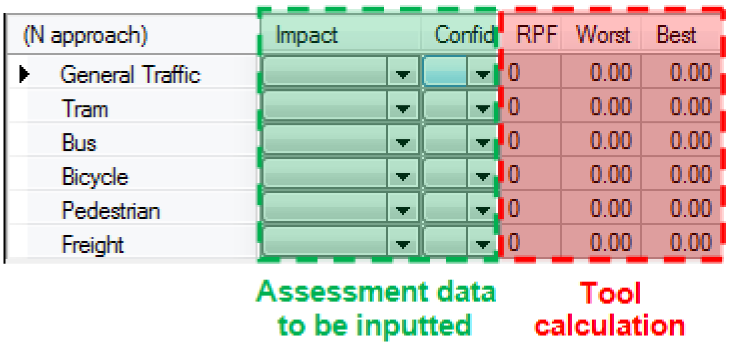
Confidence Level	Description
High (H)	Sufficient analysis, data or expert knowledge is available to provide a high level of confidence in the operational impact of the proposal. It is unlikely that the actual change will differ from that predicted.
Medium (M)	Sufficient analysis, data or expert knowledge is available to provide a moderate level of confidence in the operational impact of the proposal. The actual change could be better or worse than that predicted.
Low (L)	Insufficient analysis, data or expert knowledge is available to provide a high level of confidence in the operational impact of the proposal. The actual change could be significantly better or worse than that predicted.

Description for assigning level of confidence

Step 3— NFA Tool calculations

Tool applies factors and numerical values

After each of the assigned impact and confidence levels are entered into the NFA Tool, it applies a relative priority factor (RPF) based on the strategic road use map.

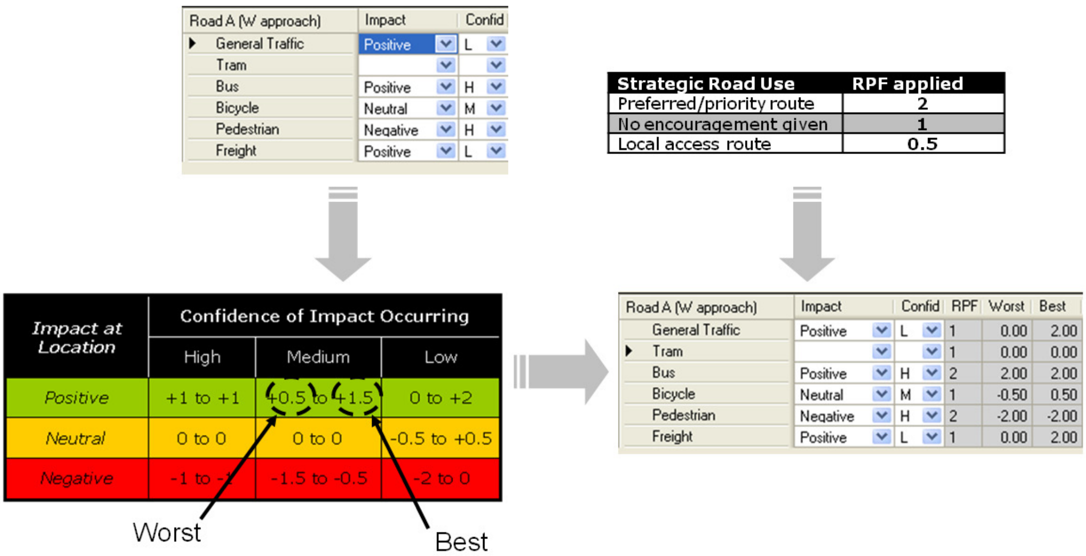


For a level 1 assessment, the RPF is simplified because the strategic road use is being used (there are no specific time periods or mode priorities by time of day). For a level 1, basically if the link is on a preferred or priority route then the corresponding mode is strongly encouraged and a RPF of 2 is applied; otherwise no specific encouragement is given, thus a RPF of 1 is applied. In the circumstances where we only want to encourage local access we would apply a RPF of 0.5.

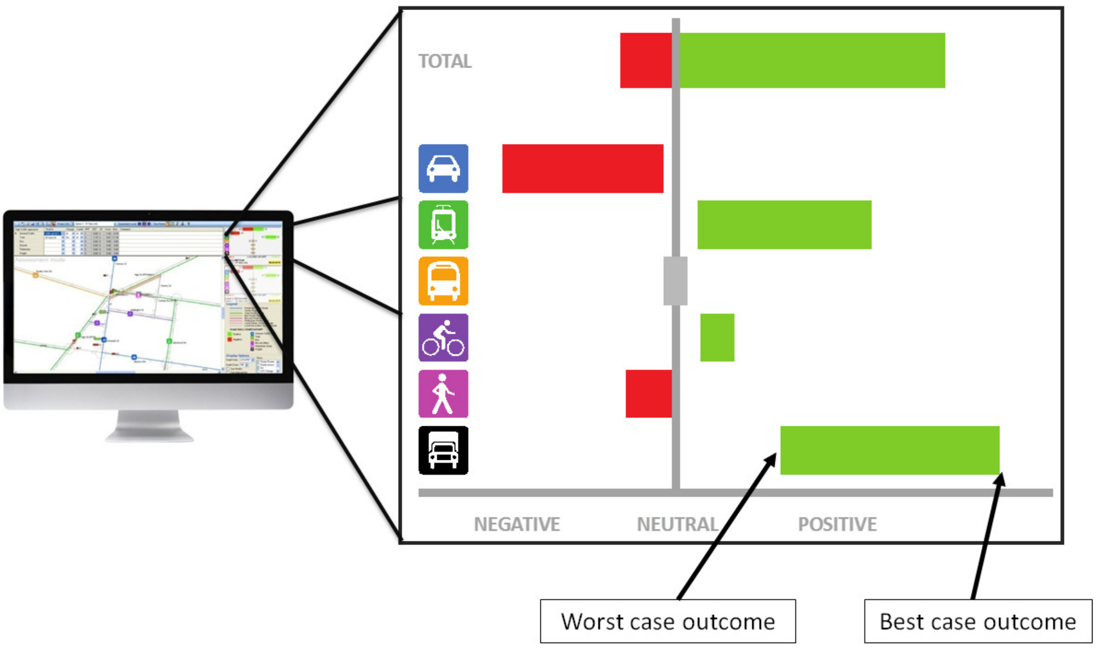
Preferred/priority route	**2**
No encouragement given	**1**
Local access route	**0.5**

The tool applies numerical values based on the level of impact and the confidence assigned to represent a range from worst to best case scenarios. The values applied by the tool are shown on the next page.

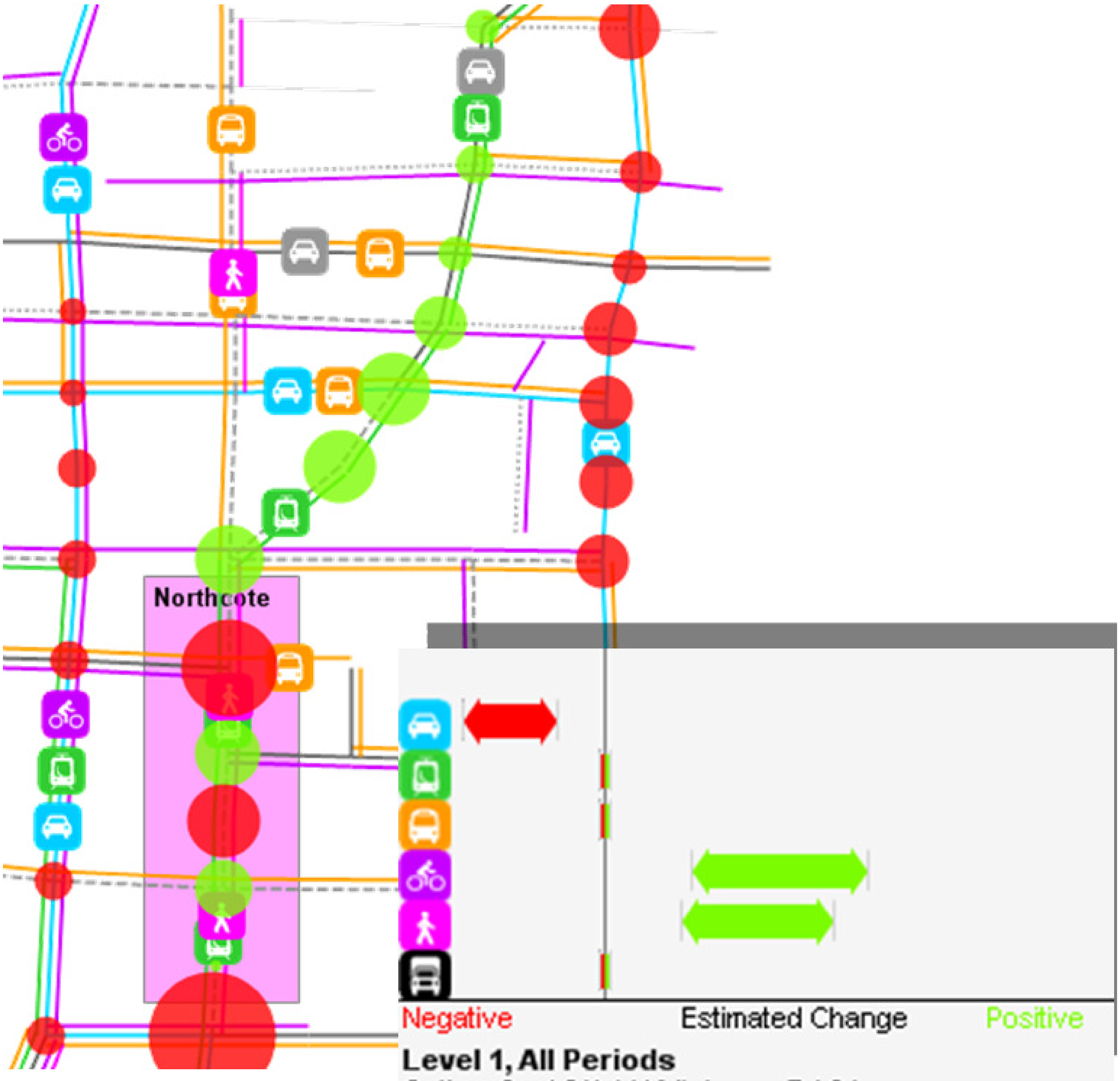
Tool determines total network fit score range



The best and worst case mode scores, weighted by the RPF, for each approach are then added together to give the mode's **total network fit score range**. The tool illustrates the ranges by way of a bar chart. The range of each bar represents the confidence in the assessment for that mode, with a narrower range indicating greater confidence. The midpoint of the bar correlates to whether the assessed impact is negative, neutral or positive. The tool interprets these midpoints to determine the likelihood of a proposal or concept aligning with the strategic road use.



Note that the tool provides different options for illustrating the impacts on the network graphically (see NFA Tool User Manual for more information). An example is shown below– note the red circles indicate a negative impact and the green positive; the size of the circles are relative to the impact.



7.3.3 Level 2 network fit assessment

Introduction

A level 2 network fit assessment (NFA) is an assessment of the proposal's fit with the road use hierarchy. The RUH reflects the operational objectives for the network at specified times of the day, so the level 2 is a much more quantitative analysis than the level 1. As the NFA Tool houses all of the calculations and factors required for the assessment, the only data that needs to be inputted is throughput, change in level of service (LOS) and confidence. Depending on the inputs required for decision-making on a particular project, the assessments can be carried out for each of the time periods or just for one particular time period, for example increasing the amount of green time given to a pedestrian crossing during the high-off peak and pm peak.

The assessment provides a common-sense way to establish whether a proposal has a good, positive, neutral or negative fit with the RUH's operational objectives.

Methodology

1. Determine scope of the network.

2. Conduct assessments.

3. NFA Tool calculations - tool applies factors and numerical values then determines network fit score range.

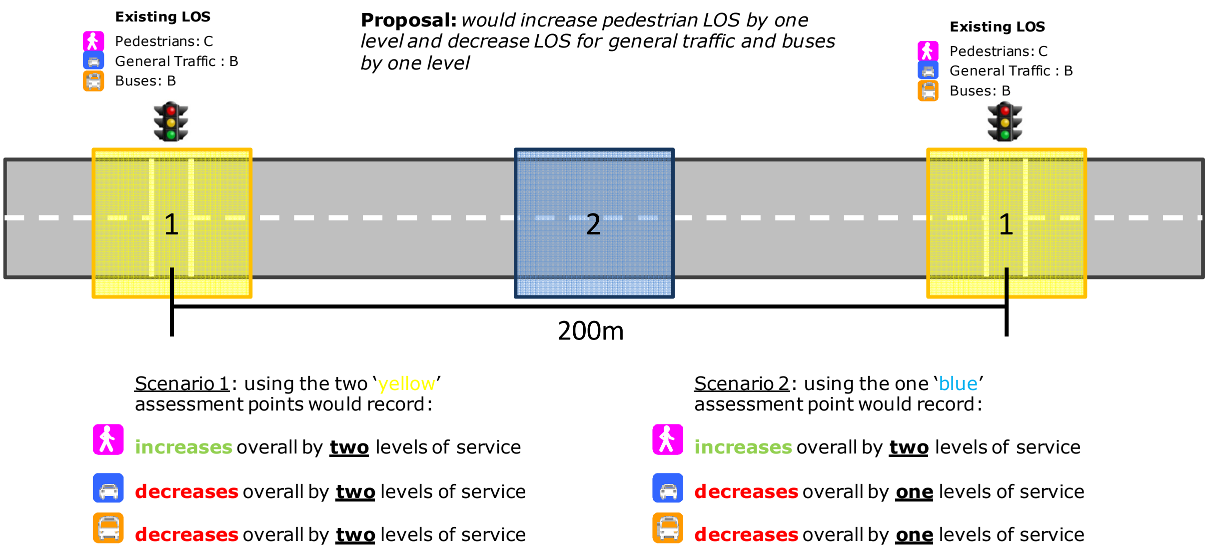
Step 1 Determine scope of the network

The method for determining the scope of the network for a level 2 assessment is similar to that described for a level 1 assessment. However, for a level 2 the extent of network impacts could be determined from traffic modelling or appropriate traffic analysis if available. It is important to keep in the back of your mind the SmartRoads level of service definitions and rapid appraisal checklist when defining the impacted network.

The NFA process acknowledges that every situation is different; for this reason it is important that the NFA takes place in a workshop format. Stakeholders need to agree and record the assumptions used in the tool. This transparency will assist decision-makers in interpreting the NFA report and the forum in which it was undertaken.

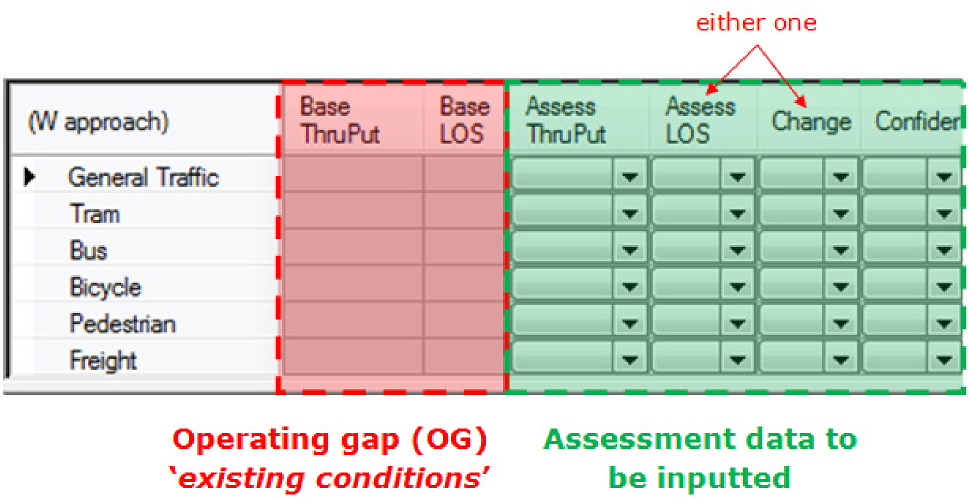
In scoping and setting up the network in the tool, it is important to consider how they will record the impacts of the proposal on network operations via the simplified link and node. As the tool is not an automated black box, instead a program for simply recording the impacts of the proposal the group needs to ensure the NFA process is not over- or under-capturing the impacts for each mode. The example below illustrates in the case of reviewing the amount of time given to pedestrians at two pedestrian operated signal crossings, which are within 200m of each other and signal linked; would it be more appropriate to represent these crossings as one assessment point (node) in the NFA Tool, and record the total impacts for each of the modes at the one location? Using two assessment points may over count the impacts from increased crossing times for pedestrians on general traffic and bus operations, instead the impact is likely to be felt at one location as the signals would be coordinated to reduce the chance of delay when approaching the next set.

Conversely, using a similar example of two sets of signals it may be appropriate to have two assessment points if, for example, they are not linked or provide completely different levels of service for different modes. The details for how to set up a network in the NFA Tool are provided in the NFA Tool User Manual.



Step 2 Conduct assessments

The NFA Tool automatically applies all of the calculations and factors required for the assessment. Workshop participants need to input data for each mode on: throughput; change in level of service (to indicate the impact); and the group's confidence in this predicted change. Part of the screen shown in the NFA Tool in assessment mode is shown below. The two columns highlighted in red are the two inputs required for the tool to calculate the current operating gap. These are usually prepared in advance of the workshop, ideally when identifying any deficiencies on the network and possible proposals to treat them. In terms of the network fit assessment this is known as the 'base case' or 'existing conditions'. The columns highlighted in green show the inputs relating to the predicted change in conditions that will enable the tool to calculate the proposal's fit with the road use hierarchy.



Throughput

Assessments are done for the whole approach and not individual movements (i.e. left, through and right are combined), so that the volume used is the total volume for all lanes and all movements on that intersection approach. In most cases, the through movement carries the predominant traffic volume and its performance has the most impact on the wider network. If a right turn is performing poorly then it will invariably cause queuing which will impact on the through movement anyway. This is a compromise that retains consideration of the key network impacts without adding a level of detail to the assessment that would be likely to have only a minimal effect on the end result.

There may be circumstances where the whole approach volume is not recorded as a combined volume, as the treatments proposed do not hinder the minor movements. In this situation the predominant movement volume would be entered. This needs to be agreed by the workshop group and noted in the assumptions.

Using base and assessed throughputs (throughput)

To simplify the testing and keep consistency the tool is programmed to first:

- use assessed throughput for both the base and assessed throughputs, in the example below, the tool would test the improvement from LOS C to B for 2000 people.
- if no assessed throughput is entered then the base throughput will be applied, in the example below the tool calculates the improvement from LOS C to B for 800 people.

Reason why the tool uses this method.

During the initial testing and development of the NFA process an issue arose in how the assessment should be carried where there is expected traffic volume changes. As the NFA is concerned with the level of LOS change for people/goods on each link, if the volumes change between the base and the assessed, then the total number of people/goods impacted across the network would not be the same giving an erroneous answer. See the example below for further explanation.

A practical example of this scenario: A grade separation of a road and rail line and new train station is modelled. The transport model indicates the new bridge (over the rail line) and station would attract more people from other parts of the network due to the better LOS experienced. The model results show that the throughput would increase from 800 to 2,000 people travelling along the road (in various modes). However, the NFA result would be negative, as the new scenario would mean: 2,000 people experiencing LOS B (post-implementation) compared to the 800 people experiencing LOS C pre-construction.

It was considered in early NFA testing to add dummy links to capture changes in LOS and throughput on other parts of the wider network. In the example above there would be locations on the broader network where the LOS would improve or at least the number of people experiencing the existing LOS would drop as the 1,200 people switched to the new route via the grade separation. However, through testing of the dummy links method it became apparent that this added a level of complexity, as there could be numerous locations of minor to major changes, and also raised the issue of consistency between assessments i.e. would everyone follow the dummy link method the same way?

Change in level of service

As the NFA is concerned with the likely change in operating gaps as a result of the proposal, the degree of change in LOS that could occur for each mode needs to be determined. Under the SmartRoads level of service criteria, a change in one LOS level such as B to C is quite significant. A more detailed description of changes in LOS has therefore been adopted to better capture the benefits and disbenefits to each mode.

Referring to Table 9, an example of ⅓ level of improvement in LOS would be going from LOS C+ to LOS B-, whilst a ⅔ level improvement would be going from LOS C+ to LOS B.

Table 9 - LOS change definitions

LOS change		How many levels of change?
High+	H+	2 levels of improvement in LOS
Medium+	M+	1 level improvement in LOS
Low+	L+	⅔ level improvement in LOS
Very Low+	VL+	⅓ level improvement in LOS
None	N	No change in LOS
Very Low-	VL-	⅓ level worsening in LOS
Low-	L-	⅔ level worsening in LOS
Medium-	M-	1 level worsening in LOS
High-	H-	2 levels of worsening in LOS

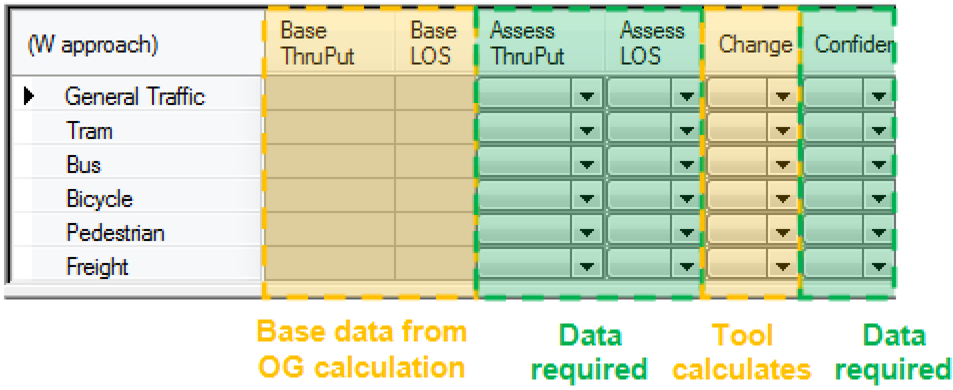
Depending on the amount and quality of data/information available to determine the change in LOS, there are three ways the change is registered by the tool. Each can be used in the same assessment. However, there needs to be consideration of the level of detail required for decision-makers, for example: are you assessing a major change to the network where a lot of modelling has been undertaken or are you just testing the validity of a concept/idea? In assessing your proposal you should consider:

- The need to know the current and assessed LOS, as this allows you to have the greatest confidence in the LOS change.
- Will you need to identify alternatives, target projects to specific operating gaps on the network and/or test out different network strategies?
- How well will the workshop group understand the current operation of the network and impacts on the level of service, if the current LOS is not available?
- It will be **difficult** to assign high levels of confidence in the LOS change if you don't know what the base condition is.

The first way is the most detailed, and also the preferred method, as it directly compares the existing LOS (base) to the new LOS (assessed).

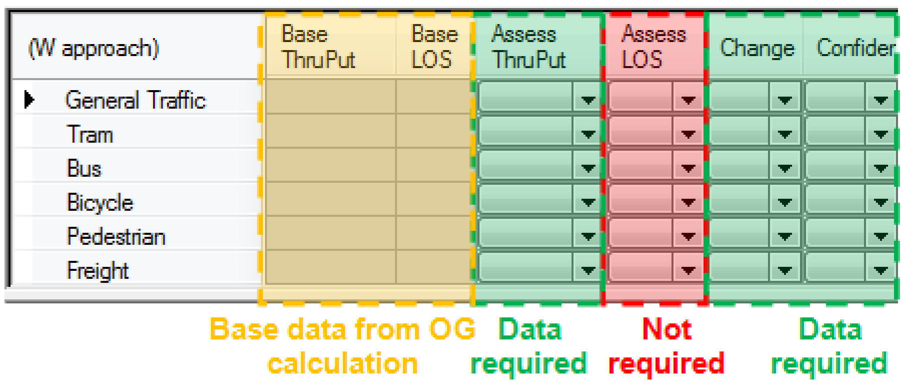
Change in LOS method 1: Base LOS–Assessed LOS=Change in LOS +/-.

The tool will calculate the change in LOS, and show the definition from Table 9 that is closest to the level of change in LOS. For example: the difference between LOS C- and B+ is 1.5+ levels of LOS change. The tool would display this as an M+. The excerpt from the NFA Tool below shows the green highlighted areas where data is entered and the yellow where the tool calculates the change.



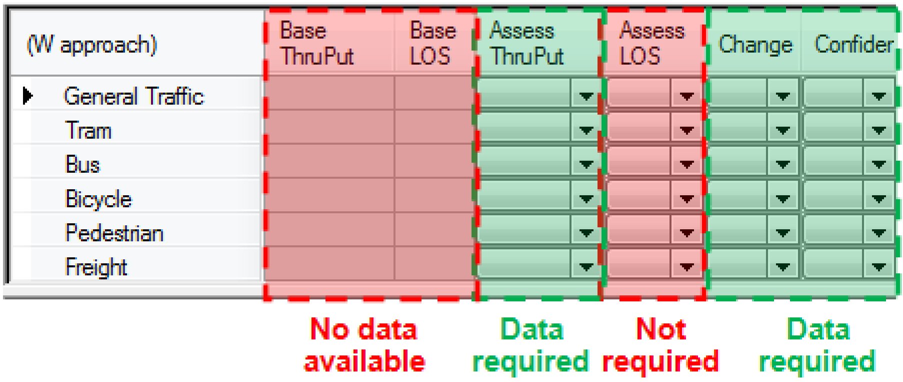
Change in LOS method 2 (Base LOS +/- approx. change in LOS)

If workshop participants do not have the appropriate information/data available, then the NFA Tool operator can directly enter the change +/- in the base LOS into the tool, having gained consensus from the workshop group. The excerpt from the NFA Tool below shows the green highlighted areas where data is entered. As you will see, data is not required for assessed LOS. The change is based on the definitions in Table 9. This method can have limitations when considering changes greater than 1 LOS (M+/-), as the change is approximated based on the definitions from Table 9. When determining very high impacts i.e. >2 levels of service, the NFA Tool operator may need to consider using the first method as anything beyond a change of 2 LOS would not be accounted for when just entering H +/- change. For example, if the current LOS for bicycles is F (base LOS) and a new separated facility is built that provides a LOS A (assessed LOS) for cyclists, then using just H+ would only represent an improvement of 2 LOS, e.g. LOS F to LOS C. To fully capture the improvement the NFA Tool operator should use the first method of inputting LOS change.

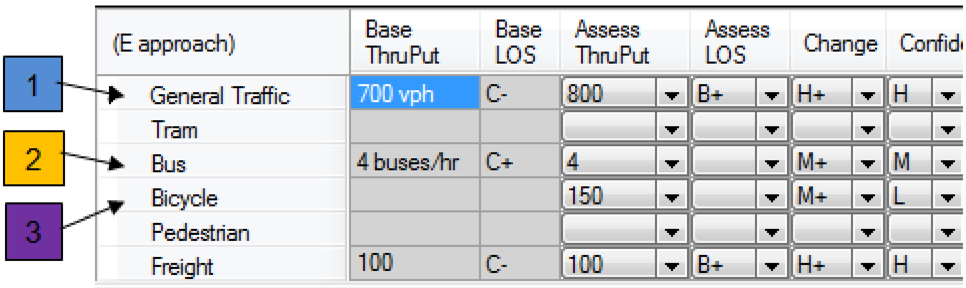


Change in LOS method 3 (Default LOS (C) +/- approx. change in LOS)

The third and least preferred way is used where there is no base LOS to use in the calculation. To enable the assessment to take place, the tool assumes that the Base LOS is C and then applies the change to this. This method is generally reserved for testing ideas and concepts- it is important workshop participants understand this and agree.



All three methods can be used in the NFA process. For example, we may have very good modelling results for general traffic/freight, qualitative analysis for buses and conceptual information for bicycles. An illustration of how each of the three methods (1, 2 ,3) would look in the NFA Tool is below.



NFA Tool data entry: different methods of registering change in LOS

Confidence level

As discussed above, the group needs to assign their level of confidence in the proposals impact. The table below sets out the three levels of confidence that can be given. This is an important aspect of the NFA facilitator's role to draw out a consensus on the group's confidence.

Confidence Level	Description
High (H)	Sufficient analysis, data or expert knowledge is available to provide a high level of confidence in the operational impact of the proposal. It is unlikely that the actual change will differ from that predicted.
Medium (M)	Sufficient analysis, data or expert knowledge is available to provide a moderate level of confidence in the operational impact of the proposal. The actual change could be better or worse than that predicted.
Low (L)	Insufficient analysis, data or expert knowledge is available to provide a high level of confidence in the operational impact of the proposal. The actual change could be significantly better or worse than that predicted.

Step 3— NFA Tool calculations

Once the required data has been entered, the tool calculates the impact in terms of worst and best case scenarios. As this is done automatically by the tool, the following explanation is provided for interest. There are two steps in the calculating the impact firstly the difference in the base operating gap and the assessed (for more detail see Section 5); secondly the difference is weighted by the group's assigned confidence levels.

To weight the operating gap difference by the confidence levels, the tool applies values to represent a range from worst to best case scenarios. The simplified matrix below shows some of the values that would be applied by the NFA Tool depending on the change in LOS and the confidence level assigned; notice how the intervals broaden out to cover the range options as the confidence level drops.

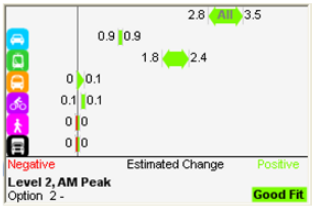
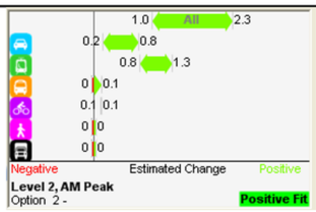
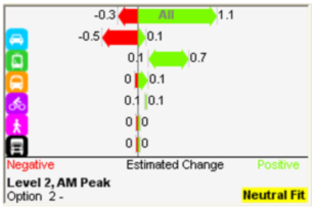
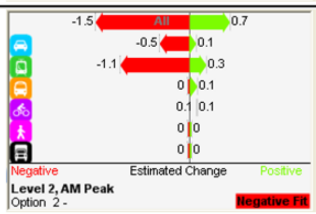
LOS change		Confidence Level High (H) +/- 0	Medium (M) +/- 0.33	Low (L) +/- 0.67
High+	H+	2 to 2	1.67 to 2.33	1.33 to 2.67
Medium+	M+	1 to 1	0.67 to 1.33	0.33 to 1.67
Low+	L+	0.67 to 0.67	0.34 to 1	0 to 1.34
Very Low+	VL+	0.33 to 0.33	0 to 0.66	0 to 1
None	N	0 to 0	-0.33 to 0.33	-0.67 to 0.67
Very Low-	VL-	-0.33 to -0.33	-0.66 to 0	-1 to 0
Low-	L-	-0.67 to -0.67	-1 to -0.34	-1.34 to 0
Medium-	M-	-1 to -1	-1.33 to -0.67	-1.67 to -0.33
High-	H-	-2 to -2	-2.33 to -1.67	-2.67 to -1.33

Below is an excerpt from the tool showing the resulting worst and best column scores, notice the ranges where High, Medium and Low confidences have been entered.

(E approach)	Base ThruPut	Base LOS	Assess ThruPut	Assess LOS	Change	Confid	RPF	REF	MSF	PW	OG	Worst	Best
General Traffic	700 vph	C-	800	B+	H+	H	1	0.40	1	1	0.13	0.40	0.40
Tram							0	0.00	0	0	0.00	0.00	0.00
Bus	4 buses/hr	C+	4		M+	M	2	0.07	1.6	1	0.26	0.15	0.29
Bicycle			150		M+	L	2	0.05	1.6	1	0.00	0.05	0.28
Pedestrian							0	0.00	0	0	0.00	0.00	0.00
Freight	100	C-	100	B+	H+	H	1	0.10	1.6	1	0.05	0.16	0.16

Tool determines total network fit score range

The tool factors the worst and best case values for each mode by approach and then adds the results together to give each mode’s final network fit range. The ranges are then summed to give a total network score range for the proposal being assessed. The total network score range is rated as having good, positive, neutral or negative fit based on the criteria outlined below.

Network Fit	Criteria	Example
Good network fit	The total **worst** and **best cases** are **both positive** values and the **difference between** the two cases is **less than the worst case** value (e.g. +3 to +5 has a difference of 2 which is less than the worst case value of 3)	
Positive network fit	The total **worst** and **best cases** are **both positive** values and the **difference between** the two cases **is greater than or equal to the worst case** value (e.g. +1 to +3 has a difference of 2 which is greater than the worst case value of 1)	
Neutral network fit	The total **worst case value is negative** and the **best case value has a higher** absolute **value** (e.g. -3 to +4); i.e. the midpoint of the range is positive	
Negative network fit	The total **worst case value is negative** and the **best case value has a lower** absolute **value** (e.g. -5 to +1 or -7 to -4); i.e. the midpoint of the range is negative	

Outputs of NFA Tool and how they can be used

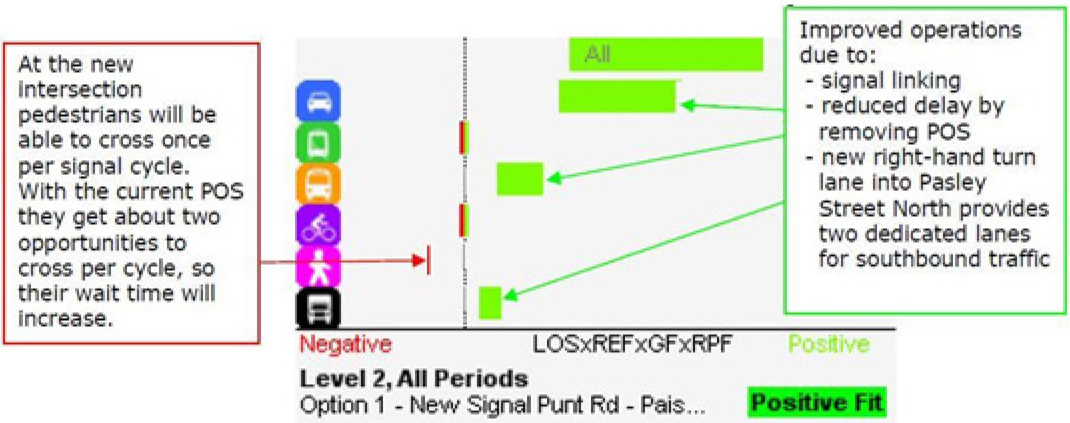
Examples of a Network Fit Assessment

Punt Road at Pasley Street North, South Yarra

Works have been proposed for the intersection of Punt Road and Pasley Street North. One of the options included:

- removing the pedestrian operated signal (POS) on Punt Road just north of Pasley Street North
- installing a set of traffic signals at the intersection, including pedestrian crossing facilities
- installing a right-hand turn lane for traffic entering Pasley Street North from Punt Road.

A NFA workshop was held, taking into account all the intersections and linking roads which were likely to be impacted by the proposal. The diagram below illustrates the outcome of the assessment:



The results from the assessment indicate that the proposed works have a 'positive fit' and will most likely align with the Network Operating Plan.

Why is it positive?

Although the assessment suggests that there will be some negative impacts for pedestrians, the proposed works are likely to provide some benefit for buses and freight, with the greatest benefit to be experienced by general traffic. As Punt Road is an identified Preferred Traffic Route and Bus Priority Route, the benefits for general traffic, freight and buses outweigh the slight negative impact for pedestrians.

Land-use Development Example

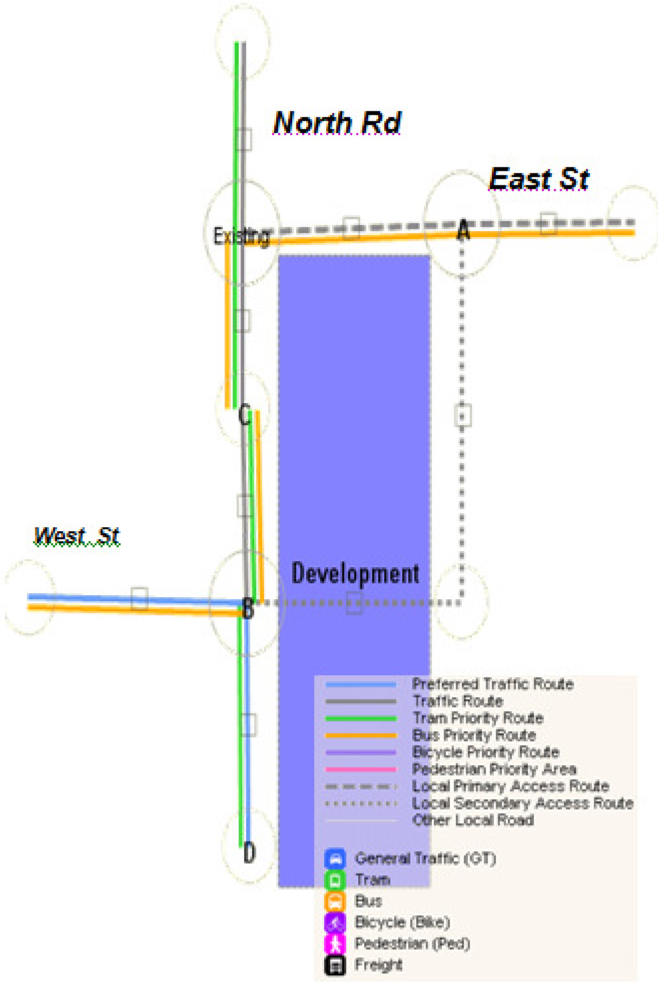
A new mixed-use development is being proposed (see illustration below), two options are tested as follows to provide access to the site:

Option 1

- New signalised intersection - **(A).**
- Addition of a right turn into development from the existing signalised intersection - **(B).**
- Two access points allowing motorists to turn left and right into and out of the development - **(C and D).**

Option 2

- New signalised intersection - **(A)**
- Two access points allowing motorists to turn left into and out of the development (no right turn access) - **(C and D).**

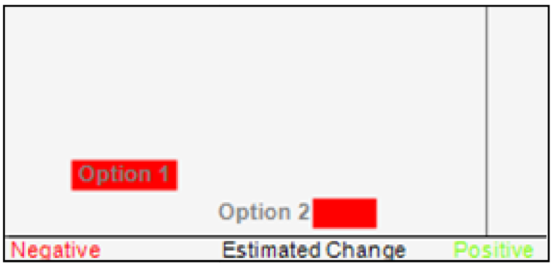


During a 'usual' Network Fit Assessment workshop, all the intersections and linking roads which were likely to be impacted by the proposal, are taken into account.

The Results

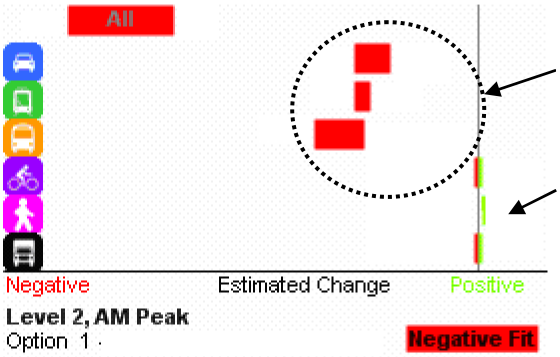
The assessments for both options returned a negative fit. However, Option 2 (with the left in and left out access) had less of an impact than Option 1.

The chart depicts a summary of outcomes for Option 1 and 2.



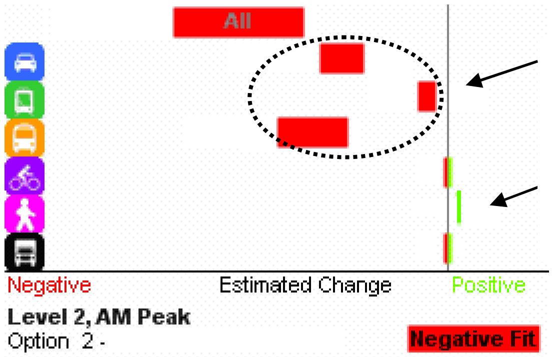
Analysis

The charts below illustrate the breakdown by transport mode for both options.



Comment: The allowance of right turns into the development at various access points on North Rd and the extra traffic generated by the development creates significant delays for trams and general traffic.

Comment: Slight improvements are recorded by pedestrians due to a crossing opportunity at East St and the North/South Access St.



Comment: The extra traffic generated by the development creates delays for general traffic and buses, and marginal delays to trams. Allowing traffic to only have left in, left out access of the development

Comment: Slight improvements are recorded by pedestrians due to a crossing opportunity at East St and the North/South Access St.

Why is it negative for both options and what's the difference?

This example has been undertaken to illustrate what happens when you get two negative fits. It was assumed that the existing intersections have the capacity to cater for the extra traffic, and it is reasonable to encourage traffic via this route.

In Option 1, the negative impacts are greater than Option 2 mainly due to the addition of the controlled right turn into the development at locations **C and D**. The right turn not only impacts on general traffic but also on trams as the new movement at the signals adds further delays to the network.

In option 2 there is no right turn at the signals into the development. Also, the right turn movements out of the development are banned. This means the impacts on general traffic, buses and trams are reduced and any negative impacts are only due to the extra traffic generated from the development.

There is a marginal improvement for pedestrians in both options due to the new crossing facilities at **A**.

7.4 Definition of NFA Tool operator and workshop facilitator roles

NFA Tool operator: pre-workshop stage

1. To define the scope of the impacted network based on the project scope report if available.

2. Ideally the impacted sites will have an intersection analysis of the current and proposed operation using an intersection analysis tool such as SIDRA. If such traffic analysis has been undertaken, then this information should be sent to all key attendees prior to the workshop.

3. To create the impacted network (with the applicable SmartRoads operational features, e.g. priority routes, principal network and activity centres of the network) with the Network Fit Assessment Tool.

4. To gather:

- throughput data such as general traffic volumes; tram services; bus services; pedestrian numbers; and cyclist volumes for each approach at each intersection for AM peak, high off peak and/or PM peak (as required)
- before and after travel delays or time savings at each approach for each impacted intersection for all modes using expert knowledge, site observation or appropriate modelling, if required.

5. To consult with VicRoads' signal services group prior to the modelling works or early in the project development stage (if applicable). Where possible, modelling outputs to be translated to reflect improvement or delays in the context of number of signal cycles required by the traffic mode to clear the intersection or to be converted to before and after SmartRoads Level of Service definitions.

6. To arrange workshop (book room, laptop and projector) and provide any traffic analysis to the key workshop attendees prior (at least one week) to the workshop.

NFA Tool operator: workshop stage

To operate the tool during the workshop to capture the agreed inputs; record notes as required; and create or display different views or features as required to assist in the discussion and decision-making process.

Facilitator: pre-workshop stage

1. Ensure the appropriate people have been invited. At a minimum, this will include: the project proponent, a VicRoads' traffic operations representative and a VicRoads' signals services representative.

2. Ensure that the operator has prepared and distributed the data, and made other arrangements as detailed above.

3. Do your homework – before the workshop, review the proposal being assessed, the key people involved in the workshop, and any possible conflict points or significant differences in perspective. You'll need to manage the discussion around these points to ensure that it remains constructive and civil. Talk to one or two of the key players who have different views. If you are not the project proponent, try not to form your own conclusions prior to the workshop: you need to be as objective as possible to keep the trust of the workshop participants.

Facilitator: workshop stage

The facilitator in a network fit assessment workshop acts as a compere to get consensus from the general discussion about the impact of the proposal on the road network and also interprets the results from the NFA Tool. A general discussion about delay to trams at a particular intersection needs to be translated/converted into a level of service change with a level of confidence. While everyone will have their own style of facilitating, the following are some key skills that will help you to conduct successful workshop.

7.4.1 The Facilitation Process

1. Outline **the purpose of the workshop** – A successful network fit assessment workshop should start with a clear, crisp articulation of the project proposal and the scope of the assessment you are carrying out. It is important to ensure that all participants agree with the purpose of the workshop. Write down the problem statement on a whiteboard or easel in plain sight of the attendees so you can refer back to it throughout the meeting. The project proponent should explain the need, background and scope of the project.

2. **Invite the participants to introduce themselves** - This helps create an environment where people feel comfortable with each other and with contributing to the discussion. You will continue to foster and maintain this environment throughout the workshop. Encourage them to not only state their name, but their relationship or connection to the proposal and perhaps ask them if they have been involved in a NFA process previously.

3. **Encourage participation** - It's all too easy for the most senior person in the room, or the most confident person in the room, to express their opinions freely and perhaps stifle those of others. *"The things which are most important don't always scream the loudest." – Bob Hawke.* Take particular note of anybody who isn't speaking up during the workshop, and look for opportunities to ask them for their views. Encouraging inclusion is important, but remember to be careful not to 'pick on' any attendees and create an environment of discomfort.

4. **Keep things moving and focussed** - Frequently as a facilitator you'll find that the discussion will drift off course and will not be contributing to the assessment. It is important to keep the discussion moving while at the same time not being so rigid that participants get frustrated or feel silenced. If the discussion has drifted or become destructive, bring it back on course.

Tip: Establish a 'parking lot' - It may be that important issues come up during the discussion which are not relevant to the assessment. Capture these topics in a 'parking lot' to be address in another forum. Ensure that the 'parking lot' is visible to everyone.

5. **Keep the discussion as objective as possible** – It is not possible to be completely objective when facilitating a workshop where you are also the project proponent. However, you can make an effort to be genuine in capturing the views of the other parties, and to be flexible about your own opinions. Make sure that you call on everybody equally, and avoid favouring your fellow project proponents. The key is to ensure that everybody agrees on the data being entered into the tool, and it is important that none of the participants feel disenfranchised by the process.

6. **Use key questions** - Facilitation usually means holding back your own opinion in favour of helping others get to a common, agreed-upon resolution. While this is not always possible in the NFA process when you may be both facilitator and proponent, you can still employ this principle by asking some key questions: What is the impact? How confident are we in that assessment? If most participants agree, then we can generally have a high level of confidence in the assessment. If there are very divergent views on the impact of the proposal, this can be captured in the tool by entering a 'low confidence' against the assessment's impact.

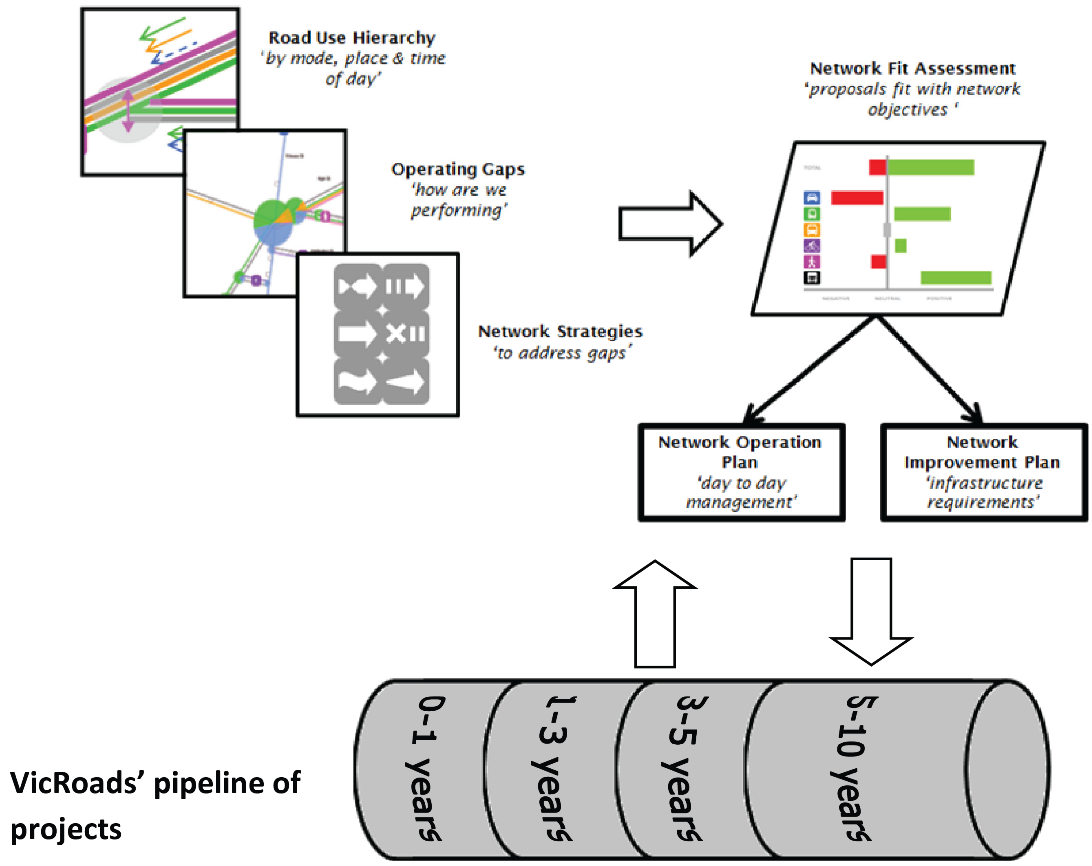
7. **Be the one in control of the discussion** - As mentioned above, part of your role is to keep the discussion moving and keep it focussed. This may mean wrestling control of the discussion from an outspoken attendee or shifting the discussion topic back to the problem statement. While you can usually find gentle ways to move the discussion on, it can be unpleasant and may even get some parties off side, but it is an important part of facilitation. Ultimately, most participants will appreciate a well-run workshop that gets through an assessment in the allocated time, instead of having to come back again to complete the process.

8 NETWORK OPERATING AND IMPROVEMENT PLANS

8.1 Introduction

The final outputs of the SmartRoads process are the Network Operating Plan (NOP) and the Network Improvement Plan (NIP). The NIP and NOP emerge from the strategic intent and operational objectives of the road use hierarchy; the existing and future operating gaps; and the network strategies. The two plans then provide the focus for the two different time frames for managing the network:

- The **NOP** is primarily concerned with optimising the current day-to-day operation of the existing network.
- The **NIP** sets out possible future projects to improve the operational performance of the network; this may include a pipeline of projects to be developed – see diagram below.



As indicated in the above diagram, if we take the road use hierarchy, the existing operating gaps and the network strategies for a particular area, we can identify possible treatments and test them through the network fit assessment process. Those that are found to have a good fit with the intent of the road use hierarchy can be incorporated into the NOP, where they are operational, or the NIP, where they are larger-scale projects requiring funding and time. As shown in the diagram, the NOP guides the current operation of the network whereas the NIP is used to guide the development of proposals in the short, medium and long term.

A good example of this process is the work undertaken when the SmartRoads process is used in planning for places, as described in Section 9. This would typically be activity centre planning and would involve the development of a NOP and NIP for an agreed sub-network.

8.2 Reporting and recording

Typically the NIP and NOP can be presented or reported together with the relevant road use hierarchy, operating gaps, network strategies and NFA outputs. Drawing all of these elements together recognises the synergies between work being done in different parts of VicRoads and adds value to existing processes by enriching them with additional data and analysis.

The report gives us as the road manager an opportunity to be transparent and open about how we operate the network and the reasoning behind our decision making. It also provides an excellent record of the huge amount of work people put into working with stakeholders and the community in devising a plan to operate the network.

From the very first network operating plan developed by VicRoads for Dandenong through to the most recent, we continue to develop SmartRoads and learn from those who implement it, and these processes will continue to influence how we put together the network operating and improvement plans. An important aspect of the plans is their support for the desired land-uses and activities in the sub-network. Accordingly, it is important to draft each plan with its intended use and audience in mind, being sure to include enough information and the right kinds of information.

9 NETWORK OPERATION PLANNING: INTEGRATING LAND-USE AND TRANSPORT

9.1 SmartRoads and land-use planning

Roads can form part of the places they connect, particularly in strip shopping centres and activity centres. SmartRoads acts as part of the process of creating and enhancing these urban places both by facilitating access and by managing the kinds of traffic within a centre. This may include high quality paths and crossings in pedestrian priority areas; providing facilities for public transport to access the activity centre, while ensuring that buses and trams don’t intrude on the public space; and providing alternative routes for freight vehicles to minimise their intrusion into retail and leisure zones. When properly managed, traffic can be part of the dynamic, vibrant energy of a successful activity centre.

To create the best possible transport solutions for Melbourne’s communities, we need to draw together the planning for transport and land use. This applies particularly to activity centres, vibrant hubs where people shop, work, meet, relax and increasingly, live. They are generally well serviced by public transport and provide multifunctional clusters of activity. This is the purpose of the TIA, which has a number of transport system objectives that are the cornerstones of this integrated approach, and decision-making principles that emphasise collaboration and transparency. The Act has a strong focus on sustainability and liveability. Section 3 details the way that the five SmartRoads objectives support this focus and respond to the requirements of the Act.

SmartRoads is an integrated framework, with its strategic road use taking “place” as a fundamental starting point for transport planning by allocating priority to various modes based on the place they are supporting or travelling through with a particular emphasis on activity centres (AC).

The strategic road use was developed in consultation with key state government agencies, local government and transport stakeholders in a series of workshops, usually focussed on one municipality. The workshops used all available traffic and land use data and drew on the experience of the participants to prepare the map based on the key SmartRoads principles. When SmartRoads was being developed, strategic road use maps were produced for each local government area in Melbourne and then joined to form an overall map of the metropolitan area.

SmartRoads has since evolved and become fundamental to the planning process in Melbourne. It now involves a series of workshops (approximately four) which are used to develop a finer-grain strategic road use for activity centres; and in an adopted form for regional cities in Victoria. This can involve including the local roads that will play a role in providing local access. The four workshops go beyond operations objectives to encompass the vision and future land uses for the area under consideration.

In line with the inclusive decision-making emphasised in the TIA, the workshops involve VicRoads, council, Department of Transport Planning and Local Infrastructure and other stakeholders. SmartRoads provides a common language which enables these various transport and land use professionals to work within the same framework.

In the first workshop, stakeholders review and agree the six SmartRoads assignment principles. Gaining understanding and agreement creates an environment where decisions can be made in accordance with the SmartRoads framework in a way that is inclusive and transparent. This involves building up a strategic road use map by considering each of the SmartRoads principles in turn – these are detailed in Section 3 and summarised as follows:

- Support AC objectives and strategic land-use planning.

- Prioritise walking in areas of high pedestrian activity and promote links to and around the AC.

- Prioritise and reduce conflict along routes to the AC and key destinations.

- Prioritise services along routes frequently linking key destinations/activities.

- Where possible travel to be on the arterial network, priority given on Principal freight network.

- Encouraged to use the arterial network over local roads, promote preferred traffic routes to avoid conflicts with abutting land use.

As the activity centres' vision and land-use planning are fundamental to achieving a sustainable transport outcome, they are considered first by the group. Once acknowledged these will shape how the strategic road use is created for pedestrians, bicycles, public transport, general traffic and freight. Working through it in this order enables conflicts to be resolved early and resolutions to be identified using the hierarchy. This creates an environment which is conducive to consensus rather than conflict, and the following workshops are conducted on the basis of a shared understanding of the same goals, enabling joint decisions to be made.

Good facilitation is an important part of an effective workshop, to ensure that all participants are brought into the discussion, all views are captured, and the process is balanced. Tips on facilitating a workshop are provided in Section 7.4.1.

The application of the key principles in developing a strategic road use map is the basis of the SmartRoads framework and developing a Network Operating Plan and Network Improvement Plan. Figure 21 summarises the key outcomes from the initial workshops. Refer to Figure 22 for a detailed flow diagram of the suggested inputs and outputs for each of the workshops. It is highlighted that the process used is very flexible and is likely to be adapted depending on the nature of the activity centre being considered and the concerns and points raised by stakeholders involved.

9.2 Key workshop outcomes

Figure 21 broadly illustrates the outcomes from the four workshops, further explanation on each workshop is given in Section 9.3 and a detailed flow diagram is provided in Figure 22.

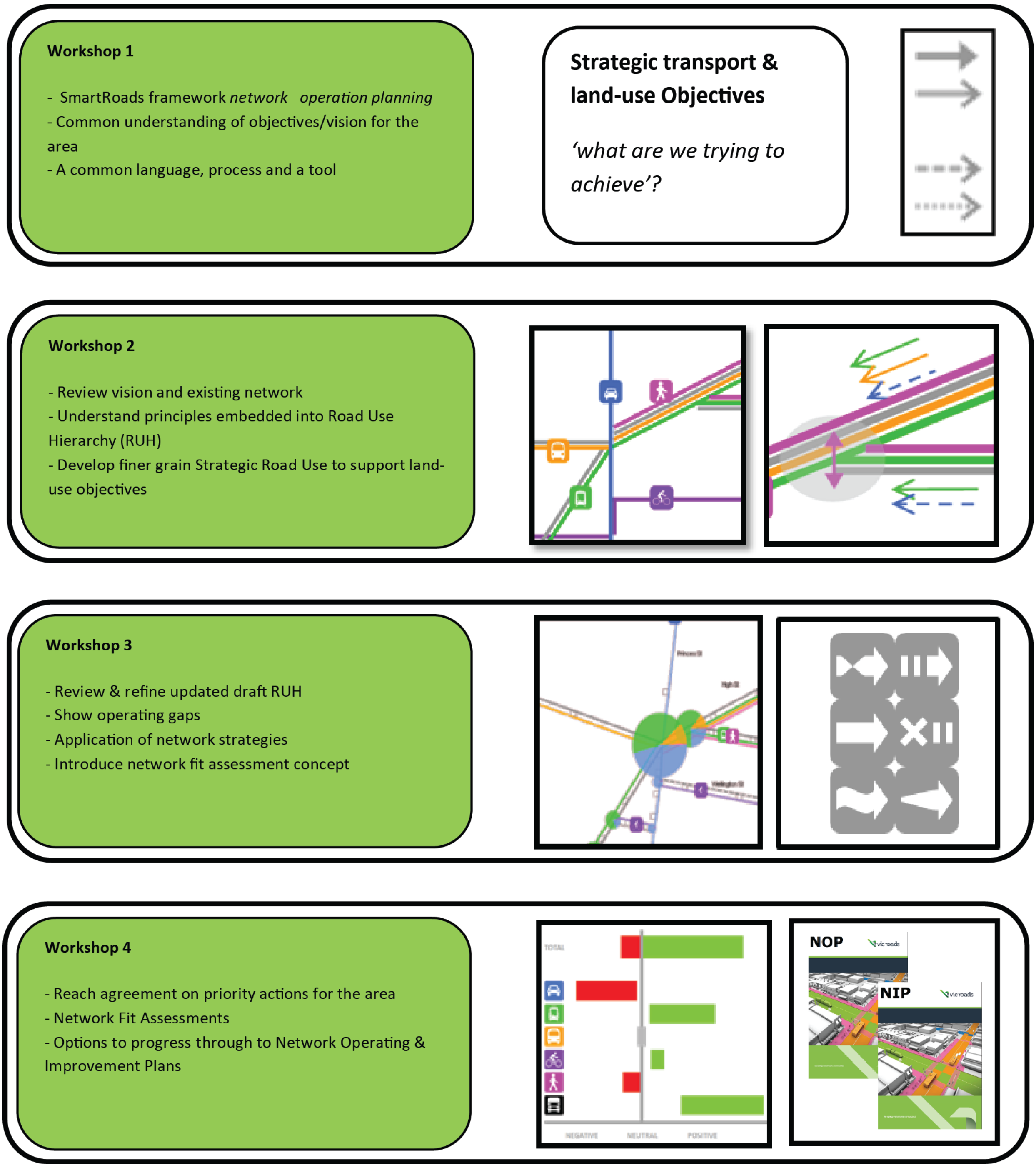


Figure 21 - Key workshop outcomes

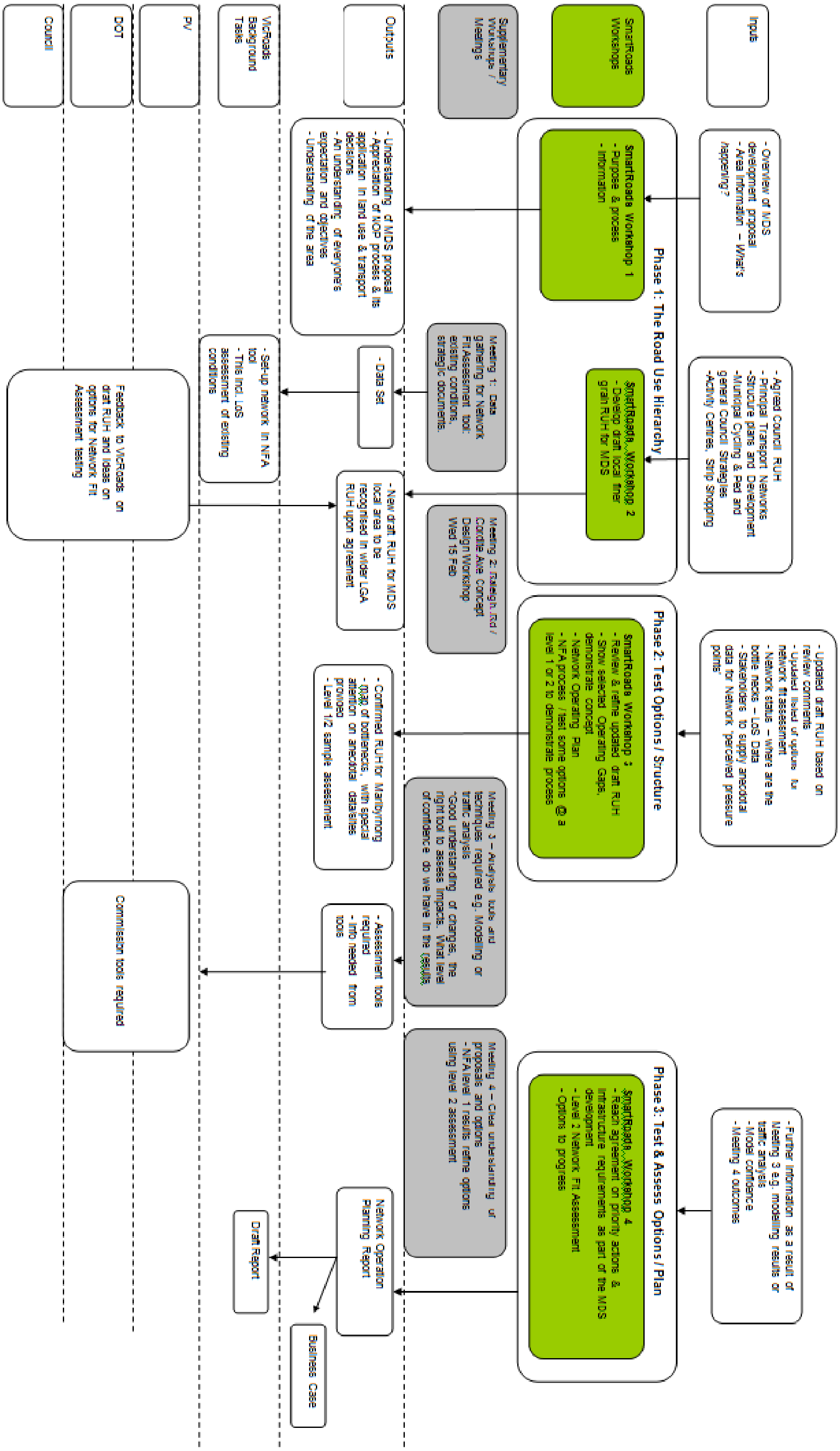


Figure 22 - Suggested inputs and outputs for each of the workshops

9.3 What generally happens in each of the workshops?

9.3.1 Workshop 1 - Purpose and process

1. The first workshop aims to have a common understanding among the group of the vision, for the activity centre (AC). This includes understanding how land-uses will look and feel in the future, and what the strategies are for delivering the vision. Participants should start to acknowledge where the transport network and the objectives of the area are mutually supportive and where they may be in conflict.
2. They should gain a better appreciation of the SmartRoads framework and its application to the AC. This includes the strategies and principles in the framework that are used to create an aspirational strategic road use i.e. '*How do we need the network to operate to support the vision and objectives of the AC*?'
3. By establishing a shared understanding of the AC and SmartRoads, means that planning for the AC can be explored using a common language, while working towards a common goal. Specifically, the interactions of the transport network with the planned land uses in the surrounding area can be examined and captured (through the development of the strategic road use in workshop 2 and in the network fit assessments undertaken in workshop 4).
4. By the end of this workshop all attendees should have:
   - an understanding of the background to the AC planning to date, the future land-uses, the vision for the AC and the strategies to deliver the vision
   - a good appreciation of the SmartRoads network operations planning process – what it does and does not do
   - a good appreciation of the application of the network operations planning in integrated land use and transport decision-making.

9.3.2 Workshop 2 – Develop draft strategic road use map and understand road use hierarchy time of day priorities

5. The vision for the AC is presented by the officer responsible for its implementation. This presentation will set the context and facilitate discussions throughout the workshop.
6. At this workshop, attendees will review the 'regional' strategic road use. In most cases, the regional strategic road use will have been previously been developed and agreed. This will enable participants to think about where and how residents of the activity centre will travel and where and how visitors to the area will access it.
7. In reviewing the regional strategic road use, attendees are asked to consider the function of the principal corridors that link the activity centre to key destinations. What types of land uses are envisioned along these corridors? What transport upgrades might be needed along these corridors to support the priority and principal routes? Is there space available to achieve the transport upgrades (higher levels of service)? Will these upgrades impact on land-use and placemaking objectives?
8. An important part of the workshop is for stakeholders to explore the objectives of the network, as these will be used to review and refine and get agreement to the draft strategic road use map in **workshop 3**. For example, these could include the need to reduce conflict points, special

consideration of amenity values, the need to separate public transport from general traffic, and various accessibility needs for businesses.

9. Towards the end of the workshop a discussion is held to confirm the collection of level of service data for all relevant modes, prior to **Workshop 3** so the operating gaps can be generated and reviewed by the group.

10. Though we will be busy enough in this workshop setting the groundwork, it will be a good opportunity to also discuss the need for any modelling or traffic analysis to be undertaken for network fit assessments in **workshop 4**

11. Post **workshop 2**, we will send out the draft strategic road use map including local roads for the area surrounding the activity centre, to allow the group to go back to their respective organisations and discuss further, any comments need to be provided prior to **workshop 3**.

9.3.3 Workshop 3 – Review and refine draft RUH, understand the network operating gaps, investigate strategies and introduce the network fit assessment concept

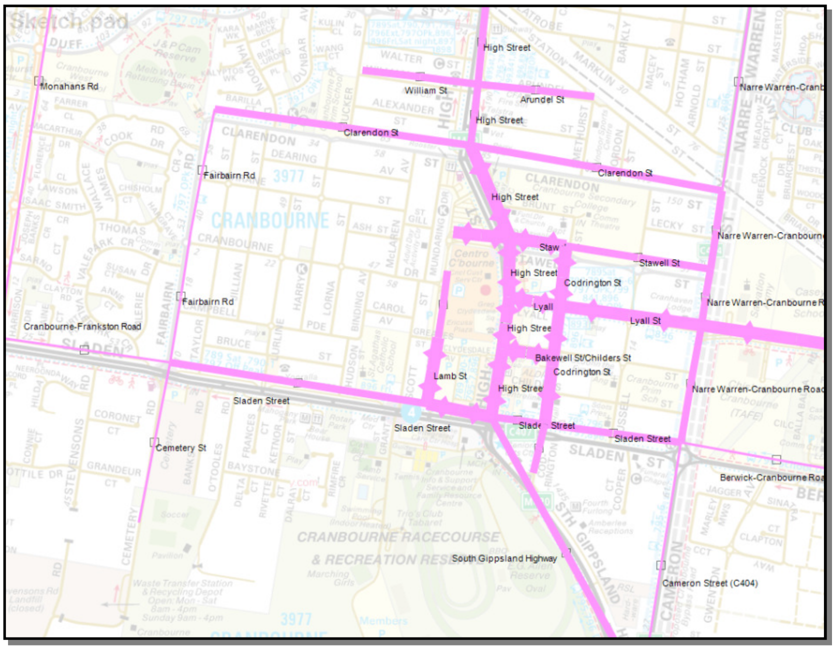
12. We are aiming to confirm the strategic road use for the activity centre after reviewing the feedback and comments received after workshop 2.

13. The time of day priorities from the SmartRoads framework will be applied to the confirmed strategic road use to generate the road use hierarchy maps for the four key time periods.

14. Though we are aiming for it to be confirmed, all stakeholders are given the opportunity to take the strategic road use maps back to their respective organisations for final sign-off prior to **workshop 4**.

15. Using the road use hierarchy (strategic road use map + time of day rules):

    - we can show the levels of encouragement maps for each of the modes for each of the four key time periods, the map below displays the levels of encouragement for pedestrians in the high-off peak period in the Cranbourne Town Centre – the thicker the line the more encouragement given



- we can present the current network operating gaps for the four key time periods (dependant on the level of service information collected). This illustrates the difference between the current performance of each mode and the network operation objectives (how we would like the network to operate).

16. Discussions will be held on the types of strategies that might be put in place on the network to achieve our objectives.

17. As part of reviewing the operating gaps and developing strategies, stakeholders are asked to begin thinking about proposals to put forward that address these gaps and meet our strategies, or land-use/amenity proposals that could possibly effect the operation of the network. These proposals will be tested through the network fit assessment process in **workshop 4**.

9.3.4 Workshop 4 – Priorities, testing and actions

18. This workshop involves undertaking network fit assessments to test operational and land-use changes against the road use hierarchy. Any required data should be prepared prior to the workshop.

19. As part of these workshops we may test an interim period (0-10 years) and an ultimate network (15+ years).

20. The aim is to reach agreement on priorities for transport and land use actions in the AC.

21. In addition to the SmartRoads assessment we can use the urban design protocol for Australian cities, 'Creating Places for People', to test options against the liveability objectives. These objectives are available at http://www.urbandesign.gov.au/

22. The resulting process goes on to inform both the:

- Network Operating Plan: how we will operate the network on a day to day basis, such as: traffic signal phasing

- Network Improvement Plan: the future interventions and possible infrastructure needed to be put in place to meet the vision of the AC and the objectives of the network.

9.4 Using the Link and Place Framework

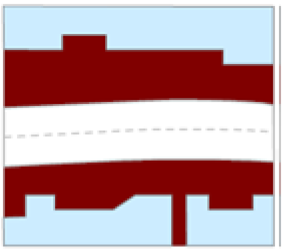
In developing the SmartRoads framework, a number of existing planning tools were reviewed. While there was no one specific tool that met VicRoads' needs, there were some key tools that were considered to be sound foundations for a comprehensive operational planning framework—the 'Link and Place' methodology in particular.

The 'Link and Place' planning model has emerged as a way of achieving better urban design and land-use outcomes by design streets for people. It recognises that roads have real consequences for placemaking.

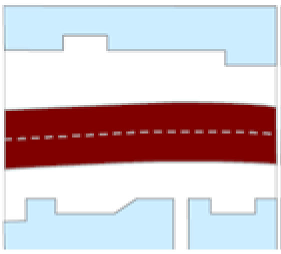
The 'Link and Place' approach advocates the creation of 'road plans', which like land use/road hierarchy plans, are an expression of future intent. The road plans integrate the considerations of the road network function, road reservation/space and adjoining land uses. The road is not just a divider of land uses, but is recognised as a *setting* for land uses and community activities in its own right.

The diagrams below further illustrate the main premise of the Link and Place model, this thinking can be incorporated into planning for places, such as: the creation of road and street cross sections that align with the place values and provide for an appropriate level of service for the identified SmartRoads road use hierarchy.

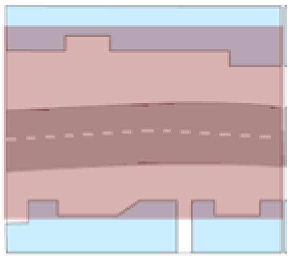
Link and Place framework:



Link function— seeks to enable users to pass through the road as quickly and conveniently as possible



Place function— seeks to encourage users to stay as long as desirable on a road and enjoy its surroundings



Road plan— how it is planned, designed and managed to recognise abutting land use and route function. Design includes urban design and landscape considerations

Example cross section:

Below is an example of a before and after cross section from Christchurch, New Zealand where they have gone through an exercise to design their road cross sections to reflect the aspirational road use hierarchy.

Typical central city street – before

Typical slow Core street – after

9.5 SmartRoads Planning for Places: Revitalising Dandenong

In 2010, the Revitalising Central Dandenong Access and Mobility Working Group was charged with developing a plan for the Dandenong central activities district that would outline how the road network would be managed. The group comprised representatives from VicRoads, City of Greater Dandenong, Department of Transport and Places Victoria (formerly VicUrban). As was the case with most activity centre planning at the time, each of these stakeholders came to the process with preconceived ideas of what the best transport solutions would be – but there was no agreed definition of the transport needs, or problems, in the area.

When the SmartRoads team became involved, they facilitated a discussion about transport objectives, posing the question: what does success look like at the end of the day?

The SmartRoads process brings participants together to agree on the five SmartRoads objectives, such as promoting links to activity centres and giving public transport first priority on designated routes on the principal public transport network. This agreement creates an environment where decisions can be made in accordance with the SmartRoads framework in a way that is inclusive and transparent. From here, the strategic road use map can be built up through a series of workshops.

In the case of Dandenong, four workshops and other meetings were held over a period of about six months. Part of the process was to go through each mode and give it absolute priority in the Metropolitan Activity Centre. This enabled all participants to see the shortfalls created by one mode dominating, and to see that each mode has a role to play in a successful transport system.

A shared language is a key component of the SmartRoads approach. This enables participants to be on the same page, working towards the same vision. In Dandenong, this resulted in a finer-grained strategic road use that included relevant local roads and sets out the priority use of each link by transport mode, by place and by time-of-day; as well as agreement on a 'monitoring gap' process that helped identify areas requiring treatments.

The SmartRoads approach is rule-based, repeatable and robust. Since the success in Dandenong, this process has been used for all Metropolitan Activity Centre planning in Melbourne and is used increasingly for various planning activities across Victoria.

10 DETERMINING LEVEL OF SERVICE

10.1 LOS Descriptions

Table 10 to Table 14 set out the LOS descriptions for each transport type.

Table 10 - Level of Service for Trams/Buses

Transport type	LOS	Description
Tram & Bus	A	Excellent operating conditions with operating speed at least 80% of the posted speed limit (excluding boarding times). Trams/Buses are unimpeded in manoeuvring in the traffic stream with no intersection delays.
	B	Relatively unimpeded flow with operating speed between 60-80% of the posted speed limit (excluding boarding times). Manoeuvring in the traffic stream is only slightly restricted and intersection delays and variability is low. In total this results in delays of approximately 30 seconds compared to posted speed limit conditions.
	C	Stable operating conditions but with manoeuvring becoming more restricted and other vehicles have an impact on tram/bus operation resulting in moderate levels of variability. Operating speeds are between 40-60% of the posted speed limit conditions (excluding boarding times). At signalised intersections, trams/buses generally have to stop in a queue but clear the intersection in 1 signal cycle (if boarding time is excluded). In total, this results in delays of approximately 60 seconds compared to posted speed limit conditions.
	D	High level of variability in which any small increases in traffic volumes can significantly increase delay for trams/buses. Operating speeds are between 20-40% of the posted speed limit conditions (excluding boarding times). At signalised intersections, trams/buses always join the back of an existing queue and take 2 signal cycles to clear the intersection. In total, this results in delays of approximately 120 seconds compared to posted speed limit conditions.
	E	Conditions are characterised by significant delays and very high levels of variability, with operating speeds between 10-20% of the posted speed limit conditions (excluding boarding times). At signalised intersections, trams/buses take 3 signal cycles to clear the intersection. In total, this results in delays of approximately 240 seconds compared to posted speed limit conditions.
	F	Tram/bus operation at this level is at very low speeds (less than 10% of the posted speed limit conditions (excluding boarding times) and experience extreme levels of variability. At signalised intersections, trams/buses can take more than 3 signal cycles to clear the intersection. Backups from downstream or right-turning traffic ahead of tram/bus significantly impacts traffic flow. In total, this results in delays of approximately 360 seconds compared to posted speed limit conditions.

Note: These LOS descriptions are based on 1km spacing between traffic signals in a 60km/h posted speed limit environment. Discretion is required when conditions vary from this- supporting data may be used to assist.

Table 11 - Level of Service for Pedestrian

Transport type	LOS	Description
Pedestrian	A	Crossing opportunities are within 25m of demand. No delay in crossing.
	B	Crossing opportunities are within 50m of demand. Average delay before being able to safely cross is less than 30 sec.
	C	Crossing opportunities are within 100m of demand. Average delay before being able to safely cross is less than 45 sec.
	D	Crossing opportunities are within 200m of demand. Average delay before being able to safely cross is less than 60 sec.
	E	Crossing opportunities are within 400m of demand. Average delay before being able to safely cross is less than 90 sec.
	F	Crossing opportunities are more than 400m from demand. Average delay before being able to safely cross is more than 90 sec.

*Refer to Tables 12 to obtain a more accurate level of service.

Tables 12a reflects a matrix of the time required to travel to the crossing points and the wait times for crossing opportunities, consistent with the above descriptors, whilst Table 12b provides a Total Delay/LOS table. Either table can be used as quick guides to determine LOS depending on the information available.

Tables 12 - Level of Service Matrix for Pedestrians

Wait time at Crossing (seconds)	<25	26-50	51-100	101-200	201-400	400+
180+	E+	E+	E	E-	F	F-
151-180	D-	D-	E+	E	F	F-
121-150	D	D	E+	E	F+	F-
91-120	D+	D+	D-	E+	F+	F
61-90	C-	D+	D	E+	E-	F
46-60	C+	C	D+	D-	E-	F+
31-45	B-	C+	C-	D-	E-	F+
16-30	B	B-	C-	D-	E-	F+
<15	A	B	C	D	E	F+

*Spacing (m)

Table 12a

Total delay**	LOS
0	A
19	A-
37	B+
49	B
61	B-
73	C+
91	C
110	C-
129	D+
162	D
195	D-
228	E+
293	E
358	E-
424	F+
492	F
560	F-
628	

Table 12 b

* Spacing is approximate distance from key demand locations to crossing points

** Total Delay= Average Wait Time + Walk Time (outside of desired walk path) (Sec)

Spacing refers to the closest walking distance required for Pedestrians to cross the road using a pedestrian facility. A pedestrian facility is any infrastructure designed to encourage pedestrians to cross the road. These facilities include but not limited to, Signalised Intersections/Crossings, Pram Ramps, Zebra Crossings, and School Crossing areas when School crossing supervisor is present etc.

Table 13 - Level of Service for Bicycles

	On-Road											Off-Road		
	No-Separation									Separation		Off-Road		
	Midblock [1]									Midblock [1]		Midblock[3]		
LOS	F-	F	E	D-	D	D+	C-	C	C+	B-	B	B+	A-	A
Midblock	No Bicycle Facilities	Wide kerbside lane	1m bicycle lane or shared Bicycle/Bus Lane	1.2 m bicycle lane with kerbside parking	1.2m bicycle lane, without green paint across side streets	1.5m bicycle lane, with green paint across side streets	1.7m bicycle lane, with green paint across side streets and kerbside parking	1.7m bicycle lane, with green paint across side streets and no kerbside parking.	2.0m bicycle lane, with green paint across side streets and no kerbside parking	Dedicated 2.0m kerb side lane, separated by parking and/or hard separator with <0.5m lateral clearance to obstruction	Dedicated 2.0m kerb side lane, separated by parking and/or hard separator	Shared Path <3.0m wide	Shared Path >3.0m wide	Dedicated minimum 3.0 metre off road path, grade separated, and minimal delay.
Approach to Intersection [1] (No-Separation) / Approach to Intersection (Separation)	Nothing[1]	Nothing[1]	Nothing[2]	Nothing[1]	Nothing[2]	Nothing[2]	Bicycle lanes completed to and from intersections with green paint[4]	Bicycle lanes completed to and from intersections with green paint[4]	Bicycle lanes completed to and from intersections with green paint[4]	Bicycle lanes completed to and from intersections with green paint.	Bicycle lanes completed to and from intersections with green paint			

LOS depicted in above table for "On-Road" Bicycle Lanes refers to 50kmh roads. LOS will be improved one level for "On-Road" Bicycle lanes with lower speed limits.

[1]Higher Bus frequency (>10/hr = -1/3LOS.), high left turn volumes, can reduce the LOS up to one level.
[2]Widening of bike lane, adding bicycle lane to and from intersection, green paint across side streets, bicycle Lantern, can improve the LOS by Maximum 2/3. Conversely, lanes without green paint across side streets can reduce LOS by 1/3.
[3]Crossing delays for Off-road paths intersecting with roads will incur the following change in LOS: <30 seconds = No Change; 30-60 seconds = - 1/3 LOS; 60-90 Seconds = - 2/3 LOS; >90 Seconds = -1 LOS.
[4]Bicycle Lane at the approach to the intersection is required to be minimum 1.2m. If bicycle lane is less than 1.2m, then LOS will be reduced by 1/3.

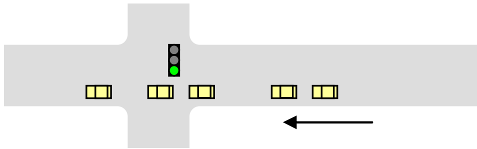
Table 14 - Level of Service for General Traffic & Freight on Arterial Roads

Transport type	LOS	Description
General traffic & freight on arterial roads	A	Excellent operating conditions with operating speed at least 80% of the posted speed limit. Vehicles are unimpeded in manoeuvring in the traffic stream with no intersection delay.
	B	Relatively unimpeded flow with operating speed between 60-80% of the posted speed limit. Manoeuvring in the traffic stream is only slightly restricted and intersection delays and variability are low. In total, this results in delays of approximately 30 seconds compared to posted speed limit conditions.
	C	Stable operating conditions but with manoeuvring becoming more restricted resulting in moderate levels of variability. Operating speeds are between 40-60% of the posted speed limit. At signalised intersections, vehicles generally have to stop in a queue but clear the intersection in 1 signal cycle. In total, this results in delays of approximately 60 seconds compared to posted speed limit conditions.
	D	High level of variability in which small increases in traffic volumes can significantly increase delay. Operating speeds are between 20-40% of the posted speed limit. At signalised intersections, vehicles always join the back of an existing queue and take about 2 signal cycles to clear the intersection. In total, this results in delays of approximately 120 seconds compared to posted speed limit conditions.
	E	Conditions are characterised by significant delays and very high levels of variability with operating speeds between 10-20% of the posted speed limit. At signalised intersections, vehicles take 3 signal cycles to clear the intersection. In total, this results in delays of approximately 240 seconds compared to posted speed limit conditions.
	F	Traffic flow at this level is at very low speeds (less than 10% of the posted speed limit) and experiences extreme levels of variability. At signalised intersections, vehicles can take more than 3 signal cycles to clear the intersection and backups from downstream significantly impacts traffic flow. In total, this results in delays of approximately 360 seconds compared to posted speed limit conditions.

Note: These LOS descriptions are based on 1km spacing between traffic signals in a 60km/h posted speed limit environment. Discretion is required when conditions vary from this- supporting data may be used to assist.

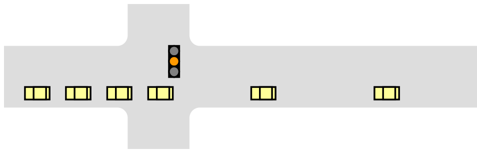
10.1.1 General Traffic LOS Examples for Arterial Roads

A



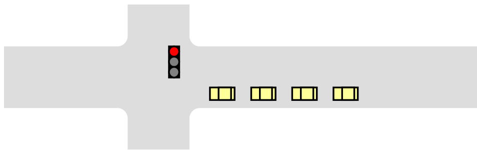
Majority of vehicles experience little or no delay. Occurs in well-co-ordinated signal systems

B



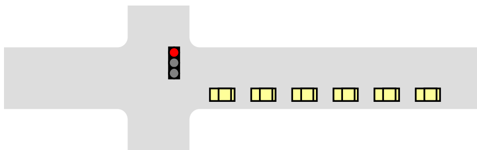
Half of the vehicles experience little or no delay. Occurs in co-ordinated signal systems with competing demands for signal time.

C



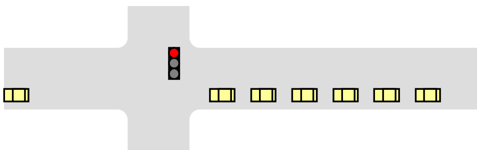
Vehicles generally have to stop but all waiting vehicles clear intersection during 1 signal cycle.

D



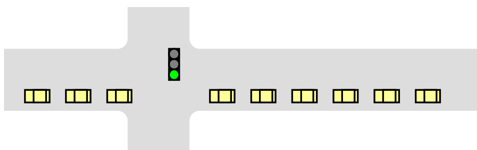
Vehicles join the back of an existing queue and take 2 signal cycles to clear intersection.

E



Vehicles join the back of an existing queue and take 3 or more signal cycles to clear intersection. Backups from downstream occasionally restricts movement

F



Vehicles take 3 or more signal cycles to clear intersection and backups from downstream significantly impact traffic flow.

Figure 23- General Traffic Level of Service for Arterial Roads

10.2 Determining Level of Service using travel speed and average delay

10.2.1 Determining Level of Service using travel speed

For general traffic, LOS can more fundamentally be determined based on the average speed of travel and traffic delays. Table 15 sets out the LOS criteria for various freeways and arterial road types in terms of travel speed. However, in most cases this data is not readily available or is difficult to observe (for arterial roads).

Table 15 - Determining Level of Service using travel speed for a Level 2 Assessment

	Freeway		Arterial Road				
LOS	**100km/h Speed Limit**	**80km/h Speed Limit**	**80km/h Speed Limit**	**70km/h Speed Limit**	**60km/h Speed Limit**	**50km/h Speed Limit**	**40km/h Speed Limit**
A	> 85km/h	> 70km/h	> 70km/h	> 60km/h	> 50km/h	> 40km/h	> 32km/h
A-	≥ 80km/h to < 85km/h	≥ 65km/h to < 70km/h	≥ 65km/h to < 70km/h	≥ 55km/h to < 60km/h	≥ 45km/h to < 50km/h	≥ 35km/h to < 40km/h	≥ 30km/h to < 32km/h
B+	≥ 76km/h to < 80km/h	≥ 61km/h to < 65km/h	≥ 60km/h to < 65km/h	≥ 50km/h to < 55km/h	≥ 40km/h to < 45km/h	≥ 31km/h to < 35km/h	≥ 27km/h to < 30km/h
B	≥ 73km/h to < 76km/h	≥ 58km/h to < 61km/h	≥ 50km/h to < 60km/h	≥ 45km/h to < 50km/h	≥ 35km/h to < 40km/h	≥ 28km/h to < 31km/h	≥ 24km/h to < 27km/h
B-	≥ 70km/h to < 73km/h	≥ 55km/h to < 58km/h	≥ 40km/h to < 50km/h	≥ 40km/h to < 45km/h	≥ 30km/h to < 35km/h	≥ 25km/h to < 28km/h	≥ 22km/h to < 24km/h
C+	≥ 66km/h to < 70km/h	≥ 53km/h to < 55km/h	≥ 35km/h to < 40km/h	≥ 35km/h to < 40km/h	≥ 26km/h to < 30km/h	≥ 21km/h to < 25km/h	≥ 20km/h to < 22km/h
C	≥ 63km/h to < 66km/h	≥ 51km/h to < 53km/h	≥ 30km/h to < 35km/h	≥ 30km/h to < 35km/h	≥ 23km/h to < 26km/h	≥ 18km/h to < 21km/h	≥ 18km/h to < 20km/h
C-	≥ 60km/h to < 63km/h	≥ 50km/h to < 51km/h	≥ 25km/h to < 30km/h	≥ 25km/h to < 30km/h	≥ 20km/h to < 23km/h	≥ 15km/h to < 18km/h	≥ 15km/h to < 18km/h
D+	≥ 56km/h to < 60km/h	≥ 46km/h to < 50km/h	≥ 21km/h to < 25km/h	≥ 21km/h to < 25km/h	≥ 16km/h to < 20km/h	≥ 13km/h to < 15km/h	≥ 13km/h to < 15km/h
D	≥ 53km/h to < 56km/h	≥ 43km/h to < 46km/h	≥ 18km/h to < 21km/h	≥ 18km/h to < 21km/h	≥ 13km/h to < 16km/h	≥ 11km/h to < 13km/h	≥ 11km/h to < 13km/h
D-	≥ 50km/h to < 53km/h	≥ 40km/h to < 43km/h	≥ 15km/h to < 18km/h	≥ 15km/h to < 18km/h	≥ 10km/h to < 13km/h	≥ 10km/h to < 11km/h	≥ 10km/h to < 11km/h
E+	≥ 46km/h to < 50km/h	≥ 36km/h to < 40km/h	≥ 13km/h to < 15km/h	≥ 13km/h to < 15km/h	≥ 8km/h to < 10km/h	≥ 8km/h to < 10km/h	≥ 8km/h to < 10km/h
E	≥ 43km/h to < 46km/h	≥ 33km/h to < 36km/h	≥ 11km/h to < 13km/h	≥ 11km/h to < 13km/h	≥ 6km/h to < 8km/h	≥ 6km/h to < 8km/h	≥ 6km/h to < 8km/h
E-	≥ 40km/h to < 43km/h	≥ 30km/h to < 33km/h	≥ 10km/h to < 11km/h	≥ 10km/h to < 11km/h	≥ 5km/h to < 6km/h	≥ 5km/h to < 6km/h	≥ 5km/h to < 6km/h
F+	≥ 25km/h to < 40km/h	≥ 20km/h to < 30km/h	≥ 6km/h to < 10km/h	≥ 6km/h to < 10km/h	≥ 3km/h to < 5km/h	≥ 3km/h to < 5km/h	≥ 3km/h to < 5km/h
F	≥ 10km/h to < 25km/h	≥ 10km/h to < 20km/h	≥ 3km/h to < 6km/h	≥ 3km/h to < 6km/h	≥ 1km/h to < 3km/h	≥ 1km/h to < 3km/h	≥ 1km/h to < 3km/h
F-	≥ 0km/h to < 10km/h	≥ 0km/h to < 10km/h	≥ 0km/h to < 3km/h	≥ 0km/h to < 3km/h	≥ 0km/h to < 1km/h	≥ 0km/h to < 1km/h	≥ 0km/h to < 1km/h

10.2.2 Determining Level of Service using average delay

Table 16 provides a guide to the determination of change in Level of Service (LOS) from traffic modelling outputs. The LOS Change is the relative change in operating conditions along the link and at the approaches to the intersection for general traffic. The LOS Change is based on the change in average delay as a proportion of the cycle time at the intersection, but is simplified into an estimated change in average delay.

Table 16 - LOS interpretation from modelling outputs in the form of delays

ΔT = Change in Average Delays			
LOS Change		Change in Average Delay for 120 second cycle (seconds)	Estimated Change in Average Delay (seconds)*
N	$\Delta T < 10\%$	$\Delta T < 10$	$\Delta T < 10$
Very Low	$10\% \le \Delta T < 33\%$	$12 \le \Delta T < 40$	$10 \le \Delta T < 30$
Low	$33\% \le \Delta T < 67\%$	$40 \le \Delta T < 80$	$30 \le \Delta T < 60$
Medium	$67\% \le \Delta T < 150\%$	$80 \le \Delta T < 180$	$60 \le \Delta T < 180$
High	$150\% \le \Delta T$	$180 \le \Delta T$	$180 \le \Delta T$

**For simplicity, the Estimated Change in Average Delay is broadly based on a typical cycle time of 120 seconds. This is recommended to be adopted regardless of cycle time.*

10.3 An observational Level of Service Assessment Methodology

10.3.1 When to measure LOS

For the purposes of operating objectives based on delay, LOS is determined for 15 minute bands within each time period (AM, HOP, PM, OP).

For example, General traffic on the Hoddle Street north approach to Johnston Street in the AM peak (6.30am to 9.30am) can be reported as shown in **Figure 24**

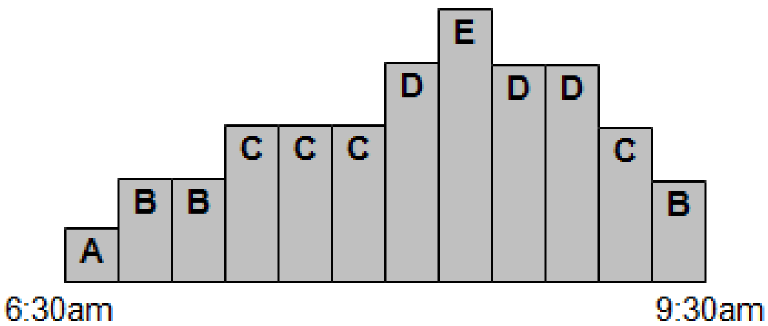


Figure 24 - Fifteen Minute LOS Example

For the example above this would result in a lowest LOS of E.

The measurement of LOS from on-site inspections has proven to present some challenges. The variability in traffic conditions over a time period can be such that it is very difficult to pin-point the LOS. This is further complicated by the number of approaches and modes at many intersections. In order to facilitate a quick and consistent way of measuring LOS, a simplified field methodology has been adopted. The aim is to collect a greater sample of simpler measurements, rather than a small sample of complex measures.

10.3.2 Simplified LOS Descriptions

Based on experience with a number of methodologies, it was found that LOS C was the easiest to identify visually. In most cases, an observer can identify whether traffic on an approach is operating at, better or worse than LOS C. Where operation is worse than C then a further assessment is made as to whether the departure-side flow is significantly impacted by a downstream queue. This is set out in Table 17.

Operating Level	General description of operation	Rating
<C	Better than C	0
C	• At least 75% of the vehicles in a stationary queue at the start of the green phase clear the intersection during that phase. • No more than 25% more vehicles joining the stationary queue clear the intersection during that phase	2
>C	Worse than C	4
>>C	Worse than C and departure-side flow is significantly impacted by a downstream queue.	6

Table 17 - Simplified LOS Descriptions

Each operating level is assigned a rating value to enable a quantified assessment to be made.

10.3.3 Methodology

For each approach/movement, take observations of each signal phase over a 15 minute period based on the simplified LOS descriptions and record (with ticks) as shown in Table 18.

Time	<C	C	>C	>>C
Rating	0	2	4	6
4:00pm-4:15pm	✓✓	✓✓✓✓		
4:15pm-4:30pm	✓	✓✓	✓✓	

Table 18 Example site assessments

The average operating level for a 15 minute period can then be calculated by summing the ratings for that period and dividing by the number of observations. This average rating can then be used to give the movement operating level (see Table 19).

Average Rating Range	**Typical Rating**	**Movement Operating Level**
<= 0.4	0	A
0.5 – 1.4	1	B
1.5 – 2.4	2	C
2.5 – 3.4	3	D
3.5 – 4.4	4	E
>= 4.5	5	F

Table 19 - Movement operating levels

Using the example above, the resulting movement operating levels can then be derived as shown in Table 20.

Time	**<C**	**C**	**>C**	**>>C**	**Movement Operating Level**
Rating	0	2	4	6	
4:00pm-4:15pm	✓✓	✓✓✓✓			(2x0+4x2)/6 = 8/6 = 1.3 (B)
4:15pm-4:30pm	✓	✓✓	✓✓		(1x0+2x2+2x4)/5 = 12/5 = 2.4 (C)

Table 20 - Example movement operating level calculations

In this example the worst 15 minute period would yield an operating level of C.

10.4 LOS on arterial roads in heavy congestion

The previous examples and methodologies for determining LOS by observation for general traffic on arterial roads begin to produce unrealistic values when traffic conditions become very congested and queues bank up through several consecutive intersections. In these situations, intersections are closely spaced and traffic on a link may well clear the intersection in a single signal cycle. But the travel speed is very low and the 'real' back of queue extends beyond the previous intersection. This situation is illustrated in Figure 25.

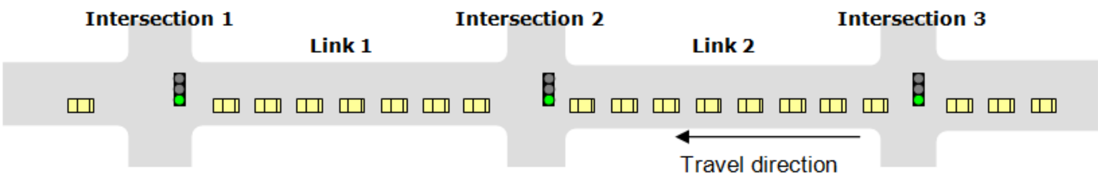


Figure 25 - Queuing through intersections in heavy congestion

Using the example in Figure 25, if each of the queues in links 1 & 2 clear their respective intersections 1 & 2 in a single traffic signal cycle, then the LOS would be determined as LOS C using the previous LOS descriptions given in Figure 23. However, in this type of congestion, traffic is moving slowly and travel speeds are more representative of LOS D, E or F. In fact in many situations, intersections 2 & 3 are usually incidental to the overall performance of the route, and intersection 1 is the controlling operational bottleneck.

To account for this situation, where LOS is determined by observation, then the LOS is adjusted where the back of queue extends back through to a previous link. This is done in 3 stages:

- Firstly, LOS is determined using the guidelines set out in Figure 23. For our example in Figure 25, let's say that traffic clears each intersection in one cycle. Therefore the LOS for links 1 & 2 are both LOS C.

- Secondly, controlling intersections are identified as those that constrain the flow of traffic from upstream links. Generally, this can be observed as a clear space downstream of the intersection. In Figure 25, this would be intersection 1.

- Thirdly, the LOS on the link leading into the controlling intersection, in this case link 1, is adjusted based on the number of intersections through which the queue extends upstream. For each intersection, the LOS is adjusted 1 level. In this example, the LOS on link 1 would be adjusted 2 levels from LOS C to LOS E. The LOS on the other upstream links is unchanged.