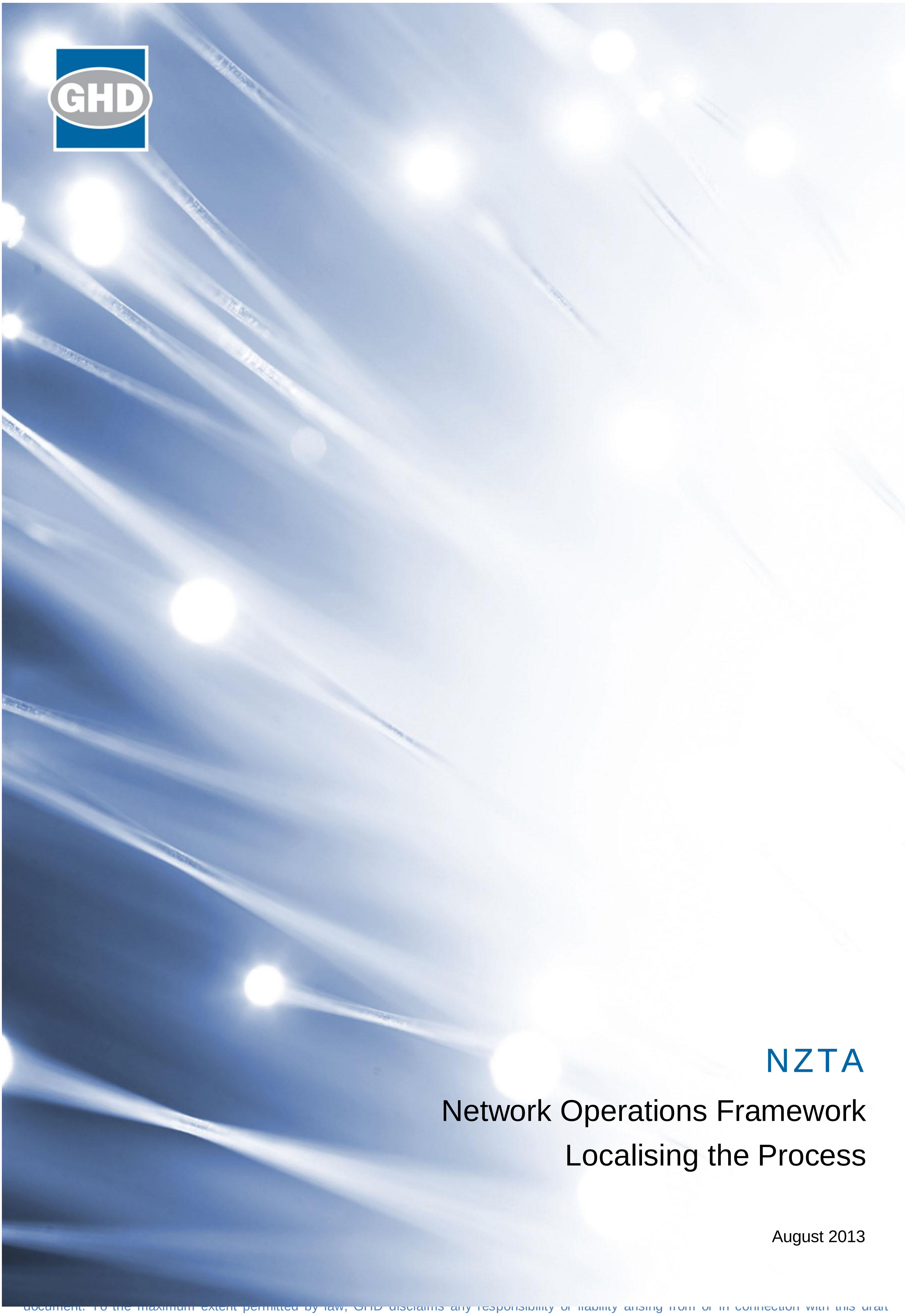

NZTA

Network Operations Framework
Localising the Process

August 2013

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1. Introduction

GHD has been commissioned to assist NZTA in customising the SmartRoads process, developed by VicRoads in Australia, to suit New Zealand conditions and context. SmartRoads is an innovative process for managing, planning and operating transport networks. It has its origins in the Austroads Network Operations Planning Framework and has been developed as a practical application of this framework for Victoria. The intended adaptation of this process is to enable the transport network operators to deliver positive transport outcomes by taking a whole network, multi-modal approach. This involves linking land use with transport decisions whilst considering the effects on the surrounding community.

The scope of work involves peer reviewing pre-existing research undertaken by the National Network Operating working framework group and recommend New Zealand appropriate:

- Numerical values;
- Land use definitions;
- Level of service definitions;
- Modal priority tables; and
- Value of time for different modes and urban categories.

1.1 Purpose of this report

The purpose of this report is to present the research undertaken in developing recommendations for New Zealand centric factors and definitions for use in the adaptation of SmartRoads. This includes peer review of existing NZTA research as well as additional data collation, analysis, literature review and spreadsheet development required to formulate the recommendations.

1.2 Scope and limitations

Standard GHD disclaimer:

This report has been prepared by GHD for NZTA and *may only be used and relied on by NZTA for the purpose agreed between GHD and the NZTA as set out in section 1.1 of this report.*

GHD otherwise disclaims responsibility to any person other than NZTA arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

2. Throughput

The following section provides informed recommendations on throughput ranges for each mode.

2.1 General Traffic

General traffic, making up the largest component of person throughput has the largest influence. Therefore, getting a reasonable degree of accuracy is important for meaningful assessment.

Holding all other factors constant, a 10% change in vehicles per hour will change relative efficiency factor by 0.1.

Initial recommendations for throughput ranges have used Auckland Harbour Bridge (AHB) as a ceiling value.

Newmarket Viaduct volumes exceed those on AHB and have been assessed. Volumes on the Newmarket Viaduct have consistently been shown to meet and exceed the maximum theoretical capacity for a free flow midblock.

However, as this is the ceiling value it needs to cover the maximum possible throughput which based on the highest capacity segments of the Auckland Motorway is the same as Melbourne at 9600 vph based on a capacity of 2400 v/h/l with 4 lanes.

Busy dual lane arterial roads like Great North Road in Auckland can carry around 2400 vph in the peak direction.

For small / medium scale urban centres, it is most important to set the increments at the lower end of the throughput range at a level where relative difference is visible. For example, a link carrying 200vph opposed by a link carrying 50vph would have no visible difference with increments of 200vph.

Figure 1 below shows the range of throughput values for general traffic from over 1200 links across Palmerston North, Gisborne, Napier, Hastings, Taupo, Wanganui, Kapiti, Whakatane, Nelson and Rotorua.

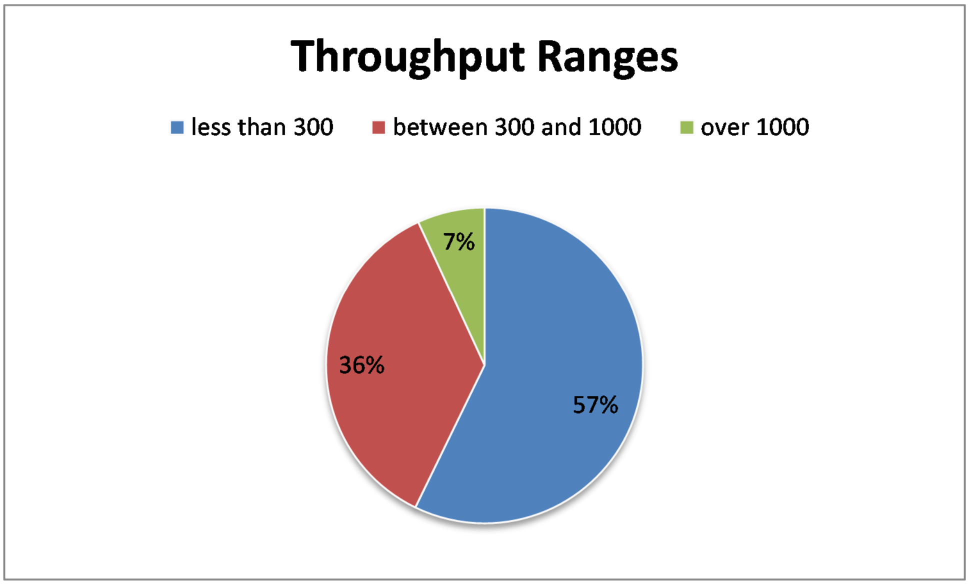

Figure 1: Throughput on roads across New Zealand

We can see that over 50% of the links have throughput values less than 300 and less than 10% are greater than 1000. Therefore, our recommendation is that increments are graduated from 50 to 100 to 200 and then to 500 in the upper ranges as per Table 1 below.

Table 1: Recommended Throughput Range – General Traffic

Throughput	Increments
0 to 300	50
300 to 1000	100
1000 to 2600	200
2600 to 9600	500

This would result in 36 available selections in the drop down list, compared to a currently available 32 selections in the SmartRoads NFA tool.

Where the increments reach 500 (at throughput values over 2600vph), this is greater than the hourly throughput on a busy arterial road like Great North Road in Auckland (approximately 2400vph) and is therefore likely to only be seen in motorway situations where larger increments do not matter as much.

In addition, we endorse the proposal for the tool to allow direct input of flows where they are available. This will allow users to not be bound by any increment values given in the drop down list.

2.2 Bus

We have looked at bus route timetables across a number of cities including Taupo, Whakatane, Gisborne, Napier / Hastings, Wanganui, Nelson, Kapiti, Palmerston North and Rotorua.

In smaller cities, most services were running either once an hour, once every 30 minutes, or once every 15 minutes on the busiest routes. This corresponds to 1, 2 or 4 buses in an hour.

In Palmerston North, most services ran a bus every 20 minutes, with the exception of the route to Massey University which runs a service every at least every 5 minutes. This shows how special activity areas can significantly change transport demands even in relatively small locations.

The current recommendation is for a bus throughput range of 0 to 120 with increments of 5.

Figure 2 below shows the relationship between timetabled bus spacing and the resulting frequency of buses on a route.

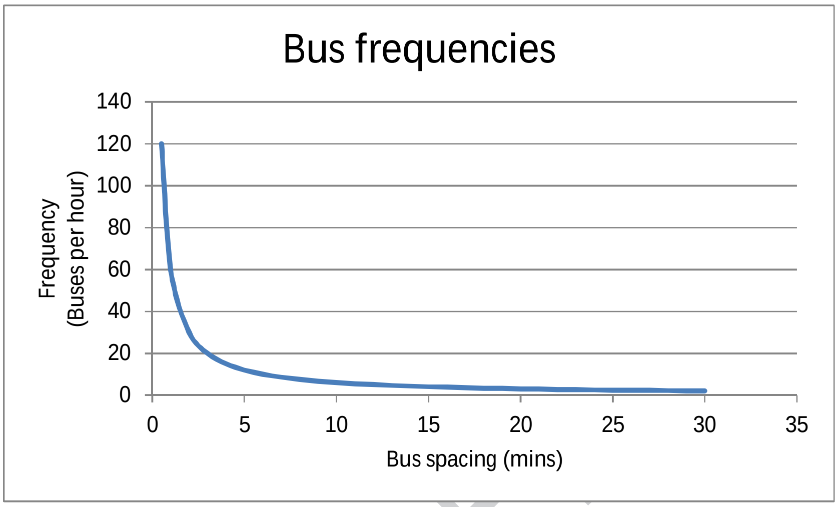

Figure 2: Bus Frequencies vs. Headway

This shows that to achieve significant numbers of buses on a particular route, spacing needs to be less than around 5 minutes. Even to achieve the smallest increment of 5 in the current range, this corresponds to one bus every 12 minutes. This is unlikely to occur in small urban centres.

It is noted that multiple services are likely to use a common route in some places such as the town centre or around bus terminals.

On the upper end of the scale, the maximum value of 120, representing one bus every 30 seconds may be too low in the future context of high frequency bus corridors in Auckland (northern busway, britomart, AMETI) and potentially Wellington. This figure in Melbourne is suitable due to a well-established tram network carrying a large amount of public transport demand on what otherwise would be high frequency bus routes.

Therefore, it is recommended that the lower end of the throughput range be extended to take into account lower frequency routes in smaller urban centres, and the higher end of the throughput range also be extended to take into account high frequency routes in Auckland. Table 2 below shows the proposed range.

Table 2: Recommended Throughput Range - Bus

Throughput	Increments
0 to 10	1
10 to 30	5
30 to 60	10
60 to 180	20

Extending the range to include values for 1 to 10 buses an hour allows smaller urban centres to distinguish routes that carry 1 bus an hour, 1 bus every 12 minutes and up to 1 bus every 6 minutes.

At the higher end of the scale, increasing the range to 180 will allow for one bus every 20 seconds on high frequency corridors.

This expanded range will increase the available values from 13 in the drop down list currently to 23.

2.3 Cycle

Cycle data in smaller urban centres is harder to source. We have reviewed data from the Whakatane walking and cycling strategy and the annual walking/cycling survey in Invercargill, these sources show peak volumes reaching around 50 cyclists, with an average of around 20. Graphs of this data are shown below.

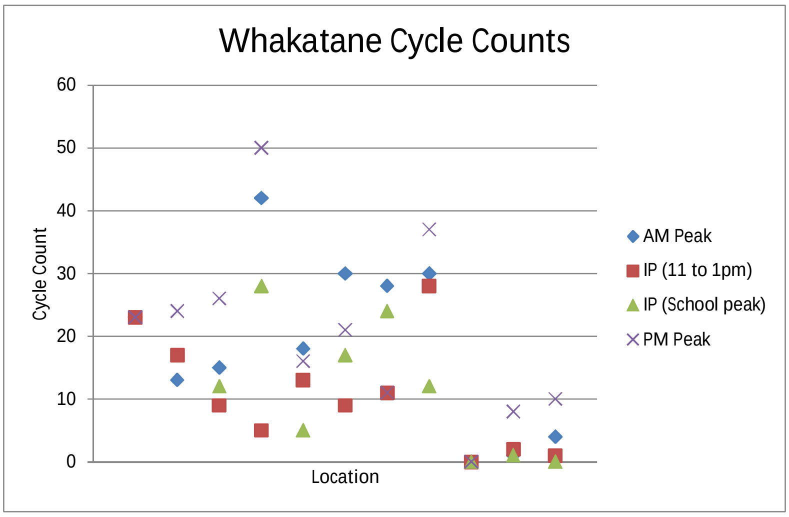

Figure 3: Whakatane Cycle Counts

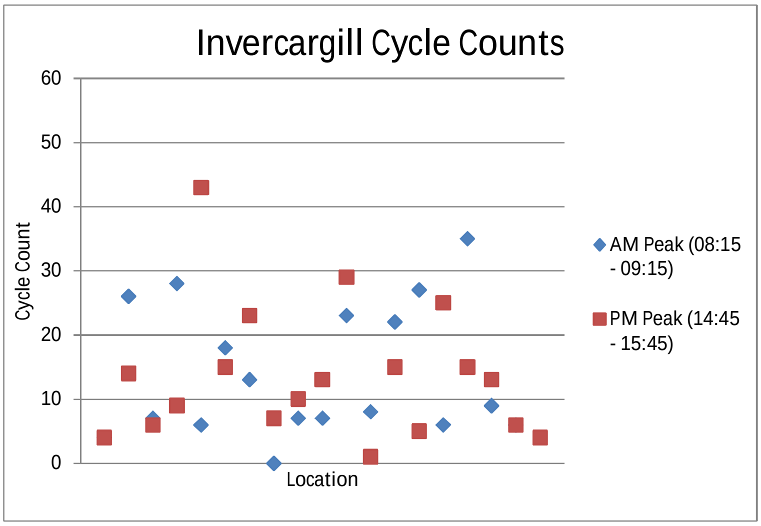

Figure 4: Invercargill Cycle Counts

The recommended range is for graduated increases between 0 and 500 to allow for all different scales of cycling facilities, as shown in Table 3 below.

Table 3: Recommended Throughput Range – Bicycle

Throughput	Increments
0 to 20	5
20 to 40	10
40 to 200	20
200 to 500	50

This throughput range allows lower values to be shown for smaller urban centres as well as catering for high volume cycle routes in major cities. The number of values in the drop down list will increase from 13 in the existing SmartRoads tool to 21 with the recommended range.

2.4 Pedestrian

Pedestrian counts can vary significantly depending on surrounding land use activity and density. However, even small urban centres can have areas with high pedestrian activity, as is shown in Figure 5 below from Whakatane.

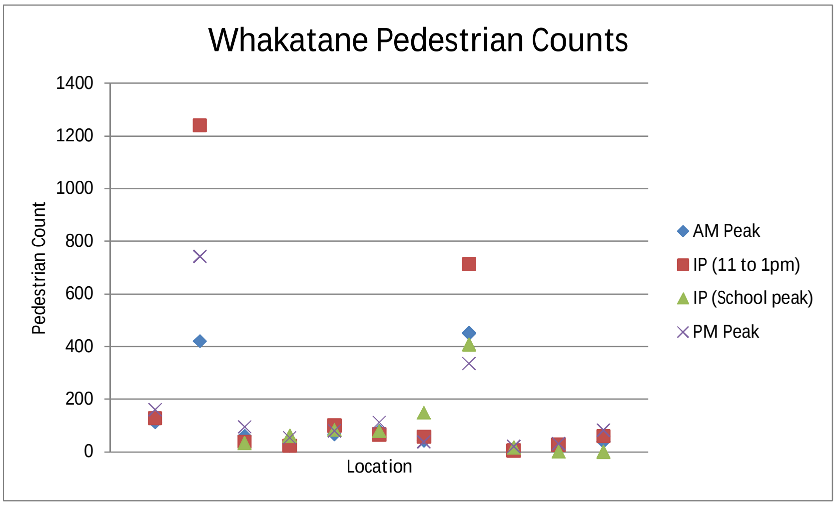

Figure 5: Whakatane Pedestrian Counts

This chart shows two locations that consistently experience high pedestrian volumes throughout the day, despite the relatively small size of Whakatane as an activity centre.

Despite this, it is still seen as important to allow small urban centres to distinguish between say 20 pedestrians and 70 pedestrian in an hour. Therefore, the following throughput range is recommended.

Table 4: Recommended Throughput Range – Pedestrian

Throughput	Increments
0 to 40	10
40 to 100	20
100 to 300	50
300 to 600	100
600 to 1200	200
1200 to 3200	400

Note that when used within the tool, these throughput volumes are per direction.

This proposed range increases the possible values from 13 in SmartRoads to 23. It allows clearer distinction of links with 'some pedestrians' without needing to select 0.

2.5 Freight

The existing SmartRoads tool increments freight by 50 trucks/hr. At the lowest level this would represent a busy road carrying 1000 veh/hr with 5% heavy vehicles, or put in other terms one truck almost every minute. Therefore, it is considered that smaller increments are needed at the lower end of the range. Table 5 gives proposed values.

Table 5: Recommended Throughput Range – Freight

Throughput	Increments
0 to 200	20
200 to 500	50

The maximum value for this range of 500 has been confirmed as sufficient against telemetry data from Tauranga Port.

2.6 Summary

By graduating the increments for each of the throughput ranges it appears to be possible to develop ranges that are appropriate for all scales of urban centres in New Zealand. Therefore, individual throughput ranges for different urban categories is not recommended.

A review of the throughput ranges is recommended to occur on a regular basis, potentially annually, to ensure their appropriateness.

As said previously, it is also recommended that users have the ability to directly input known throughput values, as opposed to selection of an increment value.

3. Relative Growth

The 'Relative Growth Factor' (RGF) is used to multiply the operating gap of 'non-car' based modes in order to account for aspirational mode shift away from private cars as the preferred mode of transport.

The original intention of the RGF was to look at actual growth, however later iterations of the tool have utilised the factor as an aspirational mode shift factor towards future public transport and walking/cycling.

SmartRoads uses a growth factor representing a rate of 5% over 10 years.

NZTA research looking at population growth has found total growth estimates of around 20% over a 20 year period.

Note that a 1% change in the RGF will correlate to a 1% change in the resulting operating gap. Therefore, by reducing the growth factor, we are reducing the relative priority of non-car based modes by that same amount in any assessment.

NZTA research has looked at PT growth targets for Auckland and Wellington, and derived a rate of 1.45 that approximately correlates to these targets.

With lower availability of suitable alternatives to private car in smaller urban centres, there is an expectation that the RGF will alter accordingly.

Additionally, even within a single urban centre, an assessment done on different parts of the network may have very different aspirations with regards to growth of non-based modes. For example, there are very different aspirations for public transport in 'lifestyle block' areas of Auckland such as Whitford compared to say, Mt Eden.

Our research into recommendations for RGF for urban centres of different scale has focussed on two areas. Firstly, a review has been carried out of strategic documents from a selection of urban centres around New Zealand. This review looked at the aspirational desires of centres of varying urban scale in regards to growth in alternative transport modes such as walking/cycling and public transport. Secondly, our research has looked at the relationship between throughput, value of time and the RGF within the context of the tool to give more transparency to how the RGF will affect the calculation of operating gaps.

3.1 Review of Strategic Documents

Putting aside the specific RGF to be recommended for centres of different urban scale, the following review of strategic documents intends to give context to the recommendations.

3.1.1 Major cities

Auckland

Auckland's 'Integrated Transport Programme' sets out the 30 year investment programme (from 2012-2041) to implement the priorities of Auckland Transport of a single transport system, with integrated transport planning and investment with land use development to "create better connections and accessibility within Auckland, across New Zealand and to the world" (Auckland Transport, 2012). A four-staged intervention process is to be implemented to roll out the one system approach over time to ensure the transport changes reflect transport user demands and changing circumstances in a coordinated and timely manner (Auckland Transport, 2012). Investigations on the 'funding gap', alternative funding scenarios and demand management measures to change travel behaviour will result in outcomes that will be addressed in the next Integrated Transport Programme. Ten year Network Plans (strategic and arterial roads, freight, public transport, cycling, and parking) will establish the high level priority for transport users for each mode, including responses to growth, multimodal infrastructure projects, increased accessibility to other modes of transport. The major network improvements include the Western Ring Route, upgrade of public infrastructure and introduction of the electric rail services - City Rail Link and the additional Waitemata Harbour Crossing (Auckland Transport, 2012).

Wellington

Wellington faces transport challenges of a growing and aging population, growing economy and increasing travel demand. The preferred strategic option to deal with such issues is 'mixed investment plus road pricing' as it is thought to provide the best result over the widest range of possible futures. It is expected that Wellington will experience a 'lower growth scenario' opposed to Auckland with very high population growth. A 'lower growth scenario' in general shows less improvement in the Public Transport indicators, but also indicated less of an issue around congestion and CO_2 emissions. The mixed investment scenario strategy is thought to provide a most balanced approach to improvement in transport, including projects such as widening Ruahine Street and Wellington Road to two lanes in each direction, duplicating the Mt Victoria and Terrace tunnels and the removal of one lane each way along the waterfront route. This approach favours a missed approach to infrastructure investment as a long-term option (Greater Wellington Regional Council, 2012). By 2020, a strategic target for Wellington is that public transport accounts for at least 21% of all region wide journeys to work (up from 17% in 2006), active mode use (pedestrians and cyclists) is increased to 30% from 28% from 2005-2009, and the average congestion on selected roads will remain below year 2003 levels despite traffic growth (20 seconds delay/km in 2003; 23.4 seconds in 2010) (Greater Wellington Regional Council, 2012). All new subdivisions and developments are to include provision for walking, cycling and public transport, as appropriate by 2020 also.

3.1.2 Medium cities

Dunedin

The 'Regional Public Transport Plan' for Otago region (revised June 2013) sets out how the Otago Regional Council will approach public transport in Dunedin over the next six years. It has a strong focus on supporting community wellbeing through mobility and accessibility, especially for those with disabilities through the 'Total Mobility Scheme' (funding assistance). The key future changes identified are increasing the number/frequency of linked services, fine-tuning the match between demand and service frequency on individual routes, shorten unnecessarily long routes, coordinating time tables to allow people to change services to suit their bus journey, journey planner on website, providing bike racks for carriage on all services, as well as compliance with any new national integrated ticketing system.

Hamilton

Access Hamilton 2010 is a review of the existing strategic direction taking into account national, regional and local changes since 2005 and looks ahead to 2040. The strategic vision of Hamilton is much like other cities to deliver an affordable, integrated, safe, responsive and sustainable transport system. Carefully planning land use to reduce the need to travel is a key approach alongside managing and optimising existing networks. A number of 'shared outcomes' are mentioned in the document including a need to accommodate NZTA's hierarchy of interventions, support land use and low cost measures before major projects are required, more ‘compact’ living environments for more sustainable communities (Waikato Regional Council, 2012 –Access Hamilton Strategy)

Additional infrastructure and services required to meet future demand are the Waikato Expressway, Wairere Drive, Southern Links and Te Rapa Bypass. An ‘opportunity’ is also to “accept that at certain times there will be more congestion”. The completion of the city cycle network, raising Public Transport mode share, and improving road safety are recognised as ‘action plans’ but not in any quantifiable measure (Hamilton City Council, 2013).

3.1.3 Small cities

Queenstown

The strategic priorities for public transport in Queenstown (and the wider Wakatipu Basin area) are identified in the ‘Regional Public Transport Plan’ for Otago Region (revised June 2013). The main proposed changes to the integrated public transport network are fine-tuning the bus routes as patterns of settlement and demand, bike racks on all services by June 2015, potential amendment of fares, and adding the night bus and water taxi fares into the integrated ticketing system. Investigations into the GoCard service for tourists and fast adaption to visitor markets are also to be investigated in the near future (ORC, 2013). Visitor-oriented services (which are predominantly shuttle services and priced accordingly) were acknowledged as an important mode of travel continuing into coming decades (ORC, 2013).

Public Transport was noted to be particularly important within a 30 minute drive of centres and along arterial routes in Otago region. The ORC notes that the community must be willing to pay for and use the services; the services themselves must be affordable, and the system must be supported by land-use planning that concentrates housing within walking and cycling distance of the key roading corridors. Attention to roading design and layout, bus infrastructure (including bus stops) accessibility to those with disabilities, and appropriate design of bus services and fares to help determine accessibility.

Taupo

Taupo has a ‘walking and cycling strategy’ in place (2010) which sets out ways to make active transport choices more attractive and viable. The policies involved seek to expand and enhance active walking and cycling networks, ensure new subdivisions provide convenient and attractive linkages for walking and cycling, provide supporting infrastructure, and implement traffic calming measures (Taupo District Council, 2012). The Waikato Regional Council (2013) notes in the Waikato Regional Land Transport Strategy that the East Taupo Arterial construction is a major roading project undertaken during the term of the previous RLTS. Planned settlement and land use outcomes are based on (1) focusing investment in a defined set of strategic corridors that represent the most significant national and regional routes in the Waikato region, (2) Targeting road safety investment under safe systems approach endorsed in the Regional Road Safety Strategy, and (3) Targeting travel demand management and alternative mode interventions based on specific local needs (Waikato Regional Council – RTLS).

Nelson

Nelson’s transport system is mainly urban roading due to the removal of the rail services in 1955, which is thought to have limited transport options in the region ever since. SBL (private – two routes) bus services and SBL (public – four routes) “The Bus” make up the public transport system in Nelson, which are not well-used. Only 0.5% of the working population travelled to their place of employment by bus in 2006 (Nelson City Council, 2009). Walking and cycling are relatively popular transport modes in Nelson, with further investment outlines in the Council Pedestrian Strategy “Stepping Out” (Nov 2005) and “Pedalling Along” (Dec 2006). However, Nelson has an issue of a high use of private motor vehicles for short distance trips.

Nelson’s Vision is ‘a sustainable transport future for Nelson’, following targets such as (ED1) reduce the average peak hour travel delays by 10% by 2018 from values recorded in 2008, (ED2) increase the share of weekday journey to work trips by public transport to at least 10% by 2018, (AM1) 80% of households within 400 m of a bus route by 2012, (ES1) Reduce Nelson’s greenhouse gas emissions from the transportation sector 2001 levels by at least 40% in 2020 (ES2) Every land use application will be reviewed to determine its consistency with the targets in the RLTS, and (A1) a 75% customer satisfaction rating for value for money in the Transport sector is achieved by 2014, as assessed by the NCC annual survey.

3.1.4 Summary/Comparisons

Most strategies for all different sizes of cities recognised that public transport is an essential core service, crucial for a functional and sustainable city. Reasons for this included that public transport moves large numbers of people in safe, economic and energy-effective way, helps to ease congestion in busy areas, enables those without cars to travel (ORC, 2013).

The main key challenge for **larger cities** is to meet travel demands and reduce congestion associated with population growth and employment, especially in Auckland. In the higher land-use density scenarios (i.e. larger cities) new development is focused around public transport nodes and corridor over and above the central area (i.e. the ‘growth spine’ in Wellington). Larger cities seem to be developing Public Transport nodes around specified areas for intensification to respond to existing traffic problems/constraints. Land-use planning compatible with an integrated transport system was strongest in larger cities in comparison to medium and smaller cities. Generally a population of larger than 300,000 is needed to begin to justify investment in rail infrastructure (Nelson City Council, 2009).

Medium cities appear to be responsive to ‘incremental’ changes in transport and land-use systems. Their strategies are targeted around public transport investment and promotion, and are still related to population growth and employment, although less so that the larger cities. Medium centres had policies in place which promoted land-use planning compatible to a sustainable integrated transport system, and initiatives to promote walking and cycling.

Smaller cities appear to have less demand for transport changes and congestion issues (obviously) and their transport strategies are not as far advanced as the larger cities (i.e. 6 year plan for Queenstown). Much of their transport strategies are more targeted to the market e.g. Aging population or tourists (Queenstown), and are catered more toward the transport disadvantaged rather than everyday commuters. Transport strategies in these towns are more about improving ‘well-connected’ local road networks or improving the affordability/reliability of existing bus services within towns and mobility to other towns/cities. Policies about new subdivisions being ‘walkable’ were common. Walking and cycling initiatives/strategies are implemented in most small towns except not often in a quantifiable measure. It seems that travel by car is still the most popular method of transport even in smaller cities, and although public transport (mainly buses) is often available and viewed as something that should be utilised more, it’s use is not always justified by the public due to varying factors (affordability, reliability, convenience, accessibility).

Integration of transport and land use planning was a key issue/priority raised in planning documents in all different sizes of cities.

3.2 Selectable RGF Levels

Taking into consideration the following:

- Difficulty in applying a single factor that is applicable across an urban centre
- Difficulty in applying a single factor that is applicable between different urban centres and the lack of quantifiable targets within strategic documents
- The different influences on the supply of public transport – commuters, tourism etc.
- The different influences on public transport, walking, cycling and freight
- The need to think strategically in regards to the influence of this factor on the relative comparison of 'non-car' based modes
- The need for transparency and flexibility between the urban centres using this tool and more specifically, how they can make it applicable to their local strategies.

It is recommended that the tool be set up in such a way that for any assessment, the user can specify high, medium, low or none for the RGF factors with qualitative definitions for each. This would then use a pre-determined RGF to be used within that assessment. Setting up the RGF factor in this way will allow users to feel as though the tool can be customised more to their local context.

The intention of this type of separation between high, medium, low etc. is that a growth factor specific to the type of assessment being done can be used. Therefore, multiple assessments within a single urban centre may use different growth factors depending on what they are looking at.

It is recommended that the selection of an RGF of high, medium, low or none is done separately for public transport, pedestrians, cycling, walking and freight in accordance with the local strategies / policies for these modes.

3.3 Relationship between throughput, value of time and RGF

When calculating an operating gap, we multiply the difference between an actual and objective level of service by a relative efficiency factor (REF). The REF converts the movement of vehicles into the movement of people, and recognises the different economic values of time for each mode. The relative growth factor (RGF) is then a multiple on the result of this calculation.

To understand the influence of RGF, we need to isolate the effect of throughput. Therefore, the following assessment considers an operating gap comparison between a lane of traffic and a bus route. The lane of traffic carries 429 vehicles per hour, which when multiplied by a vehicle occupancy of 1.4 gives a person throughput of 600. The bus route carries 12 buses an hour which when multiplied by an occupancy of 50, also gives a person throughput of 600. Hence, the throughput of people is equivalent.

The next factor that will give an imbalance of operating gap between modes is value of time, $13.12 for car travel and $11.06 for bus travel. This difference, if left unadjusted would give a

18.6% operating gap bias towards private car travel on a route carrying the exact same person throughput.

Therefore, the RGF can in a way be seen as an 'equalising' factor in that setting an RGF of 1.186 for public transport will allow equal comparison between car and bus (on a route with the same person throughput and modal priority).

Setting an RGF higher than 1.186 slightly weights the use of public transport (or walking / cycling) as being more desirable than car – in that it increases the operating gap, making the differences between observed and desired level of service 'more significant' in a given location.

The reverse is true for any RGF lower than 1.186.

3.4 Recommendation

Taking into account the discussion above as well as feedback from the National Working Group we have developed separate RGF tables for PT, Walking and Cycling, Freight.

While the numbers for PT/Walking and cycling are very similar as a result of the economic values of time being very close for these modes, separating them out allows clear distinction and the selection of different levels for each should say walking and cycling be a priority over and above public transport in a particular assessment.

It was not deemed necessary to separate out walking and cycling into two separate RGF selections. While the physical needs from an infrastructure perspective on these modes are slightly different, at a strategic level both are usually grouped together as 'active' modes and are likely to have corresponding growth aspirations.

3.4.1 Public Transport RGF

The following table shows the recommended public transport RGF for High, Medium, Low and None as well as corresponding descriptions of each level. Note that 'none' represents an RGF of 1.186 making it an equaliser of public transport to private car. It is not envisaged that any value lower than that i.e. dis incentivising the use of public transport would be required.

Table 6: Public Transport RGF Table

Level	Definition	RGF
High	• Comprehensive public transport system, with expectation of continued mode shift into the future • High quality walking and cycling facilities with public awareness campaigns • Gives approximately a 40% prioritisation to public transport over private car as a mode choice decision. • Could also be considered for use in a long term assessment	1.663
Medium	• Targeted public transport provided between specific activity areas. • Mode shift expected in the future largely as a result of external influences such as petrol costs or increased congestion rather than significant investment in the public transport network	1.425

	• Gives approximately a 20% prioritisation to public transport over private car as a mode choice decision. • Could also be considered for use in a medium term assessment.	
Low	• Public transport provided largely to aid the disadvantaged or disabled. • Minimal mode shift expected in the immediate future. • Gives approximately a 10% prioritisation to public transport over private car as a mode choice decision. • Could also be considered for use in a short term assessment.	1.307
None	• No specific mode shift away from cars is expected or applicable within the context of the specific assessment.	1.186

3.4.2 Walking and Cycling RGF

The following table shows the recommended walking/cycling RGF for High, Medium, Low and None as well as corresponding descriptions of each level. Note that 'none' represents an RGF of 1.208 making it an equaliser of walking/cycling to private car. It is not envisaged that any value lower than that i.e. dis incentivising the use of walking/cycling would be required.

Table 7: Walking and Cycling RGF Table

Level	Definition	RGF
High	• High quality, efficient, safe and attractive walking and cycling facilities with public awareness campaigns on the benefits of active travel. • Gives approximately a 40% prioritisation to walking/cycling over private car as a mode choice decision. • Could also be considered for use in a long term assessment	1.693
Medium	• Good walking and cycling facilities with some gaps. • Travel distance may restrict overall growth on active modes. • Mode shift expected to be largely natural movement/growth as opposed to significant investment in the walking/cycling network. • Gives approximately a 20% prioritisation to walking/cycling over private car as a mode choice decision. • Could also be considered for use in a medium term assessment.	1.452
Low	• Walking and cycling activity minimal, as a result of low densities and long travel distances. • Gives approximately a 10% prioritisation to	1.331

	walking/cycling over private car as a mode choice decision. • Could also be considered for use in a short term assessment.	
None	• No specific mode shift away from cars is expected or applicable within the context of the specific assessment.	1.208

3.4.3 Freight RGF

Freight is somewhat different to the other modes in that the value of time for freight is significantly higher than private car, however throughput will almost always be lower. Growth in freight is not an aspirational mode shift and is more aspirational in terms of growth in economic activity.

Simply leaving the freight RGF at ‘none’ (a value of 1) gives freight a 122.7% prioritisation over car (at equal levels of throughput) as a result of the different value of time.

Given that the RGF represents in general an aspirational mode shift or modal prioritisation, and that private car does not have a growth factor, it is not deemed appropriate to allocate ‘positive’ growth factors to freight.

Therefore the selection of freight RGF is slightly different. Two options are recommended for the selection, the first gives an RGF of 1, i.e. treating freight in the same as private car. The second is a value < 1 that cancels out the effect of the high value of time assigned to freight, enabling an equalised assessment in that one car is equivalent to one freight vehicle.

Table 8: Freight RGF Table

Level	Definition	RGF
None	No specific RGF applied	1
Mode equalised	Neutralising the effect of value of time – freight vehicles considered equal to private car	0.449

3.5 References

The following table gives references for the strategic document assessment.

Table 9: Strategic Document Literature Review Sources

Plan	Source
Generation Zero, 2013	http://voakl.net/2013/02/25/generation-zero-support-on-public-transport/
ORC, 2013	http://www.orc.govt.nz/Documents/Publications/Transport/RPTP/Regional-Public-Transport-Plan-2012-130705.pdf
Auckland Transport, 2012	http://www.aucklandtransport.govt.nz/about-us/board-members/Board-Meetings-Minutes/Documents/Board%20reports%20March%202013/AT-agenda-item-8i-attachment.pdf
Greater Wellington Regional Council	http://www.gw.govt.nz/assets/council-publications/WRLTS-2010-2040-Doco-WEB.pdf
Hamilton City Council	http://www.hamilton.co.nz/our-city/city-strategies/accesshamiltonstrategy/Documents/access%20hamilton%20presentation.pdf
Waikato Regional Council - Access Hamilton	http://www.waikatoregion.govt.nz/PageFiles/21512/2%20May/May%2002%20Item%2013a.pdf
Taupo District Council, 2012	http://www.taupodc.govt.nz/our-council/policies-plans-and-bylaws/district-strategies/cycling-and-walking-strategy/Documents/Cycling-and-Walking-Strategy.pdf
Nelson City Council, 2009	http://www.nelsoncitycouncil.co.nz/assets/Our-council/Downloads/regional-land-transport-strategy-0609.pdf

4. Vehicle Occupancy

Vehicle occupancy weights the selection of throughput values to convert vehicle movement into person movement. This is done in the calculation of the Relative Efficiency Factor (REF), discussed below.

4.1 Relative Efficiency Factor (REF)

Put in words, the REF is 'the relative efficiency of a mode of transport on a particular route compared to a reference case of an unconstrained lane of cars'.

Therefore, for example a bus running once every 5 minutes (12 buses an hour), carrying an average of 35 people and with an economic value of time for bus passengers of $13.74 compared to an unconstrained lane of 2000 cars, with an average occupancy of 1.4 and an economic value of time for car drivers/passengers of $17.09.

This becomes: 12 x 35 x 13.74 / 2000 x 1.4 x 17.09 = 0.12

If we now look at how a lane of constrained traffic carrying for example 1200 vehicles per hour and find the relative efficiency against the reference case of an unconstrained lane, we use the same car occupancy figure and economic value of time as both cases are for a 'car' mode of transport.

Therefore, we get: 1200 x 1.4 x 17.09 / 2000 x 1.4 x 17.09 = 0.6

Looking back on this equation we can see that the vehicle occupancy and economic value of time is used to multiply both the constrained and unconstrained traffic volume, therefore they cancel each other out.

So, when looking at the relative efficiency factor for cars, it becomes simply:

REF = Constrained Flow / Unconstrained Flow

Hence, car occupancy and economic value of time are only needed when deriving the reference case to compare against other modes.

<u>Therefore, car occupancy only needs to be thought of in terms of its effect on changing the reference case for determining relative efficiency of other modes</u>.

However, bus occupancy is more important as it affects the overall number of passengers when this mode is being compared against 2000 vehicles using the same link.

4.2 Car Occupancy

SmartRoads has used a car occupancy of 1.2. Fairly comprehensive research by NZTA has shown that a more appropriate figure for New Zealand is 1.4.

Car occupancy varies significantly by trip purpose, as would be expected. Data from MOT has shown that the lowest occupancies are commuter trip purposes and the highest being social activities. Table 10 summarises car occupancy by trip purpose.

Table 10: Vehicle Occupancy by Trip Purpose

Purpose	Mean Occupancy
All	1.522
Home	1.493
Work (main / other job)	1.104
Employers business	1.143
Education	1.285
Shopping	1.559
Personal business	1.444
Social visits	1.731
Recreational	1.66
Accompany or transport someone	2.125
Other	1.402

The question that this information raises is that while the ‘average’ occupancy is 1.522, the majority of trips and congestion on our networks is during peak periods, where commuter trips make up the largest proportion of traffic. It is usually for these peak periods where we analyse network operation.

Peak period data for Auckland (supplied by Auckland Transport) showed vehicle occupancy ranging from 1.14 to 1.31. This is generally in line with the data from MOT. A trend of the data from Auckland showed the further away from the CBD, the higher vehicle occupancy was.

Taking this into account, a figure of 1.4 is a reasonable compromise between the true average and the lower occupancy of commuters.

The research done by NZTA has also shown that car occupancy does not change significantly by geographical location, and therefore a constant value can be used. This is also reflected when looking at the average number of cars per household (as a proxy for car availability), as the following chart shows for major, medium and small urban centres in New Zealand.

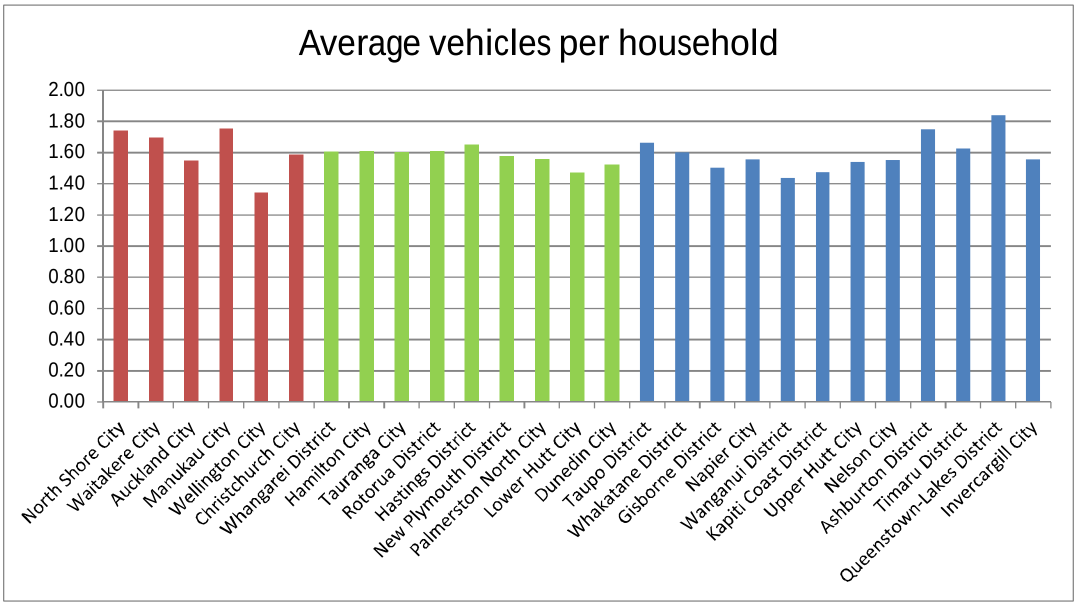

Figure 6: Average vehicles per household

This data (2006 census) shows average household ownership of cars at around 1.6, this doesn't vary much by geographical location or urban scale.

Therefore, it is recommended that a consistent car occupancy level of 1.4 across all urban scales is appropriate.

4.3 Bus Occupancy

It has been challenging to source a good sample size of bus occupancy data. The information looked at included:

- Research supplied by NZTA from the Opus Central Area Bus Operational Review (Wellington) show average peak occupancy in the AM peak of 27 and 24 in the PM.
- Christchurch surveys lower at 19 in the PM peak.
- Hamilton has an average occupancy of 15 (peak not specified)
- Whangarei has an average occupancy of 6.1 (peak not specified)
- Initial recommendations from NZTA were for bus occupancy of 35.

SmartRoads uses an occupancy of 50 for buses. Occupancy of 50 is around about the seating capacity on a standard bus and it is unlikely that buses, even in Melbourne, operate on average, at capacity. An approximate 'capacity' figure was used to ensure bus as a mode gets a reasonable level of relative significance within the tool.

One of the challenges that needs to be considered is that bus occupancy is highly variable even within an urban centre. There are a number of factors influencing people's mode choice and the attractiveness of bus over other alternatives, including:

- Preferable alternatives to bus available on the same route such as train or ferry
- Trip distance
- Amenity
- Cost

Therefore, it is not considered a reasonable simplification to apply a single occupancy to all assessments within the tool.

The recommendation is that a selection be available for each assessment allowing users to tailor the bus occupancy to the urban setting. This will allow flexibility within all urban scales, including low occupancy in large urban centres, or isolated incidence of high occupancy in smaller urban centre (for example Palmerston North Massey Campus).

Table 11 describes the recommended selections.

Table 11: Bus Occupancy Recommendation

Level	Description	Occupancy
Low	• Not uncommon to see empty buses. • Could be seen as a secondary route to train/ferry. • Services low density catchments. • Community / accessibility based services.	10
Medium	• Buses around half full during peak times. • Strong link between residential and employment/education centres,	30
High	• Buses often appear full (no free seats). • Key connection between residential and employment/education centres. • Primary mode of public transport.	40
Capacity	• Buses often appear full with some passengers standing. • Key connection between residential and employment/education centres. • Primary mode of public transport. • Likely to be on a high frequency route.	50

5. Value of Time

5.1 Introduction

Value of time has been a much debated topic worldwide. Many economic theories have been proposed by transport economists and researchers worldwide with debates on a variety of topics such as how travel times should be valued, choice of empirical model estimates and use of stated preference surveys or revealed preference surveys etc. Value of time depends on many factors such as time of the day, purpose of travel, travel mode, socio-economic characteristics and other preferences.

In New Zealand, the basis for unit travel time historically goes back to 1971 when the unit value of travel times were recommended based on a review of British and Australian practices for the National Roads Board. Many reviews of 'value of time' were undertaken by numerous specialists that included valuing the time based on a gross hourly rate plus additional employment related on costs borne by the employers (early 1980's) and average wage rate (40%) of car drivers (late 1980's). In the late 1990's the value of time was determined by the resource values defined as *the amount of money that society is willing to save a 'unit of travel time'* (Transfund Research Report No.93, 1997). Further discussion around appropriate value of time is greatly involved and henceforth has not been discussed further in this memo.

In the context of New Zealand, The New Zealand Transport Agencies' Economic Evaluation Manual (EEM) is used as a guide for travel time values to determine benefits associated with travel time savings for infrastructure and non-infrastructure related transport initiatives.

The current EEM provides the unit value of travel time disaggregated by trip purpose (e.g. work travel purpose, commuting to/from work, all other non-work travel purposes), vehicle type (car, motorcycle, light/medium/heavy commercial vehicle etc.), and passenger type (drivers, pedestrian, cyclist, bus passengers etc.). The EEM also includes travel time values combining passenger and commercial (including freight) occupants, and vehicle types for standard traffic compositions and different road types.

5.2 Value of time for SmartRoads

Value of time (per person) in the SmartRoads tool is used to calculate the REF by assigning a tangible economic value for different transport modes. The value of time per person for differing transport modes assumed in the Victorian version of the Smart Roads is included in Table 12 below.

Table 12: Value of time assumed in Victoria, Australia version of SmartRoads

Transport Mode	Value of time per person in SmartRoads (Victorian Version)
Car	$17.90
Freight	$30.06
Bus	$17.74
Bicycle	$14.43
Pedestrians	$14.43

To determine the value of time for a New Zealand centric SmartRoads tool, it was important to align the value of times used in the SmartRoads tool with the EEM values and policies. This exercise coincided with the recent review (stage 1 of the review) of EEM values by NZTA. The first stage of the EEM review provided an equity based value of time of time for all transport modes but disaggregated by trip purpose at a draft stage for the transport scheme economic efficiency appraisal process. The latest EEM value of time disaggregated by trip purpose for all modes (including vehicle occupancy) is included in Table 13 below.

Table 13: Value of time for all modes and all time periods

Transport Mode	Value of time
Work Travel Purpose	$23.85
Commuting to/from work	$7.8
Other non-work travel purpose	$6.9

To determine the value of time for use in the New Zealand adaptation of SmartRoads tool and ensuring alignment with the current EEM, GHD engaged discussions with Graeme Belliss of NZTA to confirm the overall methodology and calculations.

The SmartRoads tool utilises value of time per person per transport mode for all trip purposes in the calculation of REF. For such reasons, trip purpose splits outlined in EEM (Table A2.4, Page A2-7, EEM Vol 1) were applied to revised value of time (outlined in Table 2 above) to determine a representative value of time/mode/person for all trip purposes. Given the absence of trip purpose splits for cyclists, pedestrians and buses, representative estimated trip purpose splits were applied to these transport modes. The assumptions and calculations used in the development of the value of time for the New Zealand adaptation of SmartRoads tool have been reviewed by Graeme Bellis of NZTA.

The value of time numbers proposed for the use in New Zealand adaptation of SmartRoads tool is included in Table 14. For comparison purposes, we have outlined the value of time used in the Victoria, Australia version of SmartRoads tool in the same table.

Table 14: Value of time: Victoria, Australia version versus New Zealand adaptation of SmartRoads

Transport Mode	Value of time per person (Victorian Version)	Value of time per person (New Zealand adaptation)
Car	$16.60	$13.12
Freight	$40.50	$29.25
Bus	$11.50	$11.06
Bicycle	$11.50	$10.86
Pedestrians	$11.50	$10.86

In the near future, we envisage a review of the proposed value of time when more information becomes available or following completion of further reviews of the EEM.

6. Urban Categories

This section looks at understanding any potential separation of urban categories, complications with this approach, and the relationships between urban scale and the transportation environment.

Initial research provided by NZTA gave a split of ‘major’, ‘medium’ and ‘small’ urban categories based on population data as follows.

Table 15: Cities by population splits

Major	Medium	Small
1.5 M to 200,000	199,000 to 70,000	69,000 to 30,000
Auckland, Christchurch, Wellington	Hamilton, Dunedin, Tauranga, Whangarei, Rotorua, Hastings, New Plymouth, Palmerston Nth and Hutt City	Taupo, Whakatane, Gisborne, Napier, Whanganui, Kapiti, Upper Hutt, Nelson, Richmond, Timaru, Ashburton, Invercargill and Queenstown.

While the classification of Auckland, Wellington and Christchurch as the 3 major urban centres is a logical one based on population, it is not population alone that dictates transportation demand.

The following gives a fairly high level discussion on the potential measurements for separation of urban categories.

6.1 Population

Population has an overall influence on all other possible measurements. The given number of people in a place will dictate an overall demand for transport from a ‘number of trips’ perspective but does not necessarily represent congestion, trip lengths or transport choices.

Population also does not give us a good indication of economic productivity, another factor that must be considered when balancing transport availability.

Auckland has by far the largest population at around 1.5M, over 4 times larger than Christchurch at around 363,000.

If we then look at the population of Wellington it is only around 56% that of Christchurch.

Yet despite these differences in population, we call them all ‘major population centres’ and we see some similar trends in regards to transportation environment, all experiencing congestion related issues and a need to balance demands from competing road users including traffic, public transport and active modes.

Looking further down the list, Hamilton, Dunedin, Tauranga and Lower Hutt all have populations with a spread totalling less than 50,000, yet the characteristics of these cities result in very different transportation environments, often as a result of other characteristics such as geographic constraints or type of primary industries.

The following chart gives an alternative view of population by indexing each city against the population of Auckland.

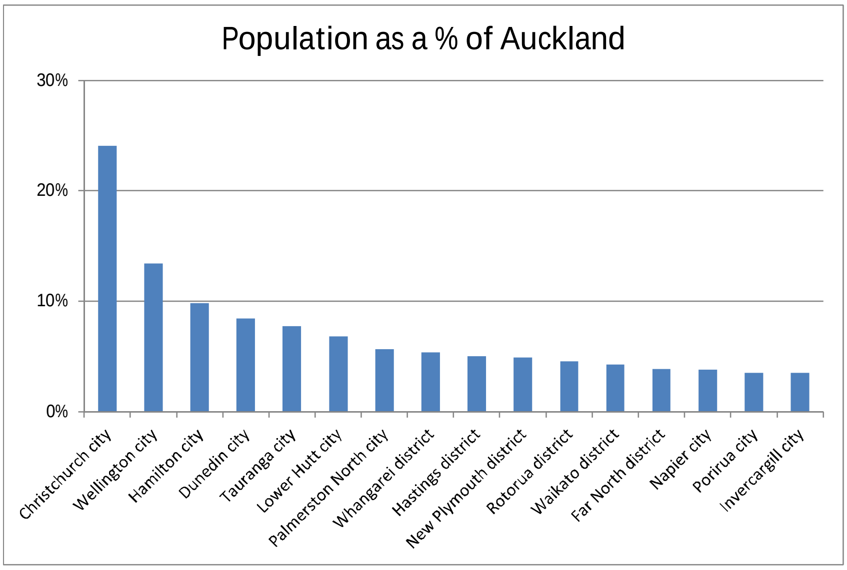

Figure 7: Population of cities in NZ as a percentage of Auckland

If Auckland was considered the only city in the 'major' category then the division between medium and small could sit at greater than 10% of the population of Auckland, resulting in Christchurch and Wellington making up the medium category. Or the division between medium and small could sit at greater than 5% of the population of Auckland, resulting in Christchurch, Wellington, Hamilton, Dunedin, Tauranga, Lower Hutt and Palmerston North making up the medium category.

Looking at the groups of cities in each category (either by population or population indexed against Auckland), categorisation seems to make some sense from a subjective point of view. However, when you look more closely at the dividing lines, they become very hard to justify. i.e. is the transport environment significantly (and justifiably) different between Lower Hutt and Palmerston North or Palmerston North and Whangarei? On what measure is this division based?

There is a risk that if the assessment tool is split into versions for different urban categories based on population that the division will remain somewhat arbitrary, creating a potential conflict point for local/regional authorities. This may promote a sense that some communities are being assessed on a different basis to others.

6.2 Population Density

Population density arguably has a more significant impact on transportation issues than population alone. It is the movement of people from dense population centres to dense employment centres that create the highest transport demand.

However, it is not that simple. It is the combination and interaction of areas with different land use and densities that result in variations in the concentrations of demand, a lack of adequate capacity servicing these concentrations of demand results in 'congestion'.

Basic (unverified) population density data has been sourced from an internet search. More time is required to refine verify this data.

Auckland has the highest density in New Zealand, yet it is relatively low in international comparisons. A lack of public transport availably is often attributed to this issue.

Wellington is second in a measure of density at 70% of that of Auckland.

Christchurch, Tauranga and Rotorua show relatively high population densities, all around 50% of the Auckland figure.

Below that, a number of cities all display similar densities including Napier, Dunedin, Palmerston North, New Plymouth, Whangarei, Nelson, Invercargill, Wanganui and Gisborne.

An outlier in this dataset is Hamilton with a density much lower than all the cities listed above. This is where further analysis of the data is required if population density is to be explored further. It could be true that Hamilton has a much lower density; however this is where the division between 'urban' and 'rural' becomes key. The point where we make this division is vital to the calculation of density and must be understood before population density is used as a measurement. The research provided in this area from Stats NZ gives a logical and systematic approach to this problem.

6.3 BERL Economics (Regional Rankings)

Previous discussions have focussed on the population and density of urban areas. However, this only represents one part of transportation demand.

We know that economic activity drives population increase and population increase drives economic activity. We also know that both economic activity and population drive transport demand. Therefore, economic activity could be considered as a measurement for grouping cities by urban category.

Each year, BERL Economics releases a study giving comparative ranking of New Zealand's 66 local authorities, 14 regions and 20 cities in terms of economic activity. This takes into account; population, employment, GDP and businesses (numbers and size).

6.4 Geography

All of New Zealand's major population centres exist in unique geographical environments that shape their land use and transport environments. While we can often see this coming through in measures such as population density, it is hard to over-emphasise how large the role of geographical constraints can play in the transportation environment of a city.

For example:

The significant coastline and shape of Auckland can result in trip distances being significantly more than travel 'as the crow flies' between origin and destination.

The hills around Wellington have forced an increased population density and as a result, public transport is more efficient and therefore well used.

The flat landscape of Christchurch contributes towards a high proportion of cyclists. This is supplemented by historical planning of wide transport corridors allowing easy retrofitting of cycle facilities.

Statistics such as population and density are unlikely to capture the resulting effects of geographic constraints that influence the transport environment. This may not be an issue, but should be considered when making decisions around the separation of urban categories.

6.5 Recommendation – Urban Categories

In summary:

- Population could be used in numerous ways to separate out urban categories, however issues remain around the boundary conditions and justifications.

- Population density may be used however clarification would be required around the urban / rural boundaries.
- Economic activity may be a useful alternative to explore.
- Geographic issues that may not show up in statistics should be considered

Taking all of this into consideration, it is recommended that the tool be developed in a way that is flexible enough to be applicable across all urban categories without the need for separation.

This is proposed to be done with drop down boxes allowing selection of different levels for factors that alter significantly in different urban centres including; bus occupancy and relative growth factors. In general there is no need for other factors to be altered.

7. Activity Areas

The following section discusses how Activity Area categories and the associated priority tables fit within the context of New Zealand urban centres. This builds on the research done by NZTA by looking at urban centres of varying scale.

The Major cities' activity centres of NZ (Auckland, Wellington, and Christchurch) have already been compared to the Melbourne activity area definitions.

This NZTA research has grouped areas from Auckland, Wellington and Christchurch into their applicable categories suburb by suburb. However, this is not feasible for every urban centre across NZ, nor is it recommended in that it could create a point of contention if a specific local authority disagrees.

Therefore, this research has focussed on the following:

1. To investigate, through relevant planning documents, broadly how the definitions of activity areas in medium / small urban centres fit within the scale and/or context of the levels set up initially for more major urban centres.
2. Review / refine definitions such that they can be used as a guide for users to assess within the context of a specific assessment being undertaken, irrespective of urban scale, the most appropriate activity area definition to be applied.
3. Ensure that the intended priority on different modes for medium/small urban centres is well captured within the definitions of activity areas.

7.1 Planning Review

The key words/definitions that are appropriate to each scale of small/medium urban centres are similar to those seen in the definitions of small/medium scale activity areas. The majority of medium/small city centres appeared to best fit in with the category 'suburban (or metropolitan) centres' (ie regional catchment, wide mix of uses including community services, somewhat well serviced by public transport), rather than 'central business district' category as they were not entirely 'intensive or high density concentrations' with an 'extensive residential component'.

It appears as though there is no need to develop new/additional categories to represent smaller urban centres, although investigation is potentially warranted into the use of 'special activity areas' in a further iteration of the tool.

There were some key themes evident across the comparison of definitions across different scale:

- Large cities have an extensive residential component in their central city areas whereas smaller scale cities were less so. This will likely affect the use of active modes for use in activities such as commuting.
- Medium/smaller city definitions often provided for an extensive lower intensity, service oriented periphery surrounding the CBD, (ie larger commercial sites, more vehicle oriented, less amenity value, less pedestrian oriented), an 'urban fringe'.
- Smaller cities generally only have one zoned business area (their city centre which is a similar scale to suburban activity area of larger cities).

- Medium cities had one business zone for the centre city, often two others with one for the 'CBD fringe (large scale retail)' and another general business zone for 'activity nodes'. This made it difficult to categorise suburb activity centres (especially Hamilton).
- Need to consider transport issues around the 'urban fringe' and differences between larger cities and medium/smaller cities

Note that this information has covered a scoping exercise based on District Plan zoning only, looking for general trends and does not cover all possible planning documents.

The table on the following page provides a summary of the definitions found in each District Plan for the city/town centres across various New Zealand medium/small cities. It categorises each centre within an existing NZ category.

Table 16 New Zealand medium/smaller cities - Activity centre categorisations

CENTRAL ACTIVITIES AREAS		
Large Cities	***Medium Cities***	***Smaller Cities***
Melbourne - *largest centre of activity with the greatest variety of uses and the most intense concentration of development.* ***Auckland -*** *the focus of national and international business, tourism, educational, cultural and civic activities. It is the focus for regional transportation services. It is surrounded by the city fringe, and lies within a 2km walkable catchment (approximately): it provides complementary living, business and entertainment activities within traditional and higher-density neighbourhood living and specialist precincts.* ***Wellington -*** *Services the whole City/region and provides a significant retail offer, particularly along the Golden Mile. The Central City contains an extensive range of retail goods and specialist stores, including several department stores. It is the centre for government and civic administration and is also a major regional employment node accommodating large government related, and corporate offices. It has an extensive residential component, together with community, recreational and entertainment facilities. The area has major cultural institutions and visitor facilities, including accommodation. It is the central transport hub offering several different transport nodes and extensive on-street and off street parking. It also has a high level of pedestrian activity. The Central City is located at the top of the hierarchy of Centres.* ***Christchurch –***	***Hamilton-*** *The Central Area of Hamilton City is the* ***principal centre*** *for* ***employment, retailing, entertainment, and business activity*** *in the Waikato Region. This has been reflected over the years by considerable investment in public infrastructure, parking, pedestrian areas, open space and community facilities, to accommodate the* ***density of people*** *and activities that regularly congregate in the Central Area.* *The Central Area comprises an* ***intensively developed***, ***pedestrian oriented*** *City Centre (being the area generally bounded by Hood, Anglesea and London Streets and the Waikato River) supported by an extensive lower intensity service oriented peripheral central area. The City Centre will continue to be a significant place of activity within the city.* ***Dunedin-*** *The Central Activity Zone has retained a* ***dominant role*** *over other areas within the City such as South Dunedin, Green Island and Mosgiel because of the* ***full range of activities*** *that take place within it. Importance of the Inner City Area to the* ***economic wellbeing of the City****, promote the Inner City Area as the* ***focal point for business, recreational, social, cultural, religious and commercial activitie****s in the City. This is particularly important given the size of the City and an expectation that any growth in its population during the next decade will be minimal. Under such circumstances it is appropriate to manage the manner in which business, recreational, social, cultural, religious and commercial activities are undertaken within the City.* ***Palmerston North-*** *represents the* ***prime retail, office, entertainment, cultural and pedestrian related retail focus of the City****. The pedestrian focused area is characterised by a concentration of* ***diverse business*** *activities that are complemented by important amenity features such as the Square. The city centre represents the* ***commercial heart of the City****. Business areas are primarily places of employment, exchange of goods and services, and social interaction. As well as providing a social focal point for the community, business areas are places where large numbers of people go to work, to do business, to shop or to be entertained. The City's business areas function as a* ***regional commercial centre*** *for the Manawatu region, providing an extremely wide range and choice of leading retailers in all categories. Business activity is concentrated within a hierarchy of four distinct business areas of the City. The hierarchy of business areas include the inner Central Business District (CBD), the outer CBD, the fringe, and local business areas. The Central Business Area (CBA) is made up of the inner CBD, outer CBD and fringe business areas (also includes 'outer CBD area included in above table).*	***Nil*** *(although the town centres are the 'focal point' for the smaller cities their attributes are best categorised into the below scenarios, as they do not have an intense concentration of development and business, service the whole region, nor do they have an extensive residential component).*

PRINCIPAL ACTIVITIES AREAS (SUBURBAN CENTRES)		
Large Cities	***Medium Cities***	***Smaller Cities***
Melbourne - *These are large centres with mix of activities that are well served by public transport. The size and/or location of Principal Activities Areas mean they have an especially important role to play as a focus for community activity, services and investment.* ***Auckland -*** *these serve regional catchments or have strategic roles within the region. They provide a diverse range of shopping, business, cultural, entertainment and leisure activities, together with higher-density residential and mixed-use environments. They have good transport access and are served by high-frequency public transportation.* ***Wellington -*** *Service a significant part of the City and/or region and provides a significant retail offer. These centres are based around a traditional main street and contain one or more large supermarket and department store. A wide range of retail goods with some specialist stores is available. A range of civic and government services, employment, office, community, recreational, entertainment, residential activities can be found which are supported by a sub-regional transport hub. These centres have high levels of pedestrian activity, together with significant on-street and off-street parking facilities.* ***Christchurch -*** *Key existing and proposed commercial/business centres identified as focal points for employment and the transport network and suitable for more intensive mixed use development. They are generally have more than 30,000m2 of Commercial Floor space, but some have less.*	***Hamilton (Rototuna, Flagstaff etc.) -*** *The provision of suburban business opportunities enables the community access to a* ***wide range of goods, services and employment in their local area****. A range of centres throughout the city exists to meet this demand, ranging from corner shops to* ***major concentrations of retail and other commercial*** *and community activities.* ***Dunedin (Mosgiel, South Dunedin, Middlemarch, Green Island****)- provided a* ***full range of social, commercial and retail activities*** *to the hinterland around them. These areas are expected to retain a* ***strong role*** *in the future.*	***Invercargill-*** *Opportunity for* ***diversity of retail and commercial activities and services contributing to a focal point for the District****, the southland Region, the Wakatipu and parts of Central and West Otago. The* ***people focus of the central city****, with art works, street furniture and public meeting places. No requirement for off-street car parking in the city centre sub-area.* ***Timaru*** *- main retail area, highest heritage and townscape values, attractive pedestrian-orientated environment,* ***wide range of commercial and social activities, shopping, business services, tourist and permanent accommodation and recreation and community facilities****.* ***Queenstown*** *- These centres satisfy both a* ***local and District function*** *and provide the* ***bulk*** *of the* ***goods and services*** *required by the residents of the District. They are supported by local shops in the smaller settlements. Queenstown is the largest and busiest of the centres with much of the activity directly attributable to tourism. It is the* ***principal administration centre for the District*** *and contains the greatest variety of activities.*
MAJOR ACTIVITIES AREAS (LOCAL TOWN CENTRES)		
Large Cities	***Medium Cities***	***Small Cities***
Melbourne – *These are similar to Principal Activities Areas but serve smaller catchment areas (e.g. Moorabbin, Pakenham, Williamstown). They provide additional scope to accommodate ongoing investment and change in retail, office, community, service and residential markets. There are a total of 94 Major Activities Areas.* ***Auckland -*** *these act as local hubs for communities, providing a wide range of retail and business services and facilities, and community facilities. They are generally accessible by frequent public transport services, and provide a range of residential living options, including mixed-use and higher-density options. They have variable capacity for accommodating new residential and business development.* ***Wellington -*** *Contain a moderate retail offer and generally service the day-to-day convenience needs of their surrounding suburb. Accessed by good public transport, some District Centres contain a small supermarket and other convenience-based retail and also have access to some community, recreational and entertainment activities. Where offices are present, they are small scale in character. Residential uses tend to be located above ground floor. Mostly on-street parking is available, with only limited off-street parking.* ***Christchurch -*** *defines District Centres as: Suburban centres within the City identified as being, or with potential to be, of a major size, serving a wide*	***Hamilton (Rototuna, Flagstaff etc.) -*** *The provision of suburban business opportunities enables the community access to a* ***wide range of goods, services and employment*** *in their local area. A range of centres throughout the city exists to meet this demand, ranging* ***from corner shops*** *to major concentrations of retail and other commercial and community activities.*	***Taupo*** *- focal point for the town's* ***economic and social interaction.*** *A town centre which is vibrant and has a* ***diverse function and role*** *underpins to a significant extent the social, economic and cultural wellbeing of the associated community. The Taupō Town Centre is an efficient place to operate a business and visit, because it contains a* ***wide range of retail and commercial service activities in a concentrated locality****. The compact nature of the town centre is supported by an integrated transportation network, both public and private, and a high level of community infrastructure which encourages extensive investment in land and buildings.* ***Nelson -*** *The City Centre is the heart of the city and provides a* ***city and regional destination.*** *It contains a concentration of mainly* ***comparison shopping, services such as banks and offices, as well as a growing number of restaurants, cafes and other entertainment activities****. All contribute to the City Centre being a* ***commercial, cultural, tourist and recreational focal point*** *to the city. Compact form which is relatively easily walked from end to end. An important part of the character and functioning of the City Centre has been the progressive development since the 1960s of parking squares. These give vehicle access and*

catchment area. These centres in terms of floor area, ranged in size from over 80,000m 2 down to under 3,000m 2 . They include a number and variety of small retail, community and service activities, and usually include a supermarket.		*parking directly behind the buildings on the main pedestrian streets.*
STRIP SHOP AREAS (NEIGHBOURHOOD CENTRES)		
Melbourne – *strip shopping area - Continuous, predominantly retail and commercial development which directly abuts both sides of the road over a distance of generally not less than 400m; a high level of pedestrian activity characterised by frequent movements across the road; generally with kerbside parking resulting in frequent parking manoeuvres; and, support of the local community and municipal council* ***Neighbourhood Activities Areas -*** *These centres have a limited mix of uses meeting local needs and are dominated by small businesses and shops and limited community services. They offer some local convenience services and some public transport provision but are not necessarily located on the Principal Public Transport Network (PPTN).* ***Auckland –*** *these provide day-to-day convenience shopping within walkable neighbourhoods. Based on a small group of shops, they may also be aligned with a community facility, such as a school.* ***Wellington*** *- Service the surrounding residential neighbourhood and offer small-scale convenience-based retail for day-to-day needs. Neighbourhood Centres tend to have easy pedestrian access for locals and have some community services and small scale offices. There is good accessibility to public transport and parking is generally on-street only.* ***Christchurch -*** *There are 120+ local centres in Christchurch which are small neighbourhood shops, generally without a supermarket.*		

7.2 Activity Area Definition Recommendations

The terms used in SmartRoads ‘Central Activity Area’, ‘Principal Activity Area’, ‘Major Activity Area’ and ‘Strip Shopping Area’ largely have little familiarity within a New Zealand context. Therefore, the recommendation in previous presentations to the National Working Group to change these is endorsed.

However, to ensure their applicability across areas of different urban scale and to avoid any confusion with area classifications in district plans, a somewhat generic naming convention is proposed.

This will avoid issues such as, for example Taupo City Centre may only be categorised as a Suburban Centre according to the definitions below, however this could cause conflict at a local level.

Table 17: Activity Area Labels

SmartRoads (Victoria)	NZTA Initial Proposal	Recommendation	Comments
Central Activity Area	Central Business District (CBD)	Activity Area Level 1 (AA1)	Represents the Central Business District of major activity areas and is unlikely to be used in assessments of smaller urban centres.
Principal Activity Area	Suburban Centre	Activity Area Level 2 (AA2)	This will be the activity area category for the primary activity centre of medium/small urban centres.
Major Activity Area	Local Town Centre	Activity Area Level 3 (AA3)	Represents a local town / small suburban centre, but not the largest / most significant activity area of an urban centre.
Strip Shopping Area	-	Activity Area Level 4 (AA4)	Represents small usually linear developments. Applicable to satellite developments, often abutting state highways or arterial roads.

Table 18 recommends the definitions / characteristics to be associated with each activity area category.

Table 18: Activity Area Definitions

Activity Area	Characteristics
Activity Area Level 1 (AA1)	Services the whole city/region and provides a significant retail offer Has a significant function as a regional centre Intense concentration of development and business It has an extensive residential component, together with community, recreational and entertainment facilities Is the central hub for public transport. *Examples: Auckland CBD, Wellington CBD, Christchurch CBD.*
Activity Area Level 2 (AA2)	Has a regional catchment for some activities Contains a wide mix of uses including community services Has diverse range of retail and commercial activities and services contributing and is focal point for the town or suburban centre The category is also applicable for a large university / campus activity area (eg. University of Auckland / Massey) or large hospital (Auckland Hospital, Wellington Hospital etc.). Is well served by public transport *Examples: Hamilton CBD, Dunedin CBD, Takapuna, Botany*
Activity Area Level 3 (AA3)	Provides for the needs of the surrounding local community Contains moderate retail Within close walking distance of major residential areas More comprehensive than a single row of shops abutting a major road This category is also applicable to a large high school or a medium size hospital. Accessible by public transport *Examples: Howick, Flagstaff, Island Bay, Bethelhem*
Activity Area Level 4 (AA4)	Continuous, predominantly retail and commercial development which directly abuts either one or both sides of a major arterial or state highway Generally with kerbside parking resulting in frequent parking manoeuvres Separated from a larger activity area by a distance of at least a few kilometres. This category is also applicable to a small high school, primary school or a small medical facility. *Examples: Kumeu, Katikati, Karori Shops*

8. Relative Priorities

The following section shows the recommended priority tables for each mode, with comments where the recommendation deviates from SmartRoads.

Taking on comments from NZTA that the network is seldomly prioritised for any mode during the off peak, specific priorities during the off peak have been removed. The category 'off peak' has however been retained for any future potential use in for example construction traffic activities.

Table 19: Pedestrian Priority Table

	Place				
	Pedestrian priority within				On a Pedestrian Priority Network
Time of day	**Local Shopping Area**	**Community Centre**	**Major Town Centre**	**Central Business District**	
AM Peak			←	◀━	←
Inter Peak	◀━	◀━	◀━	◀━	←
PM Peak	←	←	◀━	◀━	←
Off Peak					←

Pedestrian priority has been kept largely the same as SmartRoads at for each 'level' of activity centre. AM Peak for 'Major Town Centre' has been given an 'encourage' priority. This is consistent with the recommendation shown in the previous NZTA presentation.

Table 20: Bus Priority Table

	Place				
	Bus priority within				Not on a bus priority route but within the bus network
Time of day	**Outside of activity centres**	**Local Shopping Area & Community Centre**	**Major Town Centre**	**Central Business District**	
AM Peak	◀━	←	◀━	◀━	←
Inter Peak	◀━	←	←	←	←
PM Peak	◀━	←	◀━	◀━	←
Off Peak					←

Bus priority has been altered slightly, with 'strongly encourage' during AM and PM peak times for Major Town Centres and Central Business Districts where public transport is most prevalent. The reasoning behind this is due 'bus' being the primary mode of public transport in New Zealand, and the limited distance the public are prepared to walk to use buses. By encouraging efficient bus movement within activity areas, it will increase positive perceptions of this mode and encourage mode shift.

Table 21: Cycle Priority Table

	Place		
	On cycle priority route		Not on a cycle priority route but within the identified cycle network
Time of day	Outside of activity centres	Within activity centres	
AM Peak	◄──	←──	←──
Inter Peak	◄──	←──	←──
PM Peak	◄──	←──	←──
Off Peak			←──

This is consistent with SmartRoads priority for cycle network.

Table 22: General Traffic Priority Table

	Place					
	On preferred traffic route		On traffic route		On a local access route	
Time of day	Outside of activity centres	Activity centres	Local Shopping Area & Community Centre	Major Town Centre & Central Business District	Major	Minor
AM Peak	◄──	←──		←- -	←- -	←······
Intr Peak	◄──	←──		←- -	←- -	←······
PM Peak	◄──	←──		←- -	←- -	←······
Off Peak	◄──					

This is similar to the SmartRoads priority, however the ‘encourage local access only’ priority during the interpeak on traffic routes for ‘Local Shopping Area & Community Centre’ has been removed as the primary access to these types of development is via car and without this they would not be sustainable as commercial/retail developments. Larger activity centres with better public transport connections are less reliant on private cars to provide customers.

Table 23: Freight Priority Table

	Place			
Time of day	**On freight network and preferred traffic route**	**On local freight routes**	**Local Shopping Area**	**Community Centre, Major Town Centre, CBD**
AM Peak	◄——	←——	← – –	← – –
Intr Peak	◄——	◄——	←——	← – –
PM Peak	◄——	←——	← – –	← – –
Off Peak	◄——			

Freight priority has been altered slightly in that freight movement has been given an 'encourage' priority for local shopping areas during the interpeak. The reason for this is these types of areas often service freight or complimentary activities.

These priorities are a guide within an activity area. They can be changed within the tool on any specific link where deemed appropriate.

9. Levels of Service

9.1 Introduction

The NZTA research into LOS descriptions has been largely comprehensive and has looked at background research from New Zealand, Australia and the U.S.

When expanding the applicability of the assessment to a wider range of urban centres, we need to consider how the descriptors of LOS relate to urban centres of varying scale.

In doing this, we have looked at broadly characterising the peak period in centres of varying urban scale. This assessment allows us to look at the familiar and unfamiliar elements across urban scales and how these will influence the selection of levels of service during a Network Operations Planning assessment.

The following table describes the characteristics of peak periods in major, medium and small urban centres across New Zealand.

Table 24: Peak periods – subjective assessment

Major Urban Centres (Auckland / Wellington / Chch)	Medium Urban Centres (Tauranga / Hamilton / Dunedin etc.)	Small Urban Centres (Whangarei / Taupo / Invercargill etc.)
• Commuter demand builds from around 6am • Intersections rapidly become saturated and queuing increases • As demand starts to approach capacity on midblock arterial road sections, traffic starts to slow • In some areas demand starts to exceed practical capacity and flow breakdown occurs • Queuing from intersections blocks back to downstream/upstream intersections • By 8am the arterial network is largely saturated and when 'school peak' traffic joins the network, further extending the peak. • By 9am demand has reduced to a level where	• Commuter demand builds from around 7:30am • Key intersections become saturated and queuing occurs • In some sections of the central area demand starts to approach capacity on midblock arterial road sections, traffic starts to slow • In a few isolated locations demand starts to exceed practical capacity and flow breakdown occurs • By 8:30am demand has reduced to a level where the network starts to recover.	• Commuter demand builds from around 8am • Key intersections become saturated and queuing occurs • In some sections of the central area demand starts to approach capacity on midblock arterial road sections, traffic starts to slow for short periods of time • In a few isolated locations demand starts to exceed practical capacity and flow breakdown occurs • By 8:30am demand has reduced to a level where the network starts to recover.

the network starts to recover.		

We can see even from the somewhat subjective assessment above, that the characteristics that make up peak period network performance are largely similar across urban centres. It is when those characteristics are sustained over a period of time that knock-on effects cause further deterioration in operational performance. This is really the origins of peak spreading, as cities grow, people go to work earlier and later to avoid congestion, the more people that do this the more the shoulder of the peaks gets congested and further peak spreading occurs.

This raises the issue of 'time period' that is not dealt with well in the existing SmartRoads tool. If the peak delay and associated level of service occurs for 15 minutes, the tool would consider this equivalent to the same level of service occurring across an hour or two.

Therefore, there may be some merit in discussing 'peak duration' within documentation of the assessment process. Finding a quantifiable duration of peak period could be done for different urban centres by measuring average speed at key locations within and around an urban centre, and comparing observed peak speed against free flow or off peak speed. This assessment would help to somewhat validate the subjective discussion above.

9.2 General Principles

There have been a number of discussions around whether or not LOS should be individualised for different urban scales.

On one side, there is an issue that the lower levels of LOS are not likely to be seen in smaller urban centres. On the other side, does the tool loose some credibility if levels of service are being customised to the scale of the assessment location?

The recommendation, while up for debate, is that a single definition of LOS is most appropriate. Developing individualised LOS descriptions for each urban category places the entire framework into too much of a subjective assessment that could be manipulated and customised to predetermined outcomes.

In addition to this, it is recommended that LOS is linked closely, where possible, with the wider industry definitions for level of service, at least in the initial roll-out of the process. This will help to secure some credibility for the tool and will bring some familiarity for traffic engineers / transport planners who have an understanding of the traditional definitions for LOS A to F. These industry standards are from the TRB Highway Capacity Manual (HCM) and Austroads Guide to Traffic Management.

In saying this, the definitions for LOS A to F for each mode do not need to purely relate to throughput efficiency on modes other than general traffic. For example, pedestrian levels of service contain throughput, crossing and availability of facilities within each definition.

Therefore, given the increased scope around some of these definitions, the full range of LOS is quite likely to be seen in urban centres of all different scales. That is with the exception of general traffic, which is not generally an issue warranting investment in smaller urban centres.

Note that for simplicity, safety issues have generally been excluded when related to general traffic levels of service. This may be a further extension of the tool in the future.

9.3 Summary Table

The following table summarises all the detailed LOS tables for each mode.

	Public Transport	Pedestrian	Cycle	Freight	General Traffic
A	No delay at intersections. Generally free flow conditions. Interaction with other modes highly unlikely. Travel times are always reliable and predictable.	Walking speeds are freely selected, and conflicts between pedestrians are unlikely. Minimal or no delay in crossing.	Safe and attractive to all bicyclists. High quality route, with good surface conditions. No significant conflict with other traffic, and little to no delay at intersections.	Drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream. Almost no interaction with other vehicles.	Drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream. Almost no interaction with other vehicles.
B	Some delay at intersections. Generally good conditions with minimal queuing. Travel times are usually reliable and predictable.	Sufficient area for pedestrians to select walking speeds freely. Short delay before being able to cross safely (in the order of 5 to 10 seconds).	These bicycle routes are suitable for all bicyclists, with light moderate traffic flows. Short delay with moderate chance of being stopped.	Stable flow where drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream. Some interaction with other vehicles.	Stable flow where drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream. Some interaction with other vehicles.
C	Delay encountered at most major intersections. Traffic generally clears within one cycle or less than 30 seconds at unsignalised intersections. Common for interaction with general traffic or other road users to result in some delay to busses.	Space is sufficient for normal walking speeds, and for bypassing other pedestrians in primarily unidirectional streams. Delay of around 10 to 15 seconds before opportunity to cross.	These facilities are adequate for most bicyclists. Long delays, and/or multiple crossing conflicts at intersections.	Most drivers are restricted to some extent in their freedom to select their desired speed. The general level of comfort and convenience declines noticeably at this level. Reasonable interaction with other vehicles, some additional delay as a result.	Most drivers are restricted to some extent in their freedom to select their desired speed. The general level of comfort and convenience declines noticeably at this level. Reasonable interaction with other vehicles, some additional delay as a result.
D	Delay encountered at almost all intersections. Traffic may take more than one cycle to clear or be close to a minute at unsignalised intersections. Interaction with general traffic frequently adds delay to bus operation	Freedom to select individual walking speed and to bypass other pedestrians is restricted. Delay of around 20 seconds before an opportunity to cross.	Cyclists can anticipate a moderate to high level of conflict with vehicles on minor roads or local distributors. Long delay, and/or multiple crossing conflicts.	Close to the limit of stable flow. All drivers are severely restricted and to manoeuvre within the traffic stream. Common to interact with other vehicles, resulting in poor performance.	Close to the limit of stable flow. All drivers are severely restricted and to manoeuvre within the traffic stream. Common to interact with other vehicles, resulting in poor performance.
E	Significant delay and queuing at all intersections. Traffic may take 3 or more cycles to clear, or often experiences delay of around a minute at unsignalised intersections. Interaction with general traffic dictates the majority of bus operation.	Virtually all pedestrians restrict their normal walking speed. At the lower range, forward movement is possible only by shuffling. Delay of between 20 and 40 seconds before an opportunity to cross, some pedestrians take unsafe risks.	Cyclists can anticipate a high level of conflict with vehicles. Very long delay at intersection, with and/or no crossing provisions. Shared lane with higher speed traffic.	Traffic volumes are at or close to capacity, and there is virtually no freedom to select desired. Flow is unstable and minor disturbances within the traffic stream will cause breakdown. Vehicles moving together as a queue.	Traffic volumes are at or close to capacity, and there is virtually no freedom to select desired. Flow is unstable and minor disturbances within the traffic stream will cause breakdown. Vehicles moving together as a queue.
F	Intersections frequently failing to service traffic demand and long queues are experienced as a result. Interaction with general traffic / other road users determines the movement and ability of buses to operate.	All walking speeds are severely restricted, and forward progress is made only by shuffling. Footpath may not be provided. Delay in excess of 40 seconds before an opportunity to cross.	No special bicycle facility, with a high speed environment. Extreme delay and/or barriers to crossing. Potential for cyclists to encounter multi-lane roundabouts in without any specific facilities.	In the zone of forced flow. Flow breakdown occurs, and queuing and delays result. Interaction such that stop-start conditions are prevalent. It is clear that the intersection is unable to service the demand.	In the zone of forced flow. Flow breakdown occurs, and queuing and delays result. Interaction such that stop-start conditions are prevalent. It is clear that the intersection is unable to service the demand.

9.4 USL Bicycle

Definitions for cycle LOS have not been altered significantly from those originally proposed. They contain information on midblock and intersection activity. Some additions relating to speed environment and roundabout have been included.

LOS	Description	Comments
A	These facilities are generally safe and attractive to all bicyclists, but especially new riders and children. Exclusive wide separate high quality route, with good surface conditions, cycling permitted on car free streets. No significant conflict with other traffic, and little to no delay at intersections.	
B	These bicycle routes are suitable for all bicyclists, with light moderate traffic flows, few conflicts and good surface. Short delay with moderate chance of being stopped Wide marked on-road cycle lane or a narrow separated cycle way or a shared space with a low speed environment, with formal crossings.	
C	These facilities are adequate for most bicyclists. Long delays, and/or multiple crossing conflicts at intersections. Narrow marked on-road cycle lane with moderate flows, or bicycles share the lane with minor road or local distributor. Cycle facilities likely to be available at signalised intersections.	
D	Cyclists can anticipate a moderate to high level of conflict with vehicles on minor roads or local distributors. Long delay, and/or multiple crossing conflicts. Bikes share the local road with medium traffic flows. Likely to be used by experienced riders. State highways with wide lanes, sealed verge and the ability for some separation between cyclists and general traffic in high speed environments.	
E	Cyclists can anticipate a high level of conflict with vehicles. Very long delay at intersection, with and/or no crossing provisions. Shared lane with higher speed traffic. Potential for cyclists to encounter roundabouts in medium/high speed environments without any specific facilities.	

	State highways with standard width lanes and sealed verge.	
F	No special bicycle facility, with a high speed environment. Extreme delay and/or barriers to crossing. Potential for cyclists to encounter multi-lane roundabouts in high speed environments without any specific facilities. State highways with narrow lanes and unsealed verge.	

9.5 USL Pedestrian

The descriptions for pedestrian user service levels have been altered to be largely consistent with Austroads Guide to Traffic Management / HCM, along with added detail where required. This links the NOF process more closely with internationally recognised definitions of performance.

Delay values for crossings have been extracted from the Austroads Guide to Traffic Management. These delay thresholds are lower than those found in the original USL definitions and those found in SmartRoads.

Note that lower pedestrian levels of service can be a result of flow reducing performance on the footpath itself, traffic performance reducing crossing efficiency or lack of facilities reducing safety / increasing risk.

LOS	Description	Comments
A	Pedestrians move in desired paths without altering their movements in response to other pedestrians. Walking speeds are freely selected, and conflicts between pedestrians are unlikely. Minimal or no delay in crossing, no deviation away from desire lines is required. Grade separated pedestrian crossing may be available.	
B	There is sufficient area for pedestrians to select walking speeds freely, to bypass other pedestrians, and to avoid crossing conflicts. Pedestrians begin to be aware of other pedestrians, and to respond to their presence when selecting a walking path. Short delay before being able to cross safely (in the order of 5 to 10 seconds). Low speed environment.	
C	Space is sufficient for normal walking speeds, and for bypassing other pedestrians in primarily unidirectional streams. Reverse-direction or crossing movements can cause minor conflicts, and speeds and flow rate are somewhat lower. Delay of around 10 to 15 seconds before opportunity to cross. Potential need for 2 stage crossing using the median. Pedestrian protection available on the median on key desire lines.	
D	Freedom to select individual walking speed and to bypass other pedestrians is restricted. Crossing or reverse flow movements face a high probability of conflict, requiring frequent changes in speed and position. Friction and interaction between pedestrians is likely. Delay of around 20 seconds before an opportunity to cross.	

	Pedestrian protection facilities in median may exist but be slightly off the desire line. Potentially increased speed environment makes crossing more challenging.	
E	Virtually all pedestrians restrict their normal walking speed, frequently adjusting their gait. At the lower range, forward movement is possible only by shuffling. Space is not sufficient for passing slower pedestrians. Cross- or reverse flow movements are possible only with extreme difficulties. Design volumes approach the limit of walkway capacity, with stoppages and interruptions to flow. Delay of between 20 and 40 seconds before an opportunity to cross, some pedestrians take unsafe risks. Clear lack of pedestrian facilities to aid in safe crossings. Likely to be in a higher speed environment >60km/hr.	
F	All walking speeds are severely restricted, and forward progress is made only by shuffling. There is frequent, unavoidable contact with other pedestrians. Cross- and reverse-flow movements are virtually impossible. Flow is sporadic and unstable. Space is more characteristic of queued pedestrians than of moving pedestrian streams. Footpath may not be provided. Delay in excess of 40 seconds before an opportunity to cross. Opportunities to cross are more than 400m from demand. Potentially a high speed environment making crossing unsafe. Lack of street lighting making visibility an issue.	

9.6 USL Public Transport

Each of the following descriptions for public transport level of service contain 4 points:

1) General characteristics of intersection delay including signalised and non-signalised intersections.
2) Interaction with general traffic or other road users resulting in delay.
3) Bus stop operation including arrival, boarding/alighting and re-joining the traffic stream.
4) Travel time reliability.

LOS	Description	Comments
A	No delay at intersections. Generally free flow conditions. Interaction (resulting in delay) with general traffic or other road users including cyclists sharing bus lanes highly unlikely. Efficient bus stop performance (no delay on entry, efficient boarding/alighting, no delay re-joining bus lane / traffic stream). Travel times are always reliable and predictable.	
B	Some delay at intersections. Generally good conditions with minimal queuing. Reasonable interaction with general traffic/other road users but with only a small amount of delay. Some slight restrictions at bus stops on entry/exit but generally efficient boarding/alighting. Travel times are usually reliable and predictable.	
C	Delay encountered at most major intersections. Traffic generally clears within one cycle or less than 30 seconds at unsignalised intersections. Common for interaction with general traffic or other road users to result in some delay to busses. Common for buses to wait a short period of time to re-join traffic stream after stopping. Some boarding/alighting delay. Bus arrival times may be delayed slightly against scheduled times.	
D	Delay encountered at almost all intersections. Traffic may take more than one cycle to clear or be close to a minute at unsignalised intersections. Interaction with general traffic or other road users frequently adds delay to bus operation. Buses usually wait to re-join traffic stream and occasionally have to force their way into queues. Boarding/alighting delay	

	common. Common for arrival times to differ from scheduled times.	
E	Significant delay and queuing at all intersections. Traffic may take 3 or more cycles to clear, or often experiences delay of around a minute at unsignalised intersections. Interaction with general traffic / other road users dictates the majority of bus operation. Buses often queuing in general traffic on approach to bus stops, experience delay boarding/alighting and frequently have trouble re-joining the traffic stream. Often unreliable / unpredictable travel times result in timetable issues.	
F	Intersections frequently failing to service traffic demand and long queues are experienced as a result. Often takes more than 3 cycles to clear, or delays at unsignalised intersections are well over 1 minute. Interaction with general traffic / other road users determines the movement and ability of buses to operate. Buses queue on approach to stops, can encounter bus overcrowding and are often delayed for long periods of time trying exit bus stops. Buses are rarely on schedule as a result of delay and travel time unpredictability.	

9.7 USL General Traffic

The following descriptors for general traffic match more closely the Austroads / HCM 2010 descriptions. This is intended to give the definitions a level of internationally recognised credibility.

Descriptions cover midblock operation, intersections and vehicle interaction.

It is recommended that in a further iteration of the tool, consideration is given to separating out the user service levels for traffic with a movement function vs. access function, in that they have different needs and perceptions of operation.

LOS	Description	Comments
A	A condition of free-flow in which individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high, and the general level of comfort and convenience provided is excellent. Almost no interaction with other vehicles.	
B	In the zone of stable flow where drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is a little less than with level of service A. Low level of interaction with other vehicles.	
C	Also in the zone of stable flow, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level. Reasonable interaction with other vehicles, some additional delay as a result. Small amount of queuing but vehicles generally clear intersections in one signal cycle or with delay of less than 30 seconds at unsignalised intersections.	
D	Close to the limit of stable flow and approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor, and small increases in traffic flow will generally cause operational problems. Common to interact with other vehicles, resulting in poor performance. Queuing at intersections is common, can take up to 2 cycles to get through an intersection, or up to 50 seconds at unsignalised intersections.	
E	Traffic volumes are at or close to capacity, and there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream. Flow is unstable and minor disturbances within the traffic stream will cause breakdown.	

	Significant interaction with other vehicles, vehicles moving together as a queue. Significant queuing at intersections happens frequently on more than 2 approaches to an intersection. Often takes up to 3 cycles to get through an intersection, or a minutes delay at an unsignalised intersection.	
F	In the zone of forced flow, where the amount of traffic approaching the point under consideration exceeds that which can pass it. Flow breakdown occurs, and queuing and delays result. Interaction such that stop-start conditions are prevalent. It is clear that the intersection is unable to service the demand. Queuing can often be seen to be growing rather than reducing between signal cycles. Downstream congestion may inhibit effective throughput during green phases.	

9.8 USL Freight

Descriptions for freight level of service have been kept largely consistent with general traffic, given that they will almost always be mixed in the same traffic stream (freight lanes are a rare occurrence). Despite this, some issues specifically relating to freight have been included such as freight lanes, slow acceleration.

LOS	Description	Comments
A	A condition of free-flow in which individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high, and the general level of comfort and convenience provided is excellent. Almost no interaction with other vehicles, potentially with an exclusive HOV / Freight lane.	
B	In the zone of stable flow where drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is a little less than with level of service A. Low level of interaction with other vehicles. Potentially with an exclusive HOV / Freight lane.	
C	Also in the zone of stable flow, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level. Reasonable interaction with other vehicles, some additional delay as a result. Small amount of queuing but vehicles generally clear intersections in one signal cycle or with delay of less than 30 seconds at unsignalised intersections. This may be through the use of a freight/HOV bypass lane.	
D	Close to the limit of stable flow and approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor, and small increases in traffic flow will generally cause operational problems. Common to interact with other vehicles, resulting in poor performance. Congestion / grade / turn radius issues reduce the ability for freight to easily move through the network. Queuing at intersections is common, can take up to 2 cycles to get through an intersection, or up to 50 seconds at unsignalised intersections.	
E	Traffic volumes are at or close to capacity, and there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream. Flow is unstable and minor disturbances within the traffic stream will cause breakdown. Significant interaction with other vehicles, vehicles moving together as a queue.	

	Congestion / grade / turn radius issues cause freight vehicles to reduce the performance of the network due to slow acceleration. Significant queuing at intersections happens frequently on more than 2 approaches to an intersection. Often takes up to 3 cycles to get through an intersection, or a minutes delay at an unsignalised intersection.	
F	In the zone of forced flow, where the amount of traffic approaching the point under consideration exceeds that which can pass it. Flow breakdown occurs, and queuing and delays result. Interaction such that stop-start conditions are prevalent. Congestion / grade / turn radius issues cause freight vehicles to significantly reduce the performance of the network due to slow acceleration. It is clear that the intersection is unable to service the demand. Queuing can often be seen to be growing rather than reducing between signal cycles. Downstream congestion may inhibit effective throughput during green phases.	

10. Summary

This report discusses research undertaken and recommendations for each of the factors and definitions in SmartRoads. Any factors / definitions where specific recommendations have not been made, the intention is that these will remain consistent with the original SmartRoads tool.

Throughput

Recommended ranges and varied increment values have been recommended for throughput drop down lists for each mode.

In addition, it is recommended that users have the ability to directly input known throughput values without needing to use the drop down lists.

It is recommended that these throughput ranges are reviewed regularly to ensure their applicability.

Relative Growth

It is recommended that relative growth 'levels' be selectable for public transport, walking/cycling and freight. These 'levels' apply a factor that has been developed in relation to the inequality of value of time between modes and give an approximate percentage weighting towards alternative modes to private car.

Vehicle Occupancy

Car occupancy was found to be fairly consistent across New Zealand and a recommended level of 1.4 was seen as an appropriate compromise between peak and non-peak occupancies

Bus occupancy is recommended to be selectable at different levels to represent the large differences in this factor that may be observed.

Value of Time

Recommended values of time for each mode have been developed in conjunction with the NZTA EEM team.

Urban Categories

Research into urban categories found that categorisation by population / population density is not appropriate and the tool should instead be customisable for assessments in different urban centres.

Activity Areas

Generic naming, and detailed definitions for each category have been recommended for activity areas.

Relative Priorities

Relative priority tables have been altered from the original SmartRoads tables to be applicable for New Zealand. This includes removing a number of 'off-peak' priorities.

Level of Service

A one page summary table, as well as detailed mode specific level of service tables have been developed that link closely with HCM and Austroads standards. These are deemed to be applicable for urban categories of all sizes.

These factors / definitions, once adopted by the national working group can be implemented into the development of a New Zealand specific tool.

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