NGAURANGA TO AIRPORT STRATEGIC STUDY

Technical Report 1: Description of Options

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Contents

Executive Summary

This report is one of several investigating options to address the transport issues between the Western and Hutt Corridors to the north of Wellington and the Airport and Hospital to the south and east of the City, through the Wellington Central Business District (CBD) area. The purpose of the study is to identify the present and future transport needs and possible solutions that support land uses, social, business and recreational goals.

Wellington's residents not only travel fewer kilometres per year but fewer kilometres by car and are more likely to travel by passenger transport compared to residents in others cities in NZ. Wellington is expected to continue growing over the next planning horizon. While it is desirable to make walking, cycling and passenger transport more attractive alternatives to the motorcar, it is clear that the number of trips associated with this growing population is outstripping a projected shift from private car to an enhanced passenger transport system. This means that investment is needed in improving all modes if the same (or better) level of service in terms of mobility is to be maintained in future years. The recent trend for more median and high density dwellings in Wellington should help make higher quality passenger transport initiatives more viable in future years.

There is only a limited supply of road space, and all modes must compete for access to it. The concept of creating corridors which give priority to one mode over another has the potential to improve the efficiency in the way road space is used while also enhancing the amenity for pedestrians and other users.

It is proposed to accommodate a large proportion of the growing population in median to high density growth nodes at Kilbirnie and Newtown. The success of these nodes is dependant on providing a high quality, frequent and reliable passenger transport service and ensuring the nodes are walk-able. Such a high quality passenger transport service will need to be allocated with its own right-of-way, such as a dedicated busway or light rail system.

Light rail is regarded as a high quality passenger transport system that will create a needed step-change required to make the growth nodes successful. The number of passengers using the Golden Mile route in future years appears sufficient to warrant a higher quality passenger transport service than that offered by bus, including light rail or the next generation of buses including electronic guided bus systems.

While a light rail system, with its perceived higher quality, might attract more passengers within the growth nodes, it is unlikely to be as attract a significant increase in number of bus passengers from the suburbs who presently travel by bus but could use a dedicated bus way along the Golden Mile. Buses are able to penetrate the lower density suburbs while also using the high speed right-of-way along the passenger transport corridor without imposing a time penalty for transfers.

Wellington is considered too small a city to allow passenger transport service to compete with each other, and if a light rail is was adopted, it is unlikely to be viable to allow buses to compete with it along the same route.

It is unlikely that the same high quality passenger transport service can be provided to Kilbirnie as that proposed for Newtown, at least in the short term. This is because the passenger numbers expected to be generated by Kilbirnie are insufficient to justify a higher quality route. There are also a number of challenges in creating the needed right-of-way. Nevertheless, the passenger transport route via the Bus Tunnel is likely to provide the better level of service in the short to medium term given that it follows a low volume residential route where buses are unlikely to experience delays.

The airport is unlikely to generate the needed passengers to make extending the passenger transport corridor to the airport (with or without light rail) viable. However, providing some bus priority measures at key congestion points could be considered.

Creating pedestrian corridors and passenger transport (which take cycle usage into account) corridors in conjunction with an improved parking strategy will increase walking and improve safety and amenity: making Wellington an even more walk-able city.

All key arterials within the study area will be operating at or near theoretical capacity by 2016, even with the significant investment in removing key congestion points within the corridor. Without these improvements or without constraining population growth, the network will provide an increasing lower level of service. The need to re-allocate road space for passenger transport corridors and the need to enhance pedestrian connections puts further pressure on the roading network.

The widening of the motorway from Ngauranga Gorge to Aotea Quay looks likely to provide the greatest return on investment.

Notwithstanding a significant increase in capacity of the motorway as a result of duplicating the Terrace Tunnel and the reassignment of vehicle trips to this route, the waterfront will remain very busy at peak time in both directions – although it will carry fewer vehicles than it does at present. Consequently, reducing the waterfront to two-lanes in each direction creates congestion along other routes and incurs negative benefits.

Duplicating the Mount Victoria Tunnel and associated improvements along Ruahine Street and at the Basin Reserve provide the greatest economic benefits associated with improved travel time and reduced vehicle operating costs. However, the indicative costs associated with these improvements are unlikely to generate a benefit cost ratio much greater than one. The proposal to create a growth node at Newtown and the associated passenger transport corridor along Adelaide Road creates the opportunity to divert traffic flows around the growth node, using Taranaki Street and Wallace Street, and discourage traffic using Adelaide Road.

It might cost somewhere between $650 million and $900 million to complete the needed projects within the study areas and which might form part of a future corridor plan.

1 Introduction

1.1 The Project

Opus International Consultants (Opus) has been commissioned by Transit New Zealand on behalf of Transit New Zealand, Wellington City Council and Greater Wellington Regional Council to undertake a study to investigate options to address the transport issues between the Western and Hutt Corridors to the north of Wellington and the Airport and Hospital to the south and east of the City, through the Wellington Central Business District (CBD) area. Opus worked in partnership with and acknowledges the assistance of the following consultants. Arup undertook the traffic modelling using Greater Wellington Regional Council's strategic transport model and provided advice on light rail. Fraser Fleming Transport Planning carried out traffic modelling using Greater Wellington Regional Council's SATURN model. Alistair Aburn and Deyana Popova, from Urban Perspectives, provided assistance with key planning and urban design issues. Ian Clarke from Flow Consultants assisted the team with transportation advice.

The purpose of the study is to identify the present and future transport needs of the Ngauranga to Airport Transport Corridor and propose solutions that support land uses, social, business and recreational goals. Accordingly, the study investigates a range of transport mode options including walking and cycling, passenger transport, movement of goods, and private motor vehicle. A key element of the study is to consider the relationship between urban form and transport corridors and to ensure transport solutions support present and future proposals for urban intensification often referred to as Transit Orientated Development. The section of SH1 along the Inner City Bypass was excluded from the study.

1.2 Scope and Purpose of Technical Options Report

This Technical Options Report is one of several interim reports leading to a Corridor Management Plan for the study area. This report follows three previous reports, including the Phase 1 Consultation Report (July 2006), a Problem Framing Report (August 2006), and Golden Mile Capacity Assessment Report (August 2006).

The purpose of the report is to describe the range of transport options that address key issues described in the Problem Framing Report while meeting the vision statement (or problem statement) for the study:

> *"To deliver an integrated land transport system that supports the City's transport and urban development strategies (urban growth spine) and provides access to the CBD, airport, hospital and port."*

This report provides a description of a range of options and sub-options that may form part of the future transport needs for the study area. While the report provides a list of known issues about these options, the report does not attempt to fully analyse the options or undertake any evaluation or comparison of options. Such an analysis will take place after consultation, which will provide a key input into this analysis. This work will be reported in subsequent reports. It is further acknowledged that while a range of sub-options have been described in this report, this list is not intended to be an exhaustive list of sub-options. It is likely that further detailed study at scheme assessment stage may generate additional sub-options.

2 Review of Previous Studies

In this section we review a number of key historical studies undertaken within the study area with a view to identifying key issues that might guide possible future solutions. As Winston Churchill once said, *"you can not understand the future until you understand the past."*

2.1 De Leuw Cather 1963 Transport Plan

Background: De Leuw Cather, a San Francisco firm of consulting engineers, carried out a comprehensive transport study of the Wellington CBD in 1963. This study extended from Thorndon to Kilbirnie.

Motorway: The study investigated a motorway connection between the Wellington CBD and the rest of the Wellington region, a review of major roading arterials within the CBD area, an investigation of improvements to passenger transport and a review of car parking.

At the time of the study, the Thorndon – Ngauranga motorway was under construction. De Leuw Cather recommended that a motorway be constructed along the foothills connecting the Thorndon-Ngauranga motorway to Kilbirnie. This recommendation was adopted and that part of their proposed scheme, connecting Thorndon to the Terrance Tunnel, was constructed in the late 1960's and early 1970s, generally in accordance with their original scheme. Part of their scheme was never completed, including the idea of extending the motorway, mainly within a trench, to the Basin Reserve and onto Kilbirnie requiring the construction of a second Mount Victoria tunnel. The proposed route for this part of the project generally follows the northbound–lane of the Inner City Bypass. Their proposal included two large and intrusive interchanges at Taranaki Street and Kent and Cambridge Terrace. On the Kilbirnie side of the Mount Victoria Tunnel, De Leuw Cather recommended a one way pair using both Ruhaine Street and Moxham Avenue.

This foothills motorway route was not the only option investigated by De Leuw Cather. They also reluctantly investigated a waterfront route along Waterloo Quay and Jervois Quay. This was to be an elevated structure located above city streets. Even though this water-front option offered improved travel time benefits for car users, De Leuw Cather strongly recommended against this option noting the significant adverse social, community and environmental impacts such an option would create, particularly the sense of severance between the CBD and the waterfront.

They recommended that the project be constructed in 3 stages:-

- Stage I – Aotea Quay to Hill Street and duplication of Mount Victoria Tunnel
- Stage II – Hill Street to Ghuznee Street and Vivian Street
- Stage III – Ghuznee Street to Mount Victoria Tunnel

The total cost of Stage I was indicated to be £20 million (1963) which would equate to about $700 to $900 Million in 2007 dollars.

Local Street Improvements: Included in the cost indication of stage I was a proposal to create a family of one–way streets in Wellington. De Leuw Cather's recommended a one-way system was adopted by Wellington City and continues to form the basis of the one-way system that exists today.

Car Parking: De Leuw Cather expressed concern about Wellington City's policy of using valuable street space for car parking and recommended that streets be used for the movement of vehicles and not as a car park.

Rail Passengers Transport: De Leuw Cather noted that the existing railway services were unusually extensive for a city the size of Wellington and that a substantial portion of commuters to the CBD used rail. They noted that a major improvement to the rail commuter service would be to extend the railway into the CBD to provide a more convenient delivery of passengers. Two options for extending the railway were investigated;

- **Option 1 -** 5.0 km underground railway starting 1km north of the present railway station at the Ferry Terminal and passing under Molesworth Street, The Terrace, Ghuznee Street, Massey University campus to terminate at the hospital at the corner of Adelaide Road and John Street – giving a total of six underground stations. The indicative cost in 1963 was £16 million (or $600 to $700 million in 2007)
- **Option 2 -** 3.0 km underground railway starting about 500m north of the present railway station, passing under Parliament, The Terrace, Dixon Street and Courtenay Place & Cambridge Terrace. – giving 4 stations. The indicative cost of option 2 in 1963 was £11 million (or $400 to $500 million in 2007)

They noted that a significant proportion of the cost to extend the railway would need to come from central or local government funds, although the city could expect a significant increase in land value (and hence tax revenues) adjacent to the proposed underground rail system.

Bus Passenger Transport: De Leuw Cather investigated a range of improvements to the bus passenger transport system. Key to their proposal was improving the rail to bus mode transfers at the railway station to minimise the time penalty associated with mode transfer. Their proposal called for a bus transfer station immediately at the front of the rail station together with additional street connections.

They noted that the creation of a one-way street system together with improved traffic signals, removal of unregulated use of pedestrian crossing and prohibition of angle parking would significantly increase the movement and speed of buses.

2.2 R. W. Burrell 1980 – Terrace Tunnel to Mount Victoria Tunnel

Background: Burrell undertook a study for the National Roads Board in 1980 to investigate options for extending the Wellington urban motorway from Ghuznee Street to Mount Victoria. Seven options were reviewed including a full motorway (located within a trench), an at-surface Boulevard and a 'one way pair'.

One option considered included a motorway in a trench to Victoria Street, a boulevard to Sussex Street and no grade separation at the Basin Reserve (but at the expense of reduced traffic movements at the Basin Reserve) with vehicles diverting from Adelaide Road to Taranaki and Wallace Streets.

Burrell recommend a modified form of this option which retained existing traffic movements at the Basin Reserve using grade separation.

2.3 Light Rail Transit Feasibility Study 1995

In March 1995, Works Consultancy Services (Opus) in conjunction with MV AConsultancy undertook a feasibility study of providing a light rail system from the railway station to Courtenay Place. The study investigated three routes:-

a) The Golden Mile route (2.4km) generally along Lambton Quay, Willis Street and Manners Street to Courtenay Place.

b) Central Route (2.3km) utilising Featherston Street, Willis Street and Manners Street to Courtenay Place.

c) Waterfront Route (2.2km) utilising Featherston Street, Whitmore Street, Custom House and Jervois Quay and either Castle Street or Wakefield Street to Courtenay Place.

The study concluded that the preferred route was the Golden Mile. The total cost of the Light Rail system was estimated to be $50 to $60 million ($65 to $80 million in 2007).

2.4 GEHL Architects, Public Spaces and Public Life Study 2004

Background: GEHL Architects were asked to identify issues and opportunities related to the urban quality of the CBD area, with particular emphasis on improving the connections between the CBD and the waterfront. The study area extended from the railway station to Vivian Street.

Taming Vehicular Traffic: GEHL concluded that vehicular traffic dominates Wellington City CBD and this domination had a negative effect on the way public streets and spaces are perceived and used. They suggested developing a strong and clear street hierarchy of motorways, retail streets, side streets and boulevards. The Golden Mile should be developed as a retail street and the waterfront route should be developed as a boulevard. Vehicle traffic volumes and speeds must be reduced as an overall strategy to improve the quality and vitality of the inner city area. Existing road space presently allocated for cars must be re-allocated for walking, cycling and passenger transport.

Passenger Transport: GEHL suggested the creation of a number of key routes designed to give priority to buses and provide for high quality rapid passenger transport service. These routes should connect with and be supplemented by a number of local lesser quality bus routes.

Pedestrian Network: GEHL proposed the creation of a number of primary and secondary walking routes where priority is given to pedestrians over other modes. The Golden Mile was one such route. They suggested that the road space along the Golden Mile be allocated only to pedestrians and passenger transport.

Railway Station: GEHL noted that the existing main entrance to the railway station could be improved by removing vehicular access. The station is a major transport hub – linking the city to the suburbs. This link could be improved by re-locating the 'kiss and ride' and taxi pick up area from the front of the station.

3 Existing Transportation, Modal Mix and Urban Form Issues

3.1 Overview

A major transport spine operates within the study area, extending from Ngauranga Gorge in the north, to the Airport in the south, as shown in Figure 3.1.

Wellington CBD plays an important role in the region's employment, and given the concentration of regional facilities (such as airport and hospital), the capacity and efficiency of the transportation corridors serving the area must be considered of regional significance. The large number of commuters working in the CBD requires a number of high capacity and efficient transport corridors serving the CBD area.

Based on a number of key transportation indicators, Wellington can be described as a much more sustainable city than other large NZ cities. As shown in Table 3.1, Wellington not only has one of the lowest car ownership rates, but its residents travel less. We can conclude that Wellington is more compact than other cities; and because of this, requires significantly less mobility to achieve the same level of accessibility: a concept strongly promoted within the NZ Transport Strategy. When Wellington's residents do travel, they are more likely to use alternative modes to the private motorcar. Over 40% of Wellington's residents use passenger transport once a week or more, which is nearly double the rate for Auckland (at 24%) and three times the rate of Christchurch (at 15%)[1]. Over 15%[2] of Wellington's residents walked, jogged or cycled to work on census morning, which is over 100% more than Auckland and 50% more than Christchurch. Accordingly, Wellington's residents travelled less by private motorcar, meaning they consumed less fuel, discharged less green house gases and hence there is less transport related air pollution per resident than other NZ cities.

Table 3.1: Key Sustainability Transportation Indicators

Source: - Quality of Life in NZ Eight Largest Cities, 2003, page 119 to 122

	Car Ownership per household (2001)	Total distance travelled[2] (1998) *(km/year/person)*	Total distanced travelled by car[1] (1998) *(million km/year)*
Wellington City	1.4	10,900	1,480
Auckland City	1.5	12,500	3,920
Christchurch City	1.6	12,700	3,350

Notes

1. Total distanced travelled per year by motor vehicle, including both driver & passengers km
2. Based on 2001 census population figures and 1998 LTNZ data

[1] Quality of Life in NZ Eight Largest Cities, 2003 page, 123
[2] 2001 Census

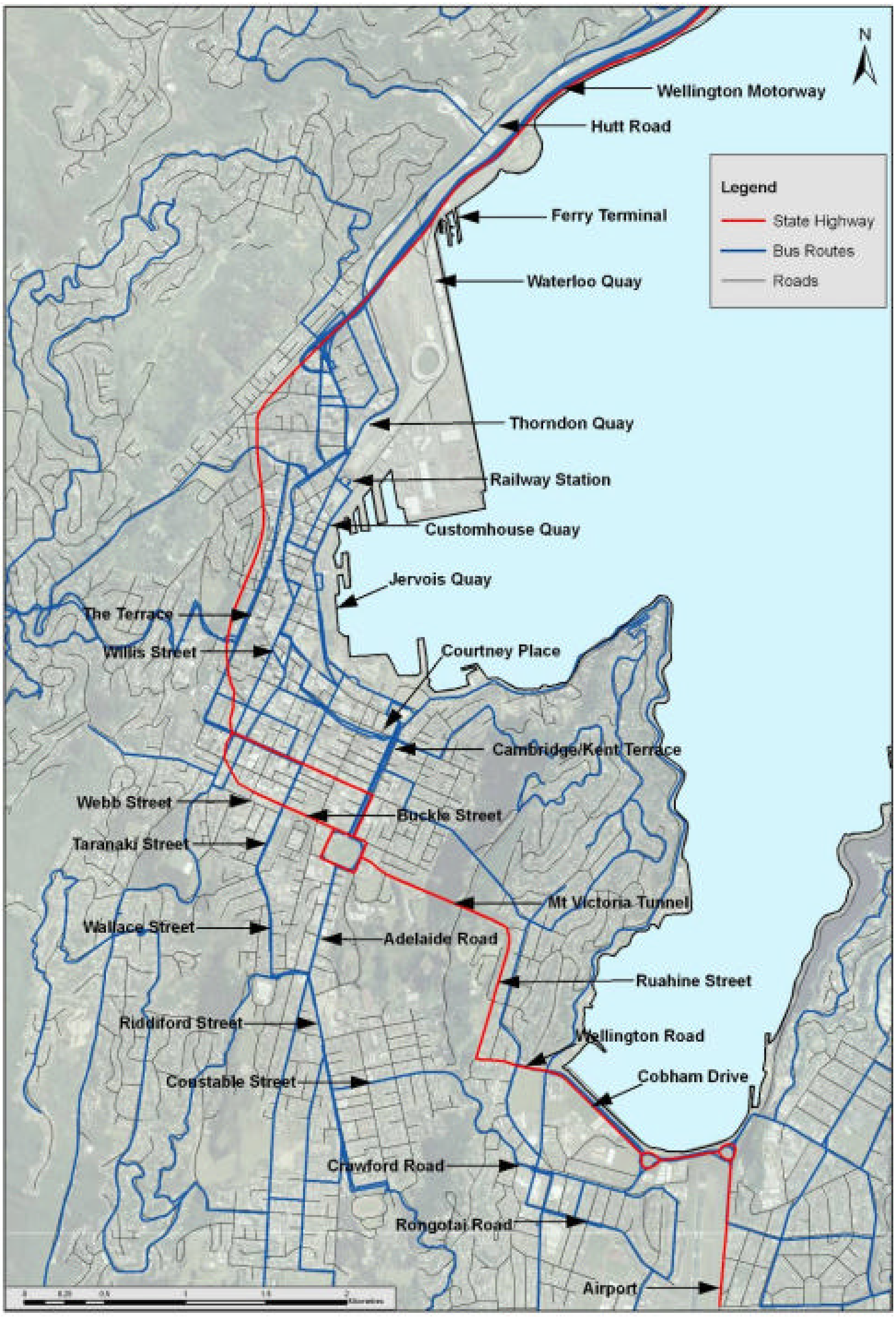

Figure 3.1: - The Study Area

Nevertheless, like other large cities within NZ and around the world, Wellington has experienced a significant growth in the use of the private motorcar with road space becoming congested as demand out-strips capacity. However, Wellington does not experience the same level of congestion as other cities, as shown in Figure 3.2.

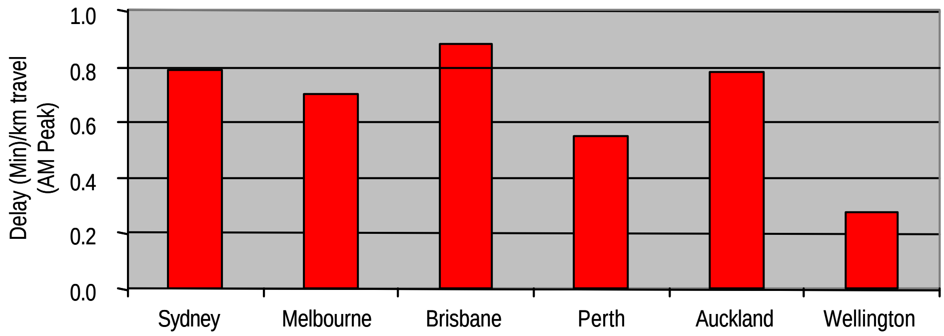

Figure 3.2: - A Comparison of Traffic Congestion

Source: - Transit New Zealand, quoted in Wellington Transport Strategy May 2004

Figure 3.3 summarises the number of trips by various key modes entering and leaving the central part of the study area from the north and east. Passenger transport, particularly rail, provides 30% of trips between Wellington City and the north across a screen line at Thorndon. A screen line along Mt Victoria shows that 18% of trips are by bus. Fifty-four percent of traffic uses the Mt Victoria Tunnel or the Bus Tunnel. Twenty-four percent uses Constable Street between Newtown and Kilbirnie.

North of the CBD: - Three key components form the transport corridor to the north: -

- A high capacity motorway links the CBD with the northern corridor - Hutt Valley Cities - and western corridor - Porirua City and Kapiti Coast.
- Hutt Road, a major arterial that runs parallel to the motorway, serves Wellington's western and north-western suburbs, and also provides a strategic route for commuter buses to the north and north-western suburbs.
- A railway provides a passenger transport service to the wider region, including the Johnsonville Line, Kapiti Line, Wairarapa Line and Melling Line. It also provides the main trunk freight link to the north and east.

The route between the CBD and Ngauranga Gorge carries over 60,000 vpd. During a morning week day, over 80% of the vehicles using this route are commuters travelling between the northern suburbs and the CBD, meaning that traffic flows can be considered tidal.

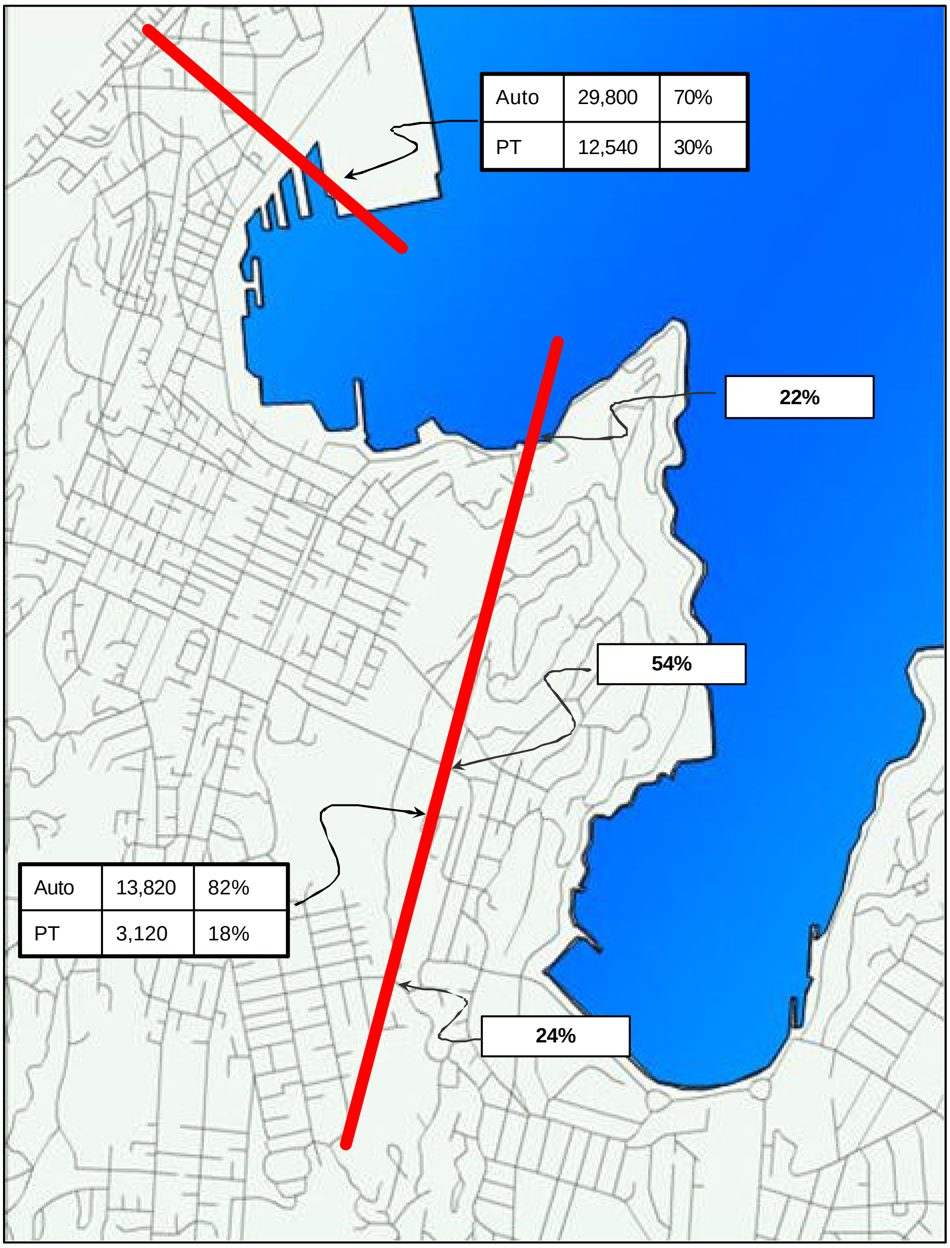

Figure 3.3: - How people travel through the study area (Morning Peak)

Source: GWRC Strategic Model for year 2001

Figure 3.4 shows the annual average daily traffic flows along key routes within the study area. The two key routes from the north include the SH1 urban motorway and the water front route, which carry similar volumes of traffic. The two key routes from the southern suburbs - Adelaide Road and Wallace Street - also carry similar volumes of traffic.

Figure 3.5 shows the hourly traffic volumes using the State Highway at Ngauranga Gorge. Although Figure 3.5 shows the combined traffic flows in both directions which tends to reduce the peak traffic flows during week days, a striking feature of graph is the significant traffic volumes being experienced during weekends.

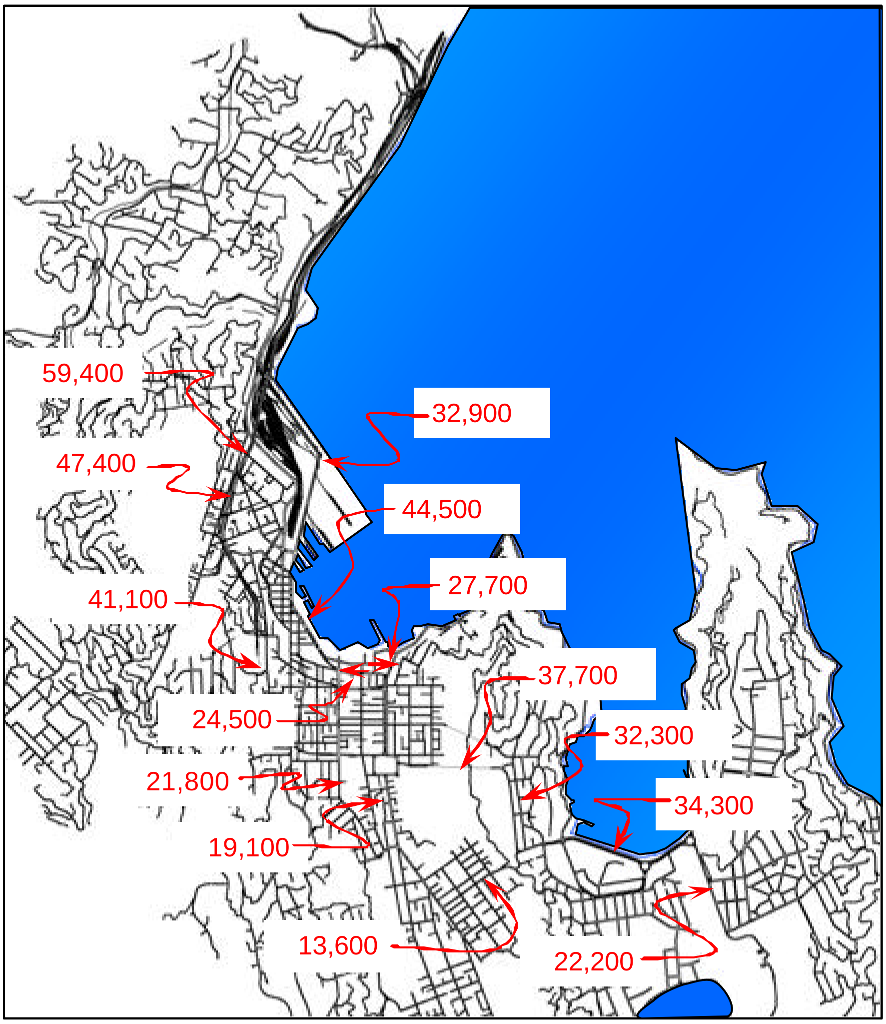

Figure 3.4: - Annual Average Daily Traffic Flows (2005)

Source: - WCC and Transit New Zealand Traffic Counts for 2005

Accessibility to the north is significantly constrained by the topography, particularly the harbour to the east and steep hills to the west. These constraints have led to an over-reliance on a limited number of high capacity transport routes through which all modes must pass. The motorway system to the north of the CBD, between Aotea Quay and the junction of SH1 and SH2, is operating at near capacity.

The CBD: - A feature of Wellington is the high capacity urban motorway that not only skirts around the intensified CBD areas but has been constructed in a trench and tunnel. This has reduced severance and ensured that Wellington City remains walk-able. This urban motorway connects with the Inner City Bypass, which uses a parallel one-way system to pass high volumes of traffic though a moderately intensified urban area using surface streets. One-way systems can be used to maximise through traffic while minimising severance, an important feature for urban areas.

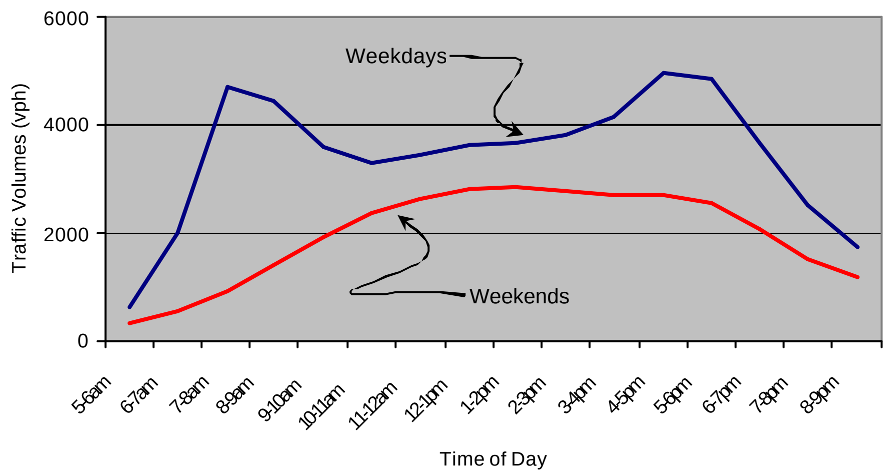

Figure 3.5: - Average hourly traffic volumes at Ngauranga Gorge
(combined directions)

Source: - Transit New Zealand

Notwithstanding the provision of this high capacity transport corridor around the CBD, nearly 50,000[3] vehicles use the waterfront route per day. Six lanes are provided, and this together with significant traffic volumes creates a barrier to pedestrians who wish to cross it, creating severance between the CBD and its waterfront: undesirable from an urban design perspective.[4] It appears that the limited capacity of the Terrace Tunnel increases the traffic volumes along the waterfront, particularly in the southbound direction.

Within and through the CBD itself, the Golden Mile route connects the railway station with Courtney Place and carries 110 buses per hour at peak time in one direction. This is a significant number of buses, even compared to world standards, and while some bus priority measures have been provided along this route, the level of service being provided is adversely affected by the number of intersections, car parking, interaction between buses and other vehicles and pedestrians, and of the capacity by the bus stops themselves. It is predicated that the level of bus service will decline in future years unless further bus priority measures are provided, including additional bus lanes, signal pre-emption, and reducing bus dwell times[5].

The CBD area also accommodates a large number of pedestrian movements, partly as a result of the railway station being located to the northern edge of the CBD. Key pedestrian corridors include Stout Street, Featherston Street, Lambton Quay and Customhouse Quay. In an evening peak, Lambton Quay carries nearly 6000 pedestrians per hour while Featherston Street carries over 2500 pedestrians

[3] Tim Kelly, "Wellington Waterfront Lane Removal: Assessment of Effects", Wellington City Council, July 2003
[4] GEHL Architects; "City to Waterfront, Public Spaces and Public Life Study", Wellington 2004
[5] Dwell time is the length of time a bus occupies a bus stop, and includes time for loading and unloading and time waiting to enter and exist a bus stop. Opus, "Ngauranga to Airport Strategy Study, Golden Mile Assessment", for Transit New Zealand, 2006

per hour.[6] These are very significant numbers and are equivalent to six to seven[7] lanes of traffic, if the same number of people were to travel by motor car.

Wellington City enjoys a high proportion of people who walk to work. On census day 2001, 19% of all work trips to the CBD were made on foot. Most significant are those who live in the CBD area, where 70% walked to work on census day.

There is an opportunity to make Wellington a more walk-able city by enhancing the level of service or journey time for these very significant numbers of pedestrian trips. Improving footpath width and giving pedestrian priority at signals and other road crossings has already been recommended[8]. There are known environmental, social and health benefits in making walking a more attractive alternative to other modes.

South of the CBD: - While accessibility from the CBD to the south east is not as constrained as that to the north, vehicles have a limited number of routes with the majority of vehicles using the route through the Mount Victoria tunnel to access the airport and eastern suburbs. To the south, a key arterial roading network exists together with an extensive bus service. Buses to the eastern suburbs are able to use a 'bus only' tunnel though Mount Victoria (referred to in this report as the Bus Tunnel). A limited but growing number of bus priority measures have been added in recent years, typically in the form of bus lanes. Over 70% of all bus trips to the CBD are from the southern and eastern suburbs[9].

The Mount Victoria vehicle tunnel (referred to in this report as the Mount Victoria Tunnel) and the Basin Reserve currently operate at capacity during peak periods, reducing accessibility to the airport and eastern suburbs, particularly for the motor vehicle.

A surprisingly large proportion - nearly 20% - of people living in the Newtown suburbs walk to work, making walking an important mode for suburbs adjacent to the CBD and as far away as Newtown.

The success of the proposals[10] to create growth nodes, being mixed use intensified areas, at Newtown and Kilbirnie is reliant on providing enhanced passenger transport services to these areas so as to encourage transit orientated development. These highly populated areas will also generate an increased number of private vehicles trips, although many of these trips will be non-work related and not necessarily at peak time. It is important, therefore, that in addition to providing facilities for passenger transport and walking, there is also adequate road capacity for general vehicles adjacent to the proposed growth nodes.

3.2 Population and Employment

Population Growth: - The population of the Wellington Region was 449,000 at the 2006 census[11] of which 179,000 people lived within Wellington City itself. By 2026, NZ Statistics forecast a population of

[6] GEHL Architects, "City to Waterfront, Public Spaces and Public Life Study", Wellington 2004
[7] Assuming 1.4 people per vehicle and 900 vehicles per hour per lane
[8] GEHL Architects; "City to Waterfront, Public Spaces and Public Life Study" Wellington 2004
[9] 2001 census
[10] Wellington City Council; "Draft Urban Development Strategy," 2006, Page 2
[11] NZ Statistics

between 440,000 to 550,000 for the region. Their forecast for the 'low growth rate scenario' indicate that population is expected to stabilise within the region at its present figure.

Nevertheless, Wellington City is expected to grow at a faster rate than the region, and to keep on growing even though the rest of the region may not, as shown in Figure 3.6. Consequently, the City can be expected to have an increasing proportion of the region's population[12] in future years. By 2026, Wellington City's population is expected to increase between 9,000 and 43,000 depending on the growth scenario.

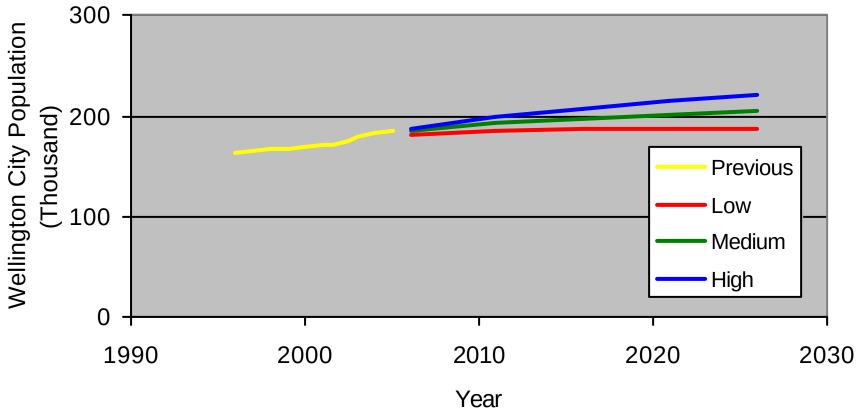

Figure 3.6: - Population Growth for Wellington City

Source: - Statistics NZ

Projected population growth rate of only 0.4% to 0.5%[13] to the year 2021 appears very timid. The landscape coupled with the vibrancy and diversity of Wellington's central city creates an attractive, positive environment for significantly higher growth figures. Wellington has all the qualities[14] to be part of the next generation of cities to experience significant growth over the next 20 years, like Melbourne and Vancouver have over the last 20 years. A key element to the growth success of these cities was their investment in transportation corridors, including high quality passenger transport systems.

Compared to the rest of NZ, where only 14% of new dwellings are medium to high density development, Wellington City constructed 40% of its new dwellings as medium to high density[15]. This trend is making Wellington City more compact and this in turn reduces the number and length of trips people need to make. Furthermore, it is making passenger transport a viable alternative to the private motor car. Given this level of medium to high density construction in previous years, the City's plan to accommodate a significant proportion of the future population growth within intensified areas and growth nodes, as discussed in the next section, appears to be an achievable target.

[12] GWRC "CBD Corridor Study, Pressures and Issues", Page 5
[13] Wellington City Council, "Quantifying the Growth Spine, supply, demand and capacity for residential development in Wellington City", September 2006
[14] Compared with NZ other large cities, Wellington City residents rated it as the best city, with over 87% saying they agreed or strongly agreed with the statement "I feel a sense of pride in the way my city looks and feels"; Quality of Life in NZ Eight Largest Cities, 2003, page 114
[15] "Quality of Life in NZ Eight Largest Cities", 2003, page 76

Proposed Growth Nodes: - Over 50% of population growth within Wellington City is expected to occur in the CBD area[16] (in the form of high density apartments). Twenty five percent is expected to occur in "brownfield"[17] suburban growth nodes at Johnsonville, Newtown and Kilbirnie. The remaining 25% growth is expected to occur in the "greenfield" northern suburbs.[18] The suburban growth nodes at Johnsonville, Newtown and Kilbirnie form part of what has been referred to as a "growth spine" extending from Johnsonville to Kilbirnie, as shown in Figure 3.7. It is emphasised, however, that while this has been referred to as a growth spine, it is not intended that intensified mixed use growth will occur along the full extent of this spine. Rather, three separate growth nodes are proposed, perhaps connected by a high quality rapid transport corridor.

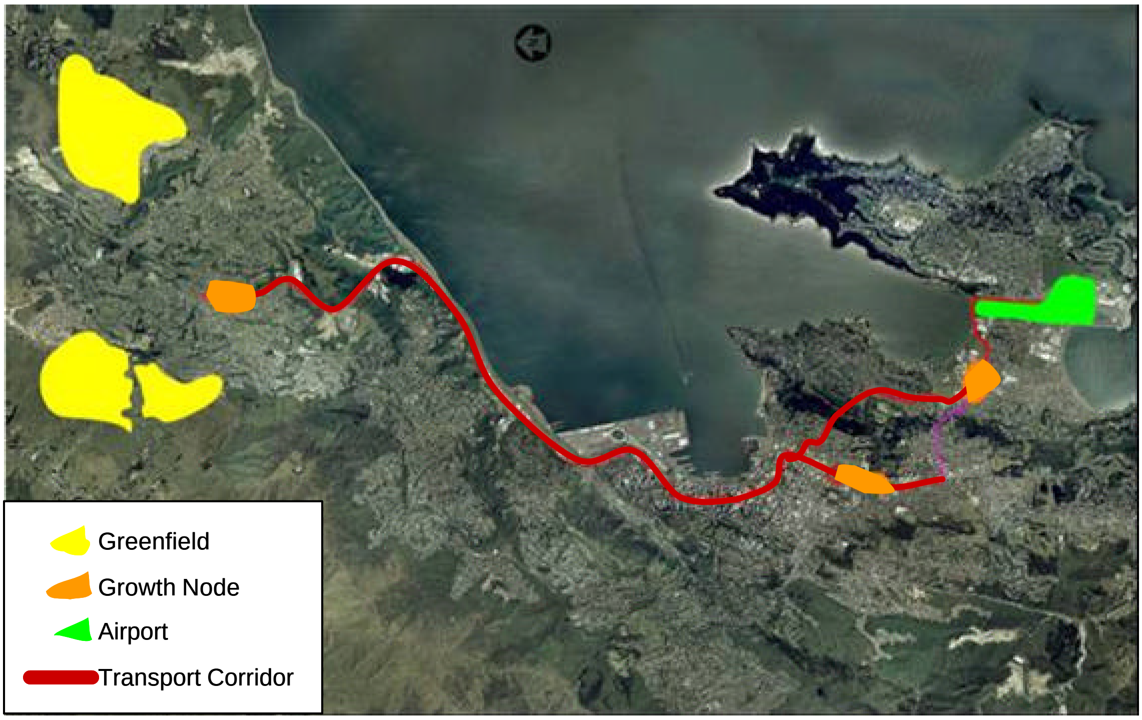

Figure 3.7: - Proposed Growth Spine

Source: - Wellington City Council

Figure 3.8 shows growth nodes that have developed in Vancouver, Canada following the construction of the sky train[19] and also refurbishment of the passenger rail link between the CBD and Fremantal, Perth, Western Australia. There are three striking features of these developments in Vancouver and Perth: -

- The growth nodes occurred after the construction of a high quality passenger transport system.

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[16] If transport costs continue to increase in future years, the region may see the present trend for apartment living in the CBD and surrounding suburbs increase in future years.
[17] Brownfield is an existing developed site suitable for re-development.
[18] WCC, "Urban Development Strategy, Working Paper 4", May 2005, Appendix 5
[19] A high quality, frequent, reliable and driverless rail system constructed in starting in 1986 for the Expo 86 World's Fair.

- The intensified development occurred in "nodes" and not as a spine along the full length of the passenger transport corridor.
- The intensified development only occurred at Subiaco because the railway was relocated in a trench[20].

Joyce skytrain station, Vancouver

Subiaco railway station, Perth

Figure 3.8: - Growth Nodes in Vancouver and Perth

Source: - Opus

Transport Corridors serving the growth nodes: - A high quality passenger transport connection between the Johnsonville growth node and the CBD has been investigated in a separate study[21]. A range of options were investigated including retaining heavy rail, replacing heavy rail with a light rail system, replacing the railway with a guided bus system and using buses on existing road network. Part way through this separate study, Council decided that the existing heavy rail network would remain. Consequently, we have assumed that the high quality passenger transport service connecting the CBD and the Johnsonville growth node will be heavy rail.

This study will investigate the connection between the CBD (starting at the railway station) and Newtown and also Kilbirnie.

Newtown Growth Node: - To help guide the project team's thinking in terms of transportation options for serving the growth node at Newtown, options for the urban area within the node were investigated. This was done to understand how the areas could be intensified, with a view to identifying key constraints, opportunities and issues for transport corridor to the Newtown growth node.

[20] Heavy rail creates severance in a similar way to major arterials and motorways. For this reason, to enable the intensified growth to occur at Subiaco, the railway was located within a trench to allow the development to occur above and ensure that the area above the railway station encouraged walking.

[21] SKM; "North-Wellington Public Transport Study, Technical Evaluation Report", November 2006.

The Newtown growth node is located along Adelaide Road and extends from the Basin Reserve to the Hospital. It is located within the valley formed by Mt Victoria to the east and Brooklyn Hills to the west. The area is about 2km from the CBD. Most of the area is zoned 'suburban centre'. Small parts at the western edge are a mixture of 'residential' and 'institutional precinct' zoning. The extent of the growth node is constrained by identified 'heritage areas' to the west and the town belt and Government House to the east. These constraints allow for the growth node to have a length of about 700m and width of between 150m and 250m.

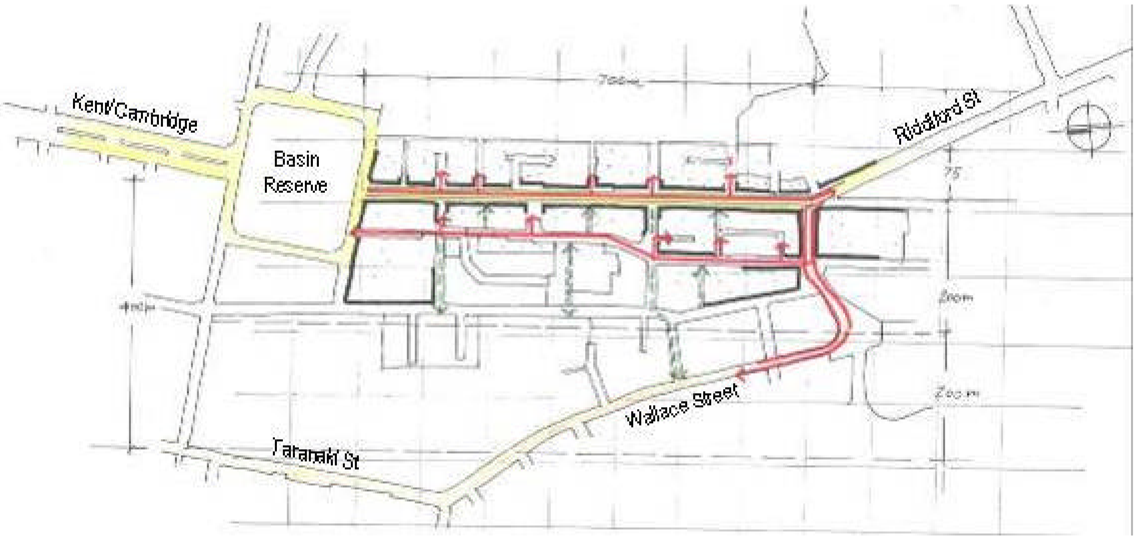
Drawing on some preliminary work undertaken by Wellington City[22], Figure 3.9 shows the extent of likely intensification at Newtown as well as some options of how the area might be served from a transportation point of view.

In the first option, Adelaide Road becomes a key passenger transport corridor and provides a one-way southbound lane for general vehicles. A complementary one-way northbound street is created one block to the east. This option provides for passenger transport though the growth node and encourages general vehicles to skirt around the node using Taranaki Street and Wallace Street. The second option creates a boulevard along Adelaide Road which accommodates both passenger transport and road space for general vehicles.

Employment: - Figure 3.10 shows the percentage of trips being undertaken within the Wellington Region. A striking feature of Figure 3.10 is the importance of the Wellington CBD in terms of employment centre with some 79,000 jobs[23]. It is expected that Wellington CBD will continue to provide a significant role as a destination for employment in future years; with the number of employment positions within the CBD increasing by about 12% by 2016 (refer to Appendix G for details).

[22] Wellington City Council; "Urban design Strategy Working Paper 8, Adelaide Road, Study on residential Intensification", May 2006.
[23] Greater Wellington Regional Council;" CBD Corridor Study;" "Pressures and Issues"

a) Possible area for intensification with existing street layout



b) Passenger transport spine through the node and one-way pair for general vehicles using Adelaide Road and King Street.

Figure 3.9: - Possible Intensification and Transport Corridors at Newtown

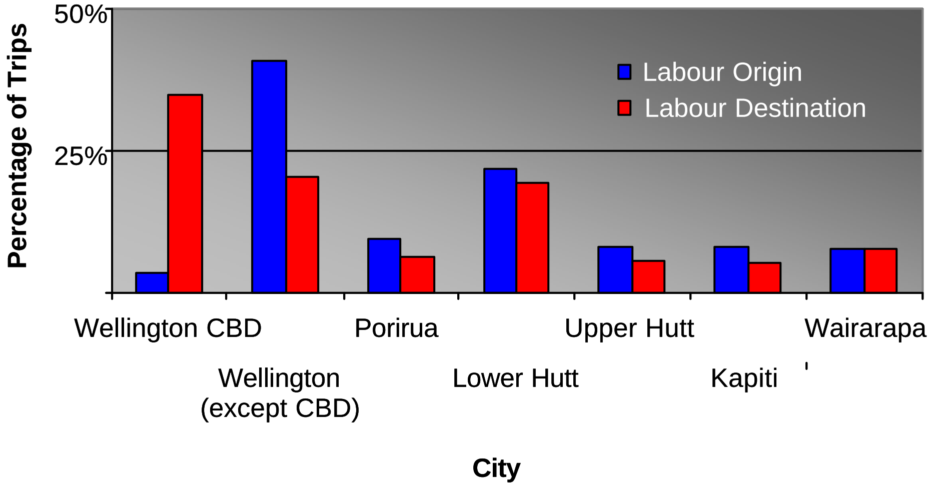


Figure 3.10: - Origin and Destination of Trips

Source: Census 2001

3.3 Trips and Travel Patterns

Overall number of trips: - Figure 3.11 summarises the number of trips in the AM peak period within the study area[24] by mode, both now (assumed to be 2001) and in future years (assumed to be 2016). The number of trips shown in Figure 3.11 was estimated using the GWRC Strategic Transport Model based on the projected population increases discussed in the earlier section[25].

Figure 3.11 indicates that we can expect about a 20% increase in the total number of trips in future years. The majority of these trips are expected to be undertaken by the private motorcar.

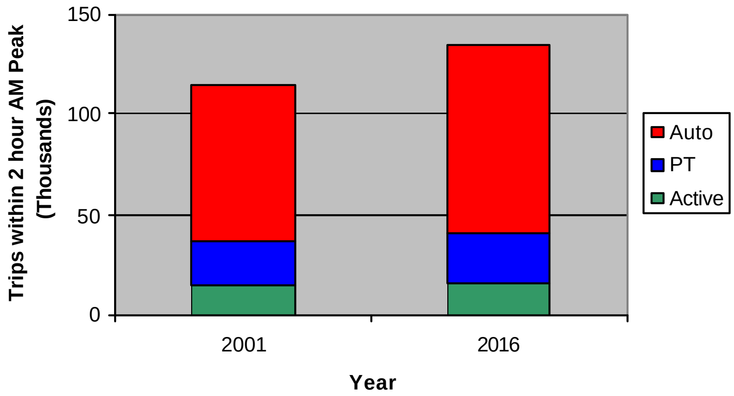


Figure 3.11: - Number of trips within study area by mode

Source: GWRC Strategic Transport Model

[24] Taken as Wellington City boundaries.
[25] The number walking trips within the 2 hour peak period are assumed to be 10% of the total number of walk trips per day.

The actual increase in population and employment assumed for the modelling is shown in Appendix G. This shows that future increases in population were assumed to be spread throughout the study area. While this is not consistent with the latest thinking in terms of growth nodes, it should nevertheless result in a similar number of trips within the study area. A key feature of the growth nodes is that, while not necessarily reducing the total number of trips, they are likely to encourage a greater percentage of active and passenger transport trips.

Existing travel patterns: - It is helpful to examine the existing travel patterns to provide insight into the reason why people use various transport modes and to explore ways that the modes that people use might change in future years particularly if passenger transport facilities are to be enhanced. Figure 3.12 to 3.14 show the percentage of people in the wider Wellington region who used the train, bus and car to get to work on Census Day 2001. We can make a number of observations from these travel patterns.

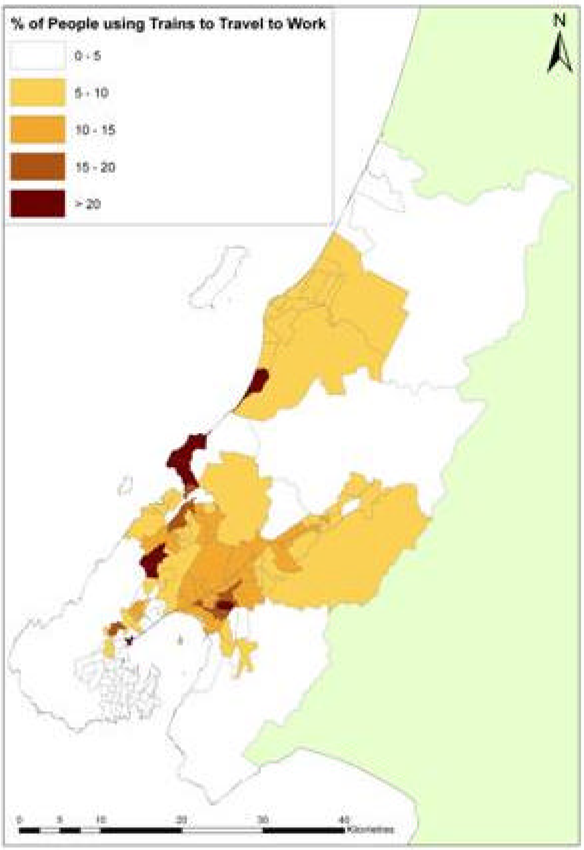


Figure 3.12: - Percentage of People who travel to work by Train

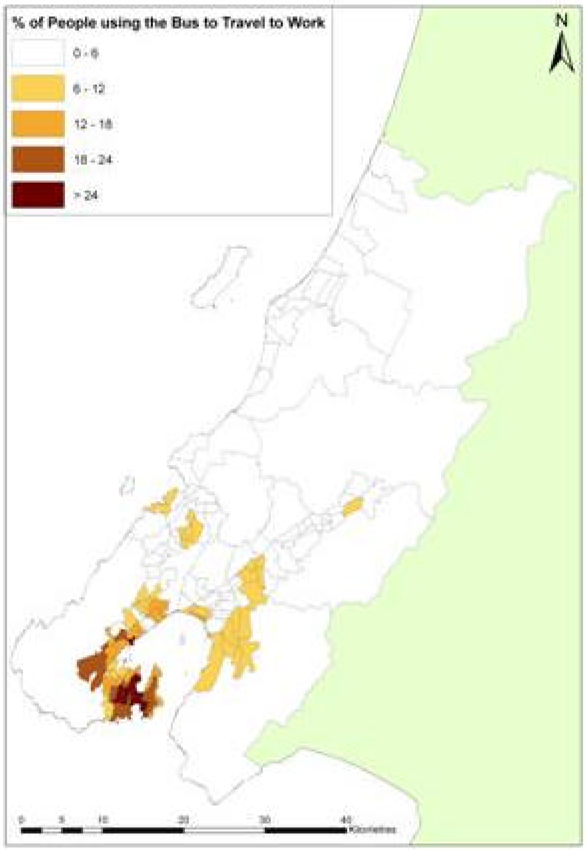


Figure 3.13: - Percentage of People who travel to work by Bus

Source: 2001 Census

- People were more likely to use rail when they live near the railway line and further from Wellington CBD. Wellington is well suited to rail, connecting several major city centres including the Hutt Valley and Porirua with the key work destination in Wellington CBD. People were more likely to use bus when they lived in suburbs near the Wellington CBD. The reason that a large number of people used bus rather than rail within the north-western suburbs of Johnsonville is that these suburbs are too close[26] to the CBD for rail to operate efficiently and because of the limited penetration that rail can make in low density suburbs in this area.

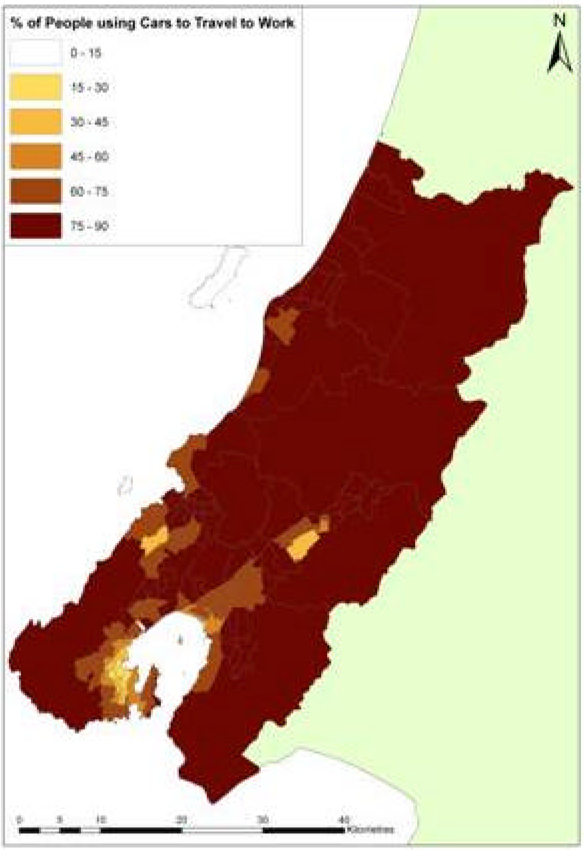


Figure 3.14: - Percentage of People who travel to work by Car

Source: 2001 Census

It is for this reason that the Wellington rail system, like many other cities, is most effective for longer distance travel[27]. Wellington commuters typically travel about 25 km when travelling by train; but only about 6 km[28] when travelling by bus[29].

There is a relationship between transport mode and urban form. Table 3.2 shows the employment densities and residential densities typically needed to make a particular transport system economically viable. Over 40 dwellings per hectare and more than 450 employees per hectare are needed to support an effective heavy or light rail system. In low density, sprawled cities like we have in NZ, the private motorcar is likely to be the most effective transport mode.

Figure 3.16 shows the number of dwellings and number of employees per hectare within the study area as at 2001. It shows that the CBD area is already of sufficient density to support rail; although the effectiveness of rail is reduced by not penetrating the CBD area to provide less than 800 m walk to employment locations, as shown in Figure 3.15. It has been argued that rail would be a lot more attractive as an alternative to the car if the rail was extended into the CBD to create a more seamless mass transit system without the time penalty and inconvenience of transfers at the train station[30].

26 Johnsonville is only 7 km to the CBD, ideally suited for bus passenger transport

27 Frank le Clercq and Jaap S de Vries; "Public Transport and the Compact City", Transportation Research Record, 1735.

28 These figures are similar to other cities, although the more densely populated areas in the UK appear to have shorter average bus distances (2 to 5 km in Scotland for example – source 2001 Scottish Census).

29 GWRC; "2004/2005 Annual Report on the Regional Land Transport Strategy", September 2005, Page 22.

Figure 3.16 shows a surprising number of small areas of high dwelling densities within the CBD area as a result of the recent increase in apartment construction; but also increasingly on the fringe of the CBD area, including Mount Victoria, Oriental Bay and (to a lesser extent) Newtown.

Figure 3.17 shows the projected number[31] of dwellings and projected number of employees per hectare within the study area for 2016. Figure 3.17 shows that the CBD and surrounding suburbs can be expected to continue to intensify in future years making a high quality passenger transport system like light rail[32] or bus more viable However, because these areas are also very close to the CBD, bus or light rail will compete with those who will decide to walk to work.

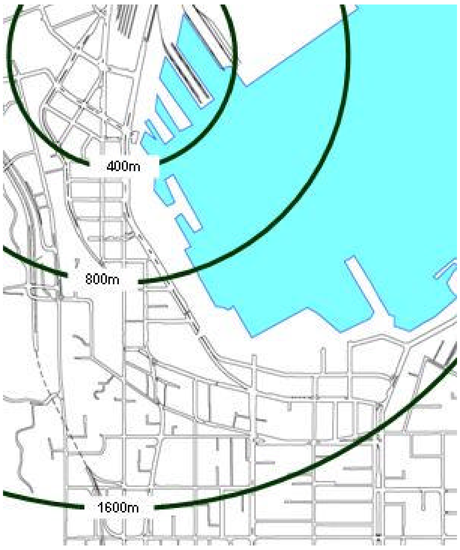


Figure 3.15: - Walk Distances between CBD and Railway Station

Table 3.2: Urban Density required to Support Various Transport Modes

Residential Density Dwellings per Hectare	Commercial Density Employees per Hectare	Effective Transport Mode
More than 40	More than 450	Heavy and Light Rail
15 to 40	100 to 450	Bus
Less than 15	Less than 100	Private Vehicles

Source: - Hans Westerman, Cities for Tomorrow, Austroads

[30] Brent Efford, "Wellington Rail and the Sustainable Vision Putting US Experience in a Kiwi context", Proceedings Towards Sustainable Land Transport, Wellington, November 2005, page 1.

[31] Projected number of dwellings and employees based on 2001 census figures in Figure 3.13 increased by the expected population increases and employment increases used in the Greater Wellington Regional Council's Strategic Transport Model. Population and employment increases assumed in this model are shown in Appendix G.

[32] In this report we do not distinguish between light rail and trams. It some cases, the term trams is used when the light rail system uses the same road space as other traffic (like Melbourne) and light rail is used when it is provided with its own right-of-way.

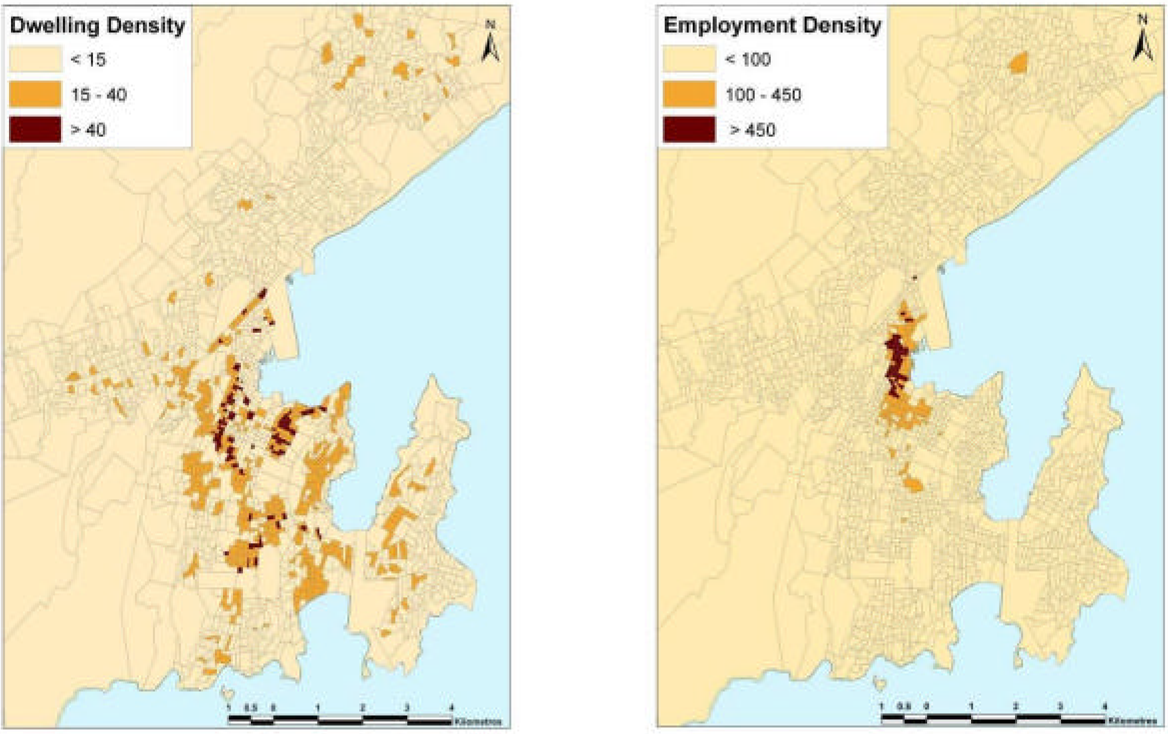


Figure 3.16: - Dwelling and Employment Density per hectare within Study Area in 2001
Source: 2001 Census

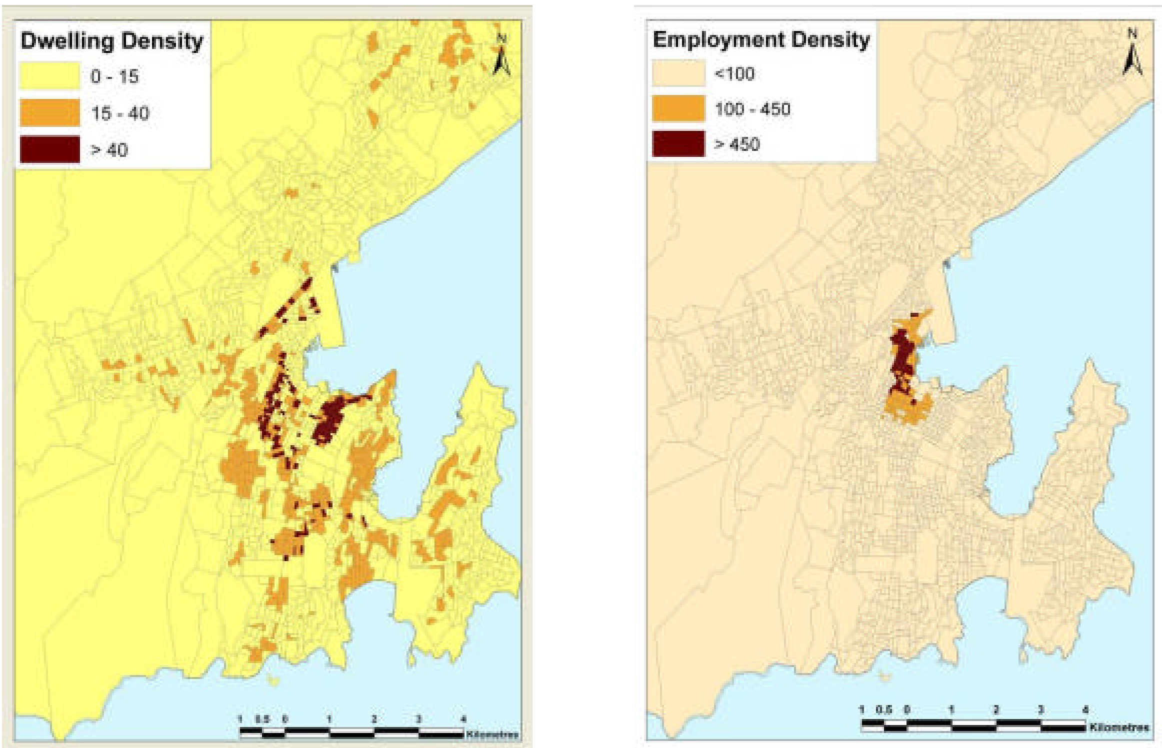


Figure 3.17: - Dwelling and Employment (CBD only) Density per hectare within Study Area in 2016
Source: 2001 Census and GWRC Strategic Transport Model

A striking feature of Figure 3.17 is the large number of areas in the eastern and southern suburbs which have sufficient density to support a viable bus system, but not light rail. This contrasts with the northern and north-western suburbs which have density figures less than 15, confirming that the private motorcar is the likely to be the most effective transport mode in these areas.

Level of Service: - Level of service is a qualitative measure to describe the operational condition for vehicles using the roading network. A summary of network performance with respect to Levels of Service for 2001 as well as the forecast 2016 'base case' (i.e. without any improvements other than committed transport projects in the region such as the Inner City Bypass) is included in Appendix E. Figure 3.18 identifies those parts of the network within the study area that are operating at the two lowest levels of service: Level E and Level F[33] in 2016.

Figure 3.18 confirms that there are a number pinch points or bottleneck within the network, including SH1 from Ngauranga to Aotea Quay, the Terrace Tunnel, Mt Victoria Tunnel, Wellington Road and Adelaide Road.

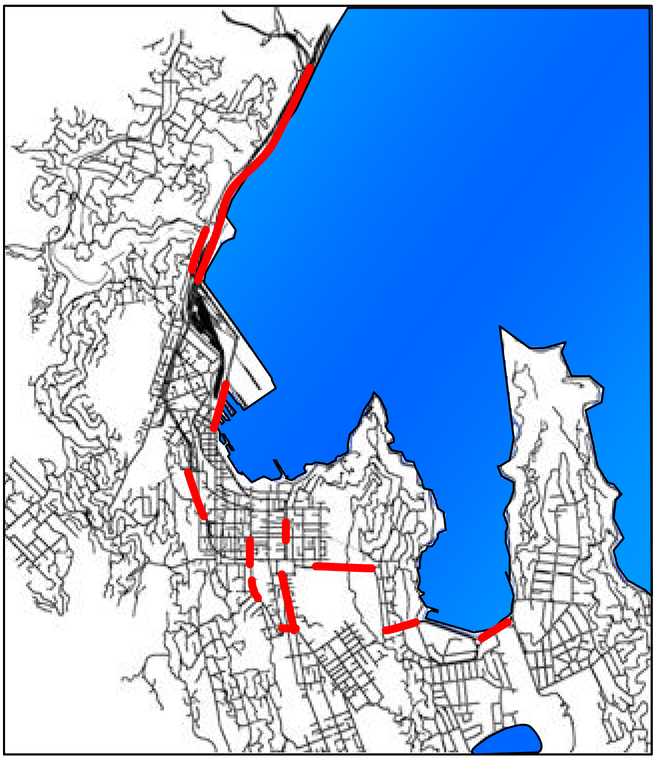


Figure 3.18: - Parts of the Network expected operate with levels of service E and F in 2016

Source: - GWRC WTSM

[33] Definitions of the five levels of service are given in Appendix E.

Whilst the increase in the number of trips forecast for 2016 typically reduces the level of service experienced by road users across the roading network, it should be noted that the construction of the Inner City Bypass is forecast to actually improve the Level of Service along the state highway between the Terrace Tunnel and Mount Victoria Tunnel in 2016 compared to the 2001 performance.

3.4 Passenger Transport

Passenger transport patterns: - Wellington City enjoys an extensive passenger transport system, including a heavy rail passenger network, a large network of bus services (refer to Figure 3.20), ferries and a cable car. Consequently, passenger transport is an important mode for Wellington City which accounted for 16% of all work trips in the 2001 census. Furthermore, the number of people using passenger transport at peak time has been increasing in recent years while motor vehicle trips have been declining.[34] This level of passenger transport use is significantly higher than other NZ cities; with Auckland City[35] only enjoying 8% and Christchurch City only 3.6%[36].

A feature of Wellington is the large number of people who commute to Wellington CBD. Compared with Auckland - where only 11%[37] of the population work in the CBD, Wellington's CBD attracts over 26% of the region's workers. The primary employment zones for passengers using passenger transport are Lambton Quay and Willis Street. The secondary employment zones are Te Aro and Courtney Place.

While the large percentage of the region's workers who commute to Wellington's CBD puts the transport corridor under pressure, it also makes passenger transport, particularly fixed systems like heavy rail, more viable.[38] The high proportion of people working in the CBD, together with the high proportion of 'white collar workers' who live adjacent to the urban railway to the north and west make rail an attractive option for commuters; and this is the reason why Wellington's passenger rail enjoys significantly higher patronage than Auckland's.[39]

Perception of Wellington's Passenger Transport System: - Table 3.3 compares how passengers feel about the affordability, safety and convenience offered by the transportation system in Wellington with two other large NZ cities. It shows that the Wellington passenger transport system is consistently rated higher than other NZ cities.

---

34 GWRC, "2004/2005 Annual Report on the Regional and Transport Strategy"

35 Auckland Region enjoys only 5.6%

36 "Quality of Life in NZ Eight Largest Cities", 2003, based on 2001 census data

37 2001 census

38 Wayne Stewart, "Society & Transport, Implications of achieving sustainable solutions", Proceedings towards Sustainable Land Transport, Wellington, November 2005, page 20.

39 Wayne Stewart, "Society & Transport, Implications of achieving sustainable solutions", Proceedings Towards Sustainable Land Transport, Wellington, November 2005, page 22

Table 3.3: Passenger Perception[1] of Passenger Transport System

Source: - Quality of Life in NZ Eight Largest Cities, 2003, page 124 to 125

	Affordable	Safe	Convenient
Wellington City	82%	83%	78%
Auckland City	53%	76%	41%
Christchurch City	71%	80%	75%

Notes

1. Percentage of passengers who felt that the passenger transport system was affordable, safe and convenient, based on a five point rating scale.

Existing Bus Services: - Figure 3.19 shows the location and frequency of the existing key bus services within the study area. A significant number of routes have over 40 buses per hour at peak time and many cities with these bus frequencies would have provided enhanced bus priority measures to maintain the required quality of service. Bus frequency along the Golden Mile is particularly heavy.

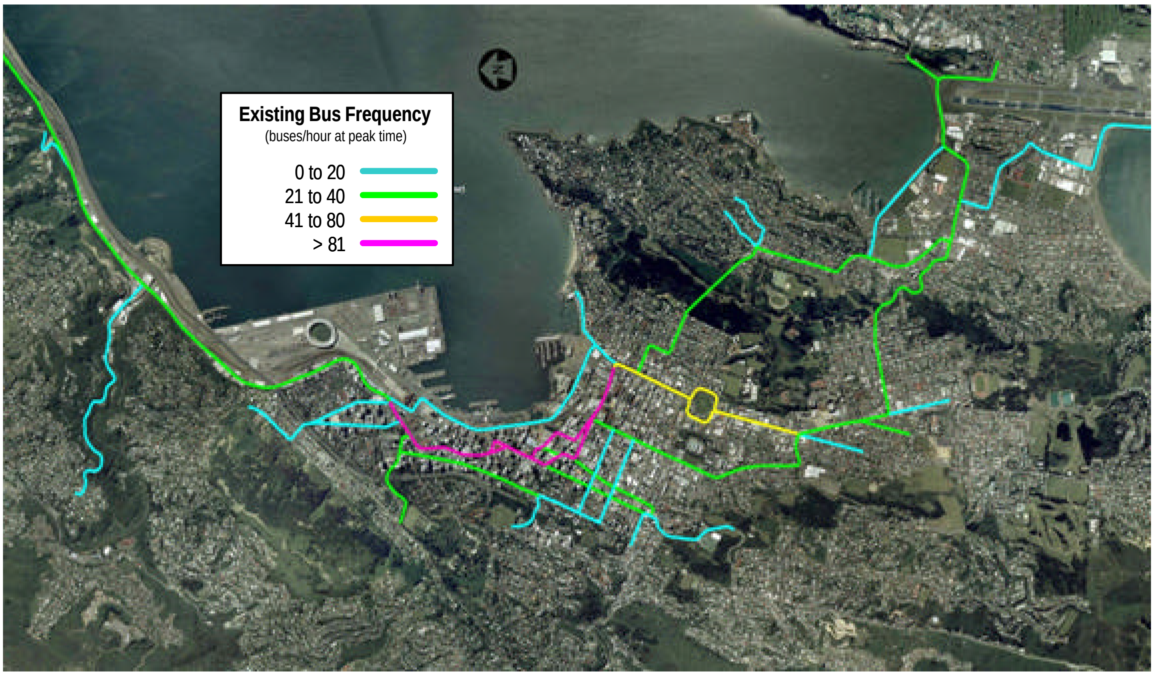


Figure 3.19: - Existing Bus Routes within the Study Area

Key Issues with Current Bus Passenger Transport Operation: - Notwithstanding Wellington enjoying an extensive network of bus routes with good patronage, buses must compete with general vehicles for use of the road space. As key arterials become more congested with general vehicles, the bus service is disrupted and level of service reduces, making bus passenger transport less attractive as an alternative to the private motorcar. Key issues with the existing bus services can be classified into three areas: -

- **Link capacity:** - Road space congestion affecting link speed, capacity and bus operation

- **Intersections:** - Delays at intersections, including signal operation
- **Bus stops: -** Delays at bus stops, due to loading times and congestion

These three areas contribute to the total journey time for passengers and affect the reliability and capacity of the bus passenger transport system. Table 3.4 shows the results of a detailed study of the bus service along the Golden Mile which identified how the total journey time was split between these three classifications. While Table 3.4 applies to the Golden Mile route, the figures provide some indication of the break down of the journey time for all suburban buses; although the link capacity is likely to form a greater proportion of the total journey on suburban routes.

Table 3.4: Bus Journey Times along the Golden Mile

Classification	Travel Time
Link Capacity	45%
Intersections	30%
Bus Stops	25%
Total	100%

Source: - GWRC, 2002

Appendix D summaries the key problems causing delay with the existing bus network and the key locations where a focus needs to be given to minimising delays.

Key Issues with Existing Rail System: - The key issue with the existing rail system is that it does not penetrate the CBD and forces passengers to walk extensive distances between their place of employment and the railway station or complete a mode change with the associated penalty. As part of this project we have investigated an option of extending the railway into the CBD.

The other key issue is existing rail frequencies. The present headways of about 25 minutes[40] at peak time is too infrequent to provide the type of high quality rapid passenger transport system offered in overseas countries that offers serious competition with the private motorcar. The impact on mode share of increasing headways has been investigated by the GWRC. The passenger rail network at Kaiwharawhara is also operating near capacity in terms of the number of trains that can pass through the Thorndon throat at peak time. If headways were to be increased in future years, this constraint would need to be addressed.

3.5 The Movement of Freight

Figure 3.20 shows the location of key industrial areas within the study area together with key transportation routes for good. The efficient movement of goods to and from the Wellington International Airport, which is one of the busiest airports in NZ, Centerport and other industrial areas is an important ingredient to the overall economic well being of the region. Freight movements are expected to increase as economic activity increases. Currently, aircraft carrying containerised freight do not use the airport. If this capability was introduced, we could see an increase in the movement of freight within the study area.

Key routes for the movement of freight include the SH1 network. The constraints on the Mount Victoria Tunnel affects the movement of goods to and from the airport while the constraints between Aotea

[40] This decreases to 20 minutes on the Johnsonville Line

Quay and the Ngauranga Gorge affect the movement of goods being transported by road to and from the port.

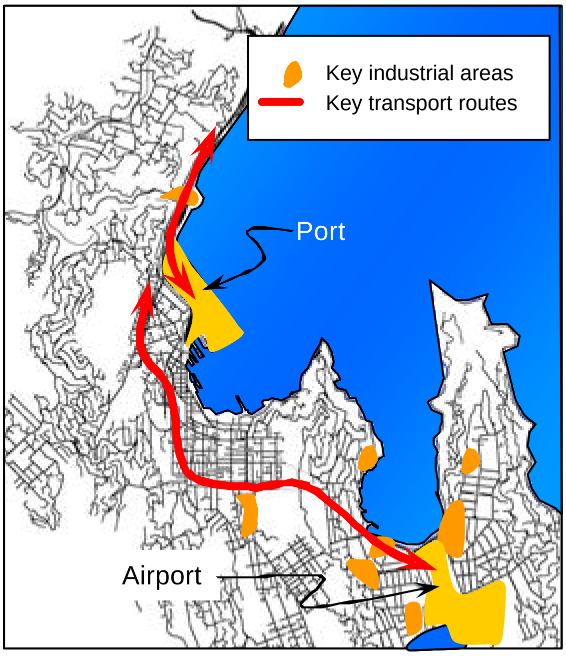


Figure 3.20: - Location of Key Freight Generators and Heavy Vehicle Transport Routes

Source: WCC District Plan

3.6 Parking

As the road controlling authority, Wellington City Council (WCC) has responsibility for managing on-street parking (plus a limited amount of off-street public car parking spaces), as well as the planning of parking in new developments. Effective parking management is important to the economic, environmental and social wellbeing of an area.[41]

Whilst it is recognised that WCC own and/or operate a minimal amount of off-street car parking, it does regulate the use of on-street parking as well as set rules through the District Plan with respect to the number of spaces that can be provided for developments. The amount, availability and cost of car parking provision within or close to the CBD has an impact on transport mode choice. For instance, the use of 'maximum' parking requirements, rather than minimum standards, is an appropriate tool to help limit development generated traffic.

Car parking policies need to be integrated within other urban objectives and as such, a balance between the various City Strategies is required in order to support the overarching strategic outcomes. A lack of parking spaces for apartments, for example, may lead to on-street car parking dominating the area and impacting on urban form. Furthermore, the impact of car parking on retail within the City has

[41] British Parking Association, Unpublished Report – BPA Seminar March 2003. Quoted from 'Parking Strategies and Management'. Institution of Highways and Transportation. July 2005.

lead to the current car parking policies with respect to free parking at weekends. This is particularly important given that other shopping areas within the region provide free parking. WCC is currently reviewing its parking policy, taking account of the differing strategic priorities, the purpose and function of roads with respect to on-street parking, and the existing pressure on residential areas around the CBD.

Any changes to the WCC Parking Policy, for instance through a restriction in the number, cost or length of permitted parking times, will need to include the needs of the City retailers and developers. Parking provision also need to reflect different types and location of development - for instance the requirement of a parking space per residential dwelling within a growth node may make intensification unviable to developers. However, if a lower level of parking provision is to be provided, it is essential that convenient and suitable alternative means of transport are provided. Similarly, appropriate alternative modes of transport need to be provided and transport better managed (for instance through workplace travel plans) should controls on the amount of private non-residential car parking are introduced.

Whilst a reduction in the total amount of the on-street parking may not be deemed appropriate given retail concerns as part of any policy review, it may be appropriate to consider relocating parking to the outskirts of the CBD with the provision of high quality pedestrian links to the CBD, thus minimising the incursion of motor vehicles into the central city. This, in conjunction with the idea of creating passenger transport corridors and pedestrian corridors (as well as the idea of retail corridors as proposed by GEHL Architects), should help create the required balance between the needs of pedestrians, the desire to enhance passenger transport and the pressure to maintain access and parking for private vehicles.

3.7 Road Safety

In 2005, road crashes in Wellington City had an estimated social cost of $85million[42]. Furthermore, as shown in Figure 3.21, despite an overall reduction in crash numbers since 1990, in more recent years, road safety gains with respect to fatal and serious crashes have started to flatten out whilst reported minor injury crashes in the City have been increasing over the past six to seven years.

A quarter of all reported injury crashes occurred on the State Highway network in Wellington City with over 60% of these state highway crashes occurring on the high speed sections of the road.

In recent years, both pedestrians and cyclists have been identified by Land Transport NZ as road users with specific road safety concerns. Pedestrians represent 20% of all casualties in Wellington City and whilst the long term pedestrian casualty trend has been decreasing (see Figure 3.22), the pedestrian casualty rate for Wellington City in 2005 of 5.1 per 10,000 population was much higher than other similar local authorities. In addition, cycle casualty numbers have been increasing over both the long and short term, with cyclist casualty rates (per population) also being higher than similar local authorities.

[42] Land Transport NZ Road Safety Issues. July 2006.

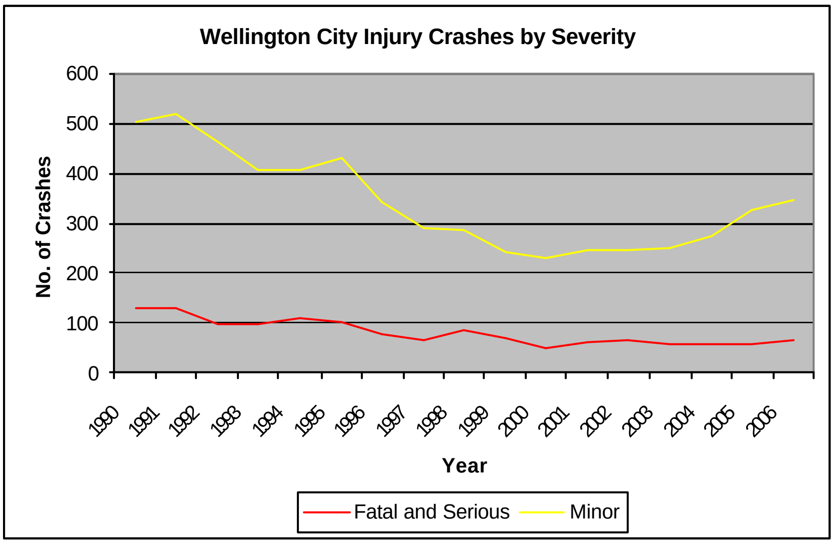


Figure 3.21: - Crash Numbers in Wellington City

Source Land Transport NZ administered Crash Analysis System (CAS)

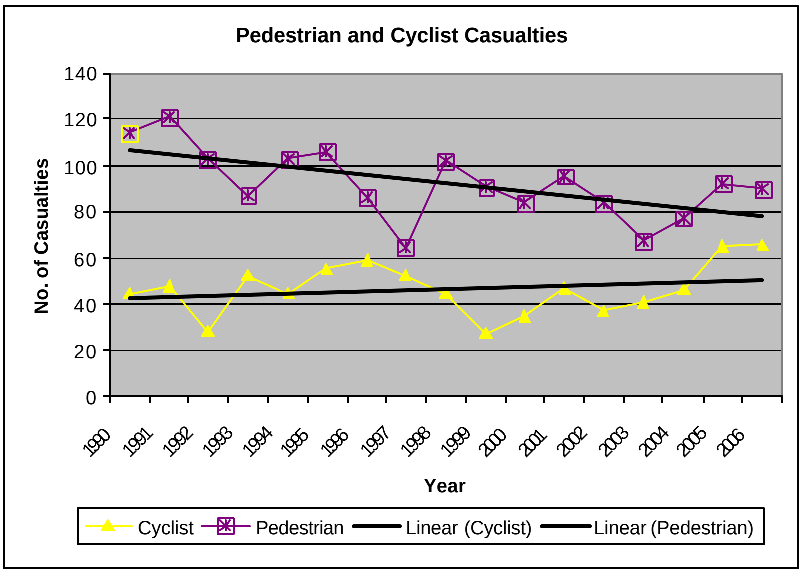


Figure 3.22: - Casualty Trends in Wellington City

Source Land Transport NZ administered Crash Analysis System (CAS)

3.8 Airport Travel Demand

Wellington International Airport is located within the eastern suburbs of Wellington City approximately 7.5km from the city CBD, as shown in Figure 3.1. The airport provides the hub for all domestic and international passengers for the Wellington Region and is therefore a key trip generator within the eastern suburbs and influences the number and type of trips through the Mt Victoria Tunnel. In 1998, over 3.5 million passengers used Wellington Airport, of which it is estimated that about 60% transfer between flights and therefore do not require trips to and from the airport.

Figure 3.23 shows the results of a survey giving the distribution of passenger trips made to and from the airport. 70% of trips are made to the Wellington City, which is estimated to be about 4,000 passenger trips per week day[43].

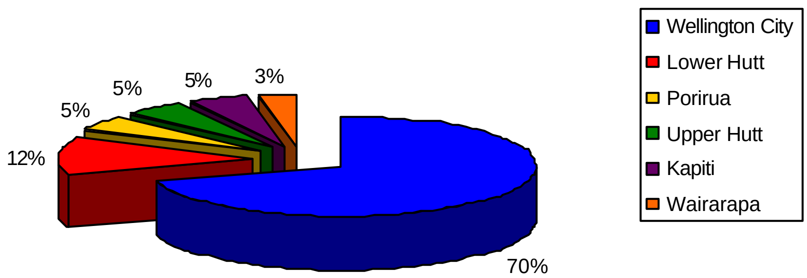


Figure 3.23: Percentage of Trips by Origin or Destination

Source Opus, "Improvements of Public Transport Linkages to Wellington Airport", 1999, page 5

The distribution of trips to and from the airport by mode is shown in Figure 3.24. Approximately 90% of trips are made by car, of which 40% are made by Taxi.

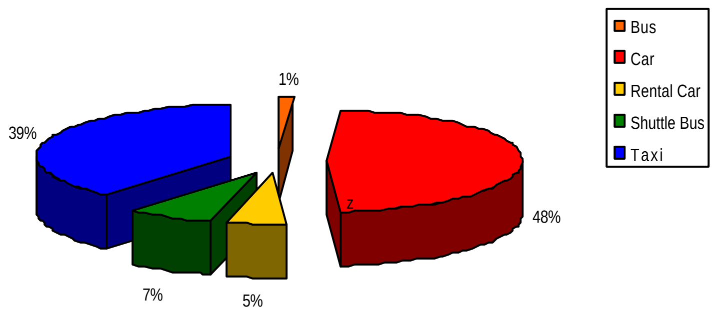


Figure 3.24: Mode of Transport for Airport Trips

Source Opus, "Improvements of Public Transport Linkages to Wellington Airport", 1999, page 6

[43] Source Opus, "Improvements of Public Transport Linkages to Wellington Airport", 1999

3.9 Pedestrian Movements

Previous Studies and Strategies: - There have been a number of previous studies and strategies developed for improving walking outcomes for the region and in the study area in particular. Wellington[44] has set an ambitious target to increase the percentage of people who walk to the CBD from 13% (recorded in 2006/07) to 18% by 2016. The 2004 Regional Pedestrian Strategy[45] set out to improve pedestrian connectivity and safety and set the target of achieving 75 % pedestrian mode share for trips less than 1 km and 56% mode share for trips between 1 km and 2 km.

Pedestrian Movement Patterns: - Walking is an important mode for Wellington City which accounted for 13.5% of all work trips in the 2001 census. This level of walking is significantly higher than other NZ cities; with Auckland City only enjoying 5.3% and Christchurch City only 4.4%[46].

Of particular interest in our study is the number of people who work in the CBD and walk to work. Of those people who work in the CBD, the percentage that walked to work on census day is shown in Figure 3.25. It shows that the closer that people live to the CBD, the higher the probability that they will walk to work. Perhaps surprisingly between 11% and 22% of people who work in the CBD walked to work from suburbs of Newtown, Mount Cook and Wadestown. Also of interest is the low percentage of people walking from Hataitai, even though it is closer to the CBD than Newtown, indicating that the Mount Victoria tunnel may create an impediment to pedestrians from these areas.

Of all people within Wellington City boundaries that walked to the CBD on census day, over 80% originated from the CBD area and suburbs immediately adjacent to the CBD, as shown in Figure 3.26.

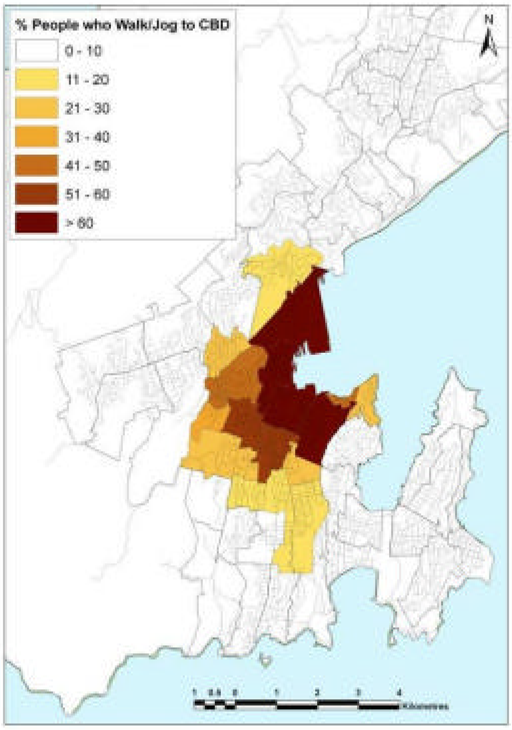


Figure 3.25: - The Percentage of People who Walked or Jogged to CBD

Source: 2001 Census

Pedestrian Flows: - Featherston Street, Customhouse Quay and Stout Street are main commuter pedestrian routes, particularly for those travelling by rail. The Golden Mile and Cuba/Manners and Courtenay areas are the premier pedestrian areas associated with retail, entertainment and office accommodation. The peak pedestrian movements are along Lambton Quay between 5.00pm and 6.00pm, with nearly 6000 people per hour.

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[44] Wellington City, LTCCP, 2006
45 Wellington City Council, Draft Transport Strategy, 2004
46 "Quality of Life in NZ Eight Largest Cities", 2003, based on 2001 census data

Figure 3.27 shows the pedestrian volume (pedestrians per hour) within the CBD during a work day in the morning peak. Pedestrian counts have also been made by GEHL Architects[47] from 10.00am to 6.00pm and at weekends. These studies indicate significant pedestrian movements along: -

- Lambton Quay, Willis Street and Customhouse Quay and waterfront in the morning, lunch time and evening peak,
- Featherston Street and Stout Street in the morning peak
- Manners, Cuba Mall and Courtney Place in the lunch time and evening peak

A key feature of these studies is that pedestrians often have a preference for a particular side of the road. For example in the morning peak, 85% of pedestrians use the east side of Featherston Street as they travel from the railway station. Similar trends can be observed along Lambton Quay and Customhouse Quay.

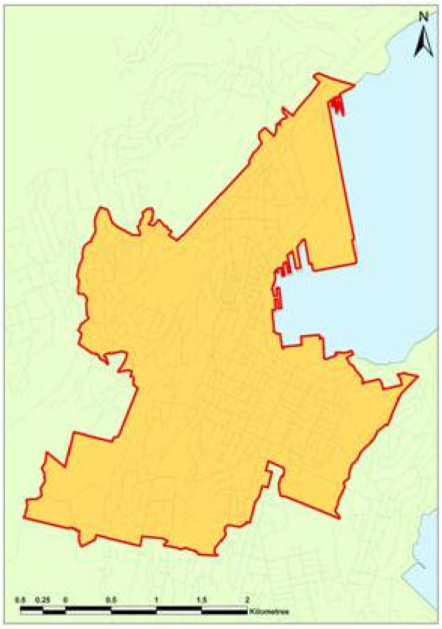

Figure 3.26: - Origins of 80% of the people walked or jogged to the CBD on Census Day

Source:2001 Census.

The waterfront route (adjacent to the harbour) is preferred to Jervois Quay as a pedestrian route. To facilitate and encourage these movements, access is required across Jervois Quay and Customhouse Quay. Different flow patterns across Customhouse and Jervois Quay occur throughout the day, with the exception of the crossing at Queens Wharf which is favoured for both morning and lunch time periods as a strong link to Lambton Quay.

In recent years there has been a significant increase in the number of people living in the CBD area. By 2001, 2150[48] people lived in the CBD area[49], a significant increase over the 680 people who lived in the CBD in 1991. Council plans for this trend to continue[50]. The significant increase in the CBD area population will generate significant additional pedestrian movements, putting further pressure on the need to create a more walk-able city.

[47] GEHL Architects, City to Waterfront, Public Spaces and Public Life Study, Wellington 2004, page 80 to 88.

[48] 2001 Census

[49] CBD area defined as that areas bound by the railway station to the north, Dixon Street and Courtney Place in the South, The Terrace in the East and Kent/Cambridge to the east.

[50] Wellington City Council, "Quantifying the Growth Spine, supply, demand and capacity for residential development in Wellington City, September 2006

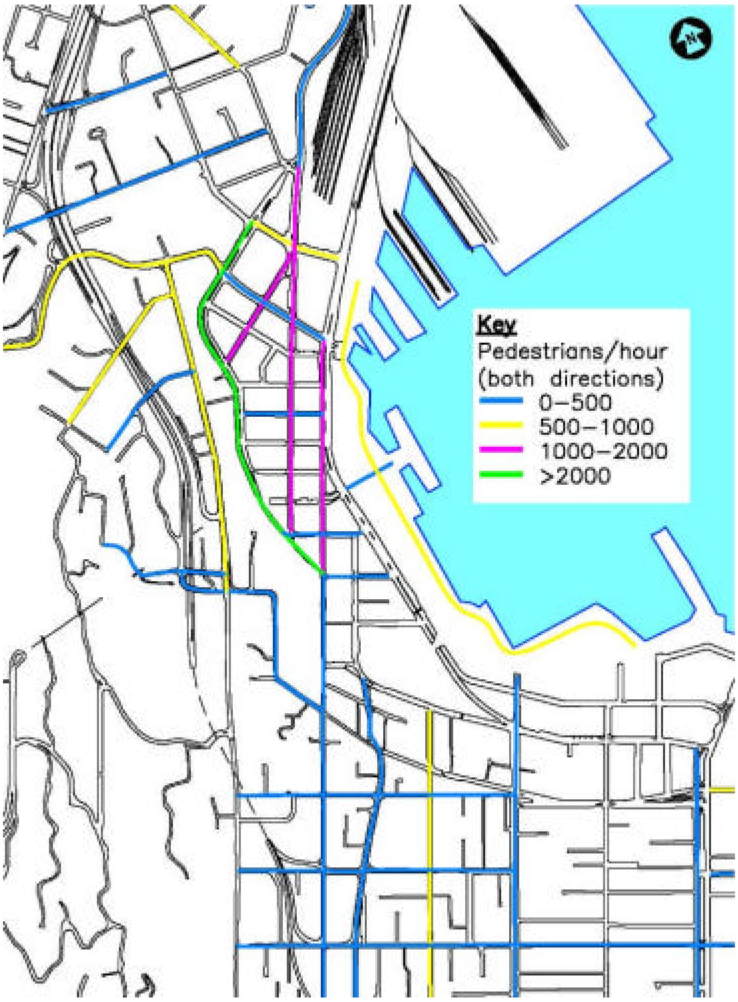

Figure 3.27: - Pedestrian Volumes

(during a work day in the am peak hour both ways)

Source: WCC survey

Safety: - Pedestrian safety presents a major challenge for Wellington City area as they make up 21% of all major road casualties in the City[51]. Wellington has a pedestrian casualty rate of 4.2 per 10,000, significantly higher than similar local authorities (2.9 casualties per 10,000).

There were a total of 232 crashes involving pedestrians including two fatal and 54 serious crashes between 2001 and 2005 within the CBD area. Sixty eight percent of these crashes occurred during weekday daytime hours with a further 8% during a weekend in the middle of the day. Crash locations exist throughout the CBD along Lambton Quay, Willis Street, Featherston Street and Courtenay Place (although some of these involve drunken pedestrians late at night/in the early morning).

[51] Land Transport NZ Road Safety Issues Report, July 2005.

3.10 Cycling

Whilst cycling (journey to work trips) has been declining for the Region, Wellington City has seen an increase in cycling trips since 1986[52] with 3% of work trips between the suburbs and the CBD being by cycle in 2001[53]. The topography and weather may be reasons for Wellington recorded a lower number of cyclists than other cities. Cycling has a higher crash risk than other modes[54].

Cycling Patterns: - Figure 3.28 shows the percentage of people who cycled to work in the CBD on census morning. Of the people who cycled to work in the CBD area on census day, over 20% came from the suburbs of Hataitai, Wilton, Newtown, Mount Victoria. Hataitai alone provided 5% of the cyclists who cycle in the CBD.

Cycle Flows: - Cycle counts show that Oriental Parade, Willis Street, Bowen Street, Adelaide Road, Evans Bay Road and Thorndon Quay are the most popular routes accessing the CBD with Cambridge Terrace, Tasman Street, Aro Street and Murphy Street currently being secondary preferred routes.

Figure 3.29 shows the official cycle routes within the study area.

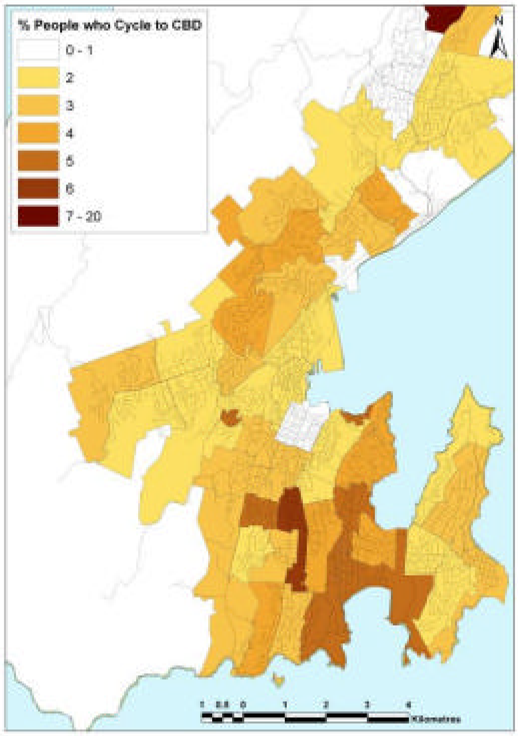

Figure 3.28: - The Percentage of People who Cycled to CBD

Source: 2001 Census

With the recent construction of the Inner City Bypass and associated east-west cycle path, along with the shared pedestrian and cycle path around the Waterfront, opportunities should be sought to connect and link these two separate facilities as part of a wider strategic cycle route network.

Safety: - Cyclists crashes present a major challenge for Wellington City area as they make up 11% of all major road casualties in the city between 2000 and 2004[55].

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52 Source: Wellington Regional Cycling Strategy. May 2004
53 Source: WCC Draft Transport Strategy. May 2004, Quoted from 2001 Census data
54 Land Transport NZ Road Safety Issues Report, July 2005
55 Wellington Regional Cycling Strategy. May 2004

.

Figure 3.29: - Existing Cycle Routes

Source: GWRC

4 Overall Approach to Strategy Study

4.1 The New Zealand Transport Strategy

The NZ Transport Strategy[56] has created a new environment within which to consider our future transport needs. The general approach adopted in the past has been to "predict and provide" our future transport needs. The NZ Transport Strategy and the Regional Transport Strategy encourages a more integrated and sustainable approach to solving future transport needs. It encourages solutions that improve accessibility but without undue reliance on mobility, particularly the private motorcar. Accordingly, in developing a transportation strategy for the Ngauranga to Airport corridor, we have been guided by the following principles:

- Improving the relationship between land-use and transport corridors, particularly the relationship between high quality passenger transport and mixed use high density developments (or growth nodes) – a concept often referred in North American Literature as "Transit Orientated Development".
- Improving the return on investment made in previous years to the transport corridor by addressing congestion points to maximise the capacity of that corridor.
- Improving the use of existing road space by reviewing how space is allocated to various modes and improving the efficiency of how that space is used by giving some modes priority along key routes.

4.2 Land-Use

Integrating land use and transport is perhaps the most promising approach to reducing car-dependency and creating more sustainable solutions. Mixed-use high density development (which we refer to as growth nodes) not only encourages more walking and cycling as an alternative to the car, but makes passenger transport a more viable option. Another key advantage of growth nodes is that they reduce urban sprawl, which is known to be the main driver to the increase in length and number of trips people make in their private motor cars: a concept that does not support sustainability.

The NZ Transport Strategy acknowledges the important relationship between urban form and transportation and that it will lead to more sustainable solutions by reducing the number and length of car trips. There is an important mutually serving relationship between land use and transportation:

- A high quality passenger transport system supports the development and success of growth nodes.
- Growth nodes create sufficient patronage to make the high quality passenger transport system viable and efficient.

Consequently, if the region is serious about the development of growth nodes at Newtown and Kilbirnie, then a key element of any future transport strategy must include provision of a rapid transit route

[56] Ministry of Transport; "NZ Transport Strategy", 2002, page 44

offering a high quality passenger transport system to connect and serve these nodes. Such rapid transit route will be segregated from other traffic within its own carriageway and operate at average speeds of 20 km/hr (including stops). For such a route to be viable it will need at least 1000 passengers per hour.

Walking and cycling are also important modes within growth nodes, as being mixed use, residents are able to access places of employment, recreation and retail without the use of the private motorcar. For people either to walk directly to work, made feasible by the nature of the mixed use development of growth nodes; or to walk to key passenger transport connections, the growth nodes must be high quality areas[57].

With this important goal in mind, it is important that transport corridors that serve these growth areas are located and designed in a way that does not sever spaces and places or prevent or discourage walking and cycling[58]. Successful overseas examples of nodes have therefore generally adopted the following principles (as shown in Figure 4.1):

- Growth nodes need to be served by roading arterials and these arterials should be located at the edge of the node to minimise severance. This leaves the more valuable land within the area for intensive development and free of barriers that prevent walking and cycling.
- High quality passenger transport (rail, guided bus or bus) routes should pass through the middle of the growth nodes.
- Where applicable, "park and ride" type facilities or other parking should be located on the edge (400m from centre) of the growth nodes.

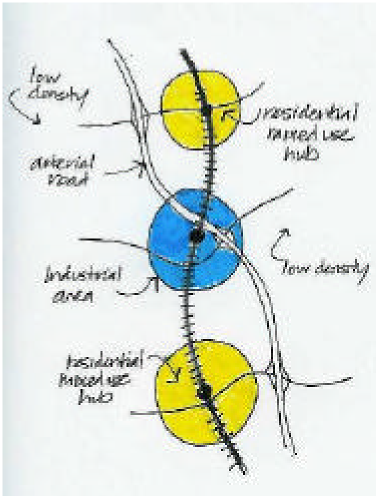


Figure 4.1: - Transport Corridors and Growth Nodes

Source: architecture BREWER DAVIDSON, Opus, "Eastern Transport Corridor Recommended Option Report", March 2004

These principles have guided our thinking when developing transport solutions within the Wellington CBD area and at the proposed growth nodes at Newtown and Kilbirnie.

Figure 3.7 showed the proposed growth nodes at Newtown and Kilbirnie. To support this land-use development, a high quality passenger transport route is required between the railway station and Newtown and Kilbirnie. A high quality passenger transport system is one that is reliable, frequent and punctual, provided by buses, guided buses, light rail or heavy rail.

Heavy rail is unlikely to be a serious option unless it is located below ground, which will be very expensive. More realistic options for Wellington City would be a bus or light rail system, although

57 Ministry of the Environment "People, Places, Spaces, a Design Guide for Urban New Zealand" designed with walking and cycling in mind. Wellington Regional Council, "Planning Guidelines to Support Alterative Transport Modes", WR Page 61.
58 Passenger Transport Supportive Land Use and Urban Design Guidelines, Kingston Morrison (now SKM) December 1997.

reasonably high densities - greater than 40 dwellings per hectare - are typically required to make a light rail system viable[59] - or an adequate return on the investment.

4.3 Maximising Capacity

Significant investment has been made with the Wellington Motorway over the last 30 to 50 years. And yet parts of this route operate well below the theoretical capacity due to significant constraints such as The Terrace Tunnel. A similar bottleneck occurs at the Basin Reserve and Mount Victoria Tunnel.

Rather than adopting a purely "predict and provide" approach to transportation planning, we have endeavoured to investigate the benefits of increasing the capacity at these bottlenecks with a view to maximising the capacity of the whole transportation corridor through the re-allocation of road space.

The re-allocation of road space was recently used in Sydney when the cross-city tunnel for general vehicles was opened. At the same time as the opening this tunnel, Sydney reclaimed a number of surface roads for passenger transport. Areas where it may be beneficial to reallocate road space include:

- The Hutt Road to provide for dedicated bus lanes to serve northern suburbs.
- The waterfront route, being Customhouse Quay and Jervois Quay with a view to reducing severance between the city and its waterfront[60].
- Cambridge, Kent Terrace, Adelaide Road, and Constable Street to provide for the high quality passenger transport route serving the Newtown and Kilbirnie growth nodes.

4.4 Use of Road Space

Reallocating Road Space: It is well established that passenger transport, walking and cycling are more efficient uses of available road space than the private motor vehicle. Road space in Wellington is presently used for a mix of motor vehicles, parking, walking and cycling. In some key locations, such as the Golden Mile, some of the available road space has already been reallocated to buses, either for part of the day or permanently, and other space for walking.

Over the last 30 to 60 years, the dominance of the private motor vehicle has led to the majority of road space being allocated to the private motor car. This is not necessarily equitable or sustainable. In their study of Wellington City, GEHL Architects noted[61] that

> *"vehicular traffic is dominating Wellington City Centre and has a negative effect on a number of streets and public spaces. City streets have been turned into highway and the vehicular traffic flows through the city centre are high".*

59 Hans Westerman, Cities for Tomorrow, Austroads
60 GEHL Architects, "City to Waterfront – Public Spaces and Public Life Study, Wellington, 2004 Page 47
61 GEHL Architects, "City to Waterfront – Public Spaces and Public Life Study, Wellington, 2004 Page 46

Street Hierarchy: - Currently just about all of the roads within the study area aim to provide for all transport modes. The motorway is the exception which has a priority for the movement of motor vehicles. It is argued that it is no longer necessary, or even desirable, to allow all roads to be used by, or provide facilities for, all modes. There are potential efficiencies to be gained by creating a road hierarchy or classification system.

GEHL Architects proposed the creation of a strong and clear street hierarchy based on three levels, as shown in Figure 4.2.

The concept for allocating priorities for certain modes along different roads is particularly important for transportation corridors serving growth nodes and within more intensified and increasing mixed use areas within the CBD. In these areas it is desirable to locate the passenger transport facilities through the middle of the node, but take the majority of routes for general vehicles around the outside of the node, as shown in Figure 4.1 to ensure that the growth node is highly walk-able.

Figure 4.2: - GEHL Architects Street Hierarchy Proposal

Source: GEHL Architects "City to Waterfront – Public Space and Public Life Study, Wellington 2004 Page 46

Two new road classifications for the study area are feasible: -

- Passenger transport corridors.
- Pedestrian corridors.

A Passenger Transport Corridor is one where priority is given to the use of the road space for passenger transport (bus or light rail). In such corridors, walking and cycling become an equal or secondary priority. And while general vehicles and parking are not necessarily banned from such corridors, they are given the lowest priority. A typical cross-section of such a corridor is shown in Figure 4.3. Passenger transport priority measures are identified in Appendix A.

A Pedestrian Corridor is one where priority is given to walking (and perhaps cycling) over other modes. Such corridors will have space for movement and parking of general vehicles, but as a secondary priority. Space and facilities for passenger transport may not necessarily be present in this corridor. Such a corridor is required to provide direct and easy access to and from major passenger transport generator (such as railway stations), employment, recreational, and retailing passenger generators. Along these corridors, careful attention will be given to providing adequate footpath width, management of street furniture and in some cases signal priority[62] for pedestrians. General issues associated with walking are contained in Appendix B.

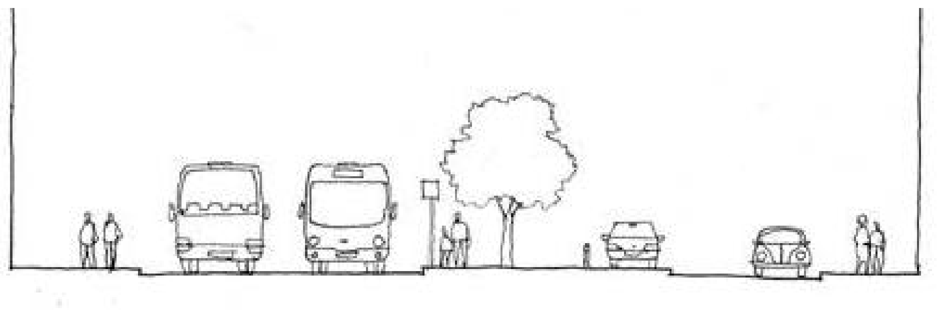


Figure 4.3: -Typical Cross-section of a Passenger Transport Corridor

[62] For example, along pedestrian corridors, pedestrians should be given crossing times at each signal controlled intersection automatically and in some cases the number of phases given to pedestrians should be increased with a view to reducing waiting time for pedestrians within each cycle.

5 Overview of Options for Passenger Transport

5.1 Overview

Corridor serving the growth nodes: - The key focus of this strategy has been the development of options for providing high quality, reliable and frequent passenger transport links between the railway station and the growth nodes at Newtown and Kilbirnie. The selection of a route for this corridor is discussed in Chapter 6 and a discussion of the type of passenger transport most suited for this route is discussed in Chapter 7.

Other passenger transport initiatives: - In addition to this primary passenger transport corridor serving the growth nodes, we discuss in Chapter 8: -

- The option of extending the passenger transport corridor to the north of the rail station along Hutt Road to service the northern and north-western suburbs: this is in addition to the existing passenger rail service provided to Johnsonville.
- The idea of providing a high quality passenger transport service to the airport, perhaps using light rail. One option would be extending the passenger transport corridor serving the growth node at Kilbirnie to the airport.
- A number of other initiatives that would improve other bus routes within the study area.

Heavy Rail: - The option of extending heavy rail into the CBD with a view to making passenger rail more attractive is discussed in Chapter 9.

In this chapter we introduce the concept of a bus hierarchy.

5.2 Proposed Bus Route Hierarchy

A hierarchy for various bus routes is recommended, as shown in Table 5.1[63]. While the proposed hierarchy provides an overall strategy for bus priority, the economic efficiency of individual treatments will need to be quantified to assess the impact on the wider network.

The key feature of such a strategy is that future growth of the bus network through increased demand and changes in urban form along each route can be considered. This might include safeguarding routes, or parts of routes, to install bus priority facilities in future years.

[63] London Bus Priority Network uses a frequency of 10 buses per hour as justification for a bus lane, however if the cost is greater than £50,000 it would need a full economic evaluation to display a positive first year rate of return.

Table 5.1 : Bus Hierarchy

Hierarchy	**Buses** *(Buses/hour)*	Description
Bus Corridor	More than 81	Ideally to include bus only areas and busways and signal pre-emption or grade separation at intersections.
Bus Lanes	41 to 80	Bus priority maximised to ensure unobstructed link flow and reduced delays at signals through detection systems, pre signals and associated bus lanes.
Bus Priority	21 to 40	Bus priority to be provided at areas in which space is available and the delay to buses justifies the introduction of bus lanes and bus protection mechanisms.
Limited Priority	Less than 20	Bus priority limited to bus stop improvements, reduction in delay at specific points (for all traffic modes) and signal detection mechanisms.

6 Description of Passenger Transport Route Options Serving the Growth Nodes

6.1 Overview

The creation of a high quality, reliable and frequent passenger transport link between the railway station and the growth nodes at Newtown is expected to be a key outcome of this study to meet the future transport needs for the city. In this section we discuss route selection and mode options for this high quality transport route.

A key feature of the Newtown growth node is that it is located near key passenger generators like the Wellington Hospital and Massey University. These facilities will generate the additional passengers needed to make a high quality passenger transport service more viable.

Future proofing: - Irrespective of the decision that is made as part of this study about the mode that should be selected for the passenger transport corridor serving the growth nodes, it is important that the route be selected and designed with a view that future generations can provide a higher quality passenger transport system in future years which is more suited to the urban density and the changing transport patterns. In this way, the selected corridor might be used by buses and trolley buses today, but replaced with a more sophisticated guided bus or light rail system of the future. Accordingly the project team was guided by the need to provide: -

- Travel in both directions (to enable double tracking if light rail was adopted)
- Minimum width of 3.5m for each lane (or light rail track), with minimum turning circle of 20m.
- Minimising the number of intersections with other roads.
- Minimising interaction with other vehicles by segregating passenger transport from other vehicles (but not pedestrians), as shown in Figure 6.1.

Nantes, France

Strasbourg, France

Figure 6.1: - Separating Passenger Transport from other Vehicles but not Pedestrians

6.2 Route Selection

A number of routes have been identified for a passenger transport corridor connecting the railway station and the growth nodes at Newtown and Kilbirnie, as shown in Figure 6.2. Two choices for routes are proposed between the railway station and Courtenay Place. A further two choices for routes are considered for serving Kilbirnie. Key issues in selecting a route, particularly the route between the railway station and Courtenay Place, include: -

- Locating the route near key people generators, minimising the walk distance. Generally people should only need to walk 200m to a bus stop, but people are prepared to walk greater distances to a light rail system and about 800m to a heavy rail system.
- Visibility of the route is also important, as the perceived distances that people believe that they need to walk can influence how far people are actually willing to walk. Visibility of the route is particular important for visitors and irregular users.
- Minimising passenger transport journey time and enhancing trip reliability by minimising the number of intersections and interaction with other vehicles (particularly along routes operating near capacity and subject to congestion).
- Ability to create a single bi-directional passenger transport route.

Clearly, some of these issues are mutually exclusive. For example, while locating the passenger transport route along the waterfront on the harbour side almost avoids all intersections for the 2.2km journey from the railway station to Courtney Place (with potential to decrease journey times from the present Golden Mile Route by as much as 10 minutes)[64], the route is further away from the key people generators, requiring passengers to walk further between the stop and their work (a distance between 200 and 300m, which has the potential to increase journey times by about 2 to 3 minutes). While it is possible to optimise route location so as to minimise total journey time[65], it must be remembered that passengers may not give equal weight to walk time and vehicle time when making decisions about mode choice[66]. A user preference survey may be needed to test the sensitivity of these complex and interrelated issues.

Without a further and more detailed study, the distances between a waterfront route and the Golden Mile are considered too small to enable the project team to argue that one route is likely to generate more passenger patronage than another. However, there may be other reasons for making the decision for one of these routes over another, including the desire to maintain the status quo and the relationship with people corridors and retail corridors.

[64] Based on existing bus journey along Golden Mile taking 20 minutes at peak time, of which 5 minutes is spent at bus stops. To travel 2.2km waterfront route at 30km/hr would take 5 minutes. Allow up 5 minutes at bus stops gives a total journey time of no more than 10 minutes.
[65] Time to walk from origin to bus stop, travel on bus, walk from bus stop to destination.
[66] Factors influencing this weight include the lack of protection from inclement weather for some walk journeys

To assist with the presentation of the five options, the route has been divided into three sections, and discussed separately. In this way, some of these options are alternatives, while others form part of the total corridor.

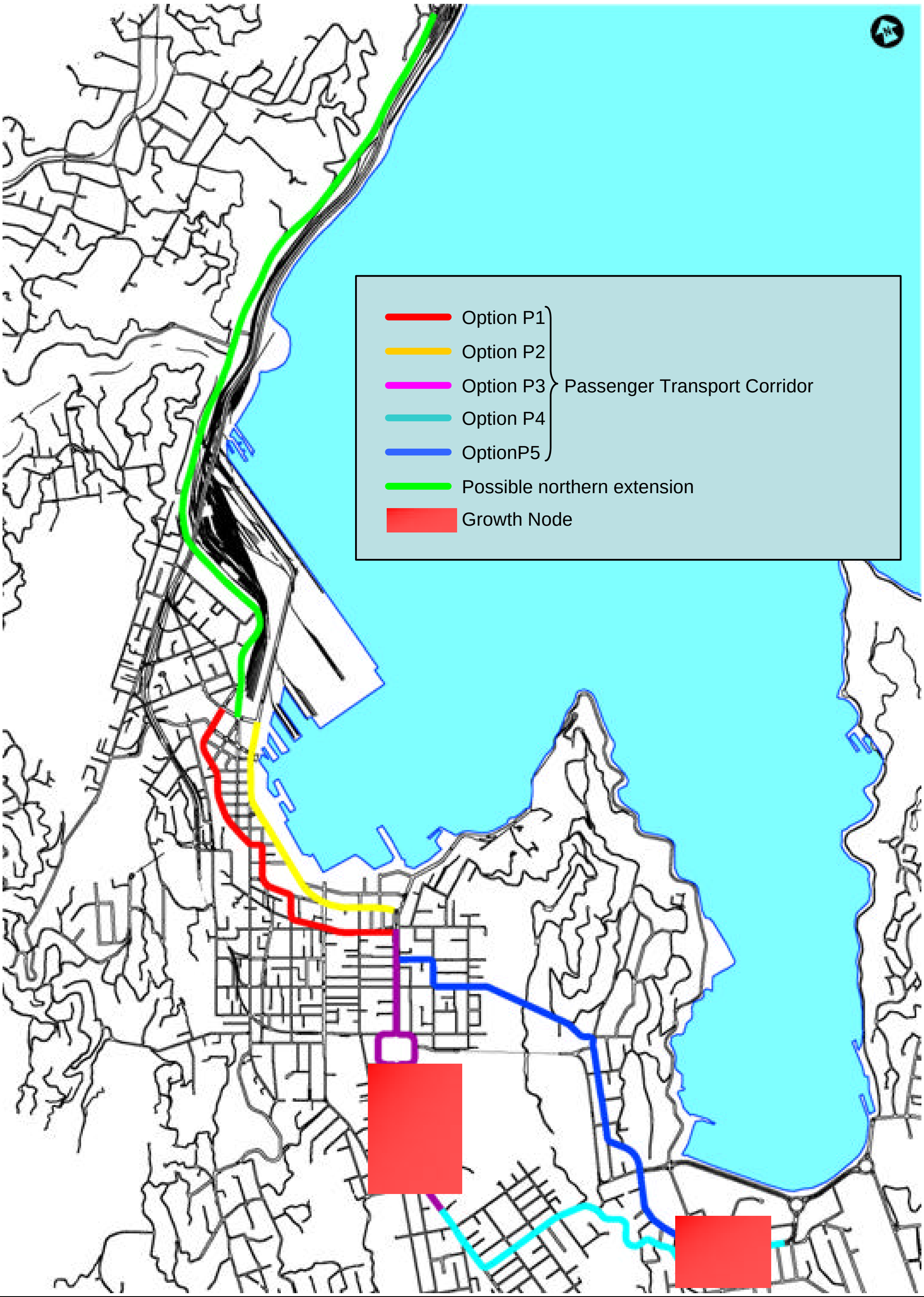


Figure 6.2: -Passenger Transport Options for Growth Nodes

It may also be feasible to consider all options. Within the CBD area, for example, there is the opportunity to create a high quality passenger transport route (perhaps incorporating light rail) along the waterfront while also maintaining the Golden Mile route for buses. A feature of this arrangement is that it has the potential to create a reliable, high capacity circular passenger transport service between the railway station and the CBD. Buses, like the City Circular, could be provided at high frequency as a means of extending the existing heavy rail services into the CBD[67]. This type of service is being provided in a number of other cities around the world[68]. While providing these additional services and routes will increase passenger numbers, it must also be remembered that passenger transport services generally require subsidy from rate payers and Land Transport New Zealand, and services need to be optimised to ensure that these subsidies remain affordable.

Similarly, there may be little benefit of distinguishing between the two options serving Kilbirnie – Option 4 or Option 5 in Figure 6.2 - unless it was decided to provide a high capacity right-of-way to Kilbirnie, in which case only one route would need to be selected. It is unlikely that the population growth figures for the growth node at Kilbirnie are sufficient to justify this type of intervention. It is expected that both routes would retain some priority improvements undertaken along both routes to improve bus services. In saying this, diverting the majority of the passengers from Kilbirnie to Newtown would increase the number of people using the passenger transport corridor between Newtown and the CBD, and this may improve the viability of the mode selected along this corridor.

Lambton Quay (between Willis & Hunter St)
adjacent to the Bank of NZ Building
(looking north)
Source: - Graham Stewart, "Around Wellington by Tram in the 20th Century, 1999

Use of Two-way Light Rail Operation along a narrow street in Nottingham, UK

Figure 6.3: - Light Rail within a narrow street

Railway Station to Courtenay Place (Golden Mile Route): - This is the most complex part of the route given the need to be near the large number of people generators, the need to pass through a number of narrow streets (which are also heavily used by pedestrians), the over-reliance of a one-way system within the CBD and the lack of a single 'spine' or corridor that would improve visibility and the

[67] Cities like Melbourne provide a similar circular service for free.
[68] Brent Efford, "Wellington Rail and the Sustainable Vision Putting US Experience in a Kiwi Context", Proceedings Towards Sustainable Land Transport Conference, November 2005, page 18

connection between the Lambton Quay area with Courtenay Place. While Lambton Quay (between Hunter and Willis Streets) and Manners Street (between Victoria Street and Willis Street) once accommodated two-way tram operation before 1950 (see Figure 6.3), they are not considered wide enough to accommodate two-way operation for a busway or modern light rail today, even with the exclusion of general vehicles, given the importance that this area plays for pedestrian movements. While pedestrians and passenger transport can use the same space (as shown in Figure 6.3), this is not recommended for these sites where large numbers of pedestrians (such as along parts of the Golden Mile) also use these routes[69] given the need to provide wide footpaths.

Two options are considered for this route, one along the Golden Mile and the other along the waterfront.

- **Option P1** uses the Golden Mile and effectively follows the existing bus route. The key difference with the present bus route is that the one-way bus system between Mercer, Wakefield and Manners (south bound) and Dixon, Victoria, Manners and Willis (**northbound**) is replaced with a conventional two-way system. This two-way passenger transport corridor will help create a stronger spine to connect the Lambton Quay area with the Courtenay Place area. Furthermore, it is less disorientating for passengers when both in-bound and out-bound passenger transport services use the same route. The proposed route through the CBD is shown in Figure 7.4.

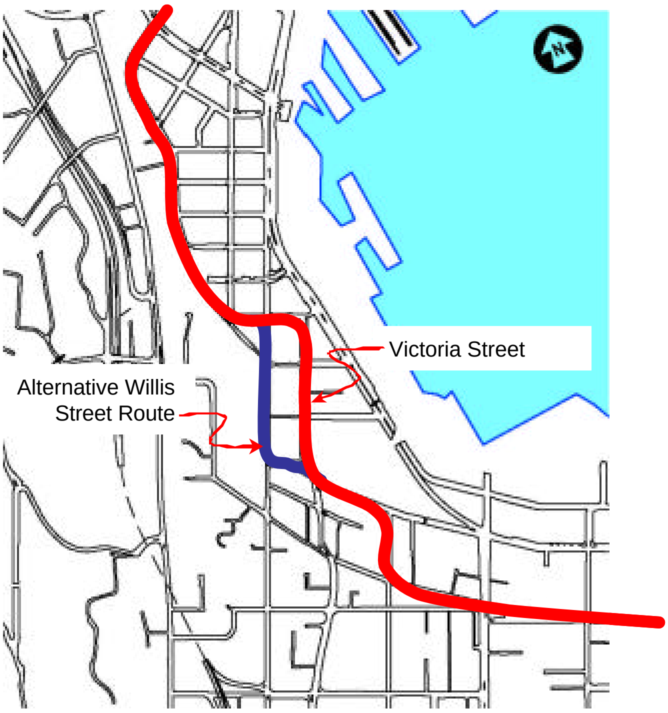


Figure 6.4: - Option P1: main route and alternative route through the CBD

69 While these roads presently form part of the Golden Mile bus route, this is only as a one-way operation.

Option P1 involves the construction of a busway or light rail along the western side of Lambton Quay. A one-way south bound traffic lane is provided as shown in Figure 6.5. With this arrangement, there is sufficient space for enhanced pedestrian areas and some parking for service vehicles, taxis and other general vehicles.

Two alternatives are suggested for a conventional two-way system: one via Victoria Street and the other via Willis Street. A third option is to retain the existing one-way system. The two-way options would require an adjustment to Wellington's one-way system; although it is possible to provide two-way bus, or light rail, operation within a one-way street for general vehicles using contra flow lanes. While a single one-way lane may be able to be provided along Hunter Street and Victoria Street (albeit at the expense of car parking), general traffic would have to be excluded along Willis Street. This creates a challenge of how to provi de for general vehicles needing to service this part of Willis Street. This could be overcome by allowing general vehicles to use the route between 7.00pm and 6.00am (i.e. outside peak times). Alternatively, parking spaces could be provided for service vehicles nearby, along adjacent streets, as the extent of the restrictions along this route is not long.

As part of Option P1, it is proposed to restrict access to Courtney Place, perhaps using a one-way system like that shown in Figure 6.5 or applying the restriction at peak times. To improve journey times for passenger transport through Courtney Place, signal controlled pedestrian crossings are recommended. A super stop[70] or interchange should be provided at Courtney Place. A full interchange would be required if a light rail option is adopted, and this would almost certainly prevent general use of Courtenay Place as a though route for general vehicles.

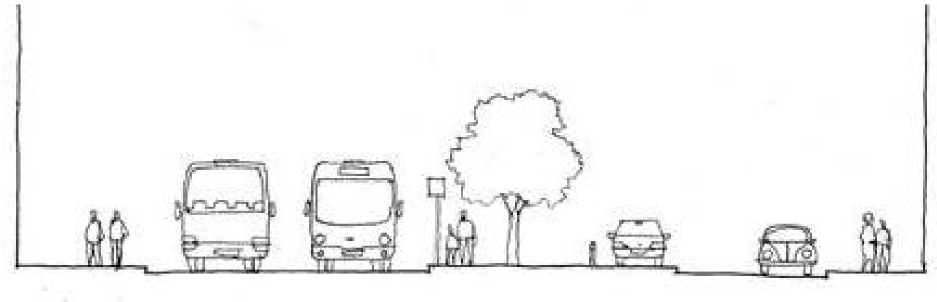


Figure 6.5: -Two-way busway and one-way south bound lane along Lambton Quay
(looking north)

- **Option P2 Waterfront route**. This option requires the number of general traffic lanes along waterfront route to be reduced to no more than two-lanes in each direction, but preferable to just one-lane in each direction. From a perspective of minimising bus journey times, this passenger transport corridor would ideally be located on the harbour side, as it would minimise the number of intersections. This is an ideal feature for a higher quality bus route or a light rail systems.

[70] A super stop might include enhanced features like multiple covered platforms, real time information, ticket sales, bike storage and toilet facilities.

The arrangement, however, would significantly disadvantage pedestrians who would need to cross four-lanes of traffic to reach the stop. From a pedestrian point of view, a two-way passenger transport corridor located on the western side of the waterfront would be best, although this complicates the numerous intersections along the route and increases signal time. Placing bus lanes or rails on each side of the road is also an option, but again requires pedestrians to cross four-lanes of traffic for half their trips. Notwithstanding the advantages or disadvantages of Option P2 might have with respect to Option P1 in terms of location to people generators and journey times, it seems that Option P2 is likely to be most viable if the waterfront route can be reduced from six lanes to just two-lanes, as shown in Figure 6.6.

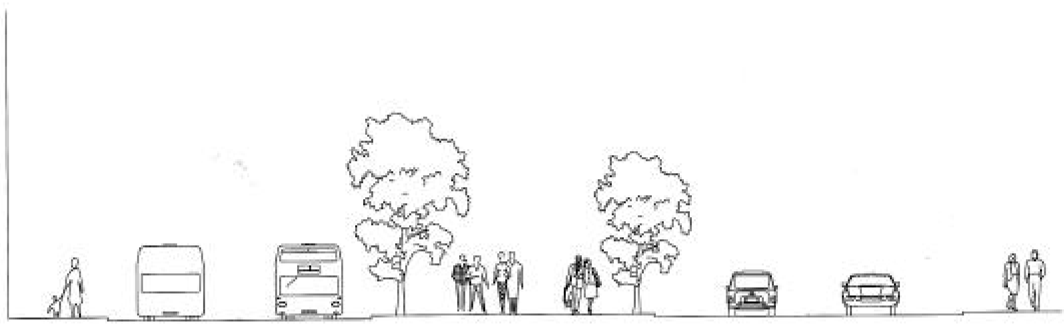


Figure 6.6: -Two-way busway and only one lane in each direction for general vehicles along the water front
(looking north)

At the Michael Fowler Centre, two alternative routes exist: -

- a two-way busway along Cable Street.
- a two-way busway along Wakefield Street.

Both options would require reverting the present one-way system to a conventional two-way system or using a contra flow system.

Key Issues: -

- The Golden Mile route is closer to key people generators, meaning passengers have a shorter walk to a stop.
- With only a minor exception, the Golden Mile route uses the existing passenger transport corridor, and therefore creates less change for patrons and retailers.
- The Golden Mile route follows Wellington's main retailing corridor, which has potential economic benefits.
- A two-way operation along the Golden Mile will require adjustment to the existing route around Willis Street, including the possibility of adjusting the one-way system.
- The Golden Mile route has lower traffic volumes using the corridor than the Waterfront route, creating a safer and higher amenity environment for passengers who need to walk to and from stops and wait at stops.

- Given the high number of pedestrians the Golden Mile has been posted at 30km/hr so as to increase safety. This increases the overall journey time which conflicts with the desire to create a rapid transit service.
- The Waterfront route has less intersections, is more direct, is shorter than the Golden Mile route and therefore provides a significantly faster journey time, an important feature of a rapid transit corridor.
- The Waterfront route is only likely to be viable if the waterfront is reduced to at least two and preferably only one lane in each direction.
- A passenger transport route along the water front is less likely to create the severance created by general vehicle lanes that they will replace (as shown in Figure 6.7).
- The Golden Mile route will create more challenges during construction than the waterfront route, particularly the need to minimise the impact on existing bus services. If the timing of the waterfront route occurred immediately after the duplication of the Terrace Tunnel, it could be constructed without affecting existing bus services or general vehicles.

Figure 6.7: - Treatment to encourage access to the waterfront
Docklands, Melbourne, Australia

- Constructing light rail along the Golden Mile creates particular challenges in terms of minimising existing bus services, particularly along a number of narrow streets along the route.

Courtenay Place to Newtown: - As shown in Figure 6.2 only one option is shown for serving the growth node in Newtown from Courtney Place: **Option P3**. The proposed route is along Kent/Cambridge Terrace, around the Basin Reserve and along Adelaide Road.

Kent/Cambridge Terrace is a wide boulevard, providing up to 3 lanes in each direction (Figure 6.8). There are two alternatives for where to locate the passenger transport corridor along Kent/Cambridge Terrace. Both retain the boulevard. A third option of locating the passenger transport along one side, as proposed for Lambton Quay is not considered feasible given the complications created by the number of intersections along this route.

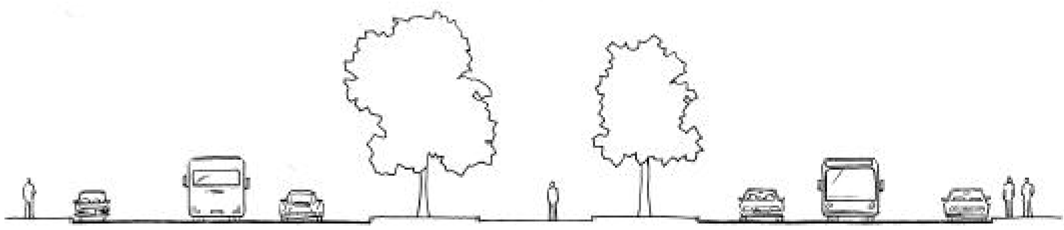
- **Central location: -** (Figure 6.8 and Figure 6.9). Locating the passenger transport corridor adjacent to the wide grass median, which would remain. A key advantage of a central location over a side location is that it provides a higher quality service for passenger transport, reducing the interference created by vehicles parking and accessing property.
- **Left lane location: -** The bus lanes or light rail are located on each side of Kent/Cambridge Terrace, as shown in Figure 6.9.

There are also two alternatives for along Adelaide Road. The first is for the busway or light rail system to be located along one side of Adelaide Road with a one-way general traffic lane serving the growth node, similar to that proposed for Lambton Quay as shown in Figure 6.5. The second is extending the Cambridge and Kent boulevard along Adelaide Road, similar to that shown in Figure 6.9.

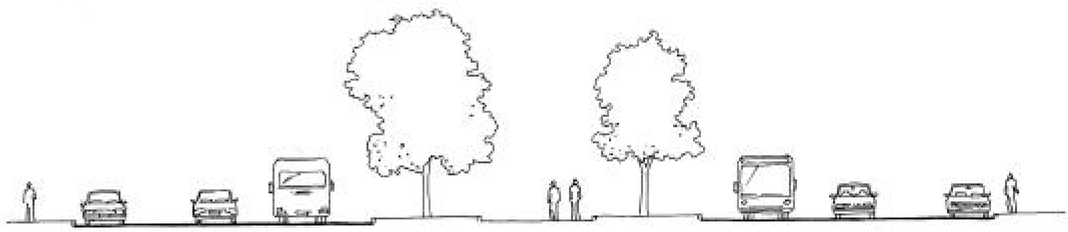
Kent and Cambridge Terrace

Light Rail in Nantes, France

Figure 6.8: - Locating Light Rail in the Centre of Boulevard



a) Bus shoulder lanes



b) Bus central lanes

Figure 6.9: - Kent and Cambridge Terrace

The passenger transport corridor should extend along Adelaide Road and Riddiford Street stopping within 200 to 300m of the Wellington Hospital. The preferred location will depend on suitable space for a super stop or if light rail is adopted, space for an interchange. Riddiford Street is narrow and in order to provide space for passenger transport and general vehicles, car parking space may need to be reallocated. If the super stop or interchange was located on the east side of Riddiford Street, there may be an opportunity to redevelop (intensify) the areas between Riddiford Street and Adelaide Road and to create a small one-way system for passenger transport using Riddiford Street southbound and Adelaide Road northbound.

Key Issues: -

- The central location is ideal for light rail as it permits the use of a central platform and for passengers to alight away from traffic flows in adjacent lanes. The central location is not as ideal for standard buses - doors open on the wrong side for a central platform – which require separate platforms on the left hand side[71]. Nevertheless Cambridge and Kent Terrace are wide enough to accommodate the additional platforms needed to accommodate a central location for buses.
- Locating the buses in the median, increases the distance of buses from private property which could improves the amenity of those that live or work there.
- The option of locating the passenger transport corridor along one side of Adelaide Road minimises traffic volumes passing through the growth node, enhancing the walk-ability and amenity value of the node: both features that will help create a high quality, intensified mixed use, and sought after residential area.
- Locating the passenger transport corridor in the median is not ideal if Option B3 or Option B4 at the Basin Reserve is adopted, as these options require passenger transport to be on the left lane when approaching or leaving the Basin Reserve. Pre-signals would be required to move the light rail or buses across to the left lane.
- A high quality passenger transport corridor along Kent and Cambridge has the potential to lead to an increase in mixed higher density land use, replacing the present vehicle orientated activities.

Newtown to Kilbirnie: - Figure 6.2 shows the two alternatives for extending the passenger transport corridor to serve the growth node at Kilbirnie. Both options are not ideally suited to a high quality busway or light rail system that has exclusive right-of-way: certainly not without significant property impact. Both routes have lower bus numbers and frequencies than the main corridor between the railway station and Newtown; therefore suggesting that a bus type system is probably more suited, where bus priority measures can be provided at all congestion points along the route to provide an adequate service at minimal cost and impact.

[71] There is probably sufficient width along Kent/Cambridge for this, although this would be at the expense of car parking and lanes for general traffic

Figure 6.10: - Trams using Constable Street near Newtown c1950

Source: - Graham Stewart, "Around Wellington by Tram in the 20th Century, 1999

While there is no operational impediment to light rail using these routes – trams operated on both routes before 1950 (Figure 6.10) – there is concern whether there is sufficient width for a modern light rail system which can operate without undue interference from other vehicles when the road space must also be used by other vehicles as well as provide for car parking and access to properties. The reduced level of service created by this arrangement limits the benefits of, and hence the return on the significant investment needed for, a light rail system.

Some localised bus priority measures will be required in Kilbirnie itself together with a super-stop or bus interchange. Two options are considered: **-**

- **Option P4** is an extension of the passenger transport route to Newtown, using the existing bus route along Riddiford Street and Constable Street. This would require traffic reduction and associated bus priority measures within Newtown retail precinct, a bus interchange or super-stop near the hospital/Newtown retail precinct area and bus lanes and parking restrictions approaching signals and along pinch points on Constable Street. If these restrictions were unacceptable, then road widening would be required which would impact on adjacent property.
- **Option P5** provides an alternative route using the existing bus route through the Mount Victoria Bus Tunnel and via Hataitai. Delays at the Mount Victoria tunnel could be reduced with out the expense of widening the tunnel by using a GPS tracking system to better manage buses and the signals used to control one-way bus flows. Some bus lanes approaching signals and intersections improvements will be required along Moxham Ave and Kilbirnie Crescent.

Key Issues: -

- It is unlikely to be feasible to create a passenger transport corridor that is segregated from other vehicles along both of these routes, given the requirements for property access, parking and through traffic.
- Given this, and the significant volumes of general traffic using Constable Street, passenger transport using the Option P4 route are likely to experience greater delays and less reliability than passenger transport using Option P5, which generally follows a route with lower traffic volumes.
- Both routes are more suited to a bus operation than light rail.
- Option P5 may experience delays at the Bus Tunnel if bus numbers continue to increase.
- Option P4 creates a more direct link between the growth nodes at Kilbirnie and Newtown, although it is unlikely that there will be sufficient number of passenger wanting to make this journey.

- Option P4 is likely to create a faster journey time from Kilbirnie to the CBD, given that it uses the high quality passenger transport corridor connecting Newtown and the CBD.
- Option P4 would increase the number of people using the passenger transport corridor between Newtown and the CBD, and this may improve the viability of the mode selected along this corridor.
- Both Option P4 and P5 create the opportunity to extend the passenger transport corridor to the airport. While Option P5 would create a more direct route, Option P4 could provide faster journey times once buses or light rail joined the right-of-way route from Newtown to the CBD.

6.3 High Quality Stops and Interchanges

High quality stops and interchanges are needed where there is heavy passenger loading and high frequency stops. Careful design is required to maximise connectivity and minimise walk time where passengers are required to change modes or transfer between services. This is because the time penalty associated with mode transfers can be significant, particularly where the headway between services is more than 3 to 5 minutes and the remaining distance to their destination is relatively short (less than 10km)[72].

While the bus terminal at the railway station has been recently upgraded, a closer location to the rail platforms may further encourage transfers. While locating the bus platforms directly above the existing rail platforms would create a more direct connection, it is unlikely that the cost of this would justify the benefits. However, consideration should be given to protecting this type of concept should plans to redevelop the airspace above the platforms proceed.

Figure 6.11: - Light rail and bus interchanges using cross platforms
Strasbourg, France

If light rail is adopted as the high quality passenger transport service to the growth nodes, then transfers to light rail as well as buses is needed at the railway station. Transfers to light rail could occur adjacent to either platform one or platform nine, depending on whether the Golden Mile or Waterfront route is adopted. Interchanges using cross platforms between light rail and buses would also be needed at Newtown and Courtenay Place to encourage bus passengers from the suburbs to transfer to light rail route to the CBD and railway station, as shown in Figure 6.11. Such facilities might include improved waiting facilities, platforms for level loading, ticket machine (enabling tickets to be collected prior to entering light rail or bus[73]),

[72] Rongfang Lui et al; "Assessment of Intermodal Transfer Penalty using Stated Preference Data", Transportation Research Record, 1607, 1997, page 74 -80.

[73] Tickets are collected to enter the platform

real time information, cycle stands, signage, and improved pedestrian linkages. In order to achieve these facilities significant space is required.

At Newtown, additional property would need to be acquired to accommodate such an interchange. Given that the Wellington Hospital will be a significant people generator, a location within 200 to 300m of this facility should be sought.

Less elaborate interchanges would be required if a bus based solution was adopted, as the need for transfer between modes would be almost eliminated.

Stops need to be designed to maximise efficiency of using the passenger transport system while also providing for the needs of people with disabilities. This can be achieved by: -

- Minimising the height difference or step between the bus or light rail and the footpath (can be achieved though the use of platforms, kneeling buses or low entry light rail units or a combination of these).
- Ensuring clear footpath entry and exit points exist, including removing street clutter, parked vehicles or other obstacles.
- Providing shelter, seating, lighting and a design that maximises personal security.

Stops, particularly those along the passenger transport corridor, should also include: -

- Real time information about the next service.
- Ticket purchase facilities (certainly at interchanges and super-stops).
- Uncluttered kerb edges.

7 Mode Selection for Passenger Transport Service to Growth Nodes

7.1 Overview

With possible routes for the passenger transport corridor outlined, we now discuss whether bus, trolley bus, guided bus or a light rail system or a combination of these should operate within the corridor. Bus systems are discussed first followed by a light rail system. At the end of this chapter, we briefly discuss the issues associated with a new range of people movers, made available with the advance of new technologies, and why we believe that they are unlikely to meet Wellington's transport needs, certainly at this time.

7.2 Passenger Numbers and Urban Form

The existing and future urban density, particularly in the southern and south-eastern suburbs is ideally suited to providing a viable bus service (refer to Table 3.2, Figure 3.16 and Figure 3.17). High urban densities of 40 dwellings per hectare and 400 employees per hectare are required to support a light rail system (Table 3.2). As seen in Figure 3.17, the CBD area has sufficient density to support light rail. And while the suburbs immediately adjacent to the CBD have adequate density to support bus, there are pockets of higher density that could support light rail. Outer suburbs have densities that support bus and the private motorcar. Based on these figures, it appears that light rail might (certainly if intensification continues) be viable to Newtown in future years; but unlikely to the more southern or south-eastern suburbs.

Table 7.1 provides a guide to the number of passengers needed to support various transport modes. At peak time along the Golden Mile, over 110[74] buses operate per hour. While actual bus passenger numbers are not available[75]; it is estimated that about 3500 to 4000[76] people may be using the Golden Mile corridor at present. Even less people would use Kent/Cambridge Terrace. Comparing Table 7.1 with Table 7.2 suggest that that light rail might be viable along the Golden Mile, certainly in future years, certainly if passenger numbers continue to increase.

Table 7.1 : Passenger Number and Mode

Mode	Passengers/hour
Bus	<5000
Light Rail	7000 to 15,000[1]
Heavy rail	>20,000

Note 1: Light rail along Swanston Street in Melbourne moves over 24,000 people per hour

The GWRC's Strategic Transport Model (WTSM) was used to predict passenger transport numbers in 2016. One scenario tested (see Chapter 18) was to make generous increases in passenger transport at the expense of further capacity improvements for general vehicles. Not only were improvements made to the frequency of bus and heavy rail services, but a light rail was also added, extending from Johnsonville to the Airport via the waterfront. Buses were provided with their own right-of-way along Lambton Quay. While transfers were permitted between bus and light rail, they were not enforced so

74 Opus, "Ngauranga to Airport Strategy Study, Golden Mile Assessment", for Transit New Zealand, 2006
75 Bus passenger numbers are not published by bus operators due to commercial sensitivity
76 Assuming that each bus carries 25 to 40 people at peak time: Based on a GWRC survey along the Golden Mile indicating average bus numbers of 37 people.

as to maximise the overall passenger transport mode share. In this way, passengers use both bus and light rail along the passenger transport corridor connecting the growth node at Newtown and the railway station. Also included in this test were effects of travel demand management - refer to Chapter 18 for details. In other words, this test paints a picture of the likely maximum shift to the passenger transport mode in future years that we might achieve. Figure 7.1 shows the extent of the passenger transport corridor and location of screen lines.

The results shown in Table 7.2 are provided to estimate of the maximum number of passengers that could be attracted to passenger transport. The results should not be viewed as a practical solution for passenger transport in Wellington, as it is unlikely that a city the size of Wellington could afford the type of duplication of passenger services being tested.

Nevertheless we can use the results from this scenario to test the vi ability of light rail. Table 7.2 summaries the passenger transport numbers across these key screen lines in the morning peak in the direction of travel that attracts the greatest passenger numbers.

Table 7.2 : Estimated passenger numbers using passenger transport corridor across key screen lines in the morning peak 2016

Screen Line *(Passengers shown for direction with greatest number)*	**Passengers/2 hour**			**Total passenger per hour**[1]
	Total	**LRT**	**Bus**	
CBD screen (Southbound from railway station to Courtenay Place)	7,802	3,510	4,292	4,681
Kent/Cambridge (Northbound towards CBD)	2,727	956	1,771	1,636
Adelaide Road (Northbound towards CBD)	2,878	943	1,935	1,727
Cobham Drive (Northbound towards CBD)	2,146	10	2,136	1,287

Note 1: Passengers per hour are assumed to be 60% of passenger in 2 hour period.

We can make the following observations from Table 7.2: -

- Light rail to the airport, when competing with buses, attracted almost no passengers.
- The CBD screen line attracted the greatest numbers to light rail at nearly 3,500 people over a 2 hour period. However, the combined light rail and bus passengers across this screen line are almost 5,000 people, making light rail an option worth further investigation along this route, if not now then certainly in future years.
- Light rail between Courtenay Place and Newtown generated only about 1,000 passengers in a 2 hour period. While forcing all bus passengers to light rail along Adelaide Road and Cambridge Terrace would increase the number of people using light rail to about 2,000 people per hour (equivalent to a light rail service of about 5 minute headways).

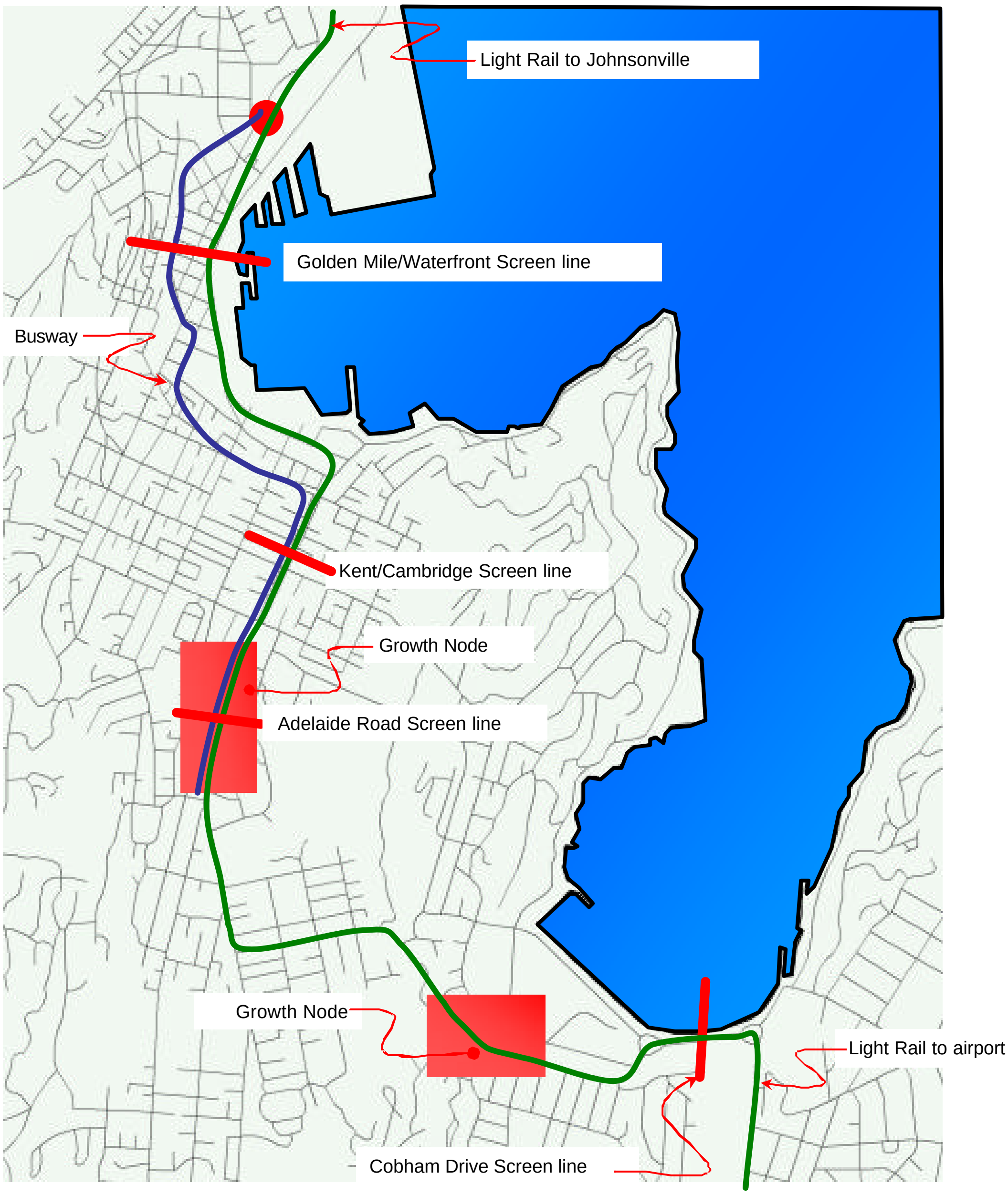


Figure 7.1 – Description of a Full Passenger Transport Option

The GWRC Strategic Transport model does not include proposed growth nodes at Newtown and Kilbirnie. While it has allowed for the expected increase in population, this has been spread over all suburbs rather than concentrating a large proportion of the growth at Newtown and Kilbirnie.

Latest thinking is for an additional 3,000[77] people within the Newtown growth node and 2,000 people in a Kilbirnie growth by 2026. In order to test the viability of a passenger transport corridor to Newtown,

77 Wellington City Council, "Quantifying the Growth Spine, supply, demand and capacity for residential development in Wellington City, September 2006.

we have considered a scenario of an additional 5,000 people living in the Newtown growth rather that being shared with Kilbirnie and that 40% of this growth would have occurred by 2016. These 5,000 people are assumed for this analysis are additional to those already included in the WTSM.

Therefore assuming a population of 2,000 people by 2016, then we might expect an additional 300 people to use the passenger transport corridor within a peak hour[78]. This is a significant increase in patronage over and above those predicted by the transport model and confirms the import role that growth nodes have in making passenger transport more viable.

Table 7.3 shows the number[79] of passengers using light rail in 2016 with the addition of 5000 people in the Newtown growth node.

Table 7.3 : Estimated Passenger Numbers in 2016

Route	Passengers/hour
Golden Mile	5,000
Adelaide Road	2,000

If a high quality bus, guided bus or light rail system was provided to the growth node at Newtown, then densities of over 40 dwellings per hectare could result (assuming there are no planning restrictions) meaning that we could have 10,000 to 15,000 people within this node in 50 years time instead of existing projections of only about 5,000. This would have a significant impact on the viability of a high quality passenger transport system such as light rail.

In order to achieve this level of density, the growth node at Newtown needs to be served by a high quality passenger transport service. Once this density has been achieved, it will make the high quality, frequent and reliable passenger transport service viable, as shown in Figure 7.2.

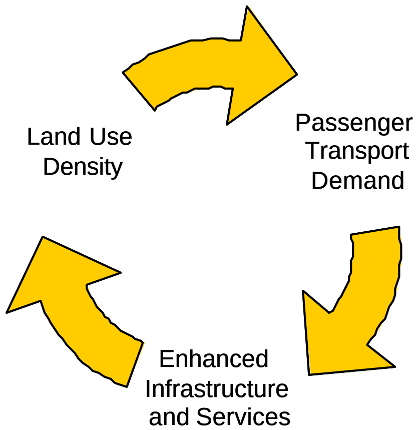


Figure 7.2 – Land-use and Passenger Transport

The above discussion confirms the importance of the passenger transport corridor to the growth nodes and emphasises the need to protect such a route now, even if the full development of the route as a rapid transit route is not viable until future years.

If buses are to remain as the primary passenger transport mode to the growth nodes, certainly in the immediate planning horizon, then it would be necessary to enhance the level of service for buses, particularly along the Golden Mile route which is already operating near capacity. It is considered feasible to upgrade the facilities for buses along the Golden Mile to accommodate the additional number of buses needed to serve the growth nodes and to provide the required level of service (including

78 Based on: - 60% of people working (from 2001 Census of people who live in CBD), 45% of people using bus or light rail to get to work (refer to Figure 3.5), and 60% of trips are made within a given peak hour and that everyone travelled to or through the CBD along the transport corridor.

79 Assumes 80% of the 800 additional passengers from the growth nodes that use passenger transport use light rail (the remaining 20% are assumed to use bus) and that they all travel through the Golden Mile.

reliably)[80], certainly within the time frame of 2026 and with projected populations within the nodes of about 5000.

7.3 Bus Systems

Buses already operate effectively within the study area and a high concentration of buses use the corridor between the railway station and Newtown. In developing a bus based system for this corridor, the project team have considered the following range of possible enhancement measures that would provide a high quality service, closer to that achieved by a rapid transit system and needed to meet the increase in bus passengers predicted to occur in future years with the development of the growth nodes at Newtown and Kilbirnie. Each is described below and discussed in terms of possible application within the study area.

Figure 7.3 - Busway operating in Adelaide

Busways provide a dedicated right-of-way for buses, and while vehicles may use the same road corridor, they are separated from buses, generally by some physical barrier. In this way buses become the primary transport mode and other road users are given a lower priority or are totally restricted. Busways aim to reduce the number of signalised intersections and side road interactions. Figure 7.3 shows a busway used as a trunk haul bus route. In a NZ context, the Northern Busway (North Shore) is an example of a busway with exclusive use by buses. When used in an urban environment, busways, unlike bus lanes, can restrict the movement of other vehicles, particularly for property access, loading zones and servicing.

80 Opus, "Ngauranga to Airport Strategy Study, Golden Mile Assessment", for Transit New Zealand, 2006

Figure 7.4 - –Guided Busway in Bradford, UK

Guided busways offer similar advantages and disadvantages to busways in that they provide an unobstructed corridor. Guided buses typically use a mechanical guidance system using a barrier and jockey wheels system to guide the bus, as shown in Figure 7.4; and are ideal for long haul routes. Used in an urban area, such a system is likely to restrict other vehicles and create pedestrian severance. Future guided bus systems are likely to use electronic guidance system, which are a lot less intrusive and more suited to urban environment. However the technology is still new and unproven and is likely to require significant set up costs (although less than a light rail system).

The key benefits of such a system include the creation of exclusive and restrictive bus facilities, and the use of platforms to reduce dwell times at bus stops. Compared to light rail, guided buses have the flexibility to penetrate the low density suburbs without the need or expense of guided facilities. In this way, the expense of the guided system can be restricted to key high capacity bus corridors.

Trolley Bus: - Wellington already operates a fleet of trolley buses. Trolley buses are quieter, cleaner and can accelerate faster than conventional diesel buses, offering advantages within an urban area like Wellington. However, they are much more costly to operate and can create additional delays given the risk of them losing their power connection, although the introduction of new trolley buses would significantly reduce this risk[81]. The overhead wires and cables supplying power to trolley buses do create visual impacts.

Trolley buses can operate along the same corridors[82] as ordinary buses or guided buses and will be able to use, and gain all the benefits of the passenger transport corridor between Newtown and the railway station. The feasibility of running light rail and trolley buses within the same corridor, however, is less certain given their different methods of collecting power from overhead wires.

81 New trolley buses are designed to reducing the likelihood of the 'sticks' coming off the tracks and buses have an auxiliary power supply to allow them to self propel or approximately 250m, thus avoiding breakdowns, delays and safety impacts associated with existing trolley bus operation.

[82] On those streets where the overhead wiring is installed

Figure 7.5 - Contra Flow Bus Lane
(Russell Square – London, UK)

Contra Flow Bus Lanes: - Contra flow bus lanes, like busways provide a bus only lane but in the opposite direction to the general traffic flow on a one-way link, as shown in Figure 7.5. Such facilities can be implemented to avoid long diversions associated with one-way traffic flows, while also improving passenger clarity and accessibility through the use of a single bus route. The existing southbound bus operation on Willis Street acts as a contra flow facility and scope exists to install similar facilities on a number of other key one-way streets in Wellington, such as Victoria Street, the southern end of Willis Street, Featherston Street and Molesworth Street.

Bus Lanes: - The introduction of additional bus lanes and modification to associated bus lane hours is a method of bus priority that is widely used around the world. Bus lanes are recommended where delays occur on the approach to signals, entry and exit of bus stops or other delay points; and the frequency of buses justifies the reallocation of road space, particularly where there is congestion caused by general vehicles. Because general vehicles are not physically prevented from using bus lanes, an enforcement regime is often also required. Bus lanes are already in operation within Wellington, particularly along the Golden Mile. Adelaide Road also operates a bus lane although this restriction is time of day dependent. Bus lanes would be required along Kent and Cambridge Terrace or the boulevard option for Adelaide Road.

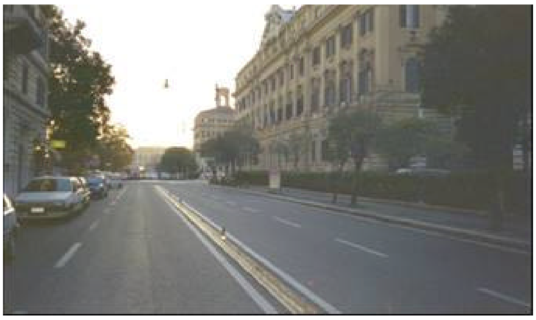


Figure 7.6 - Bus Lane Segregation
(Rome, Italy)

Bus segregation strips can be used to help create physical separation of bus lanes from general traffic lanes, as shown in Figure 7.6. While it provides clear differentiation (physical and visual) between general traffic lanes and bus lanes, it is not as restrictive as many busways or guided busway systems. The main advantage of this physical feature is that they are relatively inexpensive and easy to install and while it can restrict kerb side access for general vehicles, it will permit access for heavy goods and emergency vehicles. The segregation strip may create safety concerns for cyclists and motorcyclists. Such a facility may be appropriate for Kent and Cambridge Terrace or Adelaide Road or a similar area in which kerbside access is to be restricted.

Signal Detection and Control Management Systems: - The use of advanced signal treatment along bus corridors has the potential for significant journey time savings and improved reliability[83]. A variety of

[83] Adherence to timetables

signal treatments are available that would be suitable for this corridor, including GPS, loop, or infrared detection of buses in order to give priority at signal junctions through the allocation of additional green time, reduced green time for general traffic and pedestrians, and linking of signal junctions and other bus priority mechanisms.

Given that an existing signal control strategy exists in Wellington, the introduction of an effective linked detection system which is focused on buses could result in significant journey time savings and improved reliability. Such a system could be incorporated into bus stop information, whole route management (ensure buses do not get behind or ahead of schedule), tunnel access management, and monitoring of bus route performance.

Figure 7.7 Bus Pre-signal
(Stockwell Road – London, UK)

Bus Pre-Signals: - Bus pre-signals are used to allow buses to move ahead of general traffic queues and to gain access to a right turn lane from a nearside bus lane or general traffic lane, as shown in Figure 7.7. This involves relocating the queue from the intersection to a short distance before the intersection. These can be used in conjunction with other purposes, such as metering of traffic into particular areas. Pre-signals can also be implemented in the form of a virtual bus lane to enable buses to travel in front of general traffic in areas where there is not enough lane width to allow a separate bus lane. Locations in Wellington which could benefit from such a facility include Thorndon Quay, as buses access the central bus lane from the nearside lane/bus stop and the approaches to roundabouts and intersections on Cobham Drive.

Improved pedestrian control and crossing management: - Bus priority[84] can be achieved through the replacement of uncontrolled pedestrian crossing with signalised pedestrian crossings. Such controls could be effectively implemented in Courtney Place, Newtown and Kilbirnie.

Signal and Stop Integration: - Such a system can be provided where a bus stop is located immediately prior to a signal controlled intersections. A detection and activation system minimises bus delays by providing a green signal immediately after they leaves the bus stop. Examples where bus stops are located prior to signal intersections include Manners Street and Willis Street (northbound). As an alternative to such a system, bus stops can be relocated beyond the intersection or pedestrian crossing. This could be done on the south bound stop on Hutt Road at Kaiwharawhara.

Other Initiatives for improving bus services

- **GPS Tracking of Buses:** - Locating a GPS device on every bus and connecting this using a cellular communication network with a computer control system would enable: signal and route management, real time passenger information, route control mechanisms, and bus monitoring.

[84] Conversion of zebra or traditional signalised pedestrian crossings to pedestrian detection signal crossings could save as much as 5 seconds per bus at each crossing. Puffin; DTLR Traffic Advisory Leaflet 1/01, 1/02

Such a system would allow for improved scheduling of bus services, activating a hurry call at signals and other control points such as Mount Victoria Bus Tunnel and The Golden Mile. Such a system is not only able to speed buses up, but also slow them down to ensure they keep to the specified timetable.

- **Bus Stop Capacity: -** Improvements to bus stop capacity and the management of the bus stop environment can significantly improve[85] the operation of buses and reduce delay associated with buses waiting to approach stops and exit stops once passengers have loaded and unloaded. The key issues to be addressed include:
  - Adjusting the spacing of bus stops.
  - Whether all bus services must stop at every bus stop.
  - Ability of buses to pass other buses in order to access or exit a bus stop.
  - Avoiding having bus stops opposite each other.
  - The ability for the bus to exit the stop without interference from other traffic.
- **Electronic Ticketing: -** The dwell time of buses accounts for approximately 25% of the total journey time and one of the fundamental ways of reducing this dwell time and associated delay is through the improvement in passenger loading through the use of electronic ticketing. Current ticketing practices take an average of 8 seconds per passenger. Research[86] shows that this figure can be reduced by a third through the introduction of electronic ticketing. Loading times can be further improved when electronic ticketing is used in conjunction with boarding from both front and rear doors[87].
- **Enforcement:** The success of many bus priority measures such as bus lanes requires a clear and agreed enforcement strategy. This strategy should focus on the passenger transport corridor, being the highest bus hierarchy route and in particular those parts of the corridor where an exclusive right-of-way cannot be provided by physically means such as a barrier or kerb. The types of enforcement mechanisms that can be employed include:

Figure 7.8: -CCTV Enforcement Camera

  - Route based strategies and objectives for bus corridors;
  - Identification of hotspots and targeted enforcement of these locations;
  - Increased route / area wide on-street enforcement;
  - Bus mounted enforcement cameras; and
  - CCTV cameras to enforce and manage traffic obstructions (Figure 7.8).

[85] The delay associated with the approach to the stop and exit following the dwell time can be as high as 25% of the total journey time.
[86] Alexandra Smith, "Transport Reporter in Sydney", April 2006
[87] An approach which has been used in London involved the introduction of such an approach for the CBD only as an initial staged roll out, with the entire city to follow.

Key Issues: -

- Buses are perceived by passengers as a lower quality of passenger transport system than light rail or heavy rail.
- Buses are less likely to influence land use at Newtown and encourage higher-density development compared to a light rail system.
- Buses, including trolley buses, already operate within the city, and so the additional capital expenditure is limited to re-arranging the road space needed to segregate buses from other vehicles and providing improved bus priority. Other initiatives like GPS tracking can be incorporated within the existing bus fleet.
- Buses can penetrate the low density suburbs to the south and south-east using existing local roads while also using the high speed transport corridor without the need of, and time penalty associated with, forcing passengers to make a mode shift.
- Enhancing bus lanes, including bus right-of-way will not prevent the use of light rail and advanced guided buses in the future. The rearrangement of the existing road space and improvements needed to create a busway are also needed for a light rail system or the guided bus system of the future. In this way, the busway creates an interim investment that could be upgraded in future years to meet the needs of future generations.
- Although buses provide a lower capacity than light rail, they are more suited to meeting the present passenger numbers in Wellington.
- Light rail is likely to be more viable than buses if more ambitious growth targets were planned for at the growth node in Newtown. The return on the investment for a light rail system would be increased if future growth was concentrated at Newtown rather than splitting the growth between Newtown and Kilbirnie.
- Buses are cheaper, as they do not require the additional expense of tracks, control systems, light rail vehicles, enhanced intermodal transfer stations, maintenance and storage areas.
- As the doors of conventional buses are always located on the kerb side, buses are not as well suited as light rail in operating along the median or in contra-flow with island platforms. In these situations, buses require additional road space for multiple platforms and sufficient width to ensure pedestrians are separated from other vehicles.
- The busway will change the existing street-scape, may require adjustment to the existing one-way system, will restrict some existing traffic movements and will limit access by service vehicles to some parts of streets within the CBD.
- Construction of the busway needs to be undertaken in conjunction with improvement to the street-scape, particularly in high pedestrian areas and within retail corridors, adding to the cost of the project.
- Diesel buses are noisy and create air pollution; this is particularly an issue within high pedestrian areas and retail corridors within the Wellington CBD.

- Conventional mechanical guided bus systems create significant barriers for pedestrians and are not suited along the corridor passing through the CBD. Electronically guided buses may become a viable option in future years.
- In the future, a new generation of buses are likely to exhibit many of the same qualities as light rail system, like that shown in Figure 7.9. Such buses are not only likely to offer similar carrying capacity and dwell times as light rail but, unlike light rail, penetrate the lower density suburbs by travelling on standard carriageways.

Figure 7.9: - Future Generation of Buses

http://www.isecorp.com/gallery/albums/Wright-StreetCar-BRT/wright_streetcar_brt_red_bg.jpg

7.4 Light Rail System

Light rail is able to move a larger number of passengers per hour than a bus based system, even with the addition of a right-of-way in the form of a busway or bus lanes. Accordingly, light rail is required to support areas of high urban density, which generate large numbers of passengers at a limited number of stops.

Although light rail does share the same road space as general vehicles in many European cities as it does in Melbourne and Christchurch, often this arrangement is historical and has resulted from upgrading the tramways constructed at the turn of the century before the motor car was popularised. Creating a safe, reliable and efficient light rail system within CBD area of Wellington, where there are also large number of pedestrians, would best be achieved through providing light rail with its own right-of-way as proposed for buses.

Light rail is more expensive than a bus based system, requiring the additional expense of tracks, over head power wires and control systems. This infrastructure alone could cost between $15 to $30 million between the railway station and Newtown. However, there is also the additional cost of the light rail vehicles themselves, the need to provide enhanced inter-modal transfer stations, as well as providing specialised maintenance and storage areas. The ideal location for the storage and maintenance area is in Newtown, and land near the tracks would need to be acquired for this.

A key issue associated with the light rail option for the passenger transport corridor serving the Newtown growth node is whether light rail is provided between the growth node and the CBD at the exclusion of buses or whether buses are also allowed to operate. Of course, there is no physical reason to prevent buses and light rail operating along the same right-of-way, although trolley buses create a complication in terms of having a compatible overhead wiring system for power. And buses could be excluded from accessing the high speed transport corridor but be required to operate along slower parallel routes (like Taranaki Street). A question is not which route that buses operate, but whether buses are allowed to operate at all.

If light rail is given exclusive operational rights between the CBD and the growth node, then this will require bus passengers to transfer at Newtown and possibly Courtenay Place. This maximises passenger numbers and the return on investment of the light rail system. It also improves overall passenger transport efficiency by removing service duplication.

However, it may come at a cost in terms of reducing overall passenger transport patronage. Forcing transfers at Newtown may impose a time penalty making a journey by passenger transport less attractive unless headways of only 2 to 5 minutes are provided. Forcing transfers between bus and light rail at Courtenay Place is unlikely to be attractive given the short distance between the CBD and Courtenay Place. An important strategy for reducing the attractiveness of transfers between bus and light rail and heavy rail and light rail is integrated ticketing[88].'

Key Issues: -

- A light rail passenger transport system is more likely to influence land use at Newtown and encourage higher-density development compared to a bus based system.
- Light rail is seen as a more permanent passenger transport investment by developers, encouraging them to make longer term development commitments adjacent to the corridor.
- Light rail offers a step change in the quality of passenger transport provided for Wellington.
- Light rail carries more passengers than buses. This reduces the number of vehicles using the passenger transport corridor which in turn improves pedestrian amenity and reduces impacts on other vehicles at intersections.
- Light rail and conventional buses can run within the same corridor. However, it will be difficult to run standard light rail and trolley buses along the same carriageway, as the pantograph used by light rail to collect electric power from overhead lines is different from the poles used by trolley buses. Light rail could be modified to use the same power collector system as trolley buses, but this would be at the expense of reduced reliability of light rail and greater visual impacts.
- The most efficient and safe operation of modern light rail is achieved when it is separated from other vehicles; and while pedestrians do not need to be separated from light rail, there needs to

[88] _______"What Light Rail can do for Cities, A review of Evidence, Davies Gleave for Passenger Transport Executive Group, Feb 2005, page 20.

sufficient additional space, in the form of a wide footpath, for pedestrian movements. Separation increases the cost.

- As light rail is guided and requires fewer vehicles to carry the same number of passengers per hour, they are safer to operate in close proximity to pedestrians, including retail corridors.
- They use modern air-conditioned vehicles which are perceived by users as providing a higher quality service than buses, potentially increasing the overall mode share enjoyed by passenger transport.
- As light rail is guided, they are able to stop at platforms which are level with the vehicle floor. This together with the use of multiple doors, significantly decrease loading and unloading times at stops compared to conventional buses.
- If passengers are allowed to enter at any door, additional staff are required for ticket collection and fare enforcement[89].
- The introduction of light rail will change the existing street-scape, may require adjustment to the existing one-way system, will restrict some existing traffic movements and will limit access by service vehicles to some parts of streets within the CBD.

Figure 7.10: -Street-scape improvements carried out in-conjunction with light rail
Karlsruhe

- Light rail is typically installed in conjunction with improvement to the street-scape, particularly in high pedestrian areas and retail corridors, which while desirable, will significantly increase the cost (Figure 7.10).

89 Unless an honesty system operates as it does in Melbourne, where there is about 20% fare avoidance.

- Light rail is more expensive to maintain than a bus fleet, requiring specialist equipment and maintenance facilities and the additional cost of maintaining the track and overhead infrastructure and power system.
- Electrolysis caused by stray return currents can corrode underground services.
- Light rail can be noisy, although this can be reduced by installing a rubber boot around the track[90] at additional cost (Figure 7.11).
- The overhead power wires create visual impacts, although this can be mitigated with modern pantograph design (but potentially excluding trolley buses along the same corridor) (refer to Figure 7.12).
- The gauge of the light rail system should be the same as heavy rail (1067mm) so as to enable integration in future years with heavy rail to Johnsonville and the Hutt Valley.

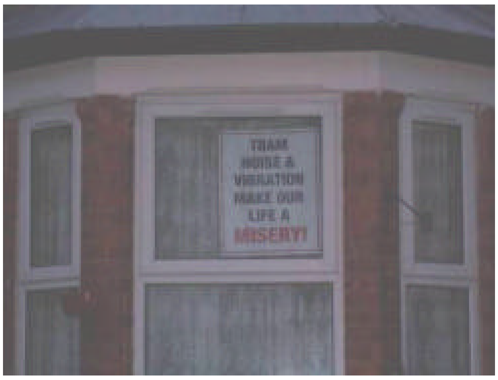


Figure 7.11: - Residents express concern about the noise of Nottingham's light rail.

Older style heavy overhead wiring, Melbourne.

Modern light and unobtrusive overhead wiring, Orleans.

Figure 7.12: -Visual impacts of wires

7.5 Other People Movers

The Project Team received a presentation from the promoters[91] of a small automatic pod for the movement of people. Each driverless pod, carrying a few people and following a fixed route, would transport people along a guide-way to their destination. This is but one of a number of new and

90 Steel rail guided transport generate noise especially on sharp corners where flanges contact rail head and produce high pitched 'screaming' type noise. This is likely to be an important issue with the Golden Mile route within the CBD where there are many sharp corners. Installing a rubber boot dampens the ability of the rail to resonate and generate noise.

91 Reading Projects promoted a personal rapid transport system based on the ULTra vehicle developed as a research vehicle in Bristol University.

futuristic passenger transport systems that are at varying stages of investigation or development around the world[92]. Key features of many of these systems is that they are fully automated (meaning they avoid the cost of a driver) and they are very frequent (perhaps supporting a headways of a number of seconds rather than minutes). Certainly, both of these features are key elements to the future generation of passenger transport systems, especially if they are to seriously compete with the private motorcar[93].

However, there are a number of issues associated with these types of systems that make them unlikely to be a feasible option for meeting the transportation needs of Wellington and other cities, certainly at this time.

- Because the systems are a fully automated, driverless system, they will need to be fully separated from other vehicles and, even more importantly, pedestrians. This means that in an urban environment, these systems will need to be elevated like the mono rail in Sydney creating adverse visual impacts and creating access problems, or located below ground in a tunnel[94], which is very costly and not ideal for personal security and accessibility.
- Because the routes are fixed, they are a more suitable transport solution for connecting a limited number of high people generators (like the domestic and international airport terminals) than Wellington's more dispersed and lower density urban form.
- The technology is not proven, creating significant cost and operational risks and the strong likelihood that the system will operate more as a tourist "Disney" ride rather than a serious people mover that will help resolve our transport issues.
- Unproven capacity, with the likely number to be significantly less than conventional and proven bus and light rail type systems.

92 Sky Cabs Limited (Auckland) have, for example, been prompting a mono rail proposal for Auckland

93 Wayne Stewart, "Society & Transport, Implications of achieving sustainable solutions", Proceedings towards Sustainable Land Transport, Wellington, November 2005

94 They could only be located at ground level if there was no interaction with other vehicles and the route could be separated from pedestrians with barriers, which in itself creates significant barriers (severance) for pedestrians: a very undesirable feature for a walk able city like Wellington.

8 Description of other Passenger Transport initiatives

8.1 Overview

In this section, we discuss a number of other initiatives for improving the bus passenger transport, in addition to the passenger transport corridor serving the growth nodes.

8.2 Extending the Passenger Transport Corridor to the North

Wellington City's growth spine extends from Johnsonville to Newtown and Kilbirnie. A separate study[95] has been undertaken to investigate the preferred transport corridor and mode for serving Johnsonville to the Railway Station. During this study, it was decided to retain heavy rail.

This decision is likely to increase bus patronage, especially to the north-western suburbs. Johnsonville is only 7km from the CBD, and this relatively short distance together with headways of only 10 minutes will not make transfers from bus to rail attractive, especially for those people living more than an 800m walk to the station. This, together with the number of buses using Hutt Road (Figure 3.20), suggests that the passenger transport corridor serving the growth nodes in Newtown and Kilbirnie could be extended from the railway station north along Hutt Road.

This extension is shown in Figure 6.2 and would require enhancements along Hutt Road and Thorndon Quay, including: -

- Providing bus lanes and pre-signals at the intersection of Ngauranga Gorge and Hutt Road and Kaiwharawhara Road and Hutt Road.
- Safeguarding space along Hutt Road for the provision of future bus lanes[96].
- Signals or intersection improvements at the intersection between Tinakori Road and Hutt Road.
- Providing bus lanes along Thorndon Quay, perhaps by modifying existing parking.

8.3 Extending Passenger Transport Corridor to the Airport

The airport is seen by many as a significant people generator, being the source of a number of trips between the airport and the CBD. To improve the connection between the airport and the CBD, there is the opportunity to extend the rapid transit from Kilbirnie to the airport, most likely along Cobham Drive. However, it unlikely that the airport would generate sufficient patronage to support a high quality passenger transport service like light rail.

Existing situation: - An existing bus service operates from the airport to the CBD and onto the Hutt Valley. This service does not provide a direct link to the CBD, but travels through the suburbs of

95 SKM; "North-Wellington Public Transport Study, Technical Evaluation Report, November 2006.

96 Ideally, these bus lanes should be either constructed or safeguarded for future construction at the same time as the four lanning of SH1 from Ngauranga Gorge to Aotea Quay, as this project is expected to reduce traffic using Hutt Road by about 40% (over 750vph reduction for year 2016 was predicted using Wellington's Strategic Transport Model)

Rongotai, Kilbirnie and Hataitai before reaching the CBD. A 30 minute bus service is provided at peak time, serving an estimated 30 to 60 people per hour. Taxis have a more significant role than buses, moving 400 to 500 people per hour[97].

Buses also serve the suburbs to the south-east beyond the Airport. Beyond Troy Street there are 30 buses per hour in the morning peak and 20 in the evening peak, meaning another 500 people are potential customers for a light rail service if they were all forced to undertake a mode transfer at the airport.

Predicted Passenger Numbers: - As shown in Table 7.2, almost no passengers were predicted by the GWRC Strategic Transport Model to use a light rail connection to the airport. A light rail service to the airport is unlikely to generate a significant mode shift from the private motorcar, given that the majority of car users would be from the lower density suburbs. The GWRC Strategic Transport Model will not estimate the mode shift from taxi passengers to light rail. However, if we assume a 30% mode shift from taxi, this would be sufficient to justify a light rail service of only 60 minute headways: this is not frequent enough to encourage a mode transfer from taxis.

Sydney and Brisbane have both invested in a heavy rail link to the airport. It is understood that in both cases, passenger numbers from the airport have been much lower than expected.

Accordingly, a high quality passenger transport service to the airport is unlikely to be viable without very significant ongoing operational subsidy and is therefore not recommended.

Airport check-in: - Transit New Zealand asked us to consider the option of providing a facility for allowing passengers to check-in at the CBD (including luggage), perhaps near or at the high quality passenger transport interchange or super-stop. We suspect that the key attraction of such a check-in-facility is that passengers would not need to manage their luggage while using the passenger transport: which may present a barrier for some passengers. However, to be effective in competing with the convenience of a taxi, the check-in-facility would need to be within short walking distance to where passengers work or visit; probably less than 50m if luggage is involved. Even within a dense urban area of the CBD, it is unlikely that a single check-in-facility can be located to achieve this. A significant consideration for such an idea is whether the airport companies would support such a proposal, which appears to impose additional costs on them with little tangible benefits, let alone any additional security associated with luggage management.

8.4 Other Initiatives for Buses

A number of other important links have been identified as benefiting from proposed interventions, as summarised in Table 8.1.

97 An Opus traffic survey conducted on 11 May 2006 between 7.00am and 9.00am and between 3.00pm to 6.00pm counted 163 taxis per hour north-bound in am peak and 204 taxis south-bound in the pm peak passing through the Mt Victoria Tunnel. Assuming that an equal number of Taxis use alternative routes like the Parade to the CBD and that there are 1.2 passengers per taxi, then there is an estimated potential pool of 400 to 500 passengers per hour at peak time. This figure is similar to the number estimated in Section 3.9, assuming that 1 hour peak trips is about 10% of the total daily trips.

A number of additional strategic interventions or concepts have been identified as being applicable to the delivery of schemes identified above and network wide in order to achieve improved reliability, reduced journey times, increased patronage and bus capacity. These are summarised in Table 8.2.

8.5 Other Issues

Given that Wellington residents are less likely to use a car compared with other NZ cities, it is worth noting the important role that taxis have in the City. Taxis can be more efficient than the private motor car in that they are better able to accommodate trip-chaining and reducing the need for car parking and traffic movements associated with finding a car park. Given the complementary role that taxis have with passenger transport and the desire to limit the number of private vehicles entering the CBD area and reducing the walk-ability, taxis (certainly those with multiple occupancies) could be permitted to use bus lanes.

Table 8.1: Other Bus Passenger Transport Enhancements

Cobham Drive:	Bus lanes either direction and pre-signals/slip roads on the approach to the Troy Street and Calabar Drive roundabouts in an attempt to improve capacity and management for buses and general traffic.
Mulgrave Street:	Providing bus pre-signals to access central bus lane between Tinakori Road and Mulgrave Street.
Molesworth Street, Mulgrave Street and Bowen Street:	Bus lanes on approaches to signals and other delay points.
Willis Street and Victoria Street (south of Manners Street):	A contra flow bus lane has been considered, however the bus frequency and the current level of delay is unlikely to justify such a proposal. Conversion of the current two way links to create a one way pair for all traffic with bus lanes and parking restrictions, thus reducing conflict and improving capacity for SH1 (Inner City Bypass) and other cross roads.
Taranaki Street:	Bus lanes with turning and parking restrictions at delay points.
Direct Terrace Links:	Bus route modification to access The Terrace via Ghuznee Street or Boulcott Street to reduce current journey via Bowen Street.
CBD to Airport Strategic Link:	Airport link and associated bus priority provision between Courtney Place and the Airport – could include use of existing / future improved SH1 and bus lanes on Cobham Drive.
Railway Station to Courtney Place High Frequency Link:	The introduction of a new or modified (City Circular) route to provide a high frequency, high quality link between the Railway Station and Courtney Place, with a limited number of stops at strategic locations and key interchange points (super stops). In the short term, this route could use the proposed Golden Mile busway and strategic transport spine, running at a high frequency and stopping at Willis Street and Courtney Place only. Long term the route could be replaced by light rail or the relocation of the route to operate on Customhouse Quay, Jervois Quay and Cable Street should bus capacity become a problem on the Golden Mile. Articulated buses could be used in order to replicate the demands associated with the high number of rail passengers arriving at any one time.

Table 8.2: Other Bus Passenger Transport Interventions
• Signal detection and bus activation at signals. • Signal Management (SCATS) to link groupings and key bus corridors. • GPS tracking, detection and route management. • Bus stop capacity assessment and upgrade to improve current capacity and operational conditions (avoid queuing for bus stop). • Consistent parking and loading strategy for key bus corridors. • Enforcement strategy to be consistent with the parking, loading, traffic management and bus priority measures, including CCTV enforcement and compliance targets. • Electronic ticketing on buses.

9 Description of Heavy Rail Options

9.1 Current Situation

The existing rail station is located at one end and to the north of the CBD, forcing a significant proportion of the rail passengers to either walk between their place of employment and the railway station or to make a mode transfer to bus: both of which impose a significant time penalty making rail less attractive to other modes, particularly the car and bus. To remove this time penalty and to make rail more attractive, the idea of extending heavy rail into the CBD has been investigated.

Heavy rail, like major roading arterials, create significant severance. Therefore the only practical option for extending heavy rail into the CBD is to locate it in a tunnel[98].

9.2 Option R1: Extending Heavy Rail along Waterfront in a Tunnel

Description: - A previous study[99] has investigated the likely cost of extending heavy rail within a cut and cover tunnel along the waterfront to connect the railway station with Courtenay Place. The proposed route is shown in Figure 9.1. A typical cross section assuming double tracking is shown in Figure 9.2. Two stations have been provided: one at Queens Wharf and the other at Taranaki Street (in addition to a connection to the existing railway station).

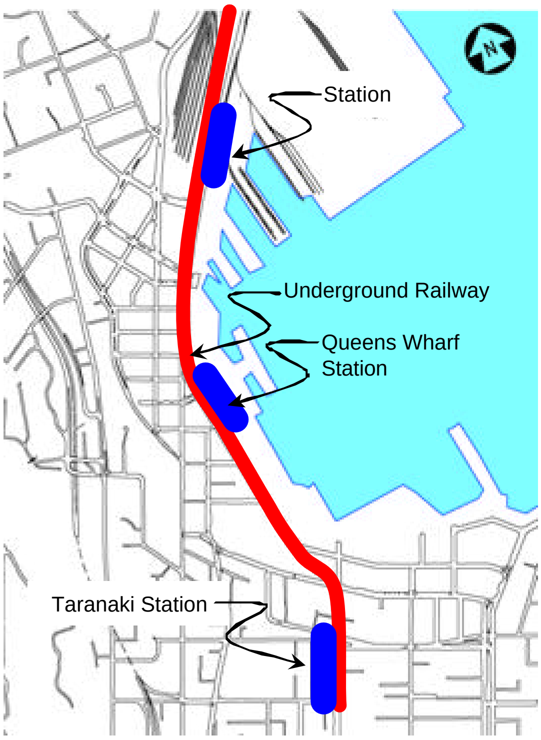


Figure 9.1: -Option R1

Key Issues: -

- Without further more detailed study, the highly variable ground conditions along the waterfront make predicting a suitable construction methodology uncertain and this increases the cost uncertainty. Furthermore, high groundwater levels will impose uplift on the tunnel structure. This means that the excavation will require dewatering to

98 While it is feasible to minimise severance by locating heavy rail on an elevated structure, this is likely to create unacceptable noise and visual impacts: even the Sky Train in Vancouver is located underground within the CBD.

99 Opus, Wellington Underground Rail: Railway Station to Taranaki Street Preliminary Outline Cost Report, Greater Wellington Regional Council, June 2005.

enable construction and together with the requirement to not interrupt any natural groundwater flows to the sea, will create further construction cost uncertainty for the tunnel. There will also be costs of minimising the risk of liquefaction during an earthquake.

- Option R1 proposes double tracking and a station at Taranaki Street operates as a cul-de-sac, in a similar way to Britomart Transport Station in Auckland. This limitation will impose restrictions on the number of passenger trains, and hence the headway that is able to be served by this CBD extension. However, with the use of appropriate signalling and enhanced train management, such an arrangement should be able to provide sufficient headway for all four rail lines, at least in the medium planning horizon.

- Construction of the cut and cover tunnel would create significant disruption to traffic using the heavily congested waterfront route and the closure (albeit temporarily) as up to four of the six traffic lanes could be required during construction. Closures of this severity are unlikely to be feasible until after additional capacity has been provided elsewhere in the network, like duplication of the Terrace Tunnel.

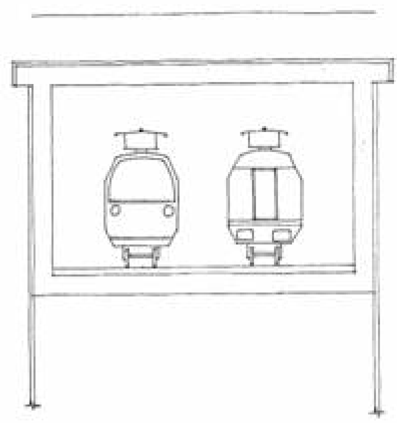


Figure 9.2: -Option R1: Typical Cross Section Through Tunnel

10 Overview of Options for General Vehicles

10.1 Overview

In the following chapters we present options for improving the highway network for general vehicles. Options are presented for the following key areas: -

- Chapter 11 Options for SH1 Ngauranga Interchange to Aotea Quay 8 laning.
- Chapter 12 Options for increasing the capacity of the Terrace Tunnel.
- Chapter 13 Options for reducing congestion at the Basin Reserve and increasing the capacity of the Mount Victoria Tunnel.
- Chapter 14 Options for increasing the capacity of Ruahine Street and Wellington Road.
- Chapter 15 Options for increasing the capacity of Wallace Street as a major arterial, which will carry additional vehicles diverted from Adelaide Road while Adelaide Road will become a passenger transport corridor.

Options for reducing the traffic capacity of the Waterfront route are discussed in Chapter 16 as part of an overall strategy to improve pedestrian movements and to encourage walking and cycling (Chapter 17) as an alternative to the private motorcar.

11 Description of SH1 Ngauranga Interchange to Aotea Quay 8 laning Options

11.1 Current Situation

SH1 south of Ngauranga Interchange carries the joint traffic to/from the main arterial routes north of the capital along SH1 and SH2. As such, traffic flows along this particular section of motorway are high with an AADT of 30,000 vehicles per day in each direction.

11.2 Existing Issues

- The tidal nature of the traffic flows associated with commuters travelling to and from the CBD result in congestion both southbound during the morning peak period and northbound in the evening peak.
- This congestion is exacerbated in the morning peak as the two southbound lanes from both SH1 and SH2 merge into only three lanes.
- Inadequate taper lengths exist for on and off ramps at Ngauranga and Aotea
- The high traffic flows and congestion may encourage some motorists to use the adjacent Hutt Road route, particularly during the peak periods.

11.3 Overview of Options

The 8-laning of State Highway 1 between the Ngauranga Interchange to the Aotea Quay on/off ramps involves an increase in the number of lanes in each direction from three to four. Figure 11.1 shows the location for the four laning. Key features for all options proposed for increasing the capacity of this section of motorway include:

- Widening of the existing motorway is restricted given the proximity of the North Island Main Trunk Railway Line on the western side of the motorway and the harbour on the eastern side.
- Providing extra capacity on the motorway may reduce traffic flows on the adjacent Hutt Road that runs parallel to SH1, providing an opportunity to reallocate existing road space from general vehicle use to provide dedicated right-of way for bus passenger transport.
- In order to provide a fourth lane southbound on the Thorndon Overbridge, a new bridging structure will need to be constructed adjacent to the current bridge which will become the new off-ramp for Aotea Quay. Because the existing Thorndon Overbridge is supported on single column piers with umbrella pier caps, it is unlikely to be feasible to strengthen the existing substructure to withstand the increased eccentric gravity loads and increased seismic load. Therefore, it is more likely that a separate bridge structure is required extending from Kaiwharawhara to Aotea Quay over the Ferry Terminal and railway lines.
- The off-ramp may need to have a different horizontal and vertical alignment from the existing Thorndon Overbridge due to several constraints, including the need to avoid the gangways to Ferry, the existing infrastructure associated with the Ferry Terminal, railway lines and a buried old concrete sea wall.

- The southbound bridge structure may impact on the cement silo, which is likely to be required to be removed.
- For all options, four-lanes will be available in both peak and inter-peak and in each direction along the Thorndon Overbridge.
- The new bridge structure will be above the existing ferry terminal and railway line and this will create a number of construction challenges and increases the cost uncertainty.
- For all options, the Aotea off-ramp may need to be closed during key stages of the construction of the new extended off-ramp.
- Providing a fourth lane creates the opportunity to restrict the use of one of the four-lanes during peak hour, such as a high occupancy vehicle lane.

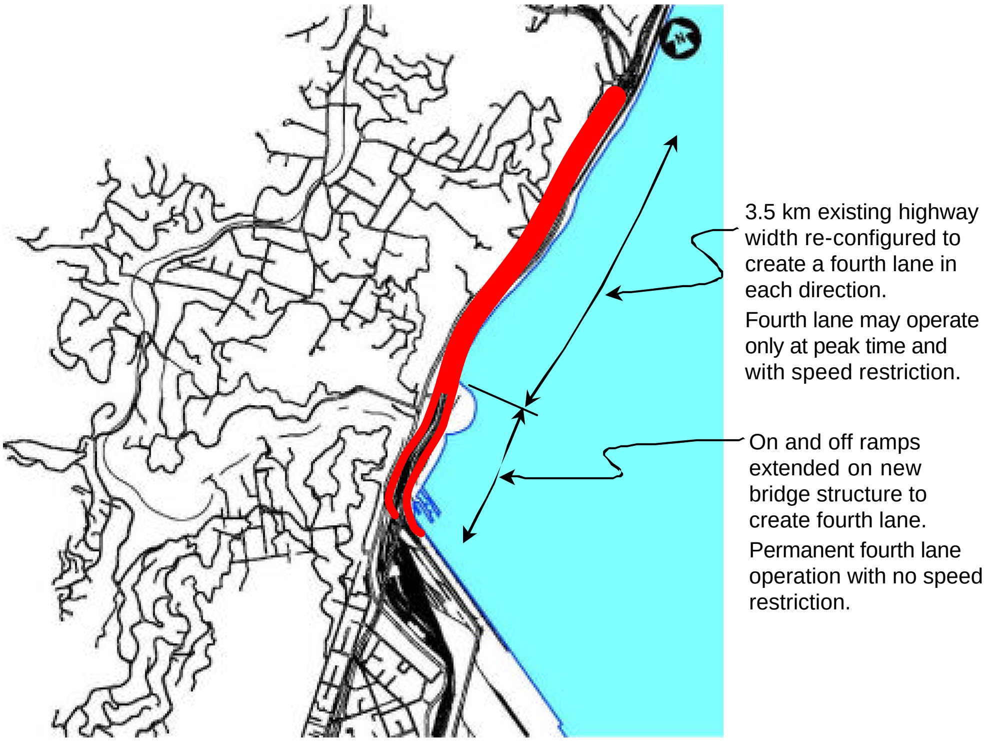


Figure 11.1 –Option A Four Laning

Given the need to provide two off-ramps along the section of the Thorndon Overbridge and need to improve the length of the merge at SH1 and SH2, the remaining length of highway is considered to be too short to justify a tidal flow arrangement.

In order to achieve the four-lanes in each direction between the Ngauranga and the Thorndon Overbridge, a distance of 3.5 km, three options have been identified:

11.4 Option A1: Utilisation of existing Shoulders as an Additional Traffic Lane

Description: Option A1 reduces the existing traffic lane widths from about 3.7m to 3.5m, but retains the existing median. It uses the existing 3.25m shoulder (where provided) as the fourth lane, but only during peak time. This cross-section is shown in Figure 11.2, and is provided in both directions.

Key Issues

- The additional fourth lane only operates during the peak periods in the direction of travel i.e. four-lanes southbound in the morning peak reverting to three lanes for the rest of the day; and vice versa for the evening northbound peak.
- In periods outside the peak periods, the fourth lane will continue to act as a shoulder.
- 80km/h speed limit to be in operation during the periods when four-lanes of traffic are operational. Outside peak periods, three lanes will operate and the legal speed will return to 100km/hr.
- Gantries will be provided for ATMS signs which will indicate permitted lanes and the prevailing speed limit for both directions of traffic.
- When four-lanes of traffic are in operation, there will be no separate roadside shoulder. Two separate lay-bys in each direction will be provided to allow vehicles to coast to a safe location in the event of a breakdown.
- This option can be accommodated within the existing highway carriageway.
- This option offers the highest risk of delays to other vehicles when a vehicle is required to stop due to a break-down or other emergency.
- A remote surveillance system could be implemented to enable early detection of breakdowns and minimise delays.

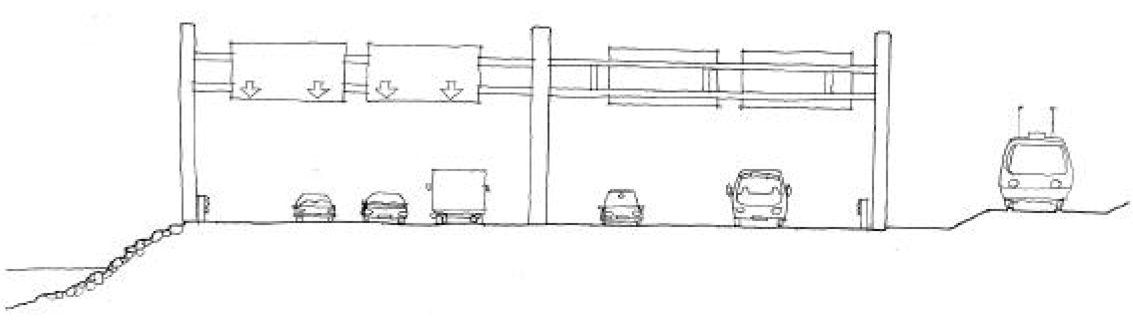


Figure 11.2 –Option A1 Typical Cross-Section

11.5 Option A2a): Reduced traffic lane and shoulder widths

Description: Option A2a) reduces the existing traffic lane widths from about 3.7m to 3.3m (retains existing median), provides an additional 3.3m wide fourth traffic lane and provides a 2.0m wide shoulder for emergency use.

Key Issues: -

- While a 2m wide shoulder for break-downs will typically be wide enough to accommodate a stopped vehicle, it is unlikely to be sufficient to allow a driver to open their door safely and is also likely affect traffic speeds and volumes in adjacent lanes. The narrow shoulder may give a false sense of security to a person leaving the vehicle.

- The reduced traffic lane widths leave less scope for driver error and may lead to increased crash rate.
- The four-lanes of traffic and the 80km/h speed limit operate during both peak and inter–peak periods.
- While widening needed for this lane arrangement can generally be accommodated within the existing road reserve, some reclamation work may be required to provide the structural support for the widening.

11.6 Option A2b): Reduced traffic lane, median and shoulder widths

Description: Option A2b) reduces the existing traffic lane widths from about 3.7m to 3.3m, provides an additional 3.3m wide traffic lane, reduces the median from 3.8m to 2.6m and provides a narrow 1.4m shoulder.

Key Issues: -

- A 1.4m wide shoulder for break-downs is not wide enough to accommodate a stopped vehicle which will encroach into the adjacent lane. A stopped vehicle is likely to adversely affect traffic flows and could be a significant crash risk.
- The reduced traffic lane widths leave less scope for driver error and may have road safety implications.
- The four-lanes of traffic and the 80km/h speed limit operate during both peak and inter–peak periods.
- This option requires the existing median barrier to be replaced with a new concrete barrier installed with associated drainage work.
- This option can be carried out within the existing motorway boundary.

12 Terrace Tunnel

Table 12.1: Morning Peak Traffic Flows through the Terrace Tunnel

(Weekday Average hourly flows)

Direction	Vehicles per hour
Northbound	1672
Southbound	1409

Source Transit NZ, February 2006

Current Situation: - Southbound traffic flows along State Highway 1 experience severe congestion problems, particularly during the morning peak period as commuter traffic heads towards (and through) the City. Congestion is exacerbated by the reduction in number of lanes southbound through the Terrace Tunnel which is limited to a single lane. This reduction in capacity for southbound vehicles encourages traffic to exit the motorway prior to the Terrace Tunnel at one of the other interchanges further north at Aotea Quay, Murphy Street, Hawkestone Street or The Terrace. Many of the vehicles using Aotea Quay use the waterfront route to pass through the CBD. These high traffic volumes create a sense of severance between the CBD and the waterfront, particularly at peak times.

Existing traffic flows through the tunnel are summarised in Table 12.1.

Existing Issues

- Roads through the central city area are used by traffic seeking to pass through the CBD rather than accessing the CBD itself as a destination. The single southbound lane on SH1 at the Terrace Tunnel acts as a bottleneck, controlling southbound traffic and will consequently limit the benefits of the Inner City Bypass that is currently being completed.
- The provision of a second southbound lane through the Terrace Tunnel will ensure that the state highway is the main arterial route for traffic passing through the city or wishing to access the southern and eastern areas of the CBD. The additional southbound capacity will encourage the re-distribution of traffic that currently exits the urban motorway north of the CBD, reducing traffic on local roads and permitting local road space to be either reallocated to passenger transport or other non-motorised road users such as enhanced pedestrian or cycling facilities. It has the potential to significantly reduce traffic flows along the waterfront, creating the opportunity to enhance pedestrian connections between the CBD and the harbour.
- In the morning peak, traffic flows through the Terrace Tunnel are about 1650 vehicles per hour northbound and about 1400 vehicles per hour southbound. These flows are unlikely to make a tidal flow arrangement through the tunnel attractive. In the evening peak about 2250 vehicles use the two northbound lanes per hour.

Overview of Options: - In order to allow the state highway to serve its primary purpose, additional southbound capacity is required through the Terrace Tunnel in order to match the adjacent capacity particularly the two-lanes of traffic to the south of the City as part of the Inner City Bypass. The existing Terrace Tunnel is not wide enough to accommodate an additional lane and therefore increased capacity can only be provided through either a new tunnel or traffic management of the existing road space. It should be noted that the original Terrace Tunnel design envisaged a duplicate tunnel on the eastern side of the existing tunnel; and as such, some provision was planned for as part of the original design and construction, albeit based on a four-lane urban motorway standard between Willis Street and Buckle Street.

There are several options for increasing the southbound capacity through the Terrace Tunnel, including the construction of a second tunnel (refer to Figure 12.1) and using a tidal flow arrangement.

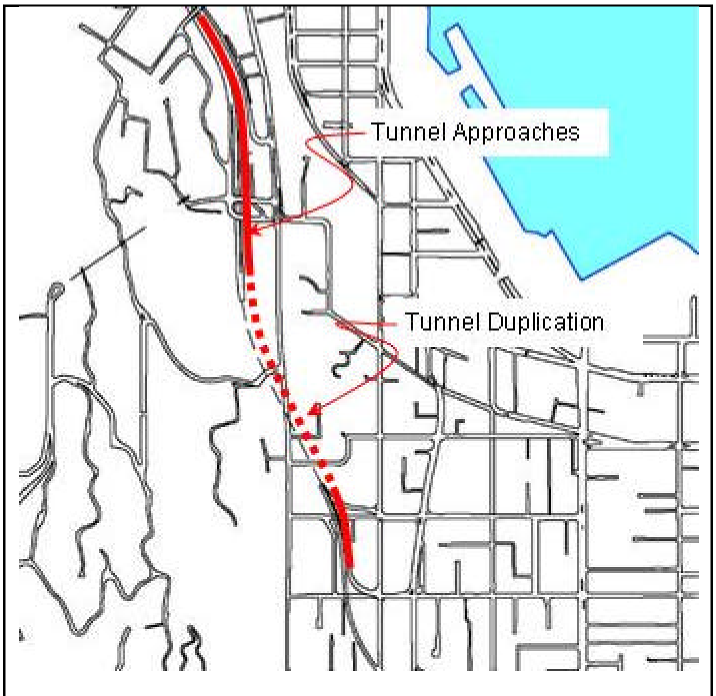


Figure 12.1 Terrace Tunnel Duplication

12.1 Option T1: Terrace Tunnel Tidal Flow

Description: - Option T1 increases southbound capacity through the use of a 'reversible' traffic lane which can be used in either direction of travel depending upon the time of day. As such, two-lanes of traffic are given over to southbound vehicles in the morning peak period (with the remaining lane northbound) and vice versa for the evening peak hour as at present.

Key Issues: -

- Northbound traffic flows during the morning peak will suffer from a lower level of service with the reallocation of northbound road space through the Tunnel. The present northbound morning peak hour flows exceed the single lane southbound traffic flow that is operating at or near capacity. Hence, the reduction of northbound traffic lanes in the morning peak would re-distribute traffic from the Terrace Tunnel onto alternative routes through the CBD, increasing travel time and distance and making these alternative routes less attractive for passenger transport and pedestrians.
- The operation of a tidal flow system to manage traffic within the existing road space requires clear guidance to road users as to the correct traffic lanes to use. To maximise safety, and to avoid head-on collisions between oncoming vehicles, a moveable physical barrier between the two streams of traffic is preferred along with variable message signs and appropriate road

markings. Unfortunately, the existing tunnel width is such that there is insufficient room available to provide a physical barrier without reducing traffic lane widths to only 3 metres[100].

- Given the limited space, and associated safety issues with the narrow lanes and limited separation, a non-barrier option is proposed involving extensive overhead variable message signs and illuminated pavement markers to denote usable traffic lanes.
- Whilst this approach has been used in NZ[101] and overseas, there are likely to be safety concerns associated with such a non-segregated system, particularly given the combination of the radius and grade change within the Terrace Tunnel and the complications of the Vivian Street off-ramp and Ghuznee Street Bridge at the south portal.

12.2 Option T2: Terrace Tunnel Duplication

Description: - Duplication of the existing Tunnel to provide two southbound lanes plus nominal shoulders with the existing tunnel reverting to two-lanes northbound plus shoulders. Figure 12.2 shows the typical cross-section.

Key Issues

- This option follows the original planned layout with a slight modification at the south portal to tie into the new Inner City Bypass at Vivian Street prior to the Willis Street traffic signals.
- The duplication proposed assumes using the substructure and the small section of superstructure that has previously been built at Shell Gully which is at a lower level compared to the northbound carriageway. Some modification to the lane drop at The Terrace off-ramp will be required to tie-in with this duplication with the new additional carriageway on the northern approach to the new tunnel portal will be required.
- At the southern portal of the 2nd tunnel, the southbound carriageway will pass under Ghuznee Street and connect to a modified Vivian Street off ramp, modifying this section of the southbound Inner City Bypass between Ghuznee Street and the Willis Street signalised intersection. The existing Ghuznee Street bridge was originally designed to allow for another span to be built at the east end of the bridge, to accommodate the additional lanes needed for the tunnel duplication.
- Pedestrian cross links, connecting within the two tunnels, could be provided at intervals to enhance driver safety in the event of an emergency.
- By removing the southbound lane, the existing tunnel can be remarked to provide improved shoulder widths for northbound vehicles.
- Ground conditions for the duplicate tunnel are not expected to be ideal for tunnelling, and part of the length of the tunnel is likely to include The Terrace 'Fault Zone'.

[100] Needed to provide minimum separation between the traffic lanes and the barrier and the tunnel walls
[101] A similar system operates in Auckland between Panmure and Pakuranga.

- The existing tunnel was constructed with an average cover of only 20m, which is very low for a tunnel with an excavation width of nearly 15m[102]. Given the low cover and poor ground conditions, up to 160mm of subsidence at ground level above the tunnel was experienced when the first tunnel was constructed[103]. Compared with the first tunnel, the second tunnel is expected to have poorer tunnelling conditions, lower cover and greater subsidence. Low cover increases the risk of parts of the tunnel roof collapsing[104]. It has been necessary to include in our indication of cost an item for mitigating the possible effects of subsidence, ranging from compensating property owners, acquiring properties, or temporarily relocating property owners.
- The distance between the first and a second tunnel was designed to provide about 33m (centre to centre)[105]. However, this reduces to about only 23m at the northern portal, which is much less than would be provided in ideal situations. While the existing tunnel was designed to accommodate the additional pressures that the second tunnel would impose given its close proximity, dealing with the effects of the two tunnels being so close together increases the cost uncertainty.
- The existing tunnel was constructed using a number of headings and stages using a road header, with localised drill and blast techniques where stronger rock conditions were encountered. The second tunnel is too short, and the type of rock is not ideal, for a Tunnel Boring Machine. Careful consideration will need to be given to the support of the tunnel during excavation, given the low cover and highly fractured rock material likely to be encountered, particularly in the fault zone.
- The tunnel will produce large qualities of cut material and unless this can be used in other projects being constructed at the same time, will need to be carted to waste. We have assumed a cartage distance of 20km for our cost indication for the project.
- Retaining walls will be required at the northern and southern portals. Soil nailing looks a feasible option.
- Temporary support will need to be provided to McDonald Crescent and the substation building providing power to the existing tunnel.
- These issues create a number of uncertainties over the design, construction and costing for a duplicate tunnel. Consequently, it is important to acknowledge that the cost of duplicating the tunnel can only be presented as a range of costs at this stage of the investigation. However, the cost uncertainly can be further refined following further more detailed investigation.

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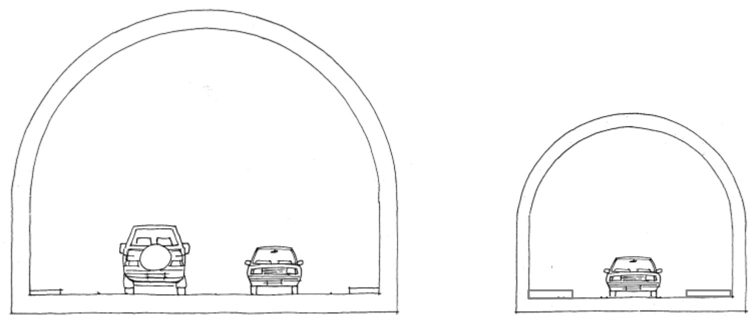
[102] Preston, R.L, Wellington Urban Motorway – The Terrace Tunnel, Engineering Geological Investigations, New Zealand Engineering, 15 August 1975.
[103] Newsome, Brian; ", Wellington Urban Motorway – Construction of the Terrace Tunnel, Transactions of the New Zealand Institution of Engineers Incorporated. Civil Engineering Section, Vol. 8 no. 1/CE, March 1981. P. 17-32.
[104] It is understood that part of the first tunnel collapsed during construction and that concrete was poured into the hole to stabilise the area and allow tunnelling to proceed.
[105] Wilcox, Peter; "Wellington Urban Motorway – The Terrace Tunnel Underground Design, New Zealand Engineering, 15 August 1975.



Option T2 **Option T3a)**

Figure 12.2 - Terrace Tunnel Cross-section for two-lane duplicate tunnel

12.3 Option T3a): Terrace Tunnel Duplication – Additional Single Lane Tunnel

Description: - Rather than provide a two-lane tunnel as proposed for Option T2, Option T3a) provides a single lane tunnel. A single additional northbound lane is provided in this tunnel on the basis that the existing tunnel will continue to operate as it currently does with two-way traffic. In this way, one northbound lane remains in the existing tunnel and an additional lane is provided in an adjacent new tunnel.

Key Issues

- The new single lane tunnel would be about 6.2 metres wide between the edges of the tunnel with a clearance of 5.5m. This is of sufficient width to allow vehicles to pass a broken down vehicle, if it was pushed up against the side of the tunnel.
- Given the limited width available, emergency vehicles may need to access the tunnel from either end.
- The existing carriageway on both approaches to the new tunnel portal can be modified to incorporate the additional single lane.
- This option removes the median barrier just south of Aurora Terrace to allow this configuration to fit into the existing carriageway without need for additional bridging.
- While this option is much cheaper than providing a duplicate two-lane tunnel, it is a non-standard approach with limited access options in case of an emergency compared to the full two-lane option. In addition it retains the existing non-divided opposing carriageways in the existing tunnel, which remains a safety concern.
- Pedestrian cross links, connecting the two tunnels, could be provided at intervals to enhance driver safety during an emergency.
- Because the single lane tunnel is slightly smaller than the two-lane tunnel, subsidence at the surface is likely to be smaller.

- Construction of a single lane tunnel will almost preclude the construction of a two-lane tunnel at a later date, as the tunnel will be very difficult to widen to two-lanes given the very poor ground conditions[106].

12.4 Option T3b: Terrace Tunnel Duplication – Restricted Additional Single Lane Tunnel

Description: Option T3b) is a variation on Option T3a) with the height of the additional single lane tunnel being reduced to provide a single additional northbound lane for small vehicles only (car/van traffic. The existing tunnel will continue to operate as it currently does with two-way traffic and would accommodate all southbound heavy vehicle traffic.

Key Issues

- The single lane Tunnel would be some 6.2 metres wide between the inside linings of the tunnel with a clearance height of 3.5 metres within the tunnel.
- Despite the limited height, access by emergency vehicles would still be possible albeit, as with Option T3a) via either end of the Tunnel.
- This option is expected to be much cheaper than the larger single lane tunnel, but is a non-standard approach will limit access options during an emergency and creates additional operational restriction (and potential confusion) associated with the need to segregate vehicle types.
- Similar to Option T3a, there is no physical barrier between opposing lanes from Aurora Terrace through the existing tunnel to Ghuznee Street.

[106] Construction of a third tunnel is also unlikely to be feasible given the space constraints.

13 Description of Basin Reserve and Mount Victoria Tunnel Options

13.1 Current Situation

With the completion of the Wellington Inner City Bypass, state highway south-east bound traffic travelling between the CBD and the eastern suburbs and the airport has to complete four-90° turns between the end of the by-pass on Vivian Street and Mount Victoria Tunnel, as shown in Figure 13.1. After leaving the Mount Victoria Tunnel, northbound traffic must circulate around the Basin Reserve before making a 90° turn onto Buckle Street, which provides a direct route to the Terrace Tunnel. Traffic has to pass though a number of intersections, the majority of which are signal controlled.

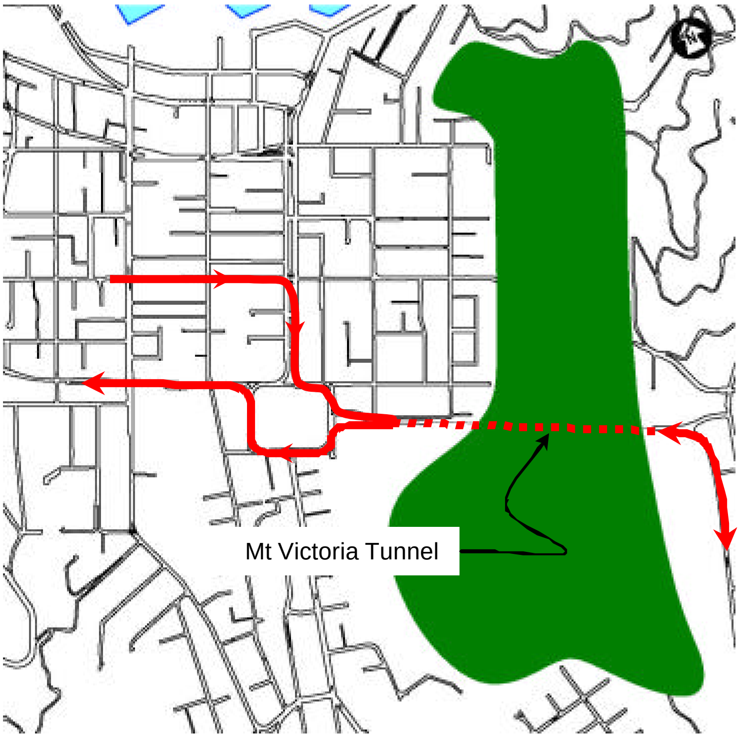


Figure 13.1: -Existing Situation at the Basin Reserve and Mount Victoria Tunnel

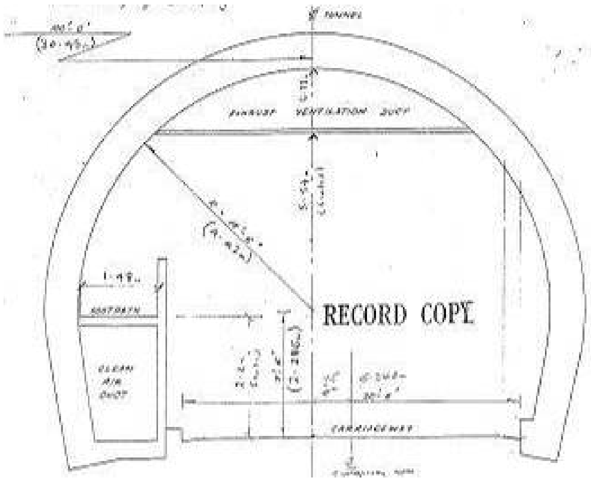
The speed limit is 50km/hr between the Terrace Tunnel and Mount Victoria Tunnel (including along the Inner City Bypass). The speed limit increases on the south-eastern portal of the Mount Victoria Tunnel to 70km/hr along Ruahine Street. Two-lanes for through traffic are provided between the Terrace Tunnel and Mount Victoria Tunnel. Only one lane is provided though Mount Victoria Tunnel and Ruahine Street.

Over 17,000 northbound vehicles use Buckle Street per day while 19,000 vehicles travel southbound along Vivian Street per day. Almost 38,000 vehicles use the Mount Victoria Tunnel – which is quite an achievement given that the tunnel is narrow and only provides one lane in each direction. At peak time, over 1600 vehicles travel in one direction through one of the tunnel lanes per hour. This is well above the theoretical capacity of about 1400[107] vph.

The Mount Victoria Tunnel, completed in 1931, provides only 6.25m between kerbs and a height clearance of approximately 5.5m, as shown in Figure 13.2. A 1.5 m wide elevated footpath located over

[107] NAASRA Guide to Traffic Engineering Practice: Part 2 Roadway capacity, Based on a short length of tunnel, narrow lane widths, no shoulders and 5% heavies.

a ventilation shaft about 2m above pavement level is provided for pedestrians and cyclists. The tunnel is 625m long.



Cross Section

Source: Wellington City Council, plan S/509

East Portal

Figure 13.2: - Mount Victoria Tunnel

13.2 Key Issues

The key issues within this part of the study area include: -

- Southbound vehicles are required to make four-90° turns between the end of the Inner City Bypass and Mount Victoria Tunnel. This indirect route creates traffic conflicts, delays and congestion.
- The limited capacity provided by only having one-lane in each direction and inadequate lane widths within the Mount Victoria Tunnel.
- The lack of amenity provided by the pedestrian/cycle path within the Mount Victoria Tunnel, particularly the poor personal security and inadequate protection from car fumes and noise.
- The intersection at Tuarima Street and Ruahine St at the south-eastern portal of Mount Victoria Tunnel where restricted sight distances, high traffic flows and inadequate merge lengths make right hand turns dangerous.
- Safety and capacity concerns relating to the high traffic flows, weaving and speed around the Basin Reserve.
- Limited access to, and parking associated with, adjacent properties bordering the Basin Reserve due to the high traffic flows.
- Poor pedestrian access to the Basin Reserve, particularly the need for pedestrians to cross significant traffic flows during events at the Basin Reserve.

13.3 Overview of Options

Options developed for this part of the study area improve the connections between the Inner City Bypass and the south-eastern side of Mount Victoria Tunnel. Five options are presented. Some of these options are mutually exclusive of each other while others can be considered working in conjunction with each other. Each option is described in the following sections.

13.4 Option B1: Pirie Tunnel

Description: - Option B1 creates a direct link for one-way Southbound traffic using Vivian Street between the Inner City Bypass and Ruahine St via a new tunnel constructed under Pirie Street and Mount Victoria as shown in Figure 13.3. For Option B1, it is assumed that northbound traffic uses the existing Mount Victoria Tunnel (made one-way) and then around the Basin Reserve using one of the following options: -

- The Basin Reserve, as it operates at present,
- Option B4, or
- Option B5.

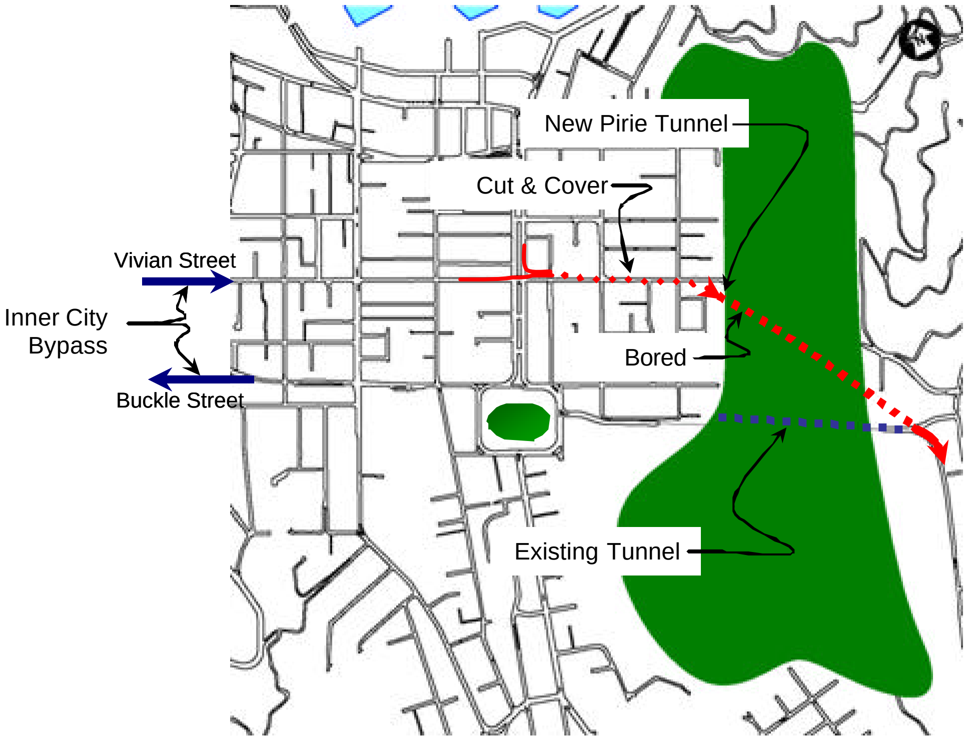


Figure 13.3: -Options B1 Pirie Tunnel
(Southbound Vivian Street Extension through a tunnel along Pirie Street)

Option B1 could have two sub-options for the intersection of Vivian St, Kent and Cambridge Terrace and Pirie Street, as follows:

- Option B1a) keeps the existing at grade signal controlled intersection (although this may operate near capacity in future years).
- Option B1b) provides a single-lane bridge over Kent and Cambridge Terrace providing a fly-over for traffic heading from Vivian Street to the Pirie Tunnel while maintaining a signalised intersection at grade for the remaining traffic movements. A feature that make this an attractive option is the topography as Vivian Street drops as it approaches Kent and Cambridge Terrace, and Pirie Street rises as it heads towards Mount Victoria. This arrangement would not only improve the efficiency for state highway traffic but would also improve travel times for vehicles using the proposed passenger transport corridor along Kent and Cambridge Terrace.

Once the route crosses Kent and Cambridge Terrace, it descends into a trench before entering a tunnel under Pirie Street and Mount Victoria. The Pirie Street portion of the tunnel would be constructed using cut and cover methods, while that section under Mount Victoria will be bored. The total length of this tunnel will be about 1000m of which about 400m will be cut and cover and 600m will be bored. Figure 13.4 shows a typical section through the cut and cover section of the tunnel.

Option B1 will impact on Pirie Street, most significantly during construction. Between 15 and 30 residential properties may need to be acquired, depending on the route adopted. About two-thirds of these residential properties could be reinstated after construction either as new homes or as original reinstated homes. There is some flexibility to the location of the trench and cut and cover tunnel near the bottom of Pirie Street. For the purpose of indicating the likely cost of this option, we have assumed that the new alignment would encroach on the northern side of Pirie Street.

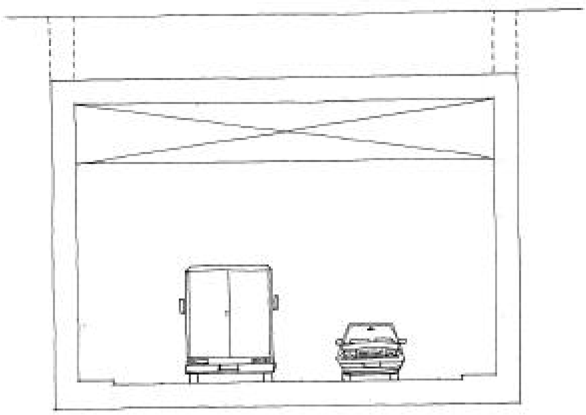


Figure 13.4: - Option B1 Cross Section through Pirie Street Cut and Cover Tunnel

After construction is completed, the Hania Street/Pirie Street can remain open but the connection between Pirie Street and Home Street will need to be closed. Access to Home Street would be reduced to a single connection to Kent Terrace. In order to minimise the number of properties that need to be acquired, it is likely that the short section of Pirie Street between Hania Street and Brougham Street would need to become one-way: either down-hill or uphill. Otherwise, all other connections and traffic movements would be unaffected in the long term.

Key Issues: -

- The road reserve width along Pirie Street is narrow at 15m, although there is a short section between Brougham and Porritt Avenue at 17.5m. This will create a number of challenges during construction, particularly the ability to keep Pirie Street open during construction to pedestrian and vehicle traffic. As the tunnel would be constructed in sections, not all of Pirie Street would be affected at the same time. Nevertheless, given the restricted work site, limited access, need to relocate services and other adverse effects of construction within close proximity to residential properties, those residents immediately adjacent to the area of construction may need to be re-located temporarily. An alternative is to locate the alignment of the cut and cover tunnel under residential properties (moving the alignment either to the north or south of Pirie Street) to enable Pirie Street to remain open during construction of the tunnel. This has greater property impacts, although again only temporary as the residential properties could be either reinstated after construction or a set of new residential properties constructed.

- The Hataitai Kindergarten, which is situated above Taurima Street, would be affected by the construction of the south-eastern portal of the tunnel, and would need to be re-located.
- Good ground conditions are expected for the bored section of the Pirie Tunnel, certainly better than that expected at the Terrace Tunnel. Because the Pirie Tunnel is further away from the existing Mount Victoria Tunnel, there is lower risk and greater cost certainty associated with the construction of that part of the tunnel to be bored.
- Emergency access for drivers could be provided at the junction between the cut and cover tunnel and the bored tunnel, by providing an exit way to Pirie Street near the Bus Tunnel.
- Excavation for the south-east portal would require careful consideration given its close proximity to the existing road and ventilation building.
- Top down construction is likely for the reinforced concrete box cut and cover tunnel, using either bored soldier pile and ground anchors or soil nailing to retain the excavation.
- After construction is completed, there is an opportunity to amalgamate a number of residential sections affected by the construction works to create more intensified residential area. The location of high quality passenger transport along Cambridge and Kent Terrace make this an attractive proposition.
- Depending on the alignment chosen for the cut and cover section of the tunnel and the construction methodology adopted, there will be limited access for construction creating greater construction cost uncertainty.
- Construction of the Pirie Tunnel will create a large volume of waste material needing disposal. For the purposes of estimating the cost, it has been assumed that a disposal site would be found within 20km of the site.
- Once the duplicated tunnel was operational, the existing Mount Victoria tunnel could be closed for refurbishment, either by: -
  - Removing the ventilation duct so as to improve lane width and provide shoulders.
  - Improving security, noise and ventilation in the existing tunnel by creating a glass wall between pedestrians and general vehicles.
- Option B1 halves the traffic volumes around the Basin Reserve, significantly improving pedestrian access both to properties adjacent to the Reserve (particularly the north-eastern corner) and to the Reserve itself.

- An outlet for the new tunnel ventilation system would be required, although the town belt offers an ideal location away from residential areas and hence the need to construct a ventilation stack of some height.
- Bus Tunnel operation would be affected while the cut and cover section of the tunnel at the top of Pirie Street was being constructed. There are several options for mitigating the effects on the operation of buses. The bus route could be temporarily re-routed along Austin Street to reduce the length of time they would be affected. The location of the cut and cover tunnel could be moved further south near the western portal of the exiting bus tunnel to allow one-way bus operation throughout construction, although this would create more property impacts. Buses could also be diverted though the Mount Victoria tunnel during the construction period, using signals at each portal to give them priority at peak time, although this creates significant travel time dis-benefits for general vehicles.
- Constructing an overpass over Cambridge and Kent Terrace (Option B1b) requires the bridge to climb up from Vivian Street. This would reduce Vivian Street to one lane during construction, restrict access to properties and has visual impacts on the area.

13.5 Option B2: - Paterson Tunnel (Parallel Duplication of Mount Victoria Tunnel)

Description: -Option B2 creates a duplicate tunnel immediately adjacent and to the north of the existing Mount Victoria Tunnel so as to create a one-way two-lane pair: referred to here as the Paterson Tunnel, as shown in Figure 13.5. This would require the conversion of the existing tunnel from two-way operation to a one-way operation northbound. The entry and exit points are such that new tunnel is able to connect onto the existing roading network at Ruahine Street to the south-east and the Basin Reserve to the north-west. The Paterson Tunnel would be approximately 600m long and have a 30 to 60m long cut and cover section at each portal.

Figure 13.5: - Option B2 Paterson Tunnel

Two 3.5m lanes are provided with a 1.2m shoulder on one side and 0.6m wide shoulder on the other, plus verge as shown in Figure 13.6. Rock cover over the tunnel would vary between 12m and 90m. Except near the portals, where cut and cover construction would be used, this cover is sufficient to minimise subsidence at the surface. A preliminary study of the feasibility of a duplicate tunnel was completed in 1988[108].

[108] Brian Newsome; "Wellington Urban Motorway, Mount Victoria Tunnel Duplication, Preliminary Study, Downer, 1988

Option B2 can be undertaken as a stand alone project or in conjunction with: -

- Option B3.
- Option B5.
- Some minor realignment of the roading network adjacent to the Basin Reserve.

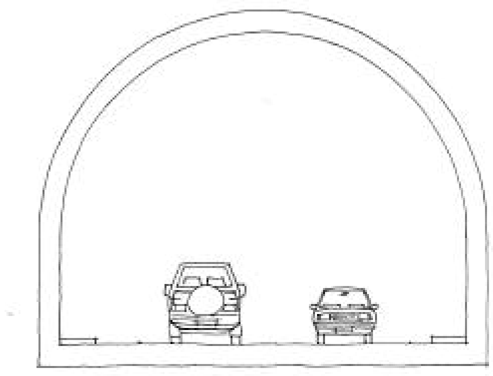


Figure 13.6: - Option B2 Cross Section through Paterson Tunnel

The minor realignment could include easing the southbound left hand turn lane from the Basin Reserve to Paterson Street, using land already owned by Transit New Zealand. This would allow two slip lanes for southbound vehicles travelling from the Kent and Cambridge Terrace to Ruahine Street via the Mount Victoria Tunnel to be separated from other traffic movements.

Key Issues: -

- The Paterson Tunnel would be located at 18m (1.5 diameters or about 30 m centre to centre) from the existing tunnel. While this is a standard acceptable distance between tunnels, some consideration may need to be given to the effects the new tunnel will have on the existing tunnel given that the construction of the linings of the existing tunnel in 1931 is unknown.
- The northern approach to the Paterson Tunnel requires about 10 properties fronting Paterson Street and Brougham Street, all of which appear to be already owned by Transit New Zealand. In-addition to these properties, Option B2 would require additional 3 to 4 properties in Austin Street, including a block of flats owned by Housing New Zealand.
- Emergency pedestrian links could be provided between the two tunnels.
- The Hataitai Kindergarten, which is situated above Taurima Street, would be affected by the construction of the south-eastern portal of the tunnel, and would need to be relocated.
- During construction of the north-western portal, Patterson Street access to Wellington East Girls College and possibly Austin Terrace may be affected.
- Adversely affected by Option B2 is Ettrick House (c1870) at 19 Paterson Street which is registered as an historic building[109]; and an English Elm, located on the corner of Dufferin Street and Paterson Street, which is registered as a notable tree.[110] Consents would be required for the removal of both.
- Excavation for the south-east portal would require careful consideration given its close proximity to the existing road and ventilation building.

[109] Ettrick House was already relocated from its original site in Austin Terrace in early 1990s. Wellington City Council District Plan, Map Reference 16, symbol 18
[110] Wellington City Council District Plan, Map Reference 16, symbol 204

- Good ground conditions are expected for the bored section of the Paterson Tunnel, certainly better than that expected at The Terrace Tunnel.
- Construction of the Paterson Tunnel will create a large volume of waste material needing disposal. For the purposes of estimating the cost, it has been assumed that a disposal site would be found within 20km of the site.
- Option B2 creates the opportunity to refurbish the existing Mount Victoria Tunnel, removing the ventilation duct so as to improve lane width and provide shoulders
- An outlet for the Paterson Tunnel ventilation system would be required, although the town belt offers an ideal location away from residential areas and hence need to construct a ventilation stack of some height.
- Enhancements could be made for pedestrian and cycling by either: -
  - Improving security, noise and ventilation in the existing tunnel by creating a glass wall between pedestrians and general vehicles, or
  - Providing additional width in the new tunnel with facilities for pedestrians and cyclists that provide for their security, noise and ventilation requirements.
- Given the close proximity of the new tunnel to the existing tunnel, there will be additional construction cost uncertainty.

13.6 Option B3: - Two-way Grade separated Option at the Basin Reserve

Background: - A detailed study of transport options around the Basin Reserve was investigated in 2001 by consultants Maunsells[111] (previously Meritec). They investigated over ten options before recommending Option H as a preferred option. Option H provided for: -

- a two-lane flyover from Paterson Street to Buckle Street.
- An underpass for Sussex Street traffic to Cambridge Terrace.
- An underpass for Kent Terrace traffic to Adelaide Road.
- This arrangement provided a direct link for northbound traffic from the Mount Victoria Tunnel to Buckle Street and Southbound traffic from Kent Terrace and the Mount Victoria Tunnel. The arrangement reduced the amount of weaving around the Basin Reserve. The scope of this study was limited to the issues of the Basin Reserve and did not extend to the capacity issues of the Mount Victoria Tunnel.

Description: -Option B3 is based on Maunsell's Option H. It provides a new direct link for northbound vehicles travelling from the existing Mount Victoria Tunnel to the Inner City Bypass along Buckle Street. Southbound vehicles travelling from the Inner City Bypass along Vivian Street and then Kent Terrace are provided with a direct link to the new Paterson Tunnel (Option B2). Both of these direct links are grade separated from other traffic movements around the Basin Reserve, minimising delays at intersections and removing the significant weaving problems that exist around the Basin Reserve. The arrangement is illustrated in Figure 13.7.

[111] Meritec, SH1 Basin Reserve Long Term Transport Solutions, Scheme Assessment Report, for Transit New Zealand, March 2001

Option B3 retains the existing signalised intersection at Vivian Street and Cambridge Terrace, requiring State Highway One traffic to make a 90^{o} right hand turn onto Kent Terrace. However, at the Basin Reserve, the right angle left-turn is eased by taking property and the three lanes along Kent Terrace splits into two 2-lane carriages. The two-lanes heading to the east through the tunnel rise up and pass over the two-lanes that continue around the Basin Reserve and to Adelaide Road or Buckle Street. The two-lanes continuing around the Basin Reserve must loop away from the two approach lanes to the tunnel and drop below ground in a trench near the Dufferin Street and Paterson Street intersection to obtain the necessary clearance under the two-lanes above. This loop encroaches onto land owned by Transit New Zealand[112] and provides for connections to Hania Street and Ellice Street, as left in and left out. Two-lanes are provided from Kent Terrace to Adelaide Road: one of these could form part of the passenger transport corridor serving the growth node at Newtown[113].

A feature of Option B3 is that southbound vehicles from the tunnel do not need to circulate around the Basin Reserve to get to Buckle Street, but are instead provided with a direct two-lane carriageway parallel to, and adjacent to, the southbound lanes. This direct link is provided on a 300 m long viaduct, which passes over the road connecting Kent Terrace with Adelaide Road, over the Basin Reserve entrance and over the road linking the Sussex Street with Cambridge Terrace at the intersection of Sussex Street and Buckle Street. In this way, there are no intersections between the tunnel portal and Buckle Street/Tory signal controlled intersection. The road linking Sussex Street with Cambridge Terrace passes under the viaduct. Two-lanes are provided for the road linking Sussex Street with Cambridge Terrace. One of these lanes could form part of the passenger transport corridor serving the growth node at Newtown.

It has been assumed that as part of the connection to Buckle Street, that Buckle Street is realigned to the north, which is in keeping with the current proposals being studied to improve amenity in front of the National War Memorial in Buckle Street. This alignment also provides for better connections and more room for construction.

The other key connection provided in Option B3, is the slip lane for westbound vehicles travelling from the tunnel to Adelaide Road via Dufferin Street. The drop-off and pick-up areas in front of St Mark's school in Dufferin Street should be able to be retained with Option B3, with some modifications.

Option B3 requires westbound vehicles exiting the tunnel to circulate around the Reserve if they want to connect to Cambridge Terrace. An alternative to this arrangement is to provide a direct connection by providing an off-ramp from the right hand side of the westbound lanes of the viaduct to the right hand side of Cambridge Terrace. This ramp is close to the entrance of the Basin Reserve and depending on the arrangement adopted for the viaduct over the Basin Reserve entrance, may affect important view shafts from Kent and Cambridge Terrace. It is difficult from the analysis completed to-date to confirm[114] if there will be sufficient traffic using this link to justify the cost, and more detailed traffic modelling is recommended at scheme assessment stage to confirm it's viability.

[112] Purchased from the Catholic Church
[113] Traffic modelling indicate that with the proposed roading enhancements at the Basin Reserve and Mt Victoria Tunnel, about 650 vehicles per hour would use this link in future years (2016), which should be accommodated within a single lane.
[114] The Transportation model predicts very low traffic movements using this link, which appears inconsistent with present traffic movements.

Option B3 can be undertaken as a stand alone project or in conjunction with Option B2, the Paterson Tunnel.

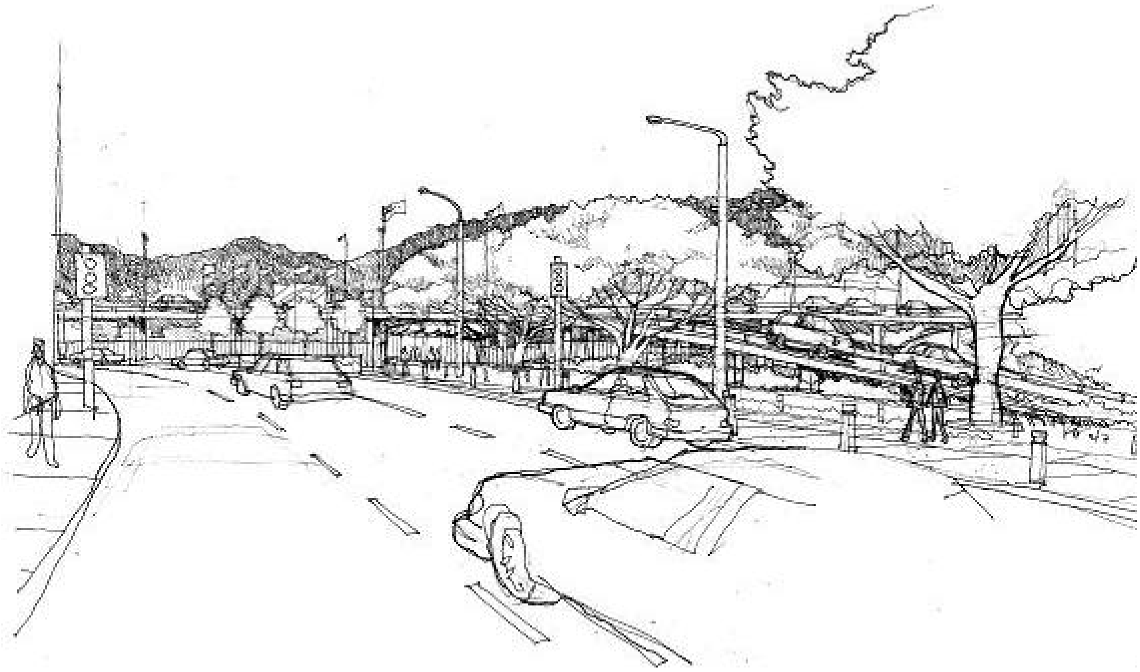
Figure 13.7: - Option B3 Alignment for Two Way Grade Separated Option at the Basin Reserve

Key Issues: -

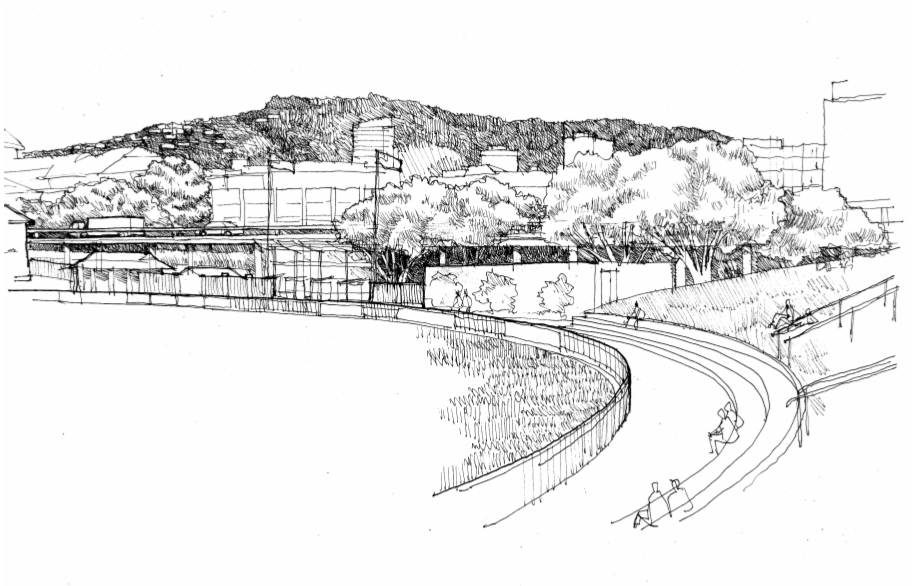
- The key issue is the visual impact of the elevated structure. The over bridges will: -
    - have a tendency to emphasis the termination point of the vista along Kent and Cambridge Terrace.
    - affect the perception, symbolic character and context of the Basin Reserve.
    - impact on the overall character of the wider surroundings.
    - Tend to segregate the existing neighbourhoods.
    - Create shading and has the potential increase noise unless mitigated.
- Option B3 requires the widening around the eastern edges of the Basin Reserve and this will impact on the spatial definition of the street, remove existing buildings that contribute to the character of the area and affect the quality of the street edges.

- The viaduct over the entrance to the Basin Reserve together with the relocation of other high volume roads away from the entranceway creates the opportunity to enhance pedestrian access to the Reserve (as shown in Figure 13.8). At-grade pedestrian crossings could be modified on Kent and Cambridge Terrace to enable pedestrians to reach this area.
- The drop-off and pick-up areas in front of St Mark's school in Dufferin Street will be safer given the significant reduction if traffic volumes in this area.
- Figure 13.9 indicates the key pedestrian routes around the Basin Reserve. A pedestrian route around the inside of the ring road connects the Basin Reserve entrance with other key pedestrian routes. Signal controlled crossing points for pedestrians could be provided across Dufferin Street (opposite St Marks) and Rugby Street (opposite Adelaide Road).
- There is the opportunity to enhance the entrance-way to the Basin Reserve by incorporating the viaduct structure into a grand entrance (as shown in Figure 13.8).
- There are number of physical constraints at the junction of Paterson Street and Dufferin Street, primarily due to St Mark's buildings to the south and the St Joseph Church to the north and the Basin Reserve to the west. Consequently, despite reducing the cross-section of the four-lanes and median barrier to a minimum, Option B3 does intrude slightly into the St Joseph Church property at the corner of Paterson Street and Ellice Street, although it is well clear of their new Church and other buildings. It may also been necessary to encroach over the Basin Reserve boundary at the corner of Paterson Street and Ellice Street, although it does not affect the view embankment and is well away from the play area.
- Option B3 affects approximately eight properties in the vicinity of Kent Terrace, Ellice Street and Dufferin Street and Paterson Street, which appear to be owned by Transit New Zealand. It should be possible to avoid the need to acquire Construction House, by reducing the horizontal curve radius from Kent Terrace to Ellis Street. The realignment of Sussex Street and Cambridge Terrace affects Transit New Zealand owned land in Buckle Street.
- Option B3 will affect Compassion Crèche (c1814) on Buckle Street which is registered as an historic building[115]; and an English Elm, located on the corner of Dufferin Street and Paterson Street, which is registered as a notable tree.[116] Consents would be required for the removal of both.

[115] Wellington City Council District Plan, Map Reference 16, symbol 42
[116] Wellington City Council District Plan, Map Reference 16, symbol 204



Looking towards Basin Reserve from left side of Kent Terrace



Looking from Basin Reserve towards Buckle Street and Cambridge Terrace

Figure 13.8: - Option B3 Artist Impression of Enhanced Entry to the Basin Reserve

- Option B3 presents a number of issues in terms of construction, particularly at the north-western corner of the ring road around the Basin Reserve. This area requires the construction of a large elevated structure and a new roading layout beneath located within a trench. This is all contained within a very constrained site though where existing complex traffic movements and large traffic volumes must be maintained. For their Option H, Maunsells presented the option which included diverting the east-bound traffic from the Basin Reserve to the tunnel along Ellice Street and then a 90^{o} bend along Brougham Street to Paterson Street and SH1. This appears workable, although it likely to create very significant delays and put additional pressure on access to Wellington East Girls College.

Figure 13.9: - Option B3 Key Pedestrian Connections at the Basin Reserve

- The more simplified Option B4 provides more options for construction without the same impacts on existing traffic.

13.7 Option B4: - One -way Grade-separated Option at the Basin Reserve

Description: -Option B4 is almost identical to Option B3, except that it does not provide the proposed direct link for east-bound vehicles travelling from Vivian Street (using the Inner City Bypass) via Kent Terrace to the Mount Victoria Tunnel. Option B4 works solely in conjunction with Option B1, where east-bound traffic from the Inner City Bypass travels instead within the new Pirie Tunnel. A key feature of this arrangement is that it reduces the number of lanes from four to two that must pass physical constraints at the north-east corner of the ring road around the Basin Reserve and in Paterson Street. The arrangement is shown in Figure 13.10.

Figure 13.10: - Option B4 Alignment for One Way Grade Separated Option at Basin Reserve

Key Issues: - Many of the issues are the same as Option B3. The key differences are: -

- Constraints for Option B3 during construction at the junction of Paterson Street and Dufferin Street are considerably less given the reduced width of carriageway.
- Option B4 presents a less constrained site for construction, particularly at the north-eastern corner of the ring road around the Basin Reserve. Construction should be able to be achieved without the cost associated with the excessive delays covered by the need to divert traffic along Ellice Street and Brougham Street. Given the reduced constraints, access to Wellington East Girls College and other properties around the Basin Reserve should not be as adversely affected as for Option B3.

13.8 Option B5: - One-way At-grade Option for the Basin Reserve

Description: -Option B5 is similar to Option B4, except that the direct link for westbound vehicles travelling from Mount Victoria Tunnel to the Inner City bypass using Buckle Street is at grade with traffic having to pass through two signal controlled intersections (one at Dufferin Street and one at Sussex Street). The arrangement is shown in Figure 13.11.

Option B5 can work in conjunction with a number of other Tunnel options such as Option B1, where east-bound traffic from the Inner City Bypass travels within the new Pirie Tunnel. A key feature of this arrangement is that it avoids the need for elevated structures near the Basin Reserve. While it avoids the weaving problems associated with traffic circulating around the Basin Reserve, westbound traffic will still be subjected to delays at the signal controlled intersections.

It is expected that delays at these intersections will be minimised when Option B5 is used in conjunction with Option W2, which proposes that Adelaide Road be used as a passenger transport corridor, with limited capacity for through traffic for general vehicles. With this arrangement, general traffic to Newtown and the suburbs south of Newtown will be encouraged to use Taranaki Street and Wallace Street. Therefore, while general vehicles will be permitted to use the ring road around the Basin Reserve, this will be primarily to permit access to properties.

Figure 13.11: - Option B5 Alignment for One Way At Grade Option at Basin Reserve

Key Issues: -

- Compared to Option B3 and B4, creates additional delays for passenger transport between the Newtown growth node and Courtney Place, although delays could be minimised with the use of signal pre-emption system for buses.

- Avoids elevated structures near the Basin Reserve.
- Provides at-grade pedestrian crossing at key pedestrian desire lines.
- The drop-off and pick-up areas in front of St Mark's School in Dufferin Street will be safer given the significant reduction of traffic volumes in this area.
- By locating the high volume westbound road at grade and in front of the main entrance to the Basin Reserve, it may impact on pedestrian access to the Reserve.
- The construction constraints at the junction of Paterson Street and Dufferin Street are considerably less for Option B3 given the at-grade solution. Nevertheless Option B5 still affects a similar number of properties to Option B4 in the vicinity of Kent Terrace, Ellice Street and Dufferin Street and Paterson Street, which appear to be owned by Transit New Zealand. The realignment of Sussex Street and Cambridge Terrace affects Transit New Zealand owned land in Buckle Street.
- Option B5 will affect Compassion Crèche (c1814) at Buckle Street which is registered as an historic building[117]; and an English Elm, located on the corner of Dufferin Street and Paterson Street, which is registered as a notable tree.[118] Consents would be required for the removal of both.
- Option B5 presents a less constrained site for construction, particularly at the north-eastern corner of the ring road around the Basin Reserve.

[117] Wellington City Council District Plan, Map Reference 16, symbol 42
[118] Wellington City Council District Plan, Map Reference 16, symbol 204

14 Description of Ruahine Street to Airport Options

14.1 Current Situation

South of Mount Victoria Tunnel, SH1 follows Ruahine Street, Wellington Road, Cobham Drive and Calabar Road, before terminating close to the airport, as shown in Figure 14.1. The speed limit and number of lanes provided varies along this section of the route: 70km/hour along Ruahine Street, decreasing to 50km/hr along Wellington Road, increasing to 70km/hr along Cobham Drive before returning to 50km/hr at the southern end of Calabar Road.

Only one lane is provided in each direction along Ruahine Street and part-way along Wellington Road. Between the intersection of Wellington Road and Kilbirnie Crescent and the airport, two-lanes in each direction are provided. This section along Cobham Drive has a physical median between opposing carriageways.

There are a number of intersections along the route. Immediately south of the existing Mount Victoria Tunnel is a 'T-intersection' which provides a vehicle connection to Hataitai traffic via Taurima Street. The existing intersection allows vehicles to make a right turn from Taurima Street towards the Mount Victoria Tunnel. This can be considered a dangerous manoeuvre given the restricted sight distances, the intersection being so close to the tunnel portal and the limited length that vehicles have to merge before entering the single lane tunnel.

Approximately halfway along Ruahine Street is a cross-roads un-signalised intersection with Goa Street and the access to Hataitai Park which includes both a north and south facing right hand turn bay. A 'T-intersection' is located at the junction of Ruahine Street and Wellington Road, which provides vehicle connections to Crawford Road. In both cases, state highway traffic has priority. Along Wellington Road, there are two signalised cross road intersections, one at Hamilton Road/Kilbirnie Crescent and the other at Evans Bay Parade. These two intersections are less than 200m apart. In addition there are two relatively minor side roads on the north side of Wellington Road, at Moxham Avenue and Walmer Street.

Along Cobham Drive, a large dual lane roundabout provides connections to Kilbirnie and Rongotai while a second large dual lane roundabout provides connections to the airport and to Miramar. State Highway One turns through 90^{o} at the second roundabout into Calabar Road and to the airport. Before reaching the airport terminal, the road passes through two small roundabouts. Along Calabar Road there is a major priority 'T-intersection with Calendonia Street where the two southbound lanes split. In the northbound direction, the right turn from Caledonia Street joins with the one lane from the airport to form two-lanes from Caledonia Street. There are a couple of other minor side connections along Calabar Road.

The 2005 traffic volumes are given in Table 14.1.

Table 14.1 : Traffic Volumes

	2005 AADT Volumes
North End of Mount Victoria Tunnel	37,700
Ruahine Street (South of Goa Street)	32,300
Cobham Drive (South of Evans Bay Parade)	34,260
Calabar Road (South of Caledonia Street)	22,195
Source Transit New Zealand	

The theoretical traffic flow capacity of Ruahine Street is likely to be less than 1800 vph, although flows up to 2400 vph are possible over short sections of highway. It appears that Ruahine Street[119], like Mount Victoria Tunnel, are currently operating at or near this upper value.

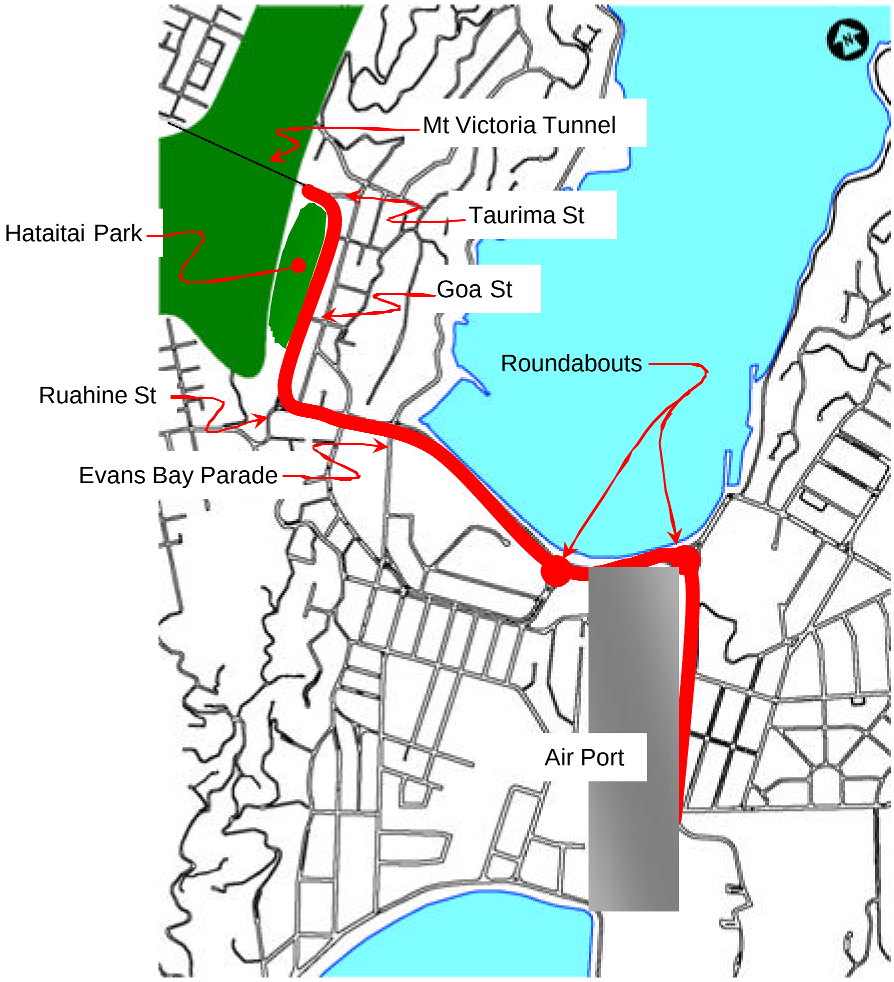


Figure 14.1: -Existing Situation between Mount Victoria Tunnel and the Airport

119 No peak hour traffic counts appear to be available for Ruahine Street

14.2 Existing Planning Provisions

The Wellington City District Plan has a number of designations (valid until 2015) that relate to improvements of Ruahine Street and Wellington Road. They are: -

- Widening the western side (non-residential side) of Ruahine Street by up to 25m from the existing boundary (into Hataitai Park).
- Widening the southern side of Wellington Road by up to 25m, between the intersection with Ruahine Street and Kilbirnie Crescent[120].
- Corner splaying improvements on the inside of the horizontal curve at the Ruahine Street and Wellington Road intersection[121].

14.3 Key Issues

There are a number of issues within this part of the study area: -

- The congestion that occurs at the Basin Reserve and through the Mount Victoria Tunnel creates a queue that can extend some 3km through the tunnel, along Ruahine Street and Wellington Road and Cobham Drive. The capacity of the route from Wellington Road to the Basin Reserve is less than the capacity of the adjacent links, to the south towards the airport and to the north onto the Inner City Bypass.
- Traffic has difficulty turning at the un-signalised Ruahine Street and Wellington Road intersection. This intersection is not only complicated by poor visibility associated with the tight curvature, but is located on a rise with that section of Wellington Road forming a very steep connection with Crawford Road.
- There are conflicts with turning vehicles accessing properties on both sides of Wellington Road. This is less of a problem in Ruahine Street, as there are only about 10 houses that have vehicle access and these houses are all on the east side. The Badminton Hall, which is near the south end of Ruhaine Street can generate considerable turning movements at certain times, although a south facing right turn bay and a narrow painted median does give some protection to this turning movement.
- Ruahine Street and Wellington Road provide little or no shoulder or provision for car parking. There are only a few properties that access Ruahine Street, and those that do generally have off-street parking areas or park at the back of the footpath (as shown in Figure 14.2).
- The northbound capacity of the Wellington Road and Kilbirnie Crescent intersection is limited by the inadequate merge distance from two-lanes provided at the signalised intersection to the single lane along Wellington Road.
- Some modifications to the operation of the two roundabouts on Cobham Drive could improve traffic flows.

[120] It does not appear to cover the block of flats on the corner of Wellington Road and Kilbirnie Crescent
[121] Wellington City Council will need to clarify the extent of this provision. It appears that the three corner properties may be affected. The middle property is owned by WCC, but the other two are privately owned.

Figure 14.2: -View of Ruahine Street (looking south from Goa Street Intersection)

14.4 Option R1: - Four-laning of Ruahine Street and Wellington Road

Description: - The four-laning of Ruahine Street and Wellington Road should include a 3.0m[122] wide median between opposing traffic (similar to that provided along Cobham Drive). It is also desirable to provide kerb side parking, on the northern side of Wellington Road to service the residential properties that remain. Kerb side parking is not considered necessary along Ruahine Street given the limited number of properties that front it. Only 1.5m wide shoulders[123] are provided on both sides of the carriageway, forcing cars that break-down to park on the footpath or to hinder through traffic movement.

It is proposed to ban right hand turns from Taurima Road onto Ruahine Street given the safety concerns noted earlier about this intersection. Vehicles from Hataitai that wish to complete this manoeuvre will need to divert to the south along Moxham Avenue to an upgraded intersection at Goa Street and Ruahine Street.

It is proposed to signalise the Ruahine Street and Goa Street intersection. This intersection also provides access to Hataitai Park. This intersection is expected to have an increased number of turning vehicles as a result of the banned right hand movements at Taurima Road. There is the possibility that right hand turns from Moxham Avenue to Goa Street may be sufficient in the morning peak to require a signalised intersection.

It is proposed to ease the existing very tight corner at the corner of Wellington Road and Ruahine Street while improving the intersection itself. A 65m radius curve is proposed which in conjunction with

[122] While this median width could be reduced to an absolute minimum of 2.0m, the wider median provides the space to develop right hand turn bays at key intersections and provide refuge for pedestrians and allows trees to be planted consistent with a boulevard.
[123] While even greater shoulder widths are required if provision is to be made for cyclists, we would recommend that cyclists be kept separate from the very high traffic volumes along SH1 and that provision be made for cyclists on a parallel route using Moxham Avenue and Hamilton Road.

5% super elevation would provide a design speed of 42 km/hr. A 50 km/hr design is possible but would require more property. There are two options for improving this intersection:

- Banning right hand turns, which simplifies the intersection and avoids the need for signals.
- Permitting all movements by providing a signalised intersection.

It is proposed that the Wellington Road and Moxham Avenue and Wellington Road and Walmer Street intersections be restricted to left in and left out so as to maximise through traffic capacity.

Only minor adjustments are required at the Wellington Road and Kilbirnie Crescent intersection.

The existing signalised intersection at Wellington Road and Evan Bay Parade will also only require minor modification. Some improvement in the performance of this existing intersection could be expected following the four-laning of Wellington Road and Ruahine Street, the duplication of Mount Victoria Tunnel and improvements at the Basin Reserve, as these improvements have been shown to reduce traffic volumes using Evan Bay Parade by over 70%, a significant proportion of which are making a right turn at this intersection.

Key Issues: -

- The proposed cross-section cannot be accommodated within the proposed designations already provided for within the Wellington City District Plan. Although it is possible to provide a four-lane carriageway within the designated footprint, this would require the elimination of the median and/or shoulders and even with these measures, retaining walls would be required in places to ensure the road stays within the designation.
- Although the exact dimensions of the designated corner splay at the corner of Ruahine Street and Wellington Road are not known, it is unlikely to provide the width needed to make the required geometric improvements needed at this corner consistent with a key four-lane arterial.
- To accommodate the recommended cross-section, it will be necessary to encroach onto property beyond the existing designation. Along Ruahine Street, this encroachment could be to the west onto council owned land at Hataitai Park, extending the existing 25m designation[124] by about an additional 3 m into Hataitai Park. Alternatively, the widening would need to be accommodated by acquiring private property on the east.
- A modification to the footbridge just south of the Taurima Road intersection to span the proposed four-laning of Ruahine Street.
- Along Wellington Road, the effect of using the full 25 m designation will be the removal of 10 houses and the acquisition of the frontage of four additional properties on the south side of Wellington Road. To accommodate recommended cross-section, the 25 m designation would need to be increased by about 5 m, involving the acquisition of another five properties.
- To achieve a 50 km/hr design speed at the intersection of Wellington Road and Ruahine Street would require a 85 m radius curve, and this in turn would require additional property in the inside

[124] It should be noted that the front part of the Badminton Hall already falls within the exiting 25 m designation and would need it's frontage modified or the building re-orientated on site..

of the curve or alternatively by pushing the alignment of Wellington Road a bit further south, or a combination of both.

- Some property acquisition is likely to be required at the corner of Goa Street and Ruahine Street to accommodate the proposed signalised intersection.
- Minor encroachment into Kilbirnie Park is likely to be avoided with the use of small retaining structures.

14.5 Option R2: - Roundabout Improvements along Cobham Drive.

Option R2 involves the provision of additional lanes on the two roundabouts along Cobham Drive to improve capacity.

Cobham Drive /Troy Roundabout: - The provision of an extra lane on the Troy Street approach to the roundabout to provide 3 approach lanes, rather than 2 lanes, with sufficient space provided on the circulating carriageway to allow two-lane of traffic. This would result in a left lane for left turners, middle lane for left and right turns and right lane for right turning vehicles.

Cobham Drive/Calabar Road Roundabout: - The provision of a slip lane from Calabar Road to Cobham Drive to allow left turners from the airport the chance to access Cobham Drive without having to enter the roundabout with a merge on Cobham Drive just beyond the roundabout. This may require a reduction in the central roundabout island and the central island on Cobham Drive in the immediate vicinity of the roundabout in order to prevent any ingress into the airport land.

15 Description of Adelaide Road and Wallace Street Options

15.1 Current Situation

With a road reserve width of 20m, Adelaide Road operates with two-lanes in each direction. While space is provided for car parking on the eastern side, a clearway operates on the western side to provide a northbound bus lane in the morning peak. Outside of this time, the bus lane can be used for on-street car parking. A 2m wide flush median is also provided.

Taranaki Street between Buckle Street and Wallace Street also has a road reserve width of 20m. Along part of Taranaki Street, only about 10m of the road reserve is used as a carriageway, with the remainder set aside as frontage to buildings on the western side. Along Wallace Street, the road reserve reduces to about 15m and remains at this width until John Street. Both streets operate with a single lane in each direction. The remaining carriageway width is used for car parking, a flush median, bus stops or to accommodate additional lanes at signals.

There are a number of intersections along Taranaki and Wallace Streets. Right hand turn bays are provided at the intersection with Rolleston Street, Hargreaves Street and at the intersection with Finlay Terrace, but this is at the expense of a reduced shoulder width and no provision for car parking. A signal controlled intersection is provided at Bidwell Street. A significant number of buses also use Wallace Street, although specific priority measures are currently provided.

15.2 Existing Issues

- Adelaide Road passes through a proposed growth node. Therefore, good transport planning would suggest that Adelaide Road should be given priority as a passenger transport corridor and general traffic should be diverted around the node.
- Given the proposed growth nodes at Newtown and Kilbirnie and the large passenger generator provided by the Hospital, we can expect an increase in the number of bus passengers and general vehicles using Adelaide Road and Wallace Street in future years[125].
- For the growth nodes to succeed, a high quality, frequent and reliable passenger transport service is required to service the growth nodes and to connect them with the CBD and railway station.
- Adelaide Road and Wallace Street are presently key arterial routes for general vehicles serving the southern suburbs, although delays[126] at the Basin Reserve presently discourage vehicles using Adelaide Road.
- During both peaks, approximately 900[127] northbound vehicles use both Wallace Street and Adelaide Road per hour, which means both routes are operating close to their theoretical

[125] The existing Greater Wellington Regional Council's Strategic Transport Model does not include the growth nodes at Newtown and Kilbirnie and therefore will under predict traffic flows and passenger transport numbers
[126] The traffic model predicts traffic will transfer from Wallace Street to Adelaide Road when the Basin Reserve is grade separated.
[127] WCC Traffic Counts

capacity. In the southbound direction, Adelaide Road carries 50% less traffic than Wallace Street in both peaks.

- In future years it is forecast that a higher proportion of northbound vehicles crossing a screen line through both Adelaide Road and Wallace Street, will use Wallace Street in the morning peak. Over 60% of southbound vehicles travelling crossing the same screen line will use Wallace Street in the evening peak[128]. The larger percentage of vehicles predicted to use Wallace Street may be due to congestion caused at the Basin Reserve.

15.3 Option W1: - Four Laning of Wallace Street

Figure 15.1 shows the extent of widening proposed for Wallace Street. Wallace Street is already operating at or close to its theoretical capacity. With the predicted growth of the node at Newtown and the desire to give priority to passenger transport along Adelaide Road, it would be desirable to increase the capacity of the south end of Taranaki Street and the Wallace Street route. While Taranaki Street could accommodate the provision of an additional two-lanes, a 2m flush median and only 2m wide footpaths within the existing road reserve, it would be at the expense of on street car parking. Massey University and Wellington High School are located on Taranaki Street and are large people generators. Accordingly it may be desirable to provide a wider footpath along the eastern side at the expense of slight narrower lanes of say 3.3m. Taranaki Street and Wallace Street are also presently used as a bus route, and while a number of buses using this route might divert to the passenger transport corridor along Adelaide Road, it is expected that some buses would continue to use this section of Taranaki Street and to continue to serve the University and School. In order to provide for the required bus stops, additional land would need to be acquired.

Increasing Wallace Street to four-lanes can not be achieved without acquiring properties. Assuming that the road is to be widened on the east side of Wallace Street, approximately 35 properties would need to be acquired. In addition, a number of small stand alone buildings on Massey Campus would need to be relocated and some car parks modified. Once this was done, there would be sufficient width for four-lanes of traffic, a 2 m wide kerb median (with 0.5 m median shoulders), car parking space on each side, bus stops and footpath (refer to Figure 15.2). The median would prevent right hand turns to properties that remain along Wallace Street, although only a few of these have off-street parking.

[128] Based on predicted traffic flows in 2016 using the Regional Strategic Transport Model, and assumes no changes (improvement projects) to the present roading network.

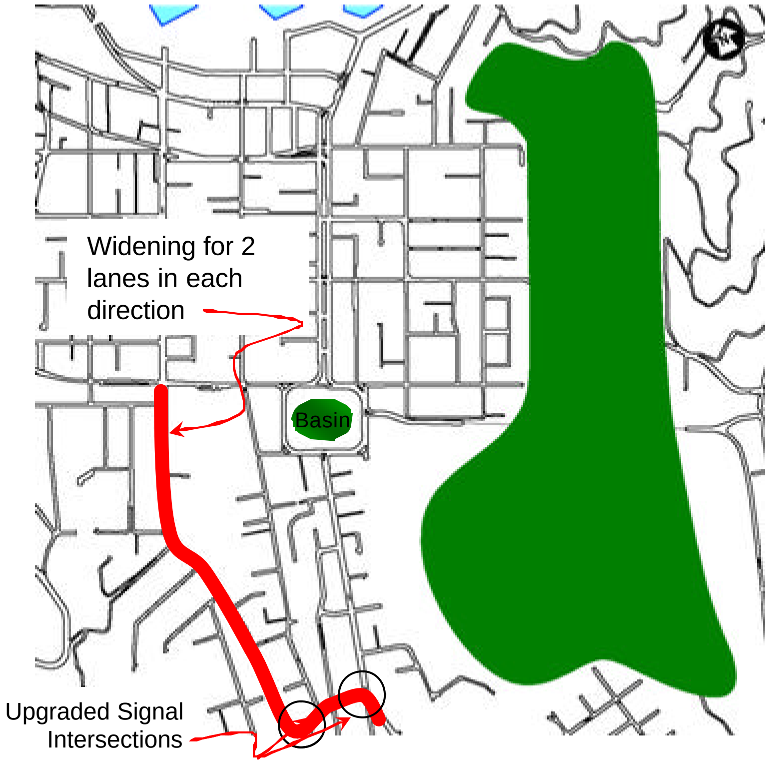


Figure 15.1: -Option W1 Four Laning for Wallace Street

Traffic signals would be retained at Bidwell Street and installed at Hargreaves Street. It is assumed that Rolleston Street could continue with a right hand turn layout.

The intersection of Wallace Street and John Street could accommodate the additional lanes provided along Wallace Street. More difficult is the intersection between John Street, Adelaide Road and Riddiford Road. The capacity of this intersection will be significantly constrained by the number of signal cycles needed to accommodate all the traffic movements. Additional signal time will also be required to provide priority for passenger transport along Adelaide Road and Riddiford Street. Making Adelaide Road one-way for traffic (either northbound or southbound) would assist with traffic signal cycles at either end (depending upon the direction of traffic), and could assist bus movements at either intersection.

Figure 15.2: - Option W1 Potential Cross Section along Wallace Street.

Key Issues: -

- Even though Wallace Street already operates as a key arterial, increasing the number of traffic lanes will change the existing character of street.
- A physical median will prevent right hand-turns, provision is made to allow u-turns at each end of Wallace Street.
- Creating four-lanes will induce more traffic and increase traffic speed, with the potential to create greater safety, amenity and severance issues for pedestrians.
- Property cost represents a significant proportion of the cost for this option.
- Social and community impacts associated with affected properties are significant.
- The negative impact on the 35 property owners whose homes will need to be acquired along Wallace Street must be weighted against the benefit of creating a vibrant and successful growth node for the 5,000 or more people who might live along Adelaide Road and the improved amenity of those people who properties remain along Wallace Street.
- Option W1 has a number of impacts on the Massey University campus.
- The section of the route along Taranaki Street is not wide enough for car parking and additional land will be required for bus stops.
- The section of the route along Taranaki Street has limited width for footpaths, particularly on the Massey University side, which is a key people generator.
- Removal of properties on the eastern side will minimise side friction and the need for property access,

15.4 Option W2: - Adelaide Road as a One way pair with King Street

Option W2 reduces Adelaide Road to a one traffic lane, which operates in the southerly direction. **Northbound** traffic uses a parallel route along King Street, which would need to be extended to the Basin Reserve. The typical cross section of Adelaide Road is shown in Figure 15.3, which shows just one 3.5m lane with adjacent space for car parking. The remainder of the carriage way is dedicated to passenger transport and pedestrians. King Street will have a narrow road reserve, only requiring one 3.5m wide lane, space for car parking and footpaths. Option W2 could be undertaken in conjunction with Option W1 - enhancing the capacity of Wallace Street.

Key Issues: -

- Centrally located passenger transport corridor is ideal for supporting a high quality growth node along Adelaide Road.
- Provides an important road hierarchy, where priority is given to Adelaide Road as a passenger transport corridor while allowing for general vehicles to use alternative Wallace St and Taranaki Street arterial.
- By making Adelaide Road a passenger transport corridor and forcing general vehicles to use Wallace and Taranaki Streets, Adelaide Road has higher amenity and safety for pedestrians and encourages the large number of walk trips within the node.

- Adelaide Road will be perceived as a natural continuation of Kent/Cambridge Terrace.
- Proposed one-way street along the extended King Street will minimise the number of vehicle crossing points needed to serve buildings on the west of Adelaide Road – which will improve the quality of the passenger transport corridor
- Option W2 reduces the southbound capacity of Adelaide Road from two-lanes to one lane.
- While the northbound capacity of the extended King Street could be similar to Adelaide Road, this route will not be as direct.
- Ideally the block length along Adelaide Road should be reduced to encourage intensification, however the cost of additional roads connecting Adelaide Road and King Street have not included in our indication of cost.
- Option W2 simplifies the intersection at Adelaide Road, Riddiford Street and Johns Street.
- Option W2 requires the connection of Hanson Street, King Street and Belfast Street.
- While the passenger transport corridor is ideal for serving the growth node along Adelaide Road, it is too far away to provide effective service to Massey University and the residential areas west of Tasman Street, and a secondary bus service along Wallace Street will still be required.
- Land required for Option W2, including the King Street extension, has not been included in our indication of cost, as it is assumed that the cost of this will be incorporated within development of the growth node itself.

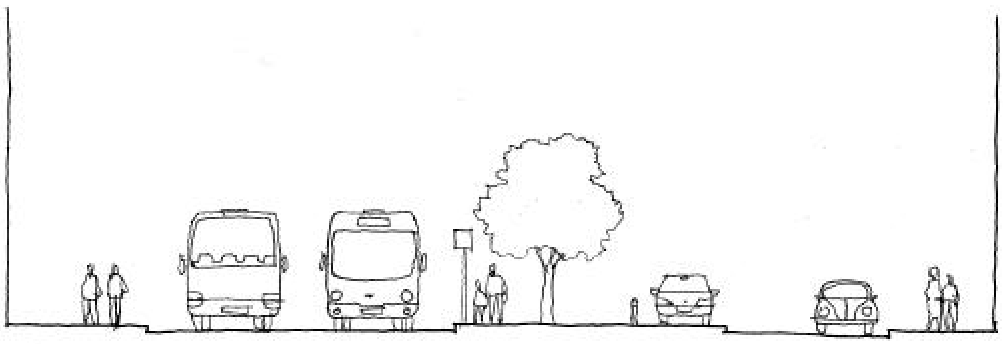
15.5 Option W3: - Adelaide Road as a Boulevard

Option W3 retains two-way operation along Adelaide Road for general vehicles, with one lane provided in each direction. Bus lanes are located in the shoulder lane. Provision is made for car parking and pedestrians. A wide centre grass median is also proposed, as shown in Figure 15.3.

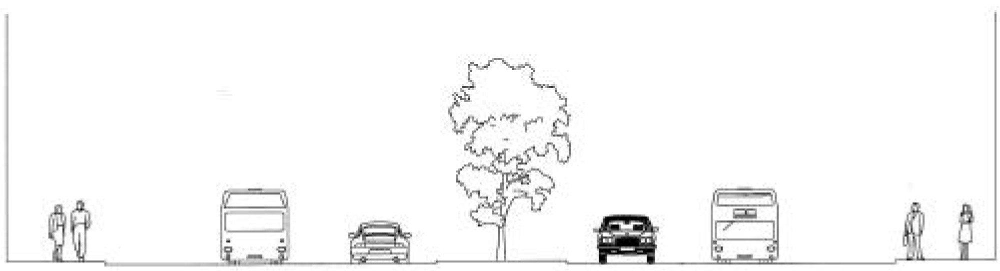
Key Issues: -

- Provides a more direct route between the Hospital and the CBD than Option W2
- As a boulevard, Adelaide Road will be perceived as a natural continuation of Kent/Cambridge Terrace, improving legibility.
- A wider street space might promote higher buildings and therefore provide greater development opportunities.
- Is likely to reduce traffic volumes along Wallace Street and Taranaki Street, improving the amenity of those that live there and also improving bus services along this route.
- Option W3 will require significant road widening, which will adversely affect the development potential of some sites.
- The wide road carriageway will be perceived as a barrier to pedestrians, making pedestrian movements more difficult than in Option W2 – walk-ability is a key element in high quality growth nodes.

- Because access to buildings will be provided from Adelaide Road, the vehicle crossings will interrupt pedestrian flows and shelter, reducing the walk-ability and amenity for pedestrians.
- Will not facilitate the easy vehicle access off Hanson Street and King Street, which could limit development opportunities.
- Ideally the block length along Adelaide Road should be reduced to encourage intensification, however the cost of additional roads connecting Adelaide Road and King Street have not been included in our indication of cost.
- We have assumed that the cost of land associated with the King Street extension and Adelaide Road improvements are incorporated within the cost of the development of the growth node and not in the cost of this option.



b) Option W2 Buses on Side with one-way pair



a) Option W3 Boulevard

Figure 15.3: - Cross Section along Adelaide Road.

16 Description of Pedestrian Options

16.1 Overview

The purpose is to enhance the existing walking environment to obtain a mode shift to walking. This will be achieved by ensuring an appropriate level of priority to pedestrians where numbers warrant it, and improving safety. Accordingly, it will be necessary to define a pedestrian route hierarchy with a specified level of service to be catered for. In order to provide this level of service, it may be necessary to identify specific design elements such as appropriate facilities and priorities to help define their status. In developing options, the project team was guided by the research by Land Transport NZ (refer to Appendix A) and were mindful of the need to: -

- Enhance pedestrian routes between the CBD and the adjacent suburbs so as to maximise the number of commuters walking to work.
- Provide an attractive pedestrian environment within the CBD that not only links key people generators (like transport hubs with places of employment), but also creates links between city residential areas, retailing areas, employment areas, entertainment areas and places for recreation.
- Identify key pedestrian routes and ensuring pedestrians are given priority over other modes, on these routes with suitable allocation of road space and other treatments.

16.2 Pedestrian Hierarchy

It is proposed to provide a pedestrian hierarchy with three levels: -

- A primary pedestrian route requires at least 2 of the Table 16.1 criteria to be met.
- A secondary pedestrian route requires 1 of the Table 16.1 criteria to be met.
- A tertiary pedestrian route requires 350 pedestrians per hour (generally applies to routes connecting suburbs with the CBD).

Table 16.1 : Pedestrian Hierarchy Criteria

Criteria	Hourly Flow of Pedestrians *(Pedestrians/hour)*
Average flow (midweek or weekend)	1500
Midweek peak flow	2000
Lunch time peak flow	700

A plan of the proposed pedestrian route hierarchy is shown in Figure 16.1.

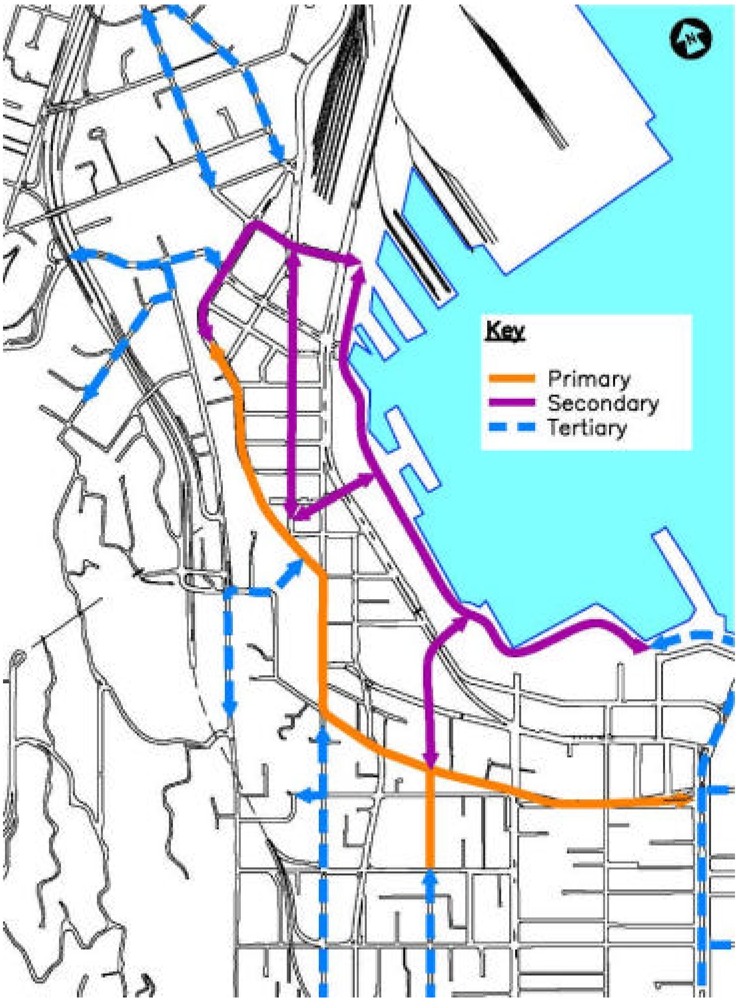


Figure 16.1: -Proposed Pedestrian Route Hierarchy

16.3 Implementing the Hierarchy

An analysis of footpath widths required to meet the level of service for the Figure 16.1 hierarchy has revealed a number of inner city footpaths that need to be widened, as shown in Figure 16.2. Figure 16.3 shows those routes that are recommended to be given the road user hierarchy of "pedestrian corridor". It is recommended that priority be given to pedestrians along these routes, including quality walking surfaces, 'green waves[129]', automatic green signal[130], good lighting, security cameras, and walking space management[131].

129 Phasing traffic signals timed to accommodate platoons of pedestrians travelling between the railway station and CBD.
130 Remove the need for pedestrians to push a button at traffic signals
131 Careful control of sandwich boards, street furniture and other intrusions to maintain walk widths.

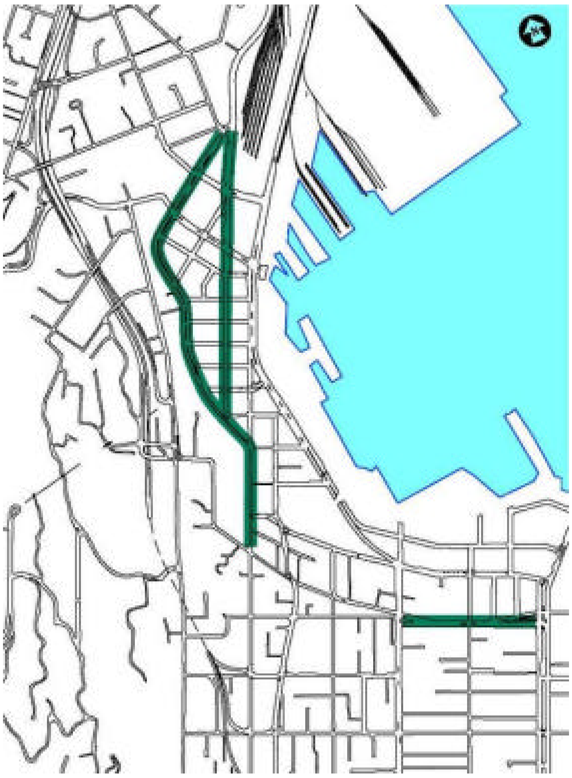


Figure 16.2: -Option P1 Upgrade in Pedestrian Routes within CBD

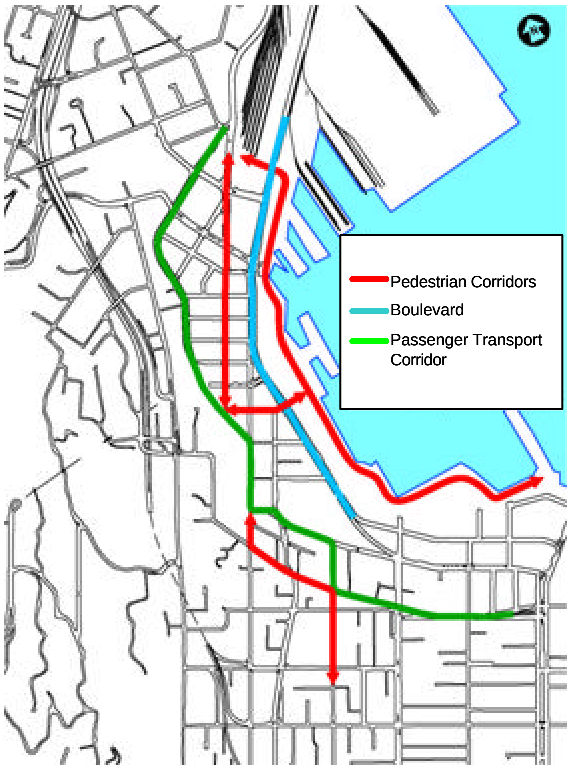


Figure 16.3: -Recommended Pedestrian Corridors

16.4 Description of Waterfront Route Options

The Wellington waterfront route (refer to Figure 16.4) extends from Bunny Street to Oriental Parade. The route, particularly along Jervois Quay and Customhouse Quay carries nearly 50,000 vehicles per day and up to 5000 vehicles per hour along three lanes in each direction, which creates a significant barrier between the waterfront and the CBD. Ironically, this route carries as much traffic as the motorway route, particularly at the Terrace Tunnel, even though the motorway is designed for the express purpose of carrying large volumes of traffic more safely and efficiently than local arterial routes that the waterfront provides.

16.5 Existing Issues

In their Public Spaces and Public Life Study of Wellington, GEHL Architects recommended[132] that traffic be reduced along the waterfront by reducing the number of lanes to two in each direction so as to create a city boulevard. A study in 2003[133] investigated the traffic impacts of reducing the number of

[132] GEHL Architects, "City to Waterfront – Public Spaces and Public Life Study, Wellington, 2004 Page 47
[133] Tim Kelly, Wellington Waterfront Lane Removal: Assessment of Effects, for Wellington City Council, July 2003

lanes to four. Without providing capacity elsewhere, the study concluded that closure of lanes would create more congestion and travel time and therefore had negative benefits.

Results from the transportation model indicate that duplicating the Terrace Tunnel is effective in diverting some vehicles away from the waterfront, particularly in the southbound direction in both morning and evening peaks. The Terrace Tunnel already provides two-lanes for northbound vehicles, so tunnel duplication does not have the same affect[134] on the northbound lanes along the waterfront.

Figure 16.4 - Wellington Water Front Route

Two options are described below for improving the waterfront route.

Given that the high traffic volumes occur only at peak time, there might be some merit in considering providing these options outside of peak times – only providing increased number of lanes at peak time and perhaps in only peak direction. This arrangement would improve connections between the city and the water front and accessibility for pedestrians during at least non-peak hours.

16.6 Option F1: - Boulevard

Description: - Reduce the waterfront to two-lanes in each direction and reclaiming some of this road space to increase the width of the median (presently being installed) to create a more defined boulevard and improved refuge for those pedestrians crossing the road, similar to the arrangement proposed by GEHL Architects[135].

Key Issues: -

- Two-lanes in each direction retains the present arterial function of the waterfront route, although it provides less capacity than what is predicted to be needed for general vehicles in the northbound direction.
- Enhances pedestrian access between the waterfront and the CBD.
- Maintains needed capacity for general vehicles.

[134] Instead, by 2016, the transport model predicts an increase in vehicles using the waterfront. The reason for this increase is that the Inner City Bypass is predicted to be operating at capacity.
[135] GEHL Architects, "City to Waterfront – Public Spaces and Public Life Study, Wellington, 2004 Page 47

16.7 Option F2: - Two-lane City Street

Description: - Reduce the waterfront to just one-lane in each direction. This is an ambitious option which, while having the potential to significantly alter traditional traffic patterns within the city, makes a powerful statement about the importance of the connection between the CBD and the waterfront, both from a safety and amenity perspective.

Key Issues: -

- Allows the road space to be reallocated for pedestrian areas.
- Significantly reduces the footprint of the existing road space and significantly improves the access between the waterfront and the CBD for pedestrians.
- Provides road space for a dedicated right of way for passenger transport, such as buses or light rail.
- Enables heavy rail to be extended into the CBD within a tunnel along the waterfront.
- Provides significantly less capacity than is needed for general vehicles particularly in the northbound direction, creating congestion and delays elsewhere in the roading network.

16.8 Pedestrian and Cycle Access between the City and Eastern Suburbs

As noted previously, Mount Victoria currently acts as a barrier to pedestrian and cycle movement between the City and the Eastern Suburbs. Four main options currently exist to permit this movement:

- Shared pedestrian and cycle path through the Mount Victoria Tunnel.
- Evans Bay Parade.
- Wellington Road and Constable Street with access via Newtown.
- Palliser Road - over the top of Mount Victoria.

All of these four options have significant constraints attached to them, particularly for pedestrians in that the Mount Victoria Tunnel suffers from poor ventilation, traffic noise and a narrow path and as such, is unattractive to pedestrians given its length and hence the time of exposure that pedestrians have to experience these conditions. The alternative routes via the coast or Newtown add considerable distance to the journey making it less attractive than the direct tunnel route, whilst the route over the top of Mount Victoria suffers from steep gradients. In addition to the above, pedestrians and cyclists are prohibited from using the Bus Tunnel, given its narrow width. Whilst these are impediments for both walkers and cyclists, pedestrians are particularly vulnerable to these factors given the differences in speed that can be achieved by each mode, and hence the impact of journey times on transport mode choice.

Given the above, it is unsurprising that the proportion of pedestrians walking to and from work in the CBD from Hataitai is low compared to other nearby, but less constrained suburbs.

Pedestrian access between the CBD and Hataitai can only reasonably be provided for by providing a direct link under Mount Victoria. Such a link needs to balance the directness of the route and potential gradients experienced whilst seeking to minimise the 'tunnel' experience in order to reduce the negative impact and connotations associated with long tunnels. As such, such a route should be extremely well lit and ventilated, be of sufficient width and height to reduce the claustrophobia effect, monitored through CCTV cameras, be well maintained and ideally, shared with other road users (albeit in a safe and appropriate manner) in order to improve personal safety by making pedestrians more conspicuous.

In duplicating the existing Mount Victoria Tunnel, it would be preferred to create a wider carriageway for general vehicles in the exiting tunnel, although this would be at the expense of the ventilation shaft and pedestrian and cycleway provided above it. The existing conditions within this tunnel are not ideal for pedestrians, but having this facility is better than no provision for access at all through Mount Victoria.

While the new tunnels could be widened to provide access for pedestrians and cyclists, this is not considered ideal from a cost point of view.

The cost of providing a new tunnel just for pedestrians and cyclists, perhaps located adjacent to the Bus Tunnel so as to minimise tunnel length would be between $20 million and $30 million. The benefits are unlikely to justify this cost.

This leaves the only practical solution of leaving the existing pedestrians route within the tunnel, perhaps with some provision for improved ventilation or providing pedestrians with a separately ventilated space.

17 Description of Cycling Options

17.1 Overview

The purpose is to enhance the existing cycling environment with a view to maintain (and increasing) existing mode share while also improving safety. It is important to note that whilst cycling is a viable transport mode, the number of people who cycle in Wellington is presently very small albeit increasing.

Accordingly, an efficient use of the road space to allow and encourage cyclists (particular commuter cyclists who are the main users of the primary cycle network[136]) to access the CBD is needed. Typically, cycle routes need to be safe, comfortable, direct, coherent and attractive whilst for commuter cyclists, with median trip lengths of approximately 5km, most will choose faster routes at the expense of higher perceived safety, comfort and attractiveness.[137]

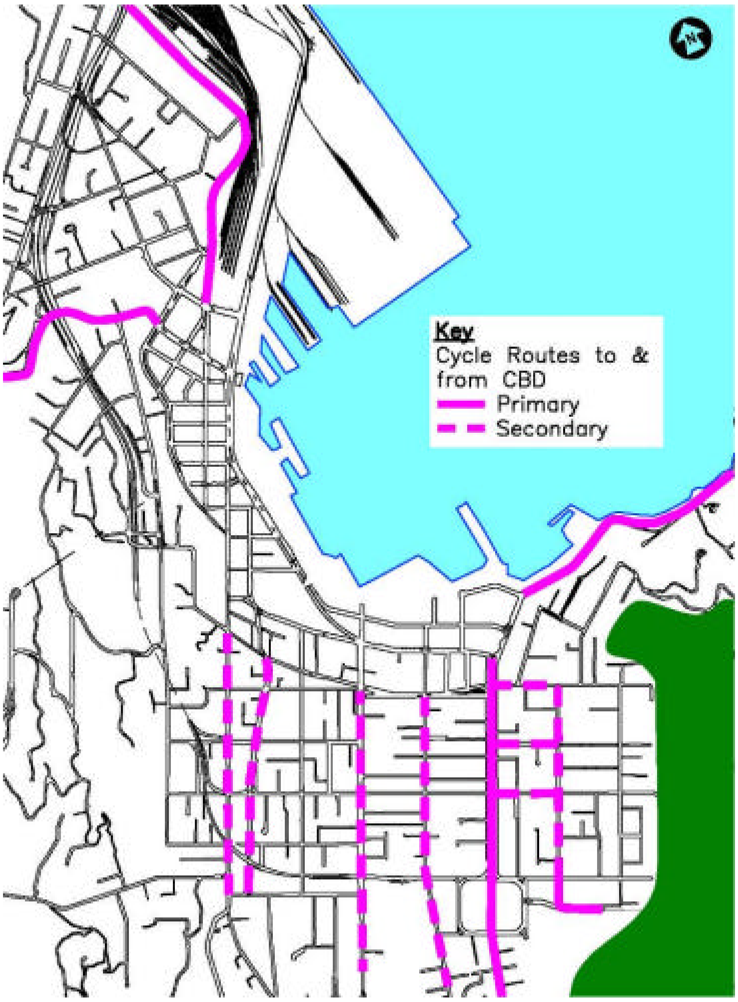


Figure 17.1: - Possible Cycling Route Hierarchy

Given the need for direct and coherent routes to the CBD from the suburbs, rather than routes with a number of detours associated with it, the opportunity exists to use appropriately designed bus lanes.

17.2 Hierarchy

An outline of a possible cycling route hierarchy is shown in Figure 17.1. It is acknowledged that there is a need to connect these routes through the CBD - not solely along the existing Waterfront shared path. As such, passenger transport improvements through the CBD should take into account cycle access needs and be designed accordingly to ensure that cyclists are not prevented from using them

[136] Land Transport Safety Authority. Cycle Network and Route Planning Guide. 2004
[137] Land Transport Safety Authority. Cycle Network and Route Planning Guide. 2004

on safety grounds. Furthermore, it emphasised that Figure 17.1 needs to be considered in conjunction with wider strategic cycling issues, particularly those being considered by the city, including linking the two existing east-west routes on the Inner City Bypass and Waterfront.

17.3 Complimentary Facilities

Just as traditional transport planning has considered the need to provide an appropriate amount of car parking at destinations around the city, the provision of secure cycle parking (and other end of trip facilities eg baggage lockers and/or showers) are essential in order to fully meet the needs of cyclists.

18 Transportation Modelling Results and Analysis

18.1 Introduction

Given the options presented in the previous Chapters, a range of transport scenarios have been modelled for the study area to enable the project team to determine the likely impact on the regional and local transport network. Two transportation models were used. The GWRC strategic transport model (WTSM), which extends over the whole region and has ability to predict future transport effects of a range of modes including passenger transport and walking. We have also used the GWRC SATURN model (SATURN), which covers the study area in some detail and can be used to investigate the effects on general traffic within the City.

The results from each of the modelled scenario's are discussed in detail in Appendix F and includes comment on the redistributed traffic flow within the network as well as a comparison between these future traffic flows and the theoretical 'operational capacity' of that road link. The impact of many of the scenarios is often limited to a few key arterials within the study area, and we have limited our comments to those routes where a significant change in traffic flow has occurred. This might have been as a result of providing additional capacity for general vehicles or as a result of taking road space away from general vehicles for alternate modes such as passenger transport.

The theoretical 'operational capacity' of that road link has been based on Austroads[138] guidelines. As identified in Chapter 3 and Appendix E, a number of key arterials within the study area already operate significantly above theoretical capacity (with a corresponding low Level of Service) creating significant constraints in the network and dispersal of traffic flows away from the most efficient or direct route. Therefore, increasing the capacity of one route appears to induce more vehicles to use that route, diverting vehicles from less attractive routes within the network that they use at present - often referred to as induced traffic - such that the link continues to operate well above theoretical capacity. This is the case for the duplication of the Mount Victoria Tunnel. This is not necessarily undesirable, as many of the alternative routes used by vehicles were not intended to provide an arterial function and this creates adverse affects for those who live along these routes or use these routes for walking or cycling.

18.2 Predicting Future Mode Share

In order to test the sensitivity of mode share in future years for an extreme range of transport solutions, two transport scenarios were tested in WTSM. The first was a full roading scenario, where additional roading improvements were made to relieve congestion at known bottlenecks, as summarised in Table 18.1. The second was to make significant improvements to passenger transport, often at the expense of reducing capacity for general vehicles where a dedicated right-of-way was required for a passenger transport corridor. As part of this second scenario, the effects of Travel Demand Management were included by adopting the approach recommended by Land Transport New Zealand[139] with respect to

[138] Austroads Guide to Traffic Engineering Practice Part 2:Roadway Capacity
[139] Land Transport New Zealand, Interim Travel Behaviour Change Procedures, December 2004, page 11: medium 'alternative diversion' rate.

reducing the number of car driver motor vehicle trips. This effectively reduced the total number of car trips for the region by about 18,000, transferring 50% to passenger transport and the remainder to walking and cycling.[140] A full description of this second scenario is given in Table 18.2 - also refer to Figure 8.1

Travel Demand Management has taken a stronger focus in transportation planning in New Zealand in recent years. The extent to which many of the travel demand management concepts will reduce private motorcar use remain unclear. One of the most promising concepts is travel planning schemes[141], which appear to have some success[142] in increasing alternatives to the private motor car, particularly walking. A recent detailed Opus[143] study in Auckland found that travel planning could help contribute to replacing 5 to 6% of motorised trips with active modes such as walking.

Figure 18.1 presents the mode share for the two scenarios and compares these with the mode share today and the mode share in future years without any additional transport improvements within the study area. The mode share was calculated just for the study area[144] (not the whole region). We can make a number of observations from Figure 18.1

- The passenger transport and TDM scenario results in a 30% increase in passenger transport trips in the morning peak period compared to the 2016 do-nothing scenario.
- The passenger transport and TDM scenario results in a 6% increase in active mode trips (walking and cycling) in the morning peak period compared to 2016 do-nothing scenario.
- The passenger transport and TDM scenario reduced the total number of car trips by about 9,000 trips (which is about an 8% reduction in trips) compared to the 2016 do-nothing scenario.
- The full roading scenario did not significantly reduced the number people using passenger transport or active modes; nevertheless it does result in significant economic benefits in terms of reduced travel times.
- The decrease in car tips associated with the passenger transport and TDM scenario is less than the increase number of car trips associated with population growth and associated economic activity within the region. Accordingly, in the morning peak, the number of car trips being made in 2016 with the passenger transport and TDM scenario is still predicted to be about 10% more than the number of car trips predicted for 2001.
- Given the above observations, the only feasible way of reducing car trips is to make a greater commitment to more intensified urban areas, which have been shown to not only increase walking trips but when located near high quality passenger transport, increase passenger transport trips.

[140] An error in the TDM coding was discovered after this report was written. While the full 18,000 car trips were removed from the model, only 3,500 Pt trips were added instead of about 9,000. This error has been adjusted in Figure 18.1; but has not been adjusted in other reported passenger transport numbers, meaning that PT trips will be slightly under predicted.
[141] ARTA Sustainable Transport Plan http://www.arta.co.nz/xxarta/plans-and-policies - "Sustainable Transport Plan 2006-16"
[142] Louise Baker; "Workplace Travel Plans - A New Rule of the Game", NZPI Conference March 2007 (yet to be published)
[143] Opus; "AMETI, Travel Demand Management Sector Plan", for Auckland City Council, Sept 2006)

[144] Study area here can best be described as the boundaries for the Wellington City Council.

- The WTSM assumes a moderate population growth scenario. If Wellington was to experience higher growth, the increase in number of car trips will be higher than that shown in Figure 18.1 and predicted elsewhere in this study.

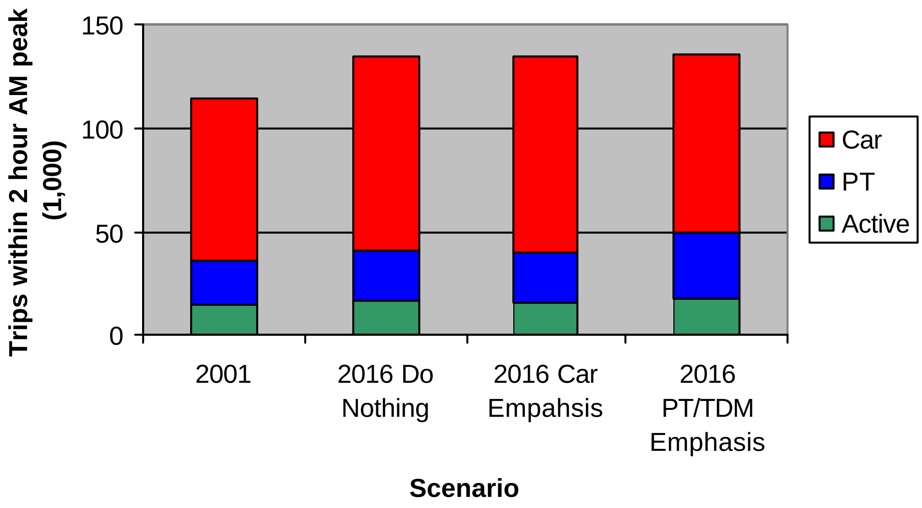


Figure 18.1: - Overall Impact on Mode

Key impacts on the two scenarios are tabulated in Appendix F for the roading scenario and the passenger transport scenario. From this analysis we can make the following general observations.

- Removing the known constraints within the road network, particularly at Ngauranga Gorge, Terrace Tunnel and around the Mount Victoria Tunnel results in improved travel time and less congestion for general vehicles, including commercial vehicles serving key freight generators particularly the port and airport.
- Removing the known constraints within the road network, particularly at Ngauranga Gorge, Terrace Tunnel and around the Mount Victoria Tunnel result in a re-distribution of vehicles off other parallel but less attractive routes. Along the Hutt Road, this will provide an immediate benefit to buses that use this route, improving travel time due to less congestion.
- By 2016 it is predicted that the resulting increase in traffic, SH1 will be operating at capacity, almost consistently along its length during the morning and evening peak. It is difficult to see how this capacity can be easily increased.
- Providing additional capacity on the motorway between Ngauranga and Aotea Quay will enable road space to be reallocated along the Hutt Road for passenger transport – and if need does not require the immediate reallocation then consideration should be given to protecting the space for such a facility for future generations.
- The duplication of the Terrace Tunnel will successfully diverted traffic from the waterfront to the Motorway. The Terrace Tunnel is predicted to operate close to its theoretical capacity. Therefore, the increased capacity provided by the motorway and Inner City Bypass is

insufficient[145] to meet the increase in traffic volumes in future years associated with ongoing population growth, and it is expected that the three lanes along the Waterfront will remain full and will operate near their theoretical capacity. Consequently, the reduction of the Waterfront route from three lanes in each direction to two (or less) is unlikely to be achieved without incurring negative travel time benefits for motorists.

- Traffic is predicted to divert from Evans Bay Parade to the duplicated Mount Victoria Tunnel, making Evans Parade less congested and safer for cyclists and other users. The Mount Victoria tunnels (despite duplication) and Ruahine Street are expected to operate at or close to their theoretical capacity.
- Improving the Basin Reserve intersection increases the attractiveness of Adelaide Road diverting vehicles from the parallel route on Wallace Street. This has amenity and safety benefits for those along Wallace Street, which presently accommodates vehicle numbers well above that it was designed to carry. The number of vehicles using Adelaide Road should ideally be accommodated within two-lanes, and this competes with the need to provide for a passenger transport corridor along Adelaide Road to serve the growth nodes.
- If Adelaide Road is used as a passenger transport corridor, increased capacity for general vehicles is needed elsewhere, probably along Wallace Street. This re-arrangement in use of road space reduces the complexity of traffic movements at the Basin Reserve but increases pressure at the intersection at Taranaki and the Inner City Bypass.
- The passenger transport scenario included replacing Adelaide Road as a passenger transport corridor with a one lane pair for general traffic operating along Adelaide and King (refer to Option W2). As a result, northbound traffic flows reduce by 2,200 vehicles along Riddiford Street and 1,000 vehicles along Adelaide Road, with a lesser reduction on Constable Street in the morning 2 hour peak period.
- Providing a light rail service from Johnsonville to the airport resulted a 65% increase in passenger boardings along the length of the Johnsonville line within the morning 2 hour peak period.
- The light rail system from the railway station to the airport is expected to attract some 5,300 passengers within the morning peak over the entire route. Passengers using light rail are generally at the expense of bus passengers, including those between south and eastern suburbs and the CBD. The section of the light rail from Kilbirnie to the Airport carries almost no passengers.
- In the passenger transport scenario, up to 7,700 passengers are expected to use the Kapiti passenger heavy rail line – a 25% increase from the committed base.
- The number of passengers using light rail between Mt Victoria and the Airport is predicted to be only 100 passengers (both directions) in the morning and 40 passengers (both directions) in the evening. This compares with over 2,200 passengers (both directions) using buses.

It is apparent that all transport modes have an important contribution to meeting the mobility needs of the city in future years. Therefore the transportation strategy must make provision for enhancing all

[145] In both the morning and evening peaks, the increase of northbound vehicles along the Waterfront appears to be caused by trip re-assignment due to the wider road improvements. In particular, the Inner City Bypass and Willis Street intersection appears to be causing some delays, which may result in some northbound traffic travelling via the Waterfront.

modes. This is easier said than done, as it will place undue demand on existing road space and available finances to achieve it. As can be seen in the following discussion about some of the key impacts of both scenarios, often increased capacity is needed for general vehicles in order to be able to provide the needed road space for improving the capacity for passenger transport without imposing additional congestion for general vehicles.

18.3 Modelling Results for Options

Table 18.3 summarises the results from the WTSM transportation modelling for the various options and combination of options described earlier in the report. Mode share and total transportation trips did not vary significantly. Many of the impacts of the various options are similar to those discussed earlier and presented in more detail Appendix F; although the actual change in vehicle numbers vary slightly depending on the option or combination of options being tested.

A number of observations can be made regarding the impact that an individual option or a combination of options has on the wider network: -

- Capacity improvements at the Terrace Tunnel and Aotea to Ngauranga Gorge reduce traffic using the Waterfront and Hutt Road whilst increasing flows along SH1. The increase in traffic along SH1 puts pressure on parts of the Inner City Bypass, Basin Reserve and the Mount Victoria Tunnel (and Ruahine Street).
- Making capacity improvements at the Basin Reserve (as a stand alone project) increases traffic using the Mount Victoria Tunnel, Adelaide Road and Kent Terrace putting pressure on existing routes, and even has minor impacts on the Waterfront with some small increases in traffic predicted given the ease of the north-south movement at the Basin Reserve.
- Improvements to only Mount Victoria Tunnel and Ruahine Street attract traffic volumes along SH1; however, Adelaide Road experiences a reduction in traffic volumes. Adding improvements at the Basin Reserve negates any Adelaide Road reduction by increasing flows along Adelaide Road. This increase competes with the desire to use Adelaide Road as a passenger transport spine and to create a growth node.
- As such, grade separated improvements to the Basin Reserve will typically have a detrimental impact on north-south movements along the proposed Kent Terrace/Cambridge Terrace and Adelaide Road passenger transport spine in terms of an increase in motor vehicle trips.
- A reduction in traffic capacity along Adelaide Road will force motorists to use Wallace Street to access the CBD and Inner City Bypass. However, the total number of northbound vehicles during the morning peak period will already be somewhat reduced should improvements be carried out along Ruahine Street and Mount Victoria Tunnel.
- The provision of enhanced passenger transport initiatives such as priority measures in the CBD and on the key approach roads tend to complement roading changes given the reduction in traffic flows on parts of the key passenger transport hierarchy. Conflict may occur along the Waterfront given the reduced capacity along Lambton Quay which results in traffic reassigning to the Waterfront.

Table 18.1: - Scenario One Roading Improvements

Improvement	**Option Number** (details in report)
8 laning Aotea to Ngauranga	Option A1
Terrace Tunnel duplication	Option T2
Existing 6 lanes on Waterfront retained with a grade separation of the rail crossing at Waterloo Quay	
Mount Victoria Tunnel duplication with southbound traffic having direct access from Vivian Street/Pirie Street to Ruahine Street.	Option B1
Grade separated Basin Reserve with northbound vehicles travelling from the Tunnel to Buckle Street passing over north-south between Adelaide Road and Kent Terrace/Cambridge Terrace.	Option B3
4-laning of Ruahine St, Wellington and Cobham Drive to Kilbirnie Crescent with at-grade intersection improvements at Goa Road and the Wellington Road intersections.	Option R1
Grade separation at the Wellington/Kilbirnie and Cobham/Evans intersections	
Minor capacity improvements at the Cobham/Troy and Cobham/Calabar roundabouts	Option R2

Table 18.2: - Scenario Two Passenger Transport Improvements

Improvement
Heavy Rail service improvements (Increasing rail frequency along the Kapiti and Hutt lines to 10 minute headways), include a 20 minute rail service to Waikanae during AM and PM Peak.
Light Rail between Johnsonville and the Airport via the railway station, the Waterfront, Cable Street, Kent Terrace, Newtown and Kilbirnie. The light rail system is typically implemented at the expense of a reduction in the level of service to general road traffic along links and at-grade intersections with a grade separated interchange envisaged at the Basin Reserve to minimise delays to both light rail and the state highway traffic.
Doubling of existing bus frequencies along various bus routes with a minimal transfer penalty between bus and light rail services at high quality transfer stations between bus and light rail.
Bus priority measures through the CBD and Courtenay Place in addition to other priority measures such as bus lanes and pre-emption signals on the approach to the CBD for instance along the Hutt Road and Thorndon Quay, Cobham Drive as well as through Newtown and Kilbirnie.
Other Strategic passenger transport interventions assumed such as signal detection and bus activation at signals, signal management (SCATS) to link groupings and key bus corridors, electronic ticketing on buses.
TDM measures based on the introduction of work place travel plans and household and community based initiatives.

Table 18.3: Summary of Transportation Modelling

Options	Travel Times (general vehicles) (mm:ss) (AM peak)		Economic Benefits (million)
	Airport-to CBD	**Gorge-to CBD**	
2001 Base	9:20	14:00	
2016 Committed Base	12:10	14.30	
Option A1 Ngauranga capacity Improvements	N/C	N/C	$40
Option T2 Terrace Tunnel Tidal Flow	N/C	N/C	-$1
Option T1 Duplication of Terrace Tunnel and **Option A1** Ngauranga capacity Improvements	12:26	11:40	$60
Option B3 Grade Separation of Basin Reserve	12:10	13:50	$34
Option B2 Mount Victoria Tunnel Duplication and **Option R1** four laning of Wellington Road	N/C	N/C	$54
Option B3 Basin Reserve Grade separation, **Option B2** Mount Victoria Tunnel Duplication and **Option R1** four laning of Wellington Road and **Option R2** Cobham Drive Improvements	9:00	13:50	$149
Light Rail from airport to railway station	13:40	14:00	-$19
Golden Mile/CBD Fringe Bus Priority Scheme	N/C	N/C	-$3.4
Bus priority improvements and TDM Measures and **Option W2** Adelaide Road/King Street one-way pair with limited north-south access for general vehicles at the Basin Reserve and grade separation for buses.	11.50	15.50	-$184
Option H Heavy Rail Penetration	No Change	No Change	$43
Option D2 Waterfront reduction	N/C	N/C	-$60
Option T1 Duplication of Terrace Tunnel and **Option A1** Ngauranga capacity Improvements **Option D2** Waterfront reduction (one lane each direction)	12:20	12:45	-$51
Option B5 At grade at Basin reserve with one lane around the Basin dedicated to passenger transport and passenger spine along Adelaide Road limiting general vehicle movements.	12:00	13:50	-$35

N/C = not calculated

19 Indication of Cost

19.1 General

The total project out-turn cost includes all items required to construct the options described in this report. The estimating process was generally in accordance with Transit SM014 process. The indication of cost excludes escalation and GST and has a date of February 2007. Construction cost rates have been based on recent roading projects in NZ and, in the case of light rail, in Australia but adjusted accordingly to suit the particular issues of these projects. In the case of tunnel estimates, rates were based on detailed analysis of the cost of constructing the previous Terrace Tunnel, but adjusted for latest construction techniques and rates.

In order to provide an indication of the likely cost, we have assessed the risks to the project and assigned a cost value to account for the resulting uncertainty these risks create. This applied to all cost items in the estimate including land, fees and construction items. To reflect the resulting uncertainty, the indication of cost is presented in terms of an expected value and 95%ile value. The later is the estimate upper limit, which on average should only be exceeded once in every 20 projects.

19.2 Option costs indication

Table 19.1 presents a summary of the cost of various options.

19.3 Indication of total corridor cost

Some but not all of the Table 19.1 options will form part of a corridor plan for the study area. The decision of which options will form part of this plan will not be taken until after consultation and further technical analysis. Assuming that a final corridor plan will include improvements passenger transport, pedestrians and general vehicles, then the total cost for the study area could range between $650 million and $900 million, depending on the options adopted.

Not included in these costing are: -

- Additional bus priority measures needed along routes other than the main passenger transport corridor from the railway station to Newtown.
- Streetscape work associated with the passenger transport corridor. This cost is not insignificant (Auckland’s Queens Street upgrade is costing $36 million for example).
- Creation of pedestrian corridors along Featherston Street.
- Additional operating costs for passenger transport services.

Table 19.1 Cost Indication

Mode	Option	Cost Indication $ Millions Expected	95%ile
General vehicles	**Ngauranga to Aotea**		
	Option A1 Existing Shoulder & Temporary Lane	42	53
	Option A2a Reduced lanes width permanent lanes	49	65
	Option A2b Reduced lanes width permanent lanes	45	60
	Terrace Tunnel		
	Option T1 Tidal Flow	3	4
	Option T2 Two-lane Duplication	161	268
	Option T3a) Single lane Duplication	91	149
	Option T3b) Single lane restricted Duplication	78	125
	Mt Victoria Tunnel and Basin Reserve		
	Option B1a[1] Pirie Tunnel and Option B4 One-way grade separation at Basin Reserve	279	435
	Option B1b[2] Pirie Tunnel and Option B4 One-way grade separation at Basin Reserve	289	450
	Option B2 Paterson Tunnel and B3 Two-way grade separation	198	317
	Option B1a Pirie Tunnel and Option B5 One-way at grade at Basin Reserve	257	402
	Ruahine Street to Airport		
	Option R1 Four-lanning and Option R2 Roundabout improvements	38	61
	Wallace Street		
	Option W1 Four lanning	44	72
	Adelaide Road		
	Option W2 One-way operation with King Street	12	22
	Option W3 Adelaide Boulevard (two-lanes for general traffic)	9	16
Passenger Transport Corridor	**Busway** (Railway Station to Basin Reserve)[3, 4]	18	33
	Light Rail Option[5] (Railway station to Newtown)	140	218
Other Passenger Transport	Option H Heavy Rail extension to CBD	308	441

1. Option B1a includes grade separation at Vivian Street, Pirie Street and Kent and Cambridge Terrace

2. Option B1b Signals at Vivian Street, Pirie Street and Kent and Cambridge Terrace 1.

3. The cost of extending the busway along Adelaide Road is covered in Option W2. Includes Option P1, P2 and P3 (Courtenay Place to Basin Reserve)

4. This cost excludes the cost of any street scape, which could add another $30 to $70 million depending on what was undertaken and the extent of the works.

5. Assumes 8 light rail vehicles and is additional to the cost of creating the right of way (i.e. additional to Bus Option)

20 Conclusions

20.1 Overview

1. Wellington can be considered a more sustainable city than other NZ cities, with residents not only travelling fewer kilometres per year but fewer kilometres by the private motorcar. Instead, Wellington residents are more likely to travel by passenger transport and walk more than other NZ large city residents.

2. A growing proportion of dwellings being built in Wellington are median and high density. This trend will help make passenger transport initiatives more viable in future years.

3. Wellington can be expected to continue growing over the next planning horizon, and this increase in population will increase the number of trips people make, both passenger transport and private motorcar. While it is desirable to make walking and cycling and passenger transport more attractive alternative to the motorcar, it is clear that the number of trips associated with a growing population is outstripping the projected shift from private car to an enhanced passenger transport system. This means that investment is needed in improving all modes.

4. There is only a limited supply of road space, and all three modes must compete for access to it. The concept of creating corridors which give priority to one mode over another will improve the way road space is presently used and significantly enhance the amenity for pedestrians and other users.

20.2 Passenger Transport

5. The success of the growth nodes at Kilbirnie and Newtown is dependant on providing a high quality, frequent and reliable passenger transport service to these areas. To create the vibrant urban form needed to make these growth nodes a success, it is essential that the node is very walk-able and that the passenger transport corridor is located through the node. While we can expect a very high proportion of people living within these nodes to use walking and passenger transport for many of their trips, a number of trips can only be made by the private motor car. Consequently, it is also necessary to provide adequate capacity for general vehicles to these nodes. To ensure the nodes are walk-able, key roading arterials should be located around the node and not through them.

6. The viability of a high quality passenger transport system for Wellington is dependant on creating these growth nodes or increasing the areas of medium density.

7. The growth node at Newtown is very close to the CBD meaning that walking will compete with passenger transport, making passenger transport less viable than if the node was located further from the CBD.

8. Given the above two observations, the key focus for passenger transport within the next planning horizon is to provide a high quality, frequent, reliable passenger transport corridor to the Newtown growth node. Associated with this node is the Wellington Hospital facility and Massey University (albeit not immediately adjacent to the corridor), which have the potential to be a high passengers generators. To create the needed level of service, this corridor should be allocated with its own right-of-way, such as a dedicated busway. Where this is not feasible, bus lanes should be provided; but only if used in conjunction with enforcement.

9. Light rail is regarded as a high quality passenger transport system which will maximise the success of the proposed growth nodes and encourage intensified development along the route, particularly along Kent and Cambridge Terraces. While this is likely to help generate increased patronage in future years, light rail can be expected to generate similar benefits to a bus based system in the shorter term. It is the view of the project team therefore that light rail is unlikely to generate a significantly greater number of passengers than a high quality bus system with its own right-of-way within the medium planning horizon. A light rail system has significant additional capital cost to a bus based system.

10. Buses are able to penetrate the lower density suburbs while also using the high speed right-of-way along the passenger transport corridor without imposing a time penalty for transfers. Newtown and Courtenay Place which are considered too close to the CBD to encourage transfers between bus and light rail. Therefore while a light rail system will attract more passengers along the route because of its perceived higher quality, particularly as a result of intensification, it is unlikely to be as attractive to passengers who must travel from the suburbs by bus, particularly if they are forced to transfer at Newtown and Courtenay Place.

11. Once the road space has been reallocated to provide a right-of-way for buses, this protects the road space for other types of passenger transport systems to be provided in future years. Once the growth nodes have been established and urban density increased, future generations may have other passenger transport options available, such as future generation of buses and electronically guided bus system which look and operate like a light rail system but use the existing road surface rather than rails.

12. The passenger transport corridor serving Kilbirnie should be of a lower quality than that proposed for Newtown, at least in the short term (albeit still with priority measures provided). This is because the passenger numbers expected to be generated by Kilbirnie as insufficient to justify a higher quality route. Two alternative routes presently serve Kilbirnie: one via Newtown and one via the Bus Tunnel. The route via the bus tunnel is preferred given that it travels along a route with lower traffic volumes which allows for a more reliable passenger transport service that is not adversely affected by other vehicles using the same route.

13. The airport is unlikely to generate the needed passengers to make extending the passenger transport corridor to the airport (with or without light rail) viable. However, providing some bus priority measures at key congestion points could be considered.

14. While it is not recommended to extend the passenger transport corridor to the north along Hutt Road within the present planning horizon, it is recommended that road space made available

by any roading improvement along SH1 be protected for future passenger transport use. Some bus priority measures at key congestion points should be considered in the short term.

15. In addition to the passenger transport corridor, there is the opportunity to improve general bus services along other secondary routes by providing bus priority measures at key locations. As part of this, a bus route hierarchy is recommended.

20.3 Pedestrians

16. Notwithstanding a significant increase in capacity of the motorway as a result of duplicating the Terrace Tunnel and the reassignment of vehicle trips to this route, the waterfront will remain very busy at peak time in both directions – although it will carry fewer vehicles than it does at present. With Wellington's increasing population comes an increase in the number of trips, and this increase cannot be accommodated within the upgraded urban motorway forcing vehicles to continue to use the waterfront as an alternative. Consequently, reducing the waterfront to two-lanes in each direction may create congestion along other routes and incur negative benefits.

17. Creating pedestrian corridors and passenger transport corridors in conjunction with an improved parking strategy will increase walking and improve safety and amenity: making Wellington an even more walk-able city.

18. Several pedestrian corridors have been identified as part of this study. Widening and other improvements are required along some of these routes to give pedestrians the required priority.

19. There is poor access for pedestrians from Hataitai and other eastern suburbs, with lower number of workers walking to work from these suburbs than other suburbs that are even further distance from the CBD. Improving pedestrian access is challenging and expensive, and is unlikely to create sufficient benefits to justify the cost.

20. The proposals for the Basin Reserve have the potential to improve pedestrian access to and around the Reserve.

20.4 Cars and Commercial Vehicles

21. All key arterials within the study area will be operating at or near theoretical capacity by 2016, even with the significant investment in removing key congestion points within the corridor. Without these improvements or without constraining population growth, the network will provide an increasing lower level of service. The need to re-allocate road space for passenger transport corridors and the need to enhance pedestrian connections puts further pressure on the roading network.

22. The widening of the motorway from Ngauranga Gorge to Aotea Quay looks likely to provide the greatest return on investment. In addition to the improved travel time that this option creates, it diverts traffic from the Hutt Road, creating the opportunity to provide greater priority along this parallel route for buses. The benefits of this project appear to be independent of other projects.

23. Duplicating the Terrace Tunnel does not look viable, certainly in terms of savings from reduced travel time for motorists. However, it is needed to help mitigate the effects of reducing capacity of the waterfront route. Given the large costs involved, the concept of a single lane car only tunnel is worth considering. While feasible and relatively cheap, tidal flow may not produce the required benefits, given the strong traffic flows that operate in both directions through the tunnel.

24. Duplicating the Mount Victoria Tunnel and associated improvements along Ruahine Street and at the Basin Reserve provide the greatest economic benefits associated with improved travel time and reduced vehicle operating costs. However, the indicative costs associated with these improvements are unlikely to generate a benefit cost ratio much greater than one.

25. Duplicating the Mount Victoria Tunnel and associated improvements along Ruahine Street and at the Basin Reserve result in a significant reduction in traffic using Evans Bay Parade and to a lesser extent Constable Street.

26. The proposal to create a growth node at Newtown and the associated passenger transport corridor along Adelaide Road creates the opportunity for different solutions to the Basin Reserve than what has been considered in the past. Given the need to divert large traffic flows around the growth node, using Taranaki Street and Wallace Street, and discourage traffic using Adelaide Road, a significantly cheaper at-grade solution at the Basin Reserve could be considered.

27. While growth nodes encourage alternatives to the car, the nodes will still generate a large number of private vehicle trips. Given this, and the reassignment of vehicles from Adelaide Road, it is necessary to increase the capacity and arterial function of Taranaki Street and Wallace Street. While widening to four-lanes would create the required capacity and improve its arterial function by minimising side friction, a significant number of properties would need to be acquired.

28. An alternate to widening Taranaki Street and Wallace Street is creating a two or four-lane boulevard for general vehicles along Adelaide Road, together with two additional dedicated lanes for passenger transport. The cross section would be similar to Kent and Cambridge Terrace. This requires a significantly wider road reserve along Adelaide Road, creating less space for pedestrians and or building footprint. The large traffic volumes are not conducive to walking and will significantly reduce amenity for pedestrians, potentially reducing the value and success of the growth node.

29. While the idea of extending Vivian Street under Mount Victoria in the Pirie Tunnel would create a more direct route for southbound SH traffic and would make construction of a grade separated option at the Basin Reserve easier to construct, it is more expensive than the Paterson Tunnel options.

20.5 Cost Indication

30. It might cost somewhere between $650 million and $900 million to complete the needed projects within the study areas and which might form part of a future corridor plan.

Appendices

Appendix A: Broad Classifications of Bus Priority Measures

Table A1 Broad Classifications of Bus Priority Measures.
Link Capacity:
• Bus only areas; • Busways and guided bus facilities; • Traffic restrictions (by type and/or hours); • Increased bus lanes; • Contra flow bus lanes; • Bus lane segregation; • High occupancy vehicle (HOV) lanes; • Tidal traffic flow and associated bus lanes; • Bus only turns; • Traffic restrictions and associated controlling mechanisms (rising bollards); • Removal of width restrictions or physical barriers associated with narrow sections of carriageway (including single trolley lines which result in delays when buses break down or are stuck in traffic); • Additional bus tunnel or road space within existing tunnels; • Route base parking and loading strategy (clearways, pay and display, and shared use facilities); • Corridor or link charging / tolling; • Enforcement strategy (corridor approach to bus priority measures and parking); and • CCTV route management and enforcement.
Traffic Signal Capacity:
• Signal control and management (stage skipping, local extensions, SCATS etc.); • Improved pedestrian control and crossing management; • Signal approach and exit detection systems; • Door activated signal detection (signal / stop integration); and • GPS tracking of buses (real time information, signal co-ordination and route management) *(also a bus stop and link issue).*
Bus Stop Capacity:
• Introduction of split bus stops and other measures to allow buses to pass buses at bus stops; • Cashless and/or electronic ticketing; • Real time passenger information; and • Improved bus stop accessibility (removal of clutter) and ease of access to buses (2 door boarding);

Appendix B Enhancing Pedestrian Movements

It is important to understand general 'drivers' and issues related to walking (see below) and then relate them specifically to Wellington – in particular to preferred and identified routes (to/from the City and within the City).

Table B1:- Why People Don't Walk: - Common shortcomings in the physical environment

Source: Land Transport NZ

- missing footpaths or sections of footpath
- poor quality (cracked, uneven or slippery) walking surfaces
- obstacles on the footpath, including poorly placed street furniture
- lack of maintenance of footpaths, including litter, dog fouling, and overhanging vegetation
- increased distances imposed by road layouts, barriers, footbridges and subways
- lack of continuous signing to potential destinations
- uncertainty about whether a route is fully accessible
- a lack of continuous pedestrian routes
- missing or unsuitable crossing treatments creating severance
- poor quality lighting
- speeding traffic
- lack of rest areas and seating
- traffic fumes and noise
- no through routes, which require indirect routes
- public routes which appear to be private
- lack of shade
- lack of shelter from inclement weather
- lack of interesting features on the route.

Table B2: - Why People Don't Walk: - Potential Social and perceptual Issues

Source: Land Transport NZ

- a perceived lack of time to make journeys
- a lack of confidence in the walking infrastructure
- confusion about which route to take and how far the destination is
- a perception that pedestrians generally have a low social status, especially in relation to car drivers
- perceived risk to personal security and/or a lack of surveillance
- a perception that motorists do not properly understand the rights of pedestrians.

Table B3: - Primary characteristics of walk-able communities

Source: Land Transport NZ

Characteristic	Definition	Benefits
Connected	The extent to which the pedestrian network links to key trip origins and destinations, as well as the extent of linkages between different routes on the network.	People can walk from one place to another without encountering major obstacles, obstructions or severance.
Convivial	The extent to which walking is a pleasant activity, in terms of interaction with people, the built and natural environment, and other road users.	Pedestrian routes are friendly and attractive, and are perceived as such by pedestrians.
Conspicuous	The extent to which walking routes and public spaces feel safe and inviting for pedestrians.	Suitable levels of lighting, visibility and surveillance over its entire length, with high quality delineation and signage.
Comfortable	The extent to which walking is accommodated for all types of pedestrian within the transport corridor.	High quality and well-maintained footpaths of suitable widths, attractive landscaping and architecture, shelter and rest places and a suitable allocation of roadspace to pedestrians.
Convenient	The extent to which walking is able to compete with other modes of transport in terms of efficiency (in time, money and space).	Walking is a realistic travel choice, partly because of the impact of the other criteria set out above, but also because walking routes are of a suitable length as a result of land use planing with minimal delays.

Table B4: - Pedestrian Infrastructure Issues

Source: Land Transport NZ

- Good provision is made for those with mobility and cognitive impairments throughout the entire network.
- The speed of motorised traffic is physically regulated to ensure the 85th percentile speed is well below the maximum speed limit, thereby improving the environment for pedestrians.
- In areas of high pedestrian density, traffic speed is determined by pedestrians, or the pedestrian routes are specifically designed to provide a higher level of safety.
- Pedestrians are placed at, or close to, the top of the road user hierarchy, with suitable land use allocations, treatments and minimised delay in locations where they may come into conflict with other road users.

Table B5: - Important elements of urban form for pedestrians

Source: Land Transport NZ

Element	Definition	Typical benefits
Pedestrian permeability	The extent to which an accessible environment is provided for pedestrians, free of obstruction and severance.	• Reduced waiting times at traffic signals and crossings • Pedestrians having priority at side road crossings • Pedestrians continuing to use routes which are stopped up for other traffic • The implementation of traffic calming, low-speed zones and home zones
Connections to transport	The extent to which the walking network integrates with likely trip origins and destinations, including the public transport network.	• The pedestrian network linking to obvious trip ends, such as shops, supermarkets, public spaces and community services • Particular attention paid to the interface between trip ends and the pedestrian network, such as providing shelters, seating, and pedestrian signage • The environment in the immediate vicinity of public transport nodes and interchanges being more intensively developed and being pedestrian-friendly

Appendix C: Definition of CBD Area

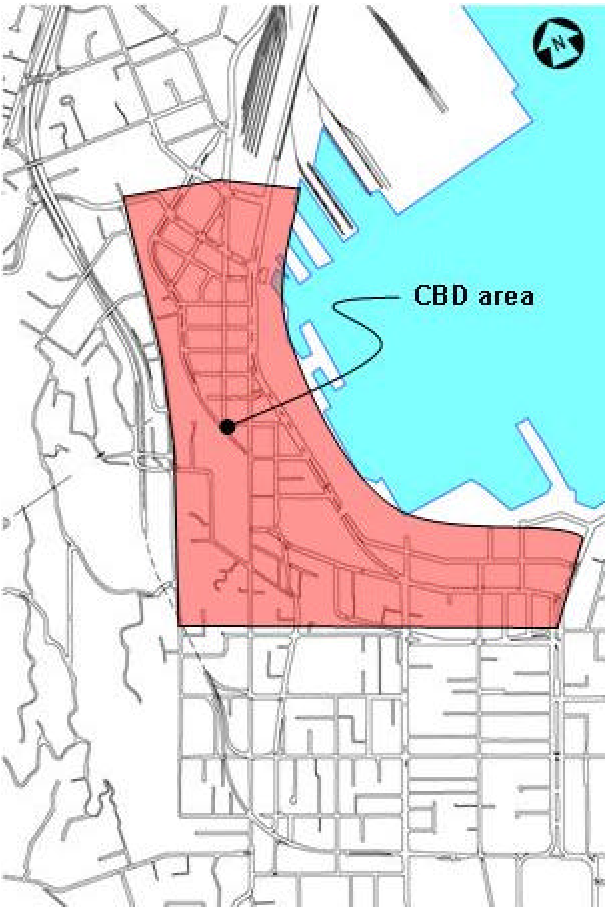


Figure C1: Definition of CBD Area

Appendix D: Issues with Wellington's Existing Bus Network

Table D1: Key Problems and Locations for Bus Network within the Study Area

Classification	Observed Problems	Key Locations
Link	• Inadequate bus priority along key bus routes, particularly between the Railway Station and the Hospital but also some secondary routes that serve this key bus route. • Capacity for buses on links in which general traffic is permitted and no (or limited) bus priority exists. • Interaction between pedestrians and buses at controlled and uncontrolled crossing points (could be signal related also). • Loading and parking disruption and delay. • Buses use historic routes and operation, providing limited passenger flexibility e.g. no direct Airport Express. • Bus on bus delay in locations in which inadequate capacity exists for buses to pass buses (bus tunnel / Willis St) or get through the network at points in which heavy cross flows exist. • Lack of effective enforcement. • Trolley bus breakdowns and delay to other buses and general traffic at points in which sufficient space to pass does not exist.	• Hutt Road (approach to signals); • Thorndon Quay; • Golden Mile; • Two-way working around Wakefield Street/Manners Street and Dixon Street/Manners Street; • Victoria and Willis Streets; • Basin Reserve (north and south bound); • Adelaide Road; • Riddiford Street and Constable Street; • Mount Victoria Bus Tunnel; and • Troy Street and Cobham Drive Roundabouts.
Intersections	• Signal and intersection delay (along route and cross flow interaction). • Limitations in bus detection and priority.	• Hutt Road / Kaiwharawhara Road; • Thorndon Quay / Mulgrave Street; • All signals on the Golden Mile[1]; • Basin Reserve; • Adelaide Road / John Street; • Riddiford Street / Constable Street; and • Wellington Road / Kilbirnie Road;
Bus Stops	• Dwell time associated with ticketing. • Bus stop accessibility and interaction with other modes. • The large number of routes being served by a single bus stop • Inability for a bus to pass another bus at bus stops.	• Wellington Bus Station; • All bus stops on the Golden Mile[2]; • Newtown; and • Kilbirnie

Notes:-
1 Specifically Lambton Quay/Whitmore Street, Manners Street/Willis Street, Taranaki Street/Manners Street), and Courtney Place/Cambridge Terrace/Kent Terrace
2 Specifically Lambton Quay by Whitmore Street, Willis Street, Manners Street (both directions) and Courtney Place

Appendix E: 2001 and 2016 Network Performance

E1 Transport Modelling

The operation and subsequent assessment of the transport network has been based on two transport modelling tools that are maintained by GWRC namely:

- The Wellington Transport Strategy Model (WTSM) which covers the Greater Wellington area. WTSM is a four-step model that forecasts region wide travel demand by mode based on demographic inputs and is used to inform strategy development and the assessment and evaluation of major transport projects. The model has been calibrated and validated to 2001 observed travel patterns and includes future year development scenarios. The model reflects a typical 24 hour weekday period and includes a time period model that disaggregates demand to three periods, the AM, inter-peak and PM peak periods for assignment to the road and public transport network. The model results quoted in this section generally reflect the WTSM outputs.
- A SATURN traffic assignment model covering the City of Wellington that represents the road network in greater detail than WTSM. The SATURN model relies on the vehicle demand supplied by WTSM.

WTSM reflects potential changes in travel patterns due to changes to the road and public transport network including:

- Where significant changes are made this may impact on the distribution of traffic from origin to destination based on changed accessibility
- Changes in mode split between private vehicle, public transport and slow modes
- Redistribution of traffic between alternative routes
- Redistribution of passengers between alternative passenger transport services and modes

E1.1 Level of Service

The main arterial roads through the study area have been assessed with respect to the forecast level of service (LoS) likely to be experienced for the 'base case' in 2001 and 2016. LoS is used as a qualitative measure to describe operational conditions for a stream of traffic[146] and can be based on a number of parameters such as average travel time, delays to traffic or traffic volumes with respect to available capacity. Urban and suburban arterial road LoS are typically described in terms of average travel speeds as urban roads are typically influenced by intersection spacing and their controls, such as traffic lights.

Definitions of the various LoS, as contained in the Austroads Guide[147] are noted below together with the criteria for each given in Table F1.1 for arterials and Table F1.2 for motorways.

[146] Austroads. Guide to Traffic Engineering Practice. Part 2 Roadway Capacity. 1988.
[147] Austroads. Guide to Traffic Engineering Practice. Part 2 Roadway Capacity. 1988

- LoS A Generally free flow conditions with individual drivers virtually unaffected by the presence of others in the stream. Vehicles are unimpeded in manoeuvring in the traffic stream.
- LoS B Relatively unimpeded operation with drivers having reasonable freedom to select travel speeds and to manoeuvre.
- LoS C Stable operating conditions but with manoeuvring and choice of travel speeds becoming more restricted.
- LoS D Conditions are close to the limit of stable flow with drivers severely restricted in their freedom to select desired speed and to manoeuvre within the traffic stream.
- LoS E Traffic volumes are at or close to capacity with virtually no freedom to select desired speed or to manoeuvre within the traffic stream.
- LoS F Traffic flow at this level exceed that which can pass along a section of the road.

Table E1.1 LoS criteria for Arterial Class for Average Travel Speeds

Level of Service	Arterial Class/ Range of Free Flow speeds (km/h)		
	I 55 to 70	II 50 to 55	III 40 to 55
A	>55	>50	>40
B	>45	>40	>30
C	>35	>30	>20
D	>25	>20	>15
E	>20	>15	>10
F	<20	<15	<10

Table E1.2 LoS criteria for Motorways for Average Travel Speeds

Level of Service	Design Speed (km/h)		
	110	100	80
A	>96	-	-
B	>91	>80	-
C	>86	>75	>69
D	>74	>67	>64
E	>48	>48	>45
F	<48	<48	<45

E1.2 2001 Base Case

Key Issues: - Various sections of the main arterial routes into and through Wellington CBD are shown as operating at or close to their theoretical capacity and with a poor level of service. Figure E1.1 shows the LoS during the morning peak period for southbound flows.

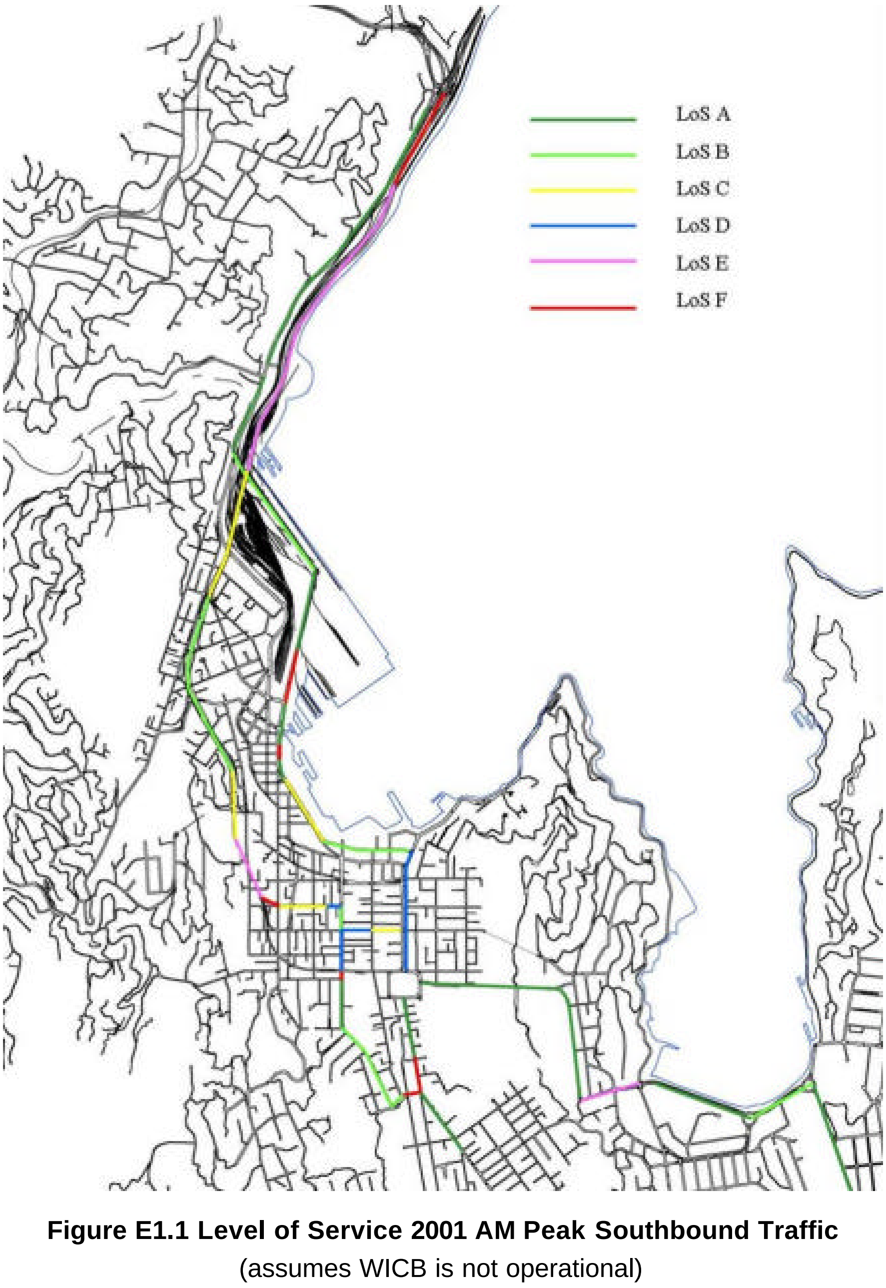


Figure E1.1 Level of Service 2001 AM Peak Southbound Traffic
(assumes WICB is not operational)

Overall, a number of pinch-points or bottlenecks exist in the system, particularly for traffic heading into the centre or around the CBD. The following key aspects should be noted:

- Southbound traffic flows on SH1 between Ngauranga and the Aotea off-ramp operates at LoS E. The Hutt Road typically operates at or close to its theoretical capacity for southbound movements and suffers a reduction in the LoS at approaches to intersections.
- South of Aotea Quay on SH1, speeds were predicted to be remain relatively good resulting in a LoS B or C as far as the Terrace Tunnel where the southbound service level drops to 'F' on the approach to Willis Street.
- Traffic on SH1 between Willis Street and the Basin Reserve in each direction typically experience a range of LoS between 'C' and 'F'
- LoS F is experienced in both directions along Wellington Road between Ruahine Street and Evans Bay Parade with northbound traffic on Ruahine Street and through the Mount Victoria Tunnel operating at LoS C and D respectively.
- Cobham Drive and Calabar Road typically operate at either LoS A or B, with the exception of northbound traffic on Calabar Road approaching the Cobham Drive, Evans Bay Parade and Wellington Road intersection which has a LoS F.
- Traffic along Jervois Quay typically operates at a LoS of between 'C' and 'D' depending upon location and direction.
- Northbound flows along Adelaide Road between the Basin Reserve and John Street are LoS F. Northbound flows on Wallace Street vary between LoS A and D.
- Aotea Quay and Waterloo Quay both operate at a LoS B with a reduction in service for southbound vehicles occurring on the approach to Bunny Street and Whitmore Street.

As in the morning peak period, a number of the main arterials serving Wellington operate at or close to capacity during the two hour evening peak period.

- Northbound traffic flows on SH1 between Aotea Quay and Ngauranga operates at LoS E with southbound traffic having a LoS B. The Hutt Road typically operates at LoS A in both directions with a reduction in LoS on the approaches to the Kaiwharawhara Road intersection.
- SH1 operates at LoS B or C south of Aotea Quay as far as the Terrace Tunnel, with southbound traffic dropping to LoS F through the Tunnel to the approach with Willis Street.
- Vivian Street and Taranaki Street, northbound from Buckle Street to Willis Street, operate at LoS F. Southbound traffic from Victoria Street to Cambridge Terrace are at LoS C with the exception of a short section of Ghuznee Street.
- Mount Victoria Tunnel operates at LoS D in each direction. Ruahine Street southbound operates at LoS D and parts of Wellington Road between Ruahine Street and Evans Bay Parade operate at LoS E and F.
- Cobham Drive and Calabar Road operate at LoS A and B depending upon the location and direction.
- Adelaide Road northbound typically operates at LoS E over its entire length. Southbound, traffic operates at LoS F on the approach to the John Street/Riddiford Street intersection.
- The LoS for traffic along Jervois Quay varies between 'A' and 'D'.

- Aotea Quay and Waterloo Quay both operate at a LoS B with a reduction in service levels to LoS D in the vicinity of Bunny Street and Whitmore Street.

Overall, the 2001 base model indicated the overall breakdown of trips as shown in the Table E1.3 below.

Table E1.3: Mode Split – Committed Base Model 2001

	Car	PT	Total	PT %
AM	149,933	29,044	178,977	16.2%
IP	143,225	10,102	153,327	6.6%
PM	182,946	25,438	208,384	12.2%

E1.2 2016 Base Case

Key Issues: - Figure E1.2 shows the forecast LoS on the main arterial routes for southbound flows during the AM peak for 2016. As can be expected given increases in traffic growth, a number of the links identified as being close to capacity in 2001 subsequently operate at an even lower level of service in 2016.

Specific routes that are forecast to operate at or beyond their capacity during the morning peak period in 2016 are identified below.

- Southbound traffic on SH1 between Ngauranga and Aotea operates at LoS F whilst northbound traffic is at LoS B. Hutt Road between Onslow Road and Kaiwharawhara Road operates at LoS A. Southbound traffic decreases to LoS 'E' on the approach to Kaiwharawhara and through to the Aotea Quay intersection. Northbound traffic operates similarly to the southbound traffic with LoS A except for those sections on the approach to the signalised intersections at Kaiwharawhara and Onslow Road.
- SH1 between Aotea Quay and the Terrace Tunnel operates at Los B and C. LoS F is experienced for southbound traffic through the Terrace Tunnel with northbound traffic at LoS D.
- Southbound sections along Vivian Street are forecast to operate between LoS B and C, whilst the northbound sections of the Inner City Bypass along Buckle Street will typically operate at LoS D.
- Mount Victoria Tunnel operates at LoS E and F for northbound flows and at LoS C for southbound flows. Northbound traffic on Ruahine Street is forecast to operate at LoS D. Wellington Road, between Evans Bay Parade and Ruahine Street, operates at LoS E/F.
- Cobham Drive and Calabar Road typically operate between LoS A and C with the exception of northbound flows on Cobham Drive between Calabar and Troy Street which has a LoS F.

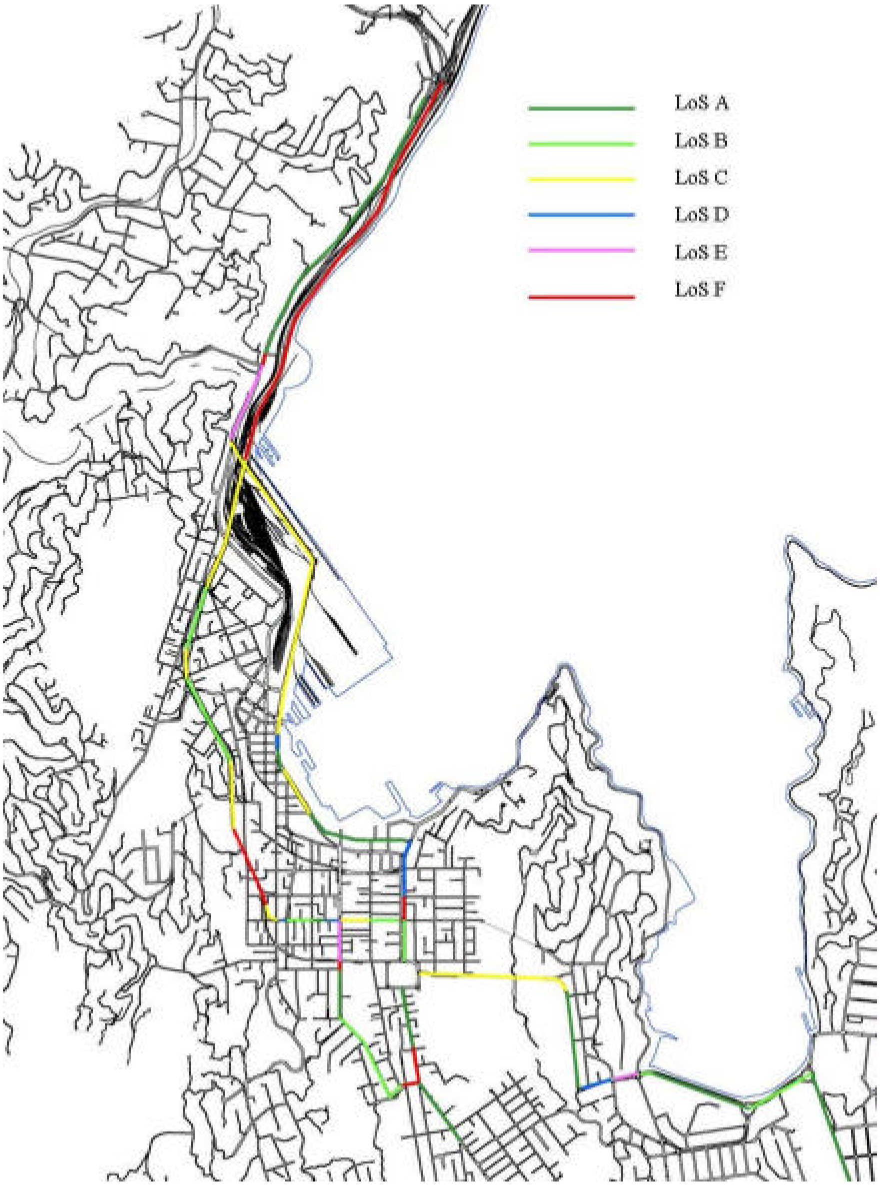


Figure F1.2 Level of Service AM Peak Southbound Traffic

- Northbound traffic along Adelaide Road between the Hospital and the Basin Reserve operates at LoS F, as does the southbound section on the approach to the Riddiford Street/John Street intersection. Wallace Street operates at LoS A to C although a northbound section on the approach Bidwill Street is forecast to operate at LoS E.
- Northbound flows on Kent Terrace tend to operate at LoS D and E whilst southbound movements on northern part of Cambridge Terrace operate at LoS between D and F.
- Southbound traffic on Aotea Quay and Waterloo Quay are forecast to operate at LoS C. Northbound sections of Jervois Quay are forecast to operate at LoS F.

During the evening peak period, the main network issues are:

- Northbound traffic on SH1 north of Aotea Quay is forecast to operate at LoS F whilst southbound flows operate at LoS B and C. Northbound Hutt Road traffic operates at LoS A with the exception of links on the approaches to the various signalised intersections along its length.
- SH1 between Aotea Quay and Terrace Tunnel operates at Los B and C in both directions with LoS D experienced for northbound traffic just north of the Terrace Tunnel and the vicinity of the Clifton on-ramp.
- Along the Inner City Bypass to the Basin Reserve, southbound traffic along Vivian Street operates at a LoS of between A and D depending upon the approaching intersection. Northbound, the LoS varies between C and E.
- Mount Victoria Tunnel operates at a LoS E in both directions with Ruahine Street operating at LoS C. Wellington Road between Ruahine Street and Evans Bay Parade operates between LoS D and E with LoS F along Cobham Drive at the northbound approach to the Cobham Drive and Evans Bay parade intersection.
- Cobham Drive and Calabar Road operate at LoS between A and D depending upon direction and location along the route.
- Adelaide Road is forecast to operate at LoS F on the approaches to the Basin Reserve and John Street intersections for northbound and southbound traffic respectively. Southbound traffic flows along Wallace Street operate at a LoS between B and E. Riddiford Street, north of Constabel Street is forecast to operate at LoS E/F.
- Aotea Quay and Waterloo Quay are forecast to operate at LoS A and B although the LoS reduces to E and F for southbound traffic along sections of the waterfront on the approach to (and south of) Bunny Street.

Overall, the 2016 base model indicated the overall breakdown of trips as shown in the Table E1.4 below.

Table E1.4: Mode Split – Committed Base Model 2016

	Car	PT	Total	PT %
AM	176,600	31,200	207,800	15.0%
IP	167,141	10,663	177,804	6.0%
PM	206,539	26,829	233,368	11.5%

It should be noted that for each of the options, the total number of car and passenger transport trips change as a result of the impact of the option, for instance with respect to changes in the level and location of congestion or the creation of a new route.

Appendix F: Key Impacts from Transport Modelling of Options

F1 Traffic Impacts of Options

A range of options have been assessed including a variety of road and public transport infrastructure projects and initiatives. The 2016 development scenario was chosen as the basis for this assessment and the base case network against which options are compared includes assumptions of committed transport projects.

For each of the options assessed, the impact of the redistributed traffic flow on the network has been commented upon with respect to the ‘operational capacity’ of a road link. This is particularly the case where an increase in traffic flow along a route has occurred, or where road space has been reallocated away from general traffic.

Operational capacity has been determined based on guidance contained in the Austroads Guide to Traffic Engineering Practice Part 2: Roadway Capacity, as shown in Table F1.1 below.

Table F1.1: - Mid-Block Theoretical Capacity for Urban Roads (with interrupted flow)

Type of Road		One-way Capacity (vehicles per hour)
Median or inside lane:	divided road	1000
	undivided lane	900
Outer or kerb lane:	adjacent parking lane or clearway	900
	occasional parked vehicles	600
4 lane road undivided		1500
4 lane road undivided – clearway		1800
4 lane divided – clearway conditions		1900
6 lane undivided		2400
6 lane divided – clearway conditions		2900

In rural situations, it should be noted that uninterrupted single lane flows can carry as much as 2400 vehicles per hour, however where overtaking is restrained, the capacity of the single lane rural road is approximately 1800 vehicles per hour. Similarly in ideal conditions, a two-lane road with a single lane in each direction can carry a total combined flow of 2800 vehicles per hour. With uninterrupted multi lane roads carrying 2000 vehicles per hour per lane (at 100km/h) reducing to 1900 vehicle per hour per lane for 80km/h design speeds. A single motorway on and off ramp can carry 1700 vehicles per hour in ideal conditions although it is recommended that a two-lane ramp be provided when traffic flows exceed

1500 vehicles per hour. Given that the WTSM model provides traffic flows over a two hour period, a peak hour flow of 60% of this two hour volume has been assumed.

As way of comparison, the Terrace Tunnel southbound carries some 1400 vehicle per hour during the morning peak hour whilst in the evening peak hour, the northbound lanes carry approximately 2300 vehicles per hour. The Mount Victoria Tunnel carries approximately 1500 vehicles per hour in each direction for the respective morning and evening peak hours.

The economic impact in terms of potential benefits over a 25 year period for each of the options has also reported. Benefits are primarily based upon vehicle operating costs and travel times over the entire network as a result of the option.

F2 Key Issues with Full Road Scenario and Passenger Transport Scenario

Table F2.1: Summary of key impacts of the Roading Scenario[148]
Morning two hour peak
(Traffic volumes for a 2 hour peak period)

An increase of 2,900 southbound vehicles along SH1 between Ngauranga Interchange and Aotea Quay, with a corresponding decrease of 2,400 southbound vehicles along Hutt Road. Traffic flows of 14,000 vehicles are forecast to use the four southbound State Highway lanes compared to the 2200 vehicles on Hutt Road. This level of traffic flow along the motorway indicates that the state highway is operating at or beyond its theoretical capacity.
A decrease of 1,400 southbound vehicles is forecast to occur along Jervois Quay and the Waterfront to around 4,300 vehicles, primarily as a result of a reduction in vehicles using both Thorndon Quay and Aotea Quay. Northbound vehicles are forecast to increase by 500 vehicles resulting in 3,100 vehicles heading north along this route.
An increase of over 2,500 southbound vehicles is forecast along SH1 near Kelburn Park and through the Terrace Tunnel with a total southbound flow of 7,100 vehicles. At this level of traffic flow, the two southbound traffic lanes through the duplicate Terrace Tunnel are operating at or over theoretical capacity. About 6,600 vehicles per 2 hour are forecast to head north through the existing Terrace Tunnel indicating that this tunnel will also operate close to theoretical capacity in the northbound direction.
1,600 northbound vehicles are forecast to join the State Highway at The Terrace on-ramp, giving the total number of vehicles using the three north bound lanes just north of this on-ramp is 8,200 vehicles.
The additional southbound traffic using the Terrace Tunnel results in an increase of 1,500 southbound vehicles along Vivian Street and through the new Pirie Tunnel under Mount Victoria – Mount Victoria Tunnel duplication. Southbound traffic flows through the new Pirie Tunnel are forecast to be 4,400 vehicles, meaning that the new tunnel will operate at or beyond its theoretical capacity. An increase of 1,000 southbound vehicles along Ruahine Street is forecast, generally with the benefit of a decrease of 1,000 southbound vehicles per hour along Evans Bay Road
An additional 2,600 northbound vehicles are forecast to use the existing Mount Victoria Tunnel (but now with 2 northbound lanes) with a similar increase along Ruahine Street. The Mount Victoria Tunnel is forecast to carry 5,800 northbound vehicles with the result that both the Tunnel and Ruahine Street operate beyond their theoretical capacity. Northbound vehicles on Evan Bay Parade decrease by 1,400 vehicles.
Small traffic reductions are predicted along Constable Street and Riddiford Street between Kilbirnie and Newtown: a reduction between 200 and 300 northbound vehicles.
Northbound traffic flows on Wallace Street reduce by 1,300 vehicles with redistribution to Adelaide Road which experiences an increase of 1,800 northbound vehicles. The northbound flow along Adelaide Road of 2,700 vehicles well exceeds the capacity of this road if only a single northbound lane is provided and the existing morning peak hour bus lane is maintained.
An increase of over 2,400 northbound vehicles is forecast for Cambridge Terrace although the road will operate within its theoretical capacity.

[148] Source: WTSM

Table F2.2 Summary of key impacts of the Roading Scenario[149]
Evening two hour peak
(Traffic volumes for a 2 hour peak period)

An increase of 2,700 northbound vehicles along the four lane section of SH1 between Aotea Quay and Ngauranga Interchange is forecast with a total traffic flow of 13,800 vehicles over the two hour period resulting in this section of the motorway operating at or close to capacity. Traffic flows on Hutt Road decrease by 2,200 northbound vehicles as a result of this redistribution of traffic to SH1.
Southbound traffic flows along the Waterfront reduce by 1,100 vehicles to 2,600 vehicles whilst northbound flows increase by 400 to 5,500 vehicles indicating that the existing three northbound lanes will operate at or close to capacity.
Southbound traffic flows along SH1 near Kelburn Park and through the Terrace Tunnel increase by over 2,200 vehicles to 7,000 vehicles. Northbound traffic through the Terrace Tunnel experience only small increases to a total two hour flow of 6,700 vehicles; a further 2,900 joining the SH1 at The Terrace on-ramp indicating that both the on-ramp and the state highway north of this section will operate at capacity.
The increase in southbound traffic flow through the Terrace Tunnel results in an increase of 1,300 southbound vehicles along Vivian Street with an additional 1,650 southbound vehicles using the new Pirie Tunnel under Mount Victoria. In total, 5,400 vehicles are forecast to use Vivian Street and 4,600 the Pirie Tunnel indicating that both of these routes will operate beyond their theoretical capacity.
The two northbound lanes of the existing Mount Victoria Tunnel experience an increase of 2,600 vehicles with a resulting traffic flow of 5,500 vehicles; a similar increase of 2,000 vehicles occurs along Ruahine Street indicating that both these routes operate beyond their theoretical capacity.
Given the increase in traffic in both directions through the Mount Victoria Tunnel, an increase of 1,100 and 2,000 southbound and northbound vehicles respectively are forecast along Ruahine Street. In comparison, Evans Bay Parade experiences a reduction in traffic of 700 vehicles northbound and 800 vehicles southbound.
A reduction of 900 northbound vehicles is forecast for Wallace Street with Adelaide Road experiencing an increase of 500 vehicles to carry a total of 1,600 vehicles. As part of the redistribution of northbound traffic, Riddiford Street experiences a reduction in traffic flows. Southbound flows along Adelaide Road increase by 600 vehicles with the resulting southbound flows in the order of 2,100 vehicles over the two hour period.
As a result of the additional northbound traffic through the Mount Victoria Tunnel and along Adelaide Road, over 1,400 northbound additional vehicles are forecast to use Cambridge Terrace and an extra 1,000 vehicles are forecast to use Buckle Street, with the result that the Inner City Bypass will operate beyond its theoretical capacity.

[149] Source: WTSM

Table F2.3 Summary of key impacts of the Passenger Transport Scenario[150]
Morning two hour peak
(Traffic volumes for a 2 hour peak period)

An 80% increase, (increase in 560 southbound passengers) using the Johnsonville light rail system connection during the morning peak period.
Up to 7,700 passenger boardings along the entire length of the Waikanae line are forecast to occur in the morning peak, approximately a 25% increase from the committed base.
The proposed light rail system between the railway station and the airport is forecast to attract over 5,200 passenger boardings along the entire route in the morning peak, generally at the expense of bus passengers including between Kilbirnie and the CBD and the Bus Tunnel.
Travel times on bus services between Newtown and Wellington Railway Station are forecast to reduce from approximately 24 minutes to approximately 13 minutes.
A decrease of 2,000 southbound vehicles along Hutt Road, with a further decrease of 2,600 vehicles along Aotea Quay. Hutt Road southbound traffic flows are forecast to be in the order of 2,800 to 3,000 vehicles. Replacing one of the traffic lanes with a bus lane along Hutt Road will result in this route operating beyond its theoretical capacity.
Southbound traffic along the Waterfront is forecast to reduce by approximately 2,800 vehicles to between 2,200 and 2,900 vehicles depending upon location along Jervois Quay with 3,300 vehicles per 2 hour heading north. The reduction in traffic capacity as a result of the light rail system means that the remaining traffic lanes will operate at or beyond their theoretical capacity. The decrease in southbound traffic continues around Cable Street and Kent Terrace.
The passenger transport scenario included replacing Adelaide Road as a passenger transport corridor with a one lane pair for general traffic operating along Adelaide and King (refer to Option W2). As a result, northbound traffic flows along Riddiford Street and Adelaide Road reduce by 2,200 and 1,000 vehicles respectively, with lesser reduction on Constable Street. Traffic flows however on Adelaide Road south of John Street are forecast to increase by 1300 vehicles putting this section of the road over its theoretical capacity.
A knock-on-effect of the reallocation of road space to passenger transport results in a reduction of northbound traffic along SH1 along the Inner City Bypass and through the Terrace Tunnel. Northbound Terrace Tunnel traffic flow decreases to 5,100 vehicles, lessening the pressure on the Terrace Tunnel.
Two way traffic flow on Evans Bay Road reduces by 700 vehicles, whilst Cobham Drive also experiences a reduction in traffic by 900 vehicles in both directions.

[150] Source: WTSM

Table F2.4 Summary of key impacts of the Passenger Transport Scenario[151]

Evening two hour peak

(Traffic volumes for a 2 hour peak period)

As can be expected, large increases in passenger transport volumes occur on the designated routes with a reduction in general traffic as noted above along certain routes where the level of service is reduced. The light rail system along the Waterfront is forecast to carry 3000 passengers in the evening peak with a reduction in bus passengers along Lambton Quay.
An increase of 600 northbound passengers on the railway station to Johnsonville light rail system is forecast to occur.
Southbound bus travel times from the railway station to Newtown are forecast to reduce from 23 minutes to 14 minutes.
A decrease of traffic of 1,500 vehicles along Aotea Quay (1,400 northbound and 100 southbound) with northbound traffic flows on Hutt Road decreasing by around 2,200 vehicles resulting in a northbound flow of about approximately 2,500 vehicles. With a reduction in traffic lanes to accommodate the northbound bus lane, the remaining traffic lane will operate beyond its theoretical capacity.
As with the morning peak period, traffic flows decrease along Cable Street, Kent Terrace, the Inner City Bypass, Evans Bay Parade and, Cobham Drive through Newtown (Adelaide Road, Riddiford Street and Constable Street with some traffic diverting to Wallace Street and Tasman Street)

151 Source: WTSM

F3 Ngauranga to Aotea Capacity Improvements Option

Modelling Description: This option allows for the provision of four-lanes of traffic in each direction along SH1 between Ngauranga Interchange and the Aotea Quay on/off ramps throughout the day.

Key Issues: - The main sphere of impact as a result of the additional roading capacity along the state highway is the redistribution of traffic from Hutt Road onto SH1. During the morning two hour peak period, the main impacts are:

- An increase in southbound traffic on SH1 between Ngauranga and Aotea of 2700 vehicles over the two hour period. Further south of Aotea Quay, additional traffic continues to use the state highway although the increase in traffic reduces along its length given the off-ramps at Murphy Street, Hawkestone Street and the Terrace. A such, this additional traffic spills into the City along these main roads whilst Thorndon Quay has some 460 fewer southbound vehicles.
- An additional 1500 southbound vehicles are forecast to use the state highway between Aotea Quay and Murphy Street despite no additional capacity being provided. At 10,200 vehicles over the two hours, the motorway will be operating at capacity.
- An additional 1200 southbound vehicles are forecast to exit the state highway at Aotea Quay resulting in 3640 vehicle using the single lane off-ramp. As such, the capacity of this off-ramp is well exceeded and a two-lane off-ramp is ideally needed for such high flows.
- During the two hour evening peak period, the reverse to the morning period happens as summarised below:
- Northbound traffic flows along SH1 increase by 2500 vehicles over the two hour period with the result that 13700 vehicles use the state highway between Aotea and Ngauranga. As such, the motorway northbound will be operating at capacity.
- Traffic along Hutt Road travelling north reduces by 2200 vehicles to 2400 vehicles.

This option of increasing capacity along the SH1 in both directions reduces the regional passenger transport modal share by 0.1% in both the morning and evening peak hours as shown below.

The 25 year benefits associated with this option is $39.6million.

Table F3 Mode Split

	Car	PT	Total	PT %
AM	176983	31038	208021	14.9%
IP	167140	10638	177778	6.0%
PM	206751	26694	233445	11.4%

F4 Terrace Tunnel Tidal Flow Option

Modelling Description: - The Terrace Tunnel Tidal Flow option involves the use of the middle lane as a reversible traffic lane with two-lanes southbound provided during the morning peak period and a single northbound lane. During the remainder of the day, the Tunnel operates as it is currently configured with two northbound lanes and a single southbound lane.

Key Issues: - The main issues associated with this option relate to the morning peak period when the amount of capacity for southbound vehicles increases at the expense of northbound flows, resulting in a redistribution of traffic to the Waterfront for northbound traffic and vice versa for southbound traffic. These morning peak period issues are summarised below:

- During the morning peak hour period, southbound traffic along the Waterfront reduces by some 1600 vehicles to between 2000 and 2600 vehicles (depending upon the section of the Waterfront) and increases by 1200 vehicles northbound to 4700 vehicles over the two hour morning peak period. The existing three lane northbound arrangement will be at its theoretical capacity with this arrangement.
- Northbound traffic decreases by 2500 vehicles through the Terrace Tunnel over the two hour morning period leaving 4200 vehicles to continue to use the single lane Tunnel. As such, the single lane northbound tunnel is forecast to carry a similar amount of traffic southbound to volumes in the Tunnel in the committed base model (i.e. without any changes to the network) and is expected to operate at or beyond its theoretical capacity. The reduction in traffic flow northbound along SH1 reduces the further north the route travels given the on-ramps at the Terrace, Tinakori Road, May Street and the Aotea Quay on-ramp.
- The additional traffic heading southbound through the Terrace Tunnel results in an additional 1100 vehicles using the Inner City Bypass (at the Kent Terrace intersection) rather than continuing along Cable Street and using Kent Terrace. A total flow of 3700 vehicles is forecast on Vivian Street at the western end indicating the Inner City Bypass will operate at or close to capacity whilst higher flows at the eastern end suggest that demand will exceed supply.
- The tidal flowing of the Terrace Tunnel results in no change in the passenger transport modal share as shown in the table below.

The 25 year benefits associated with this option is -$1.3million.

Table F4 Mode Split

	Car	PT	Total	PT %
AM	176,696	31123	207819	15.0%
IP	167139	10652	177791	6.0%
PM	206574	26771	233345	11.5%

F5 Mount Victoria Duplication/4-laning to Kilbirnie Option

Modelling Description: This option includes a duplicate of the Mount Victoria Tunnel, adjacent to the existing Tunnel (to provide two-lanes in each direction) plus the provision of two-lanes in each direction along Ruahine Street through to Kilbirnie Crescent.

Key Issues: - The overall impact of this option is that traffic redistributes from the Evans Bay Parade, as well as from Adelaide Road and Wallace Street (via Crawford Road, Constable Street and Riddiford Street) to the new main route through Mount Victoria. During the morning peak period, the main impacts are:

- An increase of 2400 vehicles northbound through the two-lanes of the Mount Victoria Tunnel with a similar increase along Ruahine Street resulting in 5500 northbound vehicles seeking to use the Mount Victoria Tunnel with 4700 northbound vehicles on Ruahine Street. At such flows, traffic demand will exceed the available capacity provided along this route.
- An additional 1000 southbound vehicles are forecast to use the Mount Victoria Tunnel and Ruahine Street with the resulting traffic flow of 3800 vehicles making this route operate at capacity during the morning peak period.
- Traffic flows along Evans Bay Parade reduce by 700 vehicles northbound and 1000 vehicles southbound over the two hour period whilst flows along Adelaide Road reduce by 600 vehicles northbound to 300 vehicles over the two hour period. Similarly, traffic flows along Riddiford Street, Constable Street and Rintoul Street decrease significantly.
- For the evening peak period, the following is forecast to occur:
- Northbound vehicles through the Mount Victoria Tunnel increase by 2000 vehicles and southbound flows increase by 1100 vehicles with the result that northbound flows are some 4900 vehicles and southbound volumes are 4100 vehicles. As such, the Tunnels will operate beyond their theoretical capacity.
- Traffic flows along Evans Bay Parade reduce by approximately 400 vehicles northbound and 500 vehicles southbound.
- Northbound traffic flows along Adelaide Road reduce by 600 vehicles whilst northbound flows on Wallace Street reduce by 400 vehicles. Southbound traffic on Adelaide Road also decreases by 900 vehicles with the result that 500 to 600 vehicles use Adelaide Road in each direction which would require only a single lane in each direction.

As a result of this option, the passenger transport mode share over the region reduces by 0.1% in both the morning and evening peak periods.

The 25 year benefits associated with this option is $53.6million.

Table F5 Mode Split

	Car	PT	Total	PT %
AM	176832	31123	207885	14.9%
IP	167272	10629	177901	6.0%
PM	206643	26690	233333	11.4%

F6 Waterfront Capacity Reduction Option

Modelling Description: The Waterfront route between Bunny Street and Taranaki Street is reduced from the current arrangement of three lanes in each direction to two-lanes in each direction.

Key Issues: - The reduction in road capacity along the Waterfront primarily results in a redistribution of traffic from the Waterfront and the approach roads such as Wakefield Street, Cable Street and Waterloo Quay, to SH1 as well as to other street through the CBD area such as Victoria Street. During the morning peak period, the following impacts occur:

- Southbound traffic flows along Jervois Quay reduce by 1900 vehicles whilst northbound flows reduce by 500 vehicles. Southbound flows of 3800 vehicles remain over this two-lane section of road with the result that this section of highway is operating at or beyond its theoretical capacity. Northbound traffic flows of 2200 vehicles can be accommodated within the reduced road space.
- Southbound traffic redistributes itself around the network either by electing to continue using the state highway (rather than exiting at the Aotea off-ramp to avoid the area totally), or continues along Waterloo Quay before diverting to the other streets in the CBD such as Victoria Street. In total, an additional 300 to 400 vehicles continue south along State Highway 1 putting additional pressure on the Terrace Tunnel, whilst a further 200 to 300 vehicles are forecast to use Victoria Street.
- South of Jervois Quay, Cable Street obviously has a reduction in traffic flow along with Oriental Parade (around to Evans Bay Parade) and Kent Terrace.
- Whilst the impact on northbound traffic is less severe than for the southbound flows, the reduction in Waterfront capacity has the impact of pushing vehicles onto either the State Highway or through the CBD along Lambton Quay and on to Molesworth Street.

The nature of the various one-way roads within the CBD area and the higher numbers of northbound traffic flows along the Waterfront in the evening compared to the morning peak results in a more significant impact on the wider roading network. In particular:

- Northbound traffic along Jervois Quay reduces by 1700 vehicles to 3400 vehicles over the two hour period with the result that the Waterfront operates at or close to its theoretical capacity. Southbound, traffic reduces by 1000 vehicles to 2800 vehicles.
- Whilst local northbound traffic diverts along Willis Street and/or The Terrace, 600 northbound vehicles redistribute themselves onto the state highway and use the Terrace Tunnel putting additional pressure onto existing flows. As part of this redistribution, traffic from the CBD heading north tends to head south, for instance along Taranaki Street, onto the Inner City Bypass before continuing north on the state highway.

A reduction in road capacity along the Waterfront has the modest impact of increasing the passenger transport mode share during the morning and evening peak periods by 0.1% as shown below.

The 25 year benefits associated with this option is -$57.9million.

Table F6 Mode Split

	Car	PT	Total	PT %
AM	176,433	31,298	207,731	15.1%
IP	167,089	10,694	177,783	6.0%
PM	206,205	26,930	233,135	11.6%

F7 Golden Mile/CBD Fringe Bus Priority Schemes Option

Modelling Description: This option includes a number of infrastructure improvements to the roading network to provide bus priority measures such as bus lanes and bus pre-emption at traffic signals for buses through the CBD as well as along a number of the key existing and potential bus routes to and from the city. In particular, bus priority measures are made along the Golden Mile, Hutt Road, Murphy/Molesworth Street, Karori Road, Willis Street/Victoria Street, Taranaki Street, Wallace Street, Kent/Cambridge Terrace, Adelaide Road and Riddiford Street.

Key Issues: - The impact of the proposed measures on travel patterns is greatest during the morning peak period. In particular, the forecast impacts are:

- During the morning peak period, southbound traffic flows along Hutt Road and Thorndon Quay reduce by 500 and 900 vehicles respectively whilst flows through Wadestown increase.
- Whilst the measures also lead to a decrease in southbound traffic along the Waterfront by 400 vehicles, some roads within the CBD such as Willis Street, Dixon Street and parts of Vivian Street experience localised increases in traffic flows as motorists find their way through the City given reduced capacity on certain routes due to the bus priority measures.
- An additional 300 inbound bus passengers are forecast to use bus services arriving from the north via Thorndon Quay, resulting in 2300 arriving into the City by bus on this route. To the south of the City, inbound bus patronage increases along both Cambridge Terrace (south of Elizabeth Street) and Taranaki Street with both routes experiencing an increase of 200 passengers over the two hour morning peak period; 1800 and 800 inbound passengers are forecast to use these two routes respectively.
- Given the increase in passenger numbers into the CBD on the key access routes, it is unsurprising that passenger numbers though the CBD along Lambton Quay, Willis Street and Courtenay Place all increase as well with an extra 1100 passengers expected to travel along Willis Street during the morning peak period.

The provision of bus priority measures increases the number of passenger transport trips at the expense of car trips across the region resulting in an increase in the passenger transport mode share for each of the time periods considered, as shown in the Table below.

The 25 year benefits associated with this option is -$3.4million.

Table F7 Mode Split Bus Improvements

	Car	PT	Total	PT %
AM	175,676	31,999	207,675	15.4%
IP	166,990	10,823	177,813	6.1%

PM	206,243	27,533	233,776	11.8%

F8 Bus Priority Improvements and TDM Measures with Adelaide Road/King Street One –Way Pair Option

Modelling Description: This option includes a number of infrastructure improvements to the roading network to provide bus priority measures such as bus lanes and bus pre-emption at traffic signals through the CBD as well as along a number of the key existing and potential bus routes to and from the city such as Cambridge Terrace/Kent Terrace, Adelaide Road, Taranaki Street, Rongotai Road, Kilbirnie Crescent, and Cobham Drive. This option also includes making Adelaide Road as the main north-south passenger transport spine at the expense of general traffic with the provision of a single southbound general traffic lane on Adelaide Road with a matching northbound service road along Hanson Street and King Street. In addition, changes to the Basin Reserve include only permitting passenger transport to travel between Kent Terrace and Dufferin Street.

Key Issues: - During the morning peak, motor vehicles flows are forecast to reduce along a number of routes into the CBD as well as around the CBD such as northbound along SH1 north of the Terrace Tunnel and southbound along the Waterfront. Passenger transport passenger numbers increase along the key routes and passenger transport spines into the city, particularly where bus priority measures improve travel times. The main impacts of this option during the two hour morning peak period are:

- Passenger transport numbers increase along routes to and from the eastern and southern suburbs through Kilbirnie to Miramar, as well as through Newtown to Berhampore and Island Bay. Inbound services from Kilbirnie increase by 300 passengers for both the Newtown and Hataitai routes respectively with an additional 500 passengers along Adelaide Road. Inbound bus passenger numbers along Hutt Road increase by over 400 people.
- Bus travel times between Newtown and the railway station decrease by over 10 minutes in each direction.
- Passenger numbers using buses passing along Lambton Quay are forecast to increase by 1600 people.
- Southbound traffic flows along Hutt Road are forecast to decrease by between 2000 and 2600 vehicles given a reduction in those feeder routes over its length. Approximately 3000 vehicles are forecast to continue using Hutt Road with the result that the road is at or over its theoretical capacity.
- Despite a reduction in southbound traffic flows along Aotea Quay and Thorndon Quay of 600 and 900 vehicles respectively, northbound flows increase along both these routes as well as along Bowen Street onto Tinakori Road, partly as a result of the bus lane on Molesworth Street reducing traffic movements along this route.
- The reduction in traffic approaching the and passing through the CBD from the north results in a reduction in southbound flows along the Waterfront, Cable Street and Kent Terrace. A reduction in northbound traffic along Adelaide Road also has an impact n the amount of traffic heading north on the Inner City Bypass and Cambridge Terrace.
- Northbound flows through the Terrace Tunnel reduce by 1800 vehicles with the result that northbound and southbound flows are approximately equal.

- Traffic flows along Cobham Drive as well as along Evans Bay Road are forecast to reduce by 2000 and 700 vehicles respectively.

As with the morning peak, passenger transport numbers increases on the main routes to and from the CBD with a corresponding decrease in motor vehicle numbers. The key impacts for the two hour evening peak that are forecast are summarised below:

- Southbound passenger numbers along Adelaide Road increase by 800 people with an additional 400 passengers forecast to travel between Newtown and Kilbirnie. Over 100 additional passengers are forecast to travel from the CBD through the Mount Victoria Bus Tunnel. Northbound bus patronage along the Hutt Road increases by 500 passengers. Overall, an additional 1500 passengers are forecast to use the bus along Lambton Quay.
- As with the morning peak, bus travel times are forecast to decrease with the southbound journey between the railway station and Newtown forecast to decrease from 23 minutes to 14 minutes.
- Northbound traffic volumes decrease by 2200 vehicles along Hutt Road over the two hour evening peak resulting in the remaining 2500 to 3000 vehicles heading north on the single lane putting the road at or over capacity.
- Adelaide Road experiences large reductions in traffic flows in both directions (1200 northbound and 1400 southbound) with increases in traffic flows being experienced on parallel routes such as Wallace Street and Tasman Street. As such, parts of Wallace Street may be expected to operate at or beyond its theoretical capacity.
- Similarly, a reduction in southbound traffic along Kent Terrace is mirrored by increases in traffic flows along Tory Street and Taranaki Street although the flows are forecast to be able to be accommodated by these roads.
- The reduction in available lanes for general traffic on Molesworth Street results in over a 1000 northbound vehicles diverting onto Bowen Street and then onto Tinakori Street. A further 300 northbound vehicles divert on to Thorndon Quay. Both Bowen Street and Thorndon Quay can accommodate the increases in forecast traffic although parts of Tinakori Road operate close to capacity.
- Northbound traffic flows along SH1 through the Terrace Tunnel are forecast to decrease by 1200 vehicles reducing the pressure on the Terrace Tunnel.

Overall, the proportion of regional passenger transport users is forecast to increase by 1.4% under this option, with a 2% increase during the morning peak period as shown in Table F14 below.

The 25 year benefits associated with this option is -$184million. This primarily due to the dis-benefits associated with motor vehicle users compared to the $63.4million benefits attributed to passenger transport users.

Table F8 Mode Split

	Car	PT	Total	PT %
AM	165,792	34,041	199,833	17.0%
IP	165,743	11,287	177,030	6.4%
PM	193,867	29,450	233,317	13.2%

F9 Rail Service Improvement Option

Modelling Description: This option involves an increase in the frequency of train services to Kapiti and the Hutt Valley with 15 and 30 minute frequencies during the peak and off peak periods respectively.

Key Issues: - The increased train service has little impact on traffic flows on the roading network in and around Wellington. Furthermore, the improved frequency has limited impact on patronage on the Kapiti rail service with the main effect being on passenger numbers using the Hutt service. Very few people are forecast to divert from the bus services to rail as a result of the improved frequency. Accordingly, the main impacts are:

- An increase of 350 passengers using the Hutt rail service during the morning peak periods, three quarters of which are inbound. This equates to a total increase of approximately 7%.
- During the two hour evening peak period, an additional 400 passengers are forecast to catch the train to and from the Hutt. This represents a 10% in passengers for the service.

As shown in the Table below, the improved rail service frequency has a modest impact of a 0.1% increase of the regional passenger transport mode share during the two hour morning and evening peak periods.

The 25 year benefits associated with this option is $9.4million.

Table F9 Mode Split

	Car	PT	Total	PT %
AM	176492	31440	207932	15.1
IP	167083	10724	177807	6.0
PM	206443	27051	233494	11.6

F10 Heavy Rail Penetration to Courtenay Place Option

Modelling Description: The option assumes the penetration of all heavy rail services beyond the railway station to Courtenay Place, with one intermediate station near the Queens Wharf. The option assumes no constraint to the current train frequency due to the provision of upgraded signalling and train management.

Key Issues: - During the morning peak period, the key impacts of the heavy rail option are:

- A reduction in 200 to 250 southbound vehicles along SH1 and Hutt Road with this reduction reflected along Aotea Quay, Thorndon Quay and the Urban Motorway.
- Patronage along the Johnsonville rail line is forecast to increase by 600 passengers over the two hour morning peak with the service forecast to carry 1500 passengers during this period, the majority of which are southbound into the CBD. An additional 1200 passengers are forecast to use the Hutt and Western rail lines.
- Whilst 4000 of the total southbound passengers on the train service leave the train at the existing railway station, a further 8000 passenger remain on the train to the new stations further south of which 3500 passengers continue on to Courtenay Place.

In the evening peak period, the heavy rail options results in the following impacts:

- A northbound reduction of 200 vehicles along Aotea Quay and Thorndon Quay is forecast to occur along with a northbound reduction of 100 vehicles along SH1.
- The Johnsonville rail line is forecast to carry an extra 400 passengers during the evening peak with a further 1800 passengers forecast along the Hutt and Kapiti Coast rail lines.
- 6600 northbound passenger are forecast to use the extended rail line of which 3100 board the train at Courtenay Place.

The impact of the extended rail line on the regional passenger transport mode share is to increase passenger transport use by 0.4% during the morning and evening peaks and by 0.1% during the inter-peak period.

The 25 year benefits associated with this option is $42.5million.

Table F10 Mode Split

	Car	PT	Total	PT %
AM	176150	32122	208272	15.4%
IP	166908	10922	177830	6.1%
PM	206134	27770	233904	11.9%

F11 Duplication of the Terrace Tunnel and Aotea to Ngauranga Capacity Improvements (8-laning) Option

Modelling Description: This combination of options includes the provision of two-lanes in each direction through the Terrace Tunnel tying into the Inner City Bypass. In addition, increased capacity is provided on SH1 between Ngauranga Interchange and Aotea Quay with an increase from three to four-lanes of traffic during the peak periods by direction (i.e. four-lanes of traffic southbound in the morning peak only with the reverse occurring during the evening peak.)

Key Issues: - During the morning peak period, southbound through traffic is forecast to divert from the Hutt Road, Waterfront route and the Terrace to the upgraded Terrace Tunnel. A further knock-on effect is a small reduction in south bound traffic using Oriental Parade to reach Kilbirnie and beyond. The key impacts for the two hour morning peak are summarised below:

- An increase of 2,700 southbound vehicles along SH1 between Ngauranga Interchange and Aotea Quay from 11,100 to 13,800 vehicles. At this level of traffic flow along the state highway, the motorway is operating at or close to its theoretical capacity.
- A decrease of 2,300 southbound vehicles along Hutt Road from 4,600 to 2300 vehicles.
- An increase of 2,500 southbound vehicles through the Terrace Tunnel resulting in a total of 7000 southbound vehicles passing through the two-lanes over a two hour period. At this level of traffic flow, the two southbound lanes of traffic will be at or approaching their theoretical capacity.
- A decrease of 1,800 southbound vehicles along the Waterfront to 3900 vehicles over the two hour period indicating the need for at least two-lanes of southbound traffic along Jervois Quay. It should be noted however that there is also an increase of 600 northbound vehicles along Jervois Quay to 3200 vehicles resulting in similar levels of northbound and southbound traffic flows in the morning peak period.
- The decrease in vehicles along the Waterfront at Jervois Quay is primarily a result of a reduction in traffic previously using Hutt Road and travelling through town via Thorndon Quay, along with other, but smaller reductions in traffic along Aotea Quay and Tinakori Road.
- The model indicates little reduction in traffic wishing to turn off SH1 prior to the Terrace Tunnel intersection as a result of the option with the exception of the Aotea Quay off-ramp.

As with the morning peak period, the southbound through traffic movement during the evening peak period is forecast to divert from the Waterfront to the upgraded Terrace Tunnel whilst northbound traffic is forecast to use the four northbound lanes on SH1 north of Aotea. The key impacts for the two hour evening peak are summarised below:

- An increase of over 2,600 northbound vehicles along SH1 between Ngauranga Interchange and Aotea Quay resulting in 13,700 heading north on SH1. 2400 head north using the Hutt Road, a decrease of 2,200 vehicles.
- An increase of 2,300 southbound vehicles through the Terrace Tunnel resulting in some 7000 southbound vehicles using the Terrace Tunnel over the two hour peak period WITH THE Tunnel operating at or close to capacity.

- A decrease of 1,400 southbound vehicles to 2300 vehicles along the Waterfront primarily as a result of a decrease in traffic along Hutt Road using Aotea Quay. An increase of 300 northbound vehicles to 5400 vehicles along Jervois Quay however also occurs primarily as a result of an increase in traffic from the Basin Reserve along Cambridge Terrace indicating that the Waterfront northbound is at its theoretical capacity.
- The model forecasts a reduction in eastbound traffic using Aro Street to access Willis Street and the Inner City Bypass with an increase in vehicles using Glenmore Street, Upland Road and Tinakori Road.

As shown in the Table E9 below, this option results in a slight reduction of 0.1% in the regional passenger transport modal share during the morning and evening peak periods due to very slight increases in car use compared to passenger transport.

The 25 year benefits associated with this option is estimated at $60.1million.

Table F11 Mode Split

	Car	PT	Total	PT %
AM	177,127	31,016	208,143	14.9%
IP	167,203	10,637	177,840	6.0%
PM	206,775	26,680	233,455	11.4%

F12 Grade Separated Basin Reserve Intersection

Modelling Description: The provision of a two-lane flyover connecting Mt Victoria Tunnel to Buckle Street for north and westbound vehicles with a two-lane connection from Kent Terrace to the Mount Victoria Tunnel for southbound traffic. Under the flyover, two traffic lanes connect Kent Terrace with Adelaide Road via Dufferin Street and two traffic lanes connect Sussex Street to Cambridge Terrace with a single lane connection to Buckle Street from Sussex Street. A single lane slip road connects traffic from the Mount Victoria Tunnel to Dufferin Street for vehicles heading towards Adelaide Road whilst a connection from the flyover to Cambridge Terrace is also provided.

Key Issues: - During the morning peak period, the provision of a grade separated interchange at the Basin Reserve is forecast to reduce travel times for vehicles passing through the Basin Reserve with the result that traffic is attracted to use the routes to and from this location. Accordingly traffic flow increases along Adelaide Road, the Mount Victoria Tunnel and Kent Terrace. These increases result in a reduction of traffic volume along Wallace Street, Evans Bay Parade and Oriental Parade as traffic diverts via the Mount Victoria Tunnel and Kent/ Cambridge Terrace. The key impacts that are forecast for this option are summarised below for the two hour morning peak:

- A decrease of 600 southbound vehicles on Evans Bay Road to 500 vehicles over the two hour peak period.
- An increase of 1,000 northbound vehicles along Cambridge Terrace to 1500 vehicles. An additional 1,700 southbound vehicles use Kent Terrace with the forecast 5400 vehicles using the section of Kent Terrace between the Basin Reserve and Vivian Street resulting in the road being at, or close to capacity.
- Increases in traffic flows on the Inner City Bypass result in 6200 vehicles being forecast to use Buckle Street over the two hour peak period and between 3000 and 4,100 vehicles on sections of Vivian Street indicating that both these routes to and from the Basin Reserve will be at their theoretical capacity.
- An increase of 1,000 vehicles using the Mount Victoria Tunnel (200 northbound and 800 southbound) is forecast with northbound and southbound flows being approximately equal at around 3,500 vehicles in each direction over the two hour peak period. Such traffic flows are well in excess of the theoretical capacity of a two-lane road with a single lane in each direction.
- Approximately 1,200 northbound vehicles are forecast to divert from Wallace Street to Adelaide Road due to the improvement at Basin Reserve resulting in 1100 northbound vehicles using Wallace Street. An increase of 1,800 northbound vehicles along Adelaide Road (north of John Road) is forecast with northbound traffic flows of 2800 vehicles over the two hour period. Given the northbound morning peak hour bus lane on Adelaide Road, Adelaide Road will operate at or beyond its capacity.
- This traffic redistribution also results in a decrease of 700 northbound vehicles along Taranaki Street with traffic diverting onto Adelaide Road and Cambridge Terrace.

Over the two hour evening peak period, similar routes are forecast to experience changes in traffic flows as for the morning peak period. These are summarised below:

- A decrease of 500 southbound vehicles on Evans Bay Road resulting in 1500 southbound vehicles using this route over the two hour evening peak.
- An increase of 700 northbound vehicles along Cambridge Terrace resulting in 1100 vehicles forecast to use this route. Similarly, southbound traffic on Kent Terrace between Vivian Street and the Basin Reserve increases by 1,800 vehicles to 6,600 vehicles over the two hour period putting this section of Kent Terrace at or beyond its theoretical capacity.
- The increase in southbound traffic on Kent Terrace is reflected by corresponding increases in traffic volumes along Vivian Street and Kent Terrace (north of Vivian Street) by 900 vehicles and 600 vehicles respectively, putting Vivian Street in particular under pressure in terms of its capacity to accommodate the forecast 4700 vehicles over this two hour peak period.
- An increase of 1,200 vehicles is forecast to use the Mount Victoria Tunnel with southbound traffic flows increasing by 900 vehicles to provide a total two hour southbound flow of 3,900 vehicles. Northbound flows increase by 300 vehicles to 3200 vehicles. These flows are well in excess of the theoretical capacity of a two-lane road with a single lane in each direction.
- Approximately 1,000 northbound vehicles are forecast to divert from Wallace Street to Adelaide Road due to the improvement at Basin Reserve resulting in a northbound traffic flow of 800 vehicles on Wallace Street. In total, 2500 vehicles are forecast to use Adelaide Road, an increase of 1,300 northbound vehicles. Increases in southbound traffic flows on Adelaide Road are more modest at 300 vehicles and an overall two hour traffic flow of 1800 vehicles. The two-lanes of traffic in each direction along Adelaide Road should be able to provide suitable capacity subject to parking restrictions being in place during this period.
- An increase of 1,300 northbound vehicles on Buckle Street is forecast to occur with two hour traffic flows in the order to 5600 vehicles putting this section of the Inner City Bypass under severe pressure with respect to the operation capacity of the route.
- This particular option on its own has negligible impact on the passenger transport modal share throughout each of the time periods considered as shown in Table E10 below.

The 25 year benefits associated with this option is $34million.

Table F12 Mode Split

	Car	PT	Total	PT %
AM	176,750	31,143	207,893	15.0%
IP	167,240	10,649	177,889	6.0%
PM	206,709	26,750	233,459	11.5%

F13 Light rail service between the Airport and Railway Station Option

Modelling Description: A light rail system between the railway station in the CBD and the Airport has been assessed. For simplicity, the light rail system follows the existing roading infrastructure where possible resulting in traffic typically having a lower level of service with respect to the number of lanes available with priority measures for the light rail system provided at at-grade intersections where the light rail and roading networks intersect. In addition, given the major intersection with traffic at the Basin Reserve, light rail has been grade separated from the roading traffic in order to make the route as attractive as possible.

The light rail route travels along Lambton Quay and Willis Street, Mercer Street, Wakefield Street, Cuba Street, Manners Street and Courtney Place. Outside of the CBD, the light rail route uses Kent Terrace, Adelaide Road, Riddiford St, Constable St, Crawford St, Rongotai Rd, Troy Rd and Cobham Drive to reach the Airport. Given the need to provide a high quality route, capacity along Adelaide Road is severely restricted as part of this option.

In addition, the transfer penalty from heavy rail to light rail at the railway station has been minimised in order to encourage light rail use for those people arriving from the north of the city. This reflects a convenient interchange between heavy rail and light rail – eg across platform.

Key Issues: - The key impacts of the light rail option on the network for the morning peak period are summarised below:

- Due to the restrictions on traffic flow on Adelaide Road, traffic is forecast to divert to Wallace Street. As such, northbound traffic along Wallace Street of 3800 vehicles is forecast along with 2900 vehicles along Adelaide Road (south of Riddiford Street) - primarily as a result of traffic from Kilbirnie diverting from Constable Street and making their way to Adelaide Road via the roads south of Constable Street.
- An increase of 500 vehicles northbound along Taranaki Street is forecast as a result of the redistributed traffic using Wallace Street, whilst some traffic also diverts from Taranaki Street eastbound onto Vivian Street to access the eastern part of the CBD via Tory Street.
- A small reduction in northbound traffic flows along Ruahine Street is forecast, although this has little impact on flows through the Mount Victoria Tunnel.
- The light rail system between the airport and existing railway station is forecast to attract 9,400 boardings.
- Some existing public transport passengers are likely to transfer from bus to the LRT, especially between Kilbirnie and the CBD with a reduction in passenger numbers on bus routes in both directions forecast to occur for instance along Kilbirnie Crescent and the Mount Victoria Bus Tunnel. The model forecasts a reduction of 1300 passengers on the bus through the Bus Tunnel.
- A reduction of 500 bus passengers is also envisaged along Wallace Street in both directions due to the competing demand of the light rail system.
- The provision of the light rail system from the railway station is forecast to also increase heavy rail patronage from the north by 400 passengers.

During the evening peak period, the following is forecast as a result of the light rail option:

- A slight increase in southbound traffic flow of 100 vehicles is forecast to occur along the Waterfront. Southbound traffic flows of 3800 vehicles over the two hour period is below the theoretical capacity of this route.
- As with the morning peak period, traffic flows along Wallace Street increase in both directions by 500 vehicles and 1300 vehicles northbound and southbound respectively. Northbound flows of 2600 vehicles and southbound flows of 3600 vehicles over the two hour period suggest that the existing route will operate above capacity.
- Given the restriction on traffic movements at the northern and southern approaches to the Basin Reserve as a result of the light rail system, southbound traffic increases on the parallel routes of Tory Street and Taranaki Street.
- As with the morning peak, some existing public transport passengers are likely to transfer from bus to the light rail system, especially between Kilbirnie and the CBD, with a reduction in passenger numbers through the Mount Victoria Tunnel of approximately 1000 passengers. The LRT system between the airport and existing railway station is forecast to attract 7,300 boardings
- A further reduction in 500 bus passengers on Taranaki Street and Wallace Street is forecast.
- A reduction in bus patronage for services using Thorndon Quay to head north is also forecast with a corresponding increase in rail patronage.

Table F12 indicates that light rail option is forecast to increase the overall regional passenger transport mode split by less than 0.2% in each of the morning and evening peak time periods indicating a limited uptake of additional passenger transport patronage for such an investment.

The 25 year benefits associated with this option is - $19.3 million.

Table F13 Mode Split

	Car	PT	Total	PT %
AM	176,322	31,633	207,955	15.2%
IP	166,891	10,860	177,751	6.1%
PM	206,258	27,230	233,488	11.7%

F14 Basin Reserve Grade Separated, Mt Victoria Tunnel duplication and four laning Wellington Road and Cobham Drive improvements Option

Modelling Description: This package includes a combination of a number of smaller options including the provision of the grade separated intersection at the Basin Reserve as described previously, and the duplication of the Mount Victoria Tunnel with access via the Basin Reserve. South of the Tunnel, Ruahine Street has been widened to two-lanes in each direction to tie in with the four-lanes along Cobham Drive with at grade improvements at the intersections with Goa Road, Wellington Road, Troy Road and Calabar Road.

Key Issues: - During the two hour morning peak hour, the roading improvements between the Airport and the Inner City Bypass is forecast to divert through traffic in both directions from Evans Bay Parade to the upgraded route. In addition, a reduction in northbound traffic along Wallace Street and Taranaki Street is forecast. However, the attractiveness of the route puts severe pressure on the other parts of the roading network to the north of the Mount Victoria Tunnel. The key impacts are summarised below for the two hour morning peak:

- An increase of 2,600 northbound and 1,400 southbound vehicles travelling through the Mount Victoria Tunnel is forecast resulting in a northbound two hour traffic flow of 5800 vehicles and 4200 vehicles southbound. Despite the increase in capacity through the Tunnel to two-lanes in each direction, the Tunnel will be forced to operate at and beyond its theoretical operating capacity in both directions.
- Similar high levels of traffic growth are forecast to occur on Ruahine Street with more modest growth along Wellington Road and Cobham Drive resulting in 4500 northbound vehicles using parts of Cobham Drive. Northbound lanes on Cobham Drive are at or close to their theoretical capacity.
- A decrease of 1,600 northbound and 900 southbound vehicles along Evans Bay Parade due to the increased attraction towards the enhanced route is forecast to occur resulting in traffic flows of some 400 vehicles in each direction at the southern end of Evans Bay Parade.
- Approximately 1,300 northbound vehicles are forecast to divert from Wallace Street to Adelaide Road due to the roading improvements at the Basin Reserve resulting in northbound traffic flows in the order of 2700 vehicles along Adelaide Road during the two hour morning peak. Given the existing northbound bus lane during the morning peak period, Adelaide Road will operate beyond its theoretical capacity.
- Given the large increase in northbound flows through the Mount Victoria Tunnel, traffic flows along Buckle Street and Cambridge Terrace increase significantly by 1300 vehicles and 2400 vehicles respectively with the result that the Inner City Bypass operates well beyond its theoretical capacity and pressure is put on Cambridge Terrace.
- Southbound traffic flows along Kent Terrace increase significantly by between 1500 and 2000 vehicles depending upon the section of the road, with traffic flows of 5800 vehicles forecast to use the section between Vivian Street and the Basin Reserve resulting in this section of road operating beyond its theoretical capacity.

- A decrease of 600 northbound vehicles is forecast to occur along Taranaki Street as traffic is likely to divert via Adelaide Road and Cambridge Terrace.

Similar large changes to traffic flows are forecast to occur in the evening peak period albeit with larger increases in traffic southbound from the CBD area using the enhanced roading route. The key impacts that are forecast are summarised below for the two hour evening peak:

- Traffic flow increases by 2,300 vehicles northbound and 2,400 southbound through the Mount Victoria Tunnel with traffic flows in each direction in the order of 5,200 to 5,400 vehicles. As with the morning peak period, such traffic flows are beyond the theoretical capacity of the two two-lane tunnels.
- Large increases in traffic are experienced along the route between the Mount Victoria Tunnel and Evans Bay Parade with smaller northbound increases along Cobham Drive.
- Northbound traffic flows away from the Basin Reserve along Buckle Street and Cambridge Terrace both increase by approximately 1000 vehicles over the two hour evening period with the 6800 vehicles forecast to use Buckle Street pushing the operating capacity of the Inner City Bypass at this point beyond its theoretical limit.
- Traffic flows along Vivian Street and Kent Terrace (between Vivian and the Basin Reserve) along SH1 increase by 1,300 and 2800 respectively. This results in traffic flows along Vivian Street being in the order of 5100 vehicles and 7500 vehicles along Kent Terrace. Accordingly, both routes are over capacity given this level of traffic flow.
- Evans Bay Parade experiences a decrease of 500 northbound vehicles and 1,500 southbound vehicles as a result of the more attractive route through Mount Victoria Tunnel.
- Northbound traffic flows along Wallace Street decrease by approximately 1,100 vehicles whilst northbound traffic on Adelaide Road only increases by 500 vehicles. As such, northbound traffic using Constable Street and Riddiford Street through Newtown from Kilbirnie is forecast to decrease by approximately 500 vehicles, redistributing itself to the Mount Victoria Tunnel.

This combination of roading enhancements results in a 0.1% reduction in the regional passenger transport mode share with small increases in car based traffic and a small reduction in passenger transport use.

The 25 year benefits associated with this option is $148.5million.

Table F14 Mode Split

	Car	PT	Total	PT %
AM	176,987	30,972	207,959	14.9%
IP	167,431	10,597	178,028	6.0%
PM	206,916	26,579	233,495	11.4%

F15 Duplication of the Terrace Tunnel and Aotea to Ngauranga Capacity Improvements (8-laning) with the Waterfront Route Reduced to a Single Lane in each direction

Modelling Description: This package replicates a similar option of duplicating the Terrace Tunnel and providing four-lanes of traffic along SH1 between Ngauranga Gorge and Aotea Quay during the morning and evening peak periods for southbound and northbound traffic respectively. In conjunction with the above capacity increases, road capacity along Jervois Quay between Taranaki Street and Bunny Street is reduced with only a single lane in each direction.

Key Issues: - During the morning peak, traffic is forced to redistribute from the Waterfront onto a number of different routes. Despite the provision of additional roading capacity through the Terrace Tunnel, a number of southbound vehicles seek to still make their way through the CBD either via the Waterfront or adjacent roads within the CBD. The main impacts of this option during the two hour morning peak period are:

- Over 3,400 southbound vehicles divert away from the Waterfront leaving 900 to 1300 vehicles heading south along Jervois Quay. Despite the reduction in road capacity for northbound traffic, traffic flows are forecast to actually increase with the result that 2700 vehicles to use this route. As such, a two way road with a single lane in each direction operates over its theoretical capacity in this instance with southbound traffic speeds along the Waterfront forecast to drop to below 10km/hr in some sections.
- Given the increased capacity along sections of the state highway, southbound traffic flows along Aotea Quay and Thorndon Quay are forecast to reduce by 700 and 900 vehicles respectively with an extra 2700 southbound vehicles forecast to use SH1 north of Aotea Quay and an additional 2100 vehicles forecast use SH1 south of Aotea Quay. As such, a further 700 vehicles are forecast to use the Aotea off-ramp during the morning peak period despite the downstream capacity limitations.
- In addition to the increase in southbound traffic flows along SH1 between Ngauranga and Aotea resulting a total morning peak flow of 13,900 vehicles putting the motorway at capacity, southbound traffic volumes along the Hutt Road decrease by 1800 vehicles. The remaining southbound traffic flows along Hutt Road vary between 2100 and 4300 vehicles depending upon the section of the Hutt Road indicating that two-lanes of traffic are needed along parts of the route in order to meet demand.
- As a result of the redistributed traffic, eastbound flows along Cable Street and southbound traffic flows Kent Terrace (as far as the intersection with Vivian Street) are forecast to reduce by 2300 vehicles and 1200 vehicles respectively with a further reduction of 500 vehicles northbound on Oriental Parade.
- Over 2,700 additional southbound vehicles are forecast to use the Terrace Tunnel, with morning peak flows forecast to reach 7200 vehicles over the two hour period and hence results in the Tunnel operating beyond its theoretical capacity. This high increase and level of southbound traffic is reflected along the entire length of the urban motorway.
- In addition to increases along the state highway to bypass the centre of the city, large increases in traffic flows are forecast to occur in the CBD itself, particularly for southbound traffic along

Featherston Street and Victoria Street with southbound traffic flows as high as 4500 vehicles and 3200 vehicles respectively. A such, these roads within the CBD operate well over their capacity.

- The additional southbound traffic using the Terrace Tunnel increases traffic levels along the Inner City Bypass to approximately 5000 vehicles over the two hour morning period with the result that the route operates beyond its theoretical capacity with large delays expected at the various intersections along its length.

The impact of the combined options during the evening peak differs from the morning period given the much higher northbound flows along the Waterfront in the 2016 base situation. The key impacts for the two hour evening peak that are forecast are summarised below:

- Northbound and southbound traffic flows along the Waterfront decrease by 1800 vehicles and 1200 vehicles respectively. Overall, traffic flows of 3000 northbound vehicles and 1800 southbound vehicles are forecast to use the Waterfront over the two hour evening period indicating that the single lanes in each direction will be operating over capacity.
- Traffic flows along Aotea Quay are forecast to reduce by 1000 vehicles in each direction with northbound traffic flows along Hutt Road forecast to decrease by 2400 vehicles.
- The increase in northbound traffic along SH1 between Aotea and Ngauranga is forecast to be 2500 vehicles with demand meeting the increased supply of road capacity.
- Although up to 700 additional (two way) vehicles use the Waterfront during the evening peak, when compared to the AM peak, the impact on streets adjacent to the Waterfront in the evening is likely to be less significant than the morning peak with the main increases of 800 vehicles occurring along Wakefield Street as drivers seek to bypass the Waterfront.
- As the capacity of the Waterfront is constrained, traffic volumes through the Terrace Tunnel are forecast to increase by up to 900 northbound vehicles and 2,300 southbound vehicles putting additional pressure on the existing northbound traffic flows. 7300 northbound vehicles and 7000 southbound vehicles are forecast to use the Terrace Tunnel over the two hour evening peak with the result that the Tunnel operates beyond its theoretical capacity.

The combined options of providing additional capacity on SH1 through the Terrace Tunnel and between Aotea Quay and Ngauranga Gorge, whilst reducing capacity along the Waterfront has negligible impact on the regional passenger transport mode share, as shown in Table E13 below.

The 25 year benefits associated with this option is -$50.9 million

Table F15 Mode Split

	Car	PT	Total	PT %
AM	176,648	31,265	207,913	15.0%
IP	167,117	10,705	177,822	6.0%
PM	206,083	26,928	233,011	11.6%

F16 Adelaide Road as a Passenger Transport Spine with an At-Grade Basin Reserve Intersection improvement Option

Modelling Description: This option includes the provision of a bus lane in each direction along with a Northbound vehicle lane between John Street and the Basin Reserve. Improvements have also been made around the northern side of the Basin Reserve by routing the northbound lanes of the state highway around the northern side of the Basin Reserve rather than forcing state highway traffic to travel around the Basin Reserve. This approach requires the provision of traffic signal controlled intersection at Dufferin Street and Paterson Street as well as at Sussex Street and Buckle Street. Bus lanes linking Adelaide Road to Kent and Cambridge Terrace have also been provided around the Basin Reserve.

Key Issues:- During the two hour morning peak, the changes to Adelaide Road results in a transfer of vehicles from Wallace Street and Taranaki Street onto Adelaide Road, with a resulting increase in flows along Buckle Street as well as some vehicles continuing north along Cambridge Terrace and along the Waterfront. Southbound traffic that previously used Adelaide Road is diverted onto Wallace Street or through the Mount Victoria Tunnel to access Newtown via Constable Street. The key impacts for the two hour morning peak period are summarised below:

- An increase of 1,100 northbound vehicles along Adelaide Road is forecast to occur with a corresponding decrease of 400 vehicles and 200 vehicles northbound along Wallace Street and Tasman Street. Addition traffic is also forecast along Adelaide Road south of John Street. Northbound traffic flows along Adelaide Road between John Street and the Basin Reserve are forecast to be 2100 vehicles putting the single lane at or beyond its theoretical capacity.
- An additional 600 vehicles are forecast to use Buckle Street between the Basin Reserve and Taranaki Street as a result of the diverted vehicles using Adelaide Road rather than Wallace Street putting additional pressure on this link of the Inner City Bypass.
- Large reductions in traffic flows around the south eastern corner of the BASIN Reserve between Mount Victoria Tunnel and Adelaide Road are experienced.
- The enhanced bus priority measures results in an increase of 200 southbound passengers along Kent Terrace and Adelaide Road.
- During the evening peak period, the removal of the southbound lane along Adelaide Road results in traffic being redistributed around a wide number of routes, rather than focussing on one or two as in the morning peak. The main impacts during the two hour evening peak period are:
- Northbound traffic flows on Adelaide Road are forecast to increase by 1000 vehicles with an equal reduction in northbound flows along Wallace Street and Adelaide Road. As with the morning peak period traffic flows along Adelaide Road between John Street and the Basin Reserve are forecast to be 2100 vehicles putting the single lane at or beyond its theoretical capacity.
- Southbound traffic redistributes onto a large number of routes with the result that approach roads to the Basin such as Cable Street and Kent Terrace have flows reducing by 700 vehicles and 1000 vehicles respectively. Redistributed traffic diverts onto Oriental Parade (100 vehicles), Wallace Street (400 vehicles), Tasman Street (100 vehicles), and Brooklyn Road (500 vehicles)

with traffic making their way to the south suburbs via Happy Valley Road. These increases put Brooklyn Road, Wallace Street and Oriental Parade under further pressure with these specific roads operating at or beyond their theoretical capacity.

- Given the redistribution in traffic flows, a shift in volumes occurs within the CBD area, typically from Kent Terrace onto Taranaki Street and Tory Street as well as along Vivian Street and Buckle Street with the Inner City Bypass route in particular being at or beyond its theoretical capacity.
- The bus priority measures has the impact of attracting a further 200 passengers onto routes using Adelaide Road.

The 25 year benefits associated with this option is -$35.1million.

Table F16 Mode Split

	Car	PT	Total	PT %
AM	176,570	31,267	207,837	15.0
IP	167,073	10,697	177,770	6.0
PM	206,338	26,898	233,236	11.5

Appendix G: Population and Employment Growth Figures assumed in the WSTM

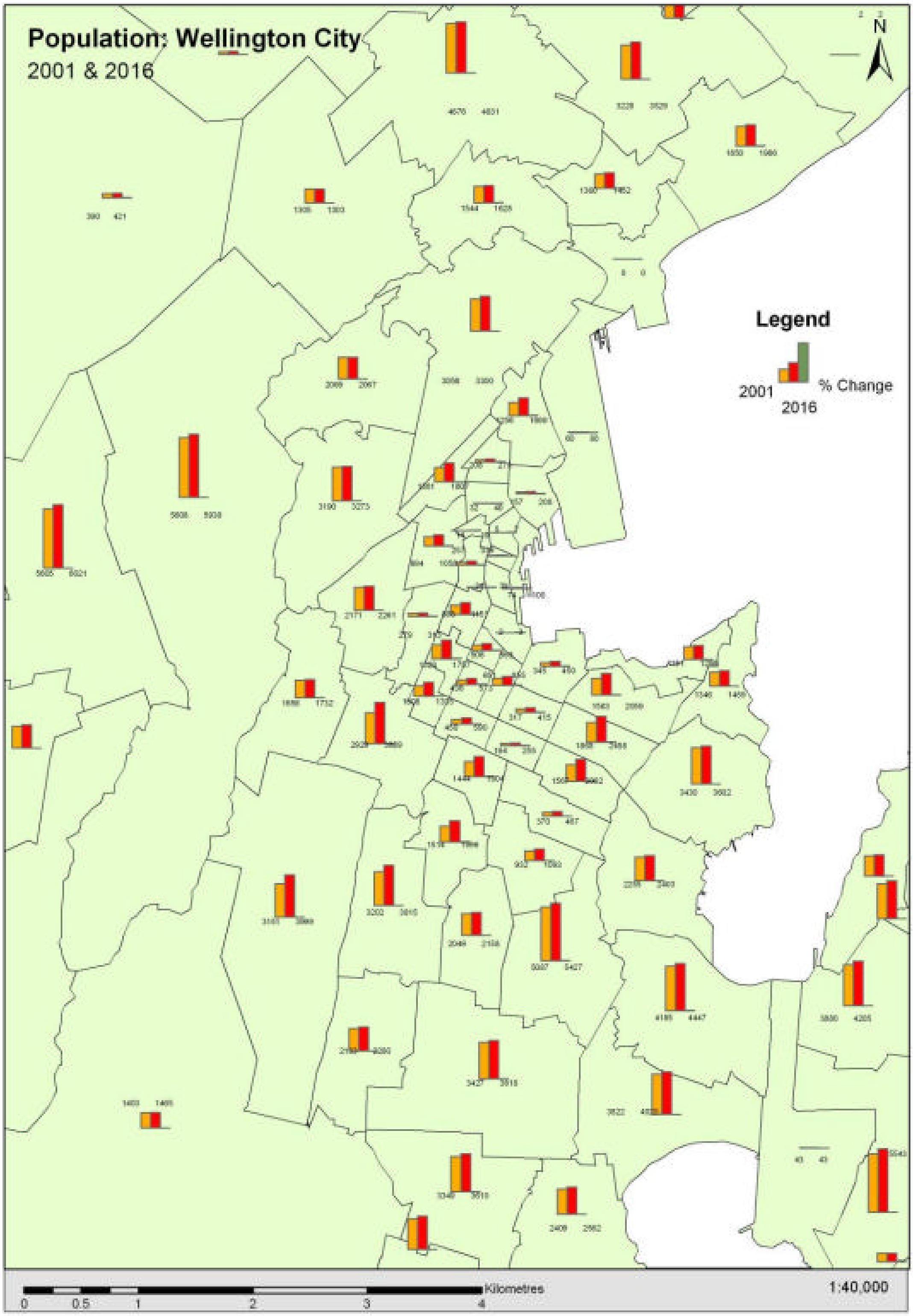


Figure G1: Assumed Population for 2001 and 2016 used within WSTM

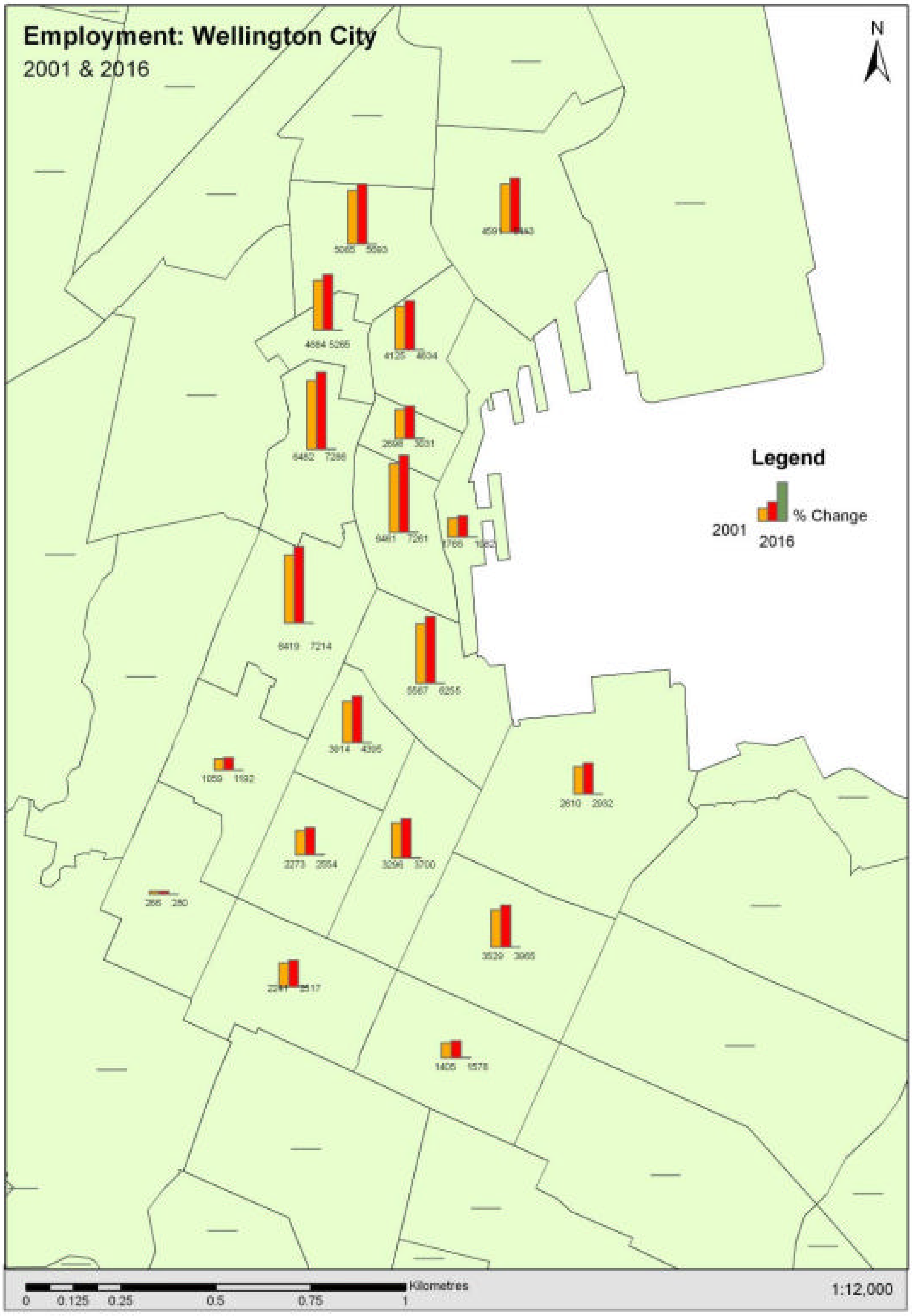


Figure G2: Assumed Employment for 2001 and 2016 used within WSTM