Appendix C
Transport Assessment - Existing Conditions and Future No Project Scenario

February 2018

C

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Part 1 – Existing Conditions Report

1 Introduction

North East Link is a proposed new road link between the Eastern Freeway and the M80 Ring Road (M80) in Melbourne's north eastern suburbs. The purpose of this report is to assist the development of the business case and to document the existing transport conditions of Melbourne's north east.

This report covers the current performance of the transport network, identifies existing travel demand and travel patterns, and highlights congestion hotspots that constrain the future growth of the area.

A comprehensive understanding of the existing travel demands and transport network constraints is required to develop an appropriate solution for North East Link that will improve the efficiency and effectiveness of the broader transport network.

1.1 Study area

This report focuses on two geographical areas:

- The wider metropolitan Melbourne area; and
- The local area (referred to as the study area).

Metropolitan Melbourne

The metropolitan Melbourne area comprises the road network within the Melbourne Statistical Division (MSD), presented in Figure 1. Infrastructure projects of metropolitan scale such as the North East Link Project have the potential to impact the broader transport network and will generally influence network-wide statistics such as vehicle kilometres travelled (VKT) and average vehicle speeds.

Local area

The study area focuses on Melbourne's north eastern suburbs, spanning from the Merri Creek in the west to Melbourne's outer fringes in the north and east. The study area is presented in Figure 2. This extent covers a wide area between the Eastern Freeway in the south and the M80 in the north to determine the optimal project corridor and transport solution.

While the metropolitan Melbourne assessment focuses on whole-of-network statistics, the local area assessment explores issues related to the arterial and freeway road network, public transport routes and walking and cycling in the area.

Figure 1 **Melbourne Statistical Division**

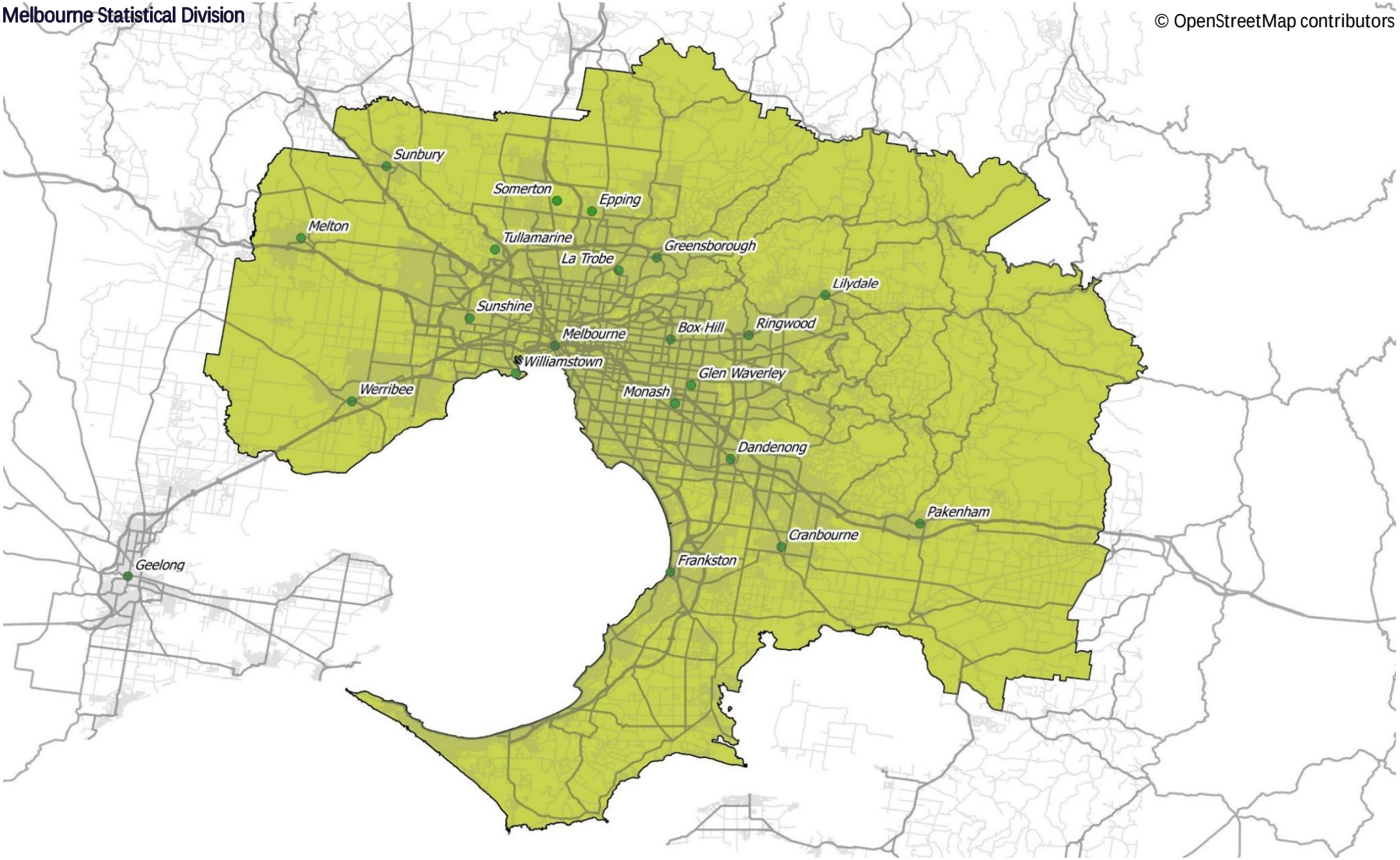
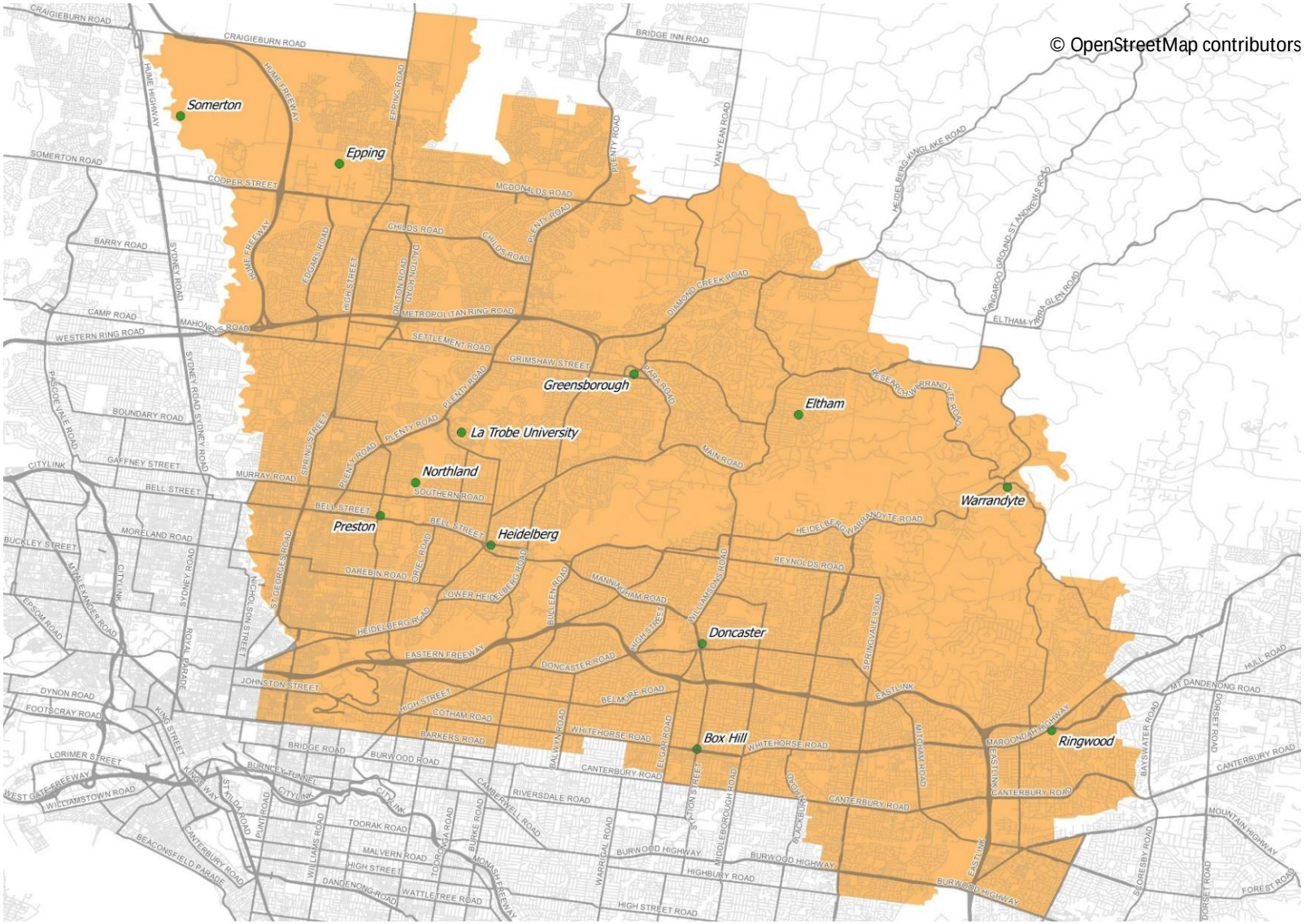


Figure 2 **Study area**



1.2 Structure of this report

This report is structured as follows:

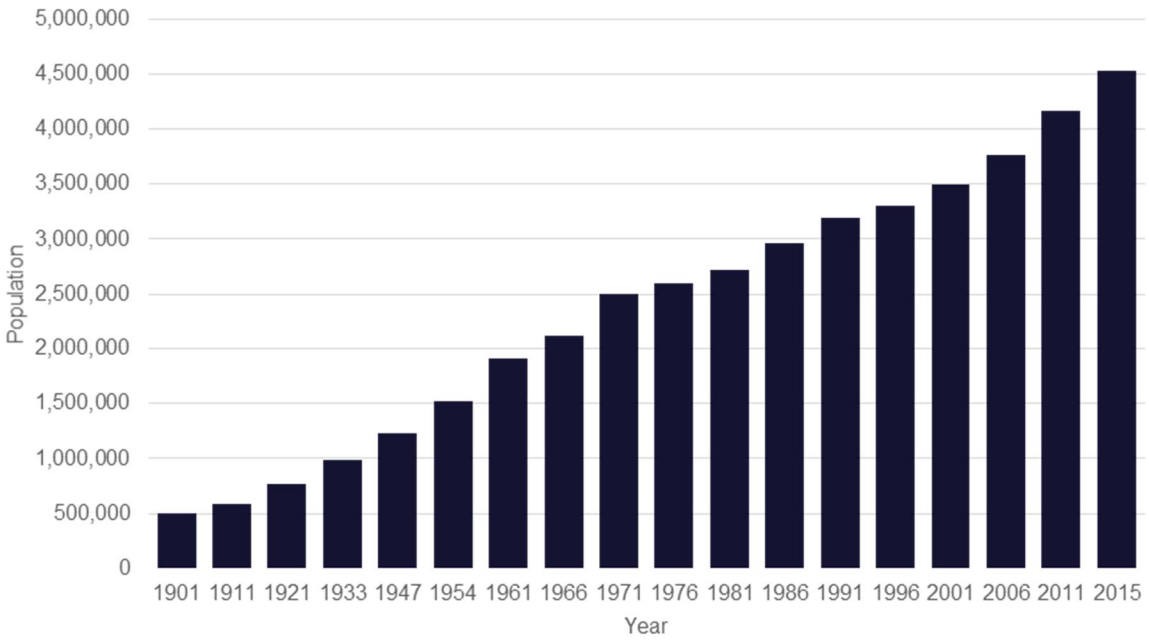
- Chapter 2 provides a Melbourne-wide historical context, charting the development of the growth of the city and the transportation network;
- Chapter 3 presents an overview of the north eastern suburbs, including population, jobs and employment, and transport trends;
- Chapter 4 assesses the road based transportation network, highlighting traffic conditions, trip patterns, issues and bottlenecks;
- Chapter 5 presents an assessment of road safety within the study area;
- Chapter 6 provides an assessment of the freight industry, including freight flows, demands and network constraints;
- Chapter 7 presents an overview of the public transport network in the north east; and
- Chapter 8 provides a summary of the walking and cycling network, including recreational and cycling, trends and issues.

2 Historical context

2.1 Historical population growth and urban sprawl

Since Melbourne was founded in the early 1800s, the city has grown exponentially in both land area and population, largely aided by favourable flat topography and an abundance of accessible land. From a population of just over 500,000 people[1] at the turn of the 20th century, Melbourne today has a population of more than 4.6 million people[2]. The growth in the city's population over the last century is presented in Figure 3.

Figure 3 Melbourne's Population 1911 - 2015



Source: Australian Bureau of Statistics, Australian historical population statistics, 2014, catalogue number 3105.0.65.001, Greater Melbourne (GCCSA)

The lack of geographical obstacles such as watercourses or mountains has enabled land to be developed cheaply, resulting in low population densities by global standards. This low density urban sprawl largely characterises Melbourne's suburbs, with housing typically consisting of detached single or two storey dwellings on large parcels of land. Development of land further away from the centre of Melbourne was enabled firstly by the large expansion of the rail network in the late 19th century to early 20th century and later by the mass uptake of private automobiles post World War II and the accompanying investment in a high capacity arterial road and freeway network. As the population has grown and the city has spread, the freight task has also needed to increase to meet the demands of the growing city.

[1] Australian Bureau of Statistics, Australian historical population statistics, 2014, catalogue number 3105.0.65.001, Greater Melbourne (GCCSA)
2 Victoria in Future 2016 – Greater Melbourne Capital City Statistical Area

The Melbourne Central Business District (CBD) in the early 1900s is presented in Figure 4 (showing ships docking to unload cargo adjacent to the CBD with no development along Southbank) and Figure 5 (Flinders Street Station including the original Princes Bridge Station which transported passengers on the Hurstbridge and Epping lines).

Figure 4 **Aerial view over Melbourne looking from South Wharf, 1925**[3]

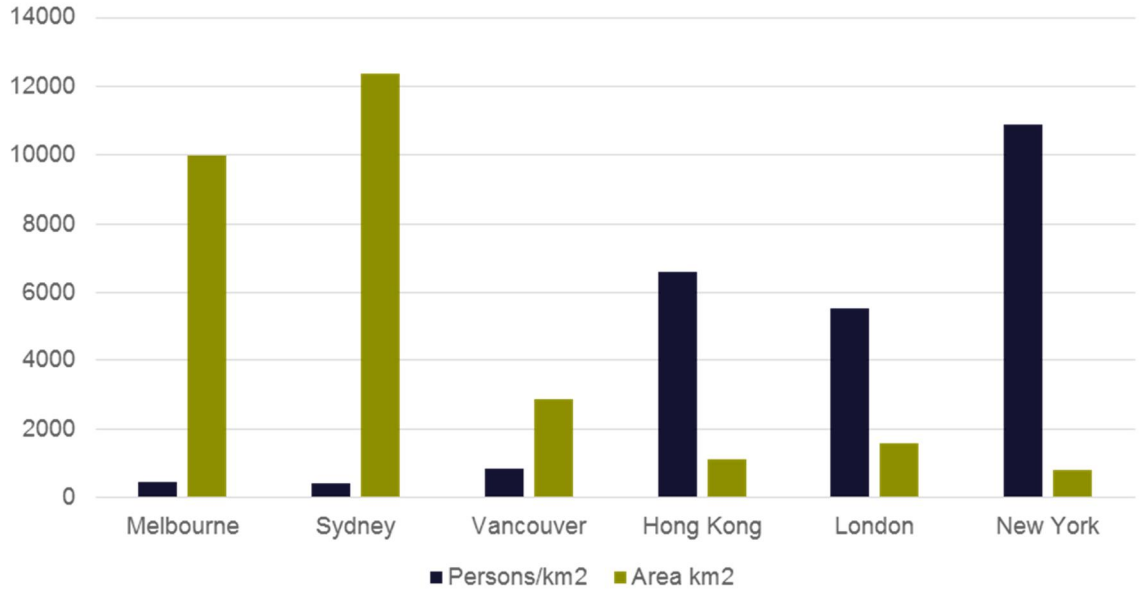
Figure 5 **Flinders Street Station and Princes Bridge, 1929**[4]

Melbourne today spans an area of approximately 10,000 square kilometres (ABS, 2011), with many regions within its boundary 100 kilometres apart, taking hours to travel from end to end. Its urban boundaries have eclipsed the areas of some of the largest cities in the world, which typically house many more people within smaller footprints.

As presented in Figure 6, the urban footprint of Melbourne is far more extensive and has lower or comparable populations compared to other global cities due to the low population density per square kilometre. Together, Melbourne and Sydney cover a geographical area of more than 22,000 square kilometres, equating to almost one fifth of the entire land mass of England.

[3] Herald Sun Image Library
[4] Herald Sun Image Library/ARGUS

Figure 6 Comparison of Melbourne's population density and land area to other global cities



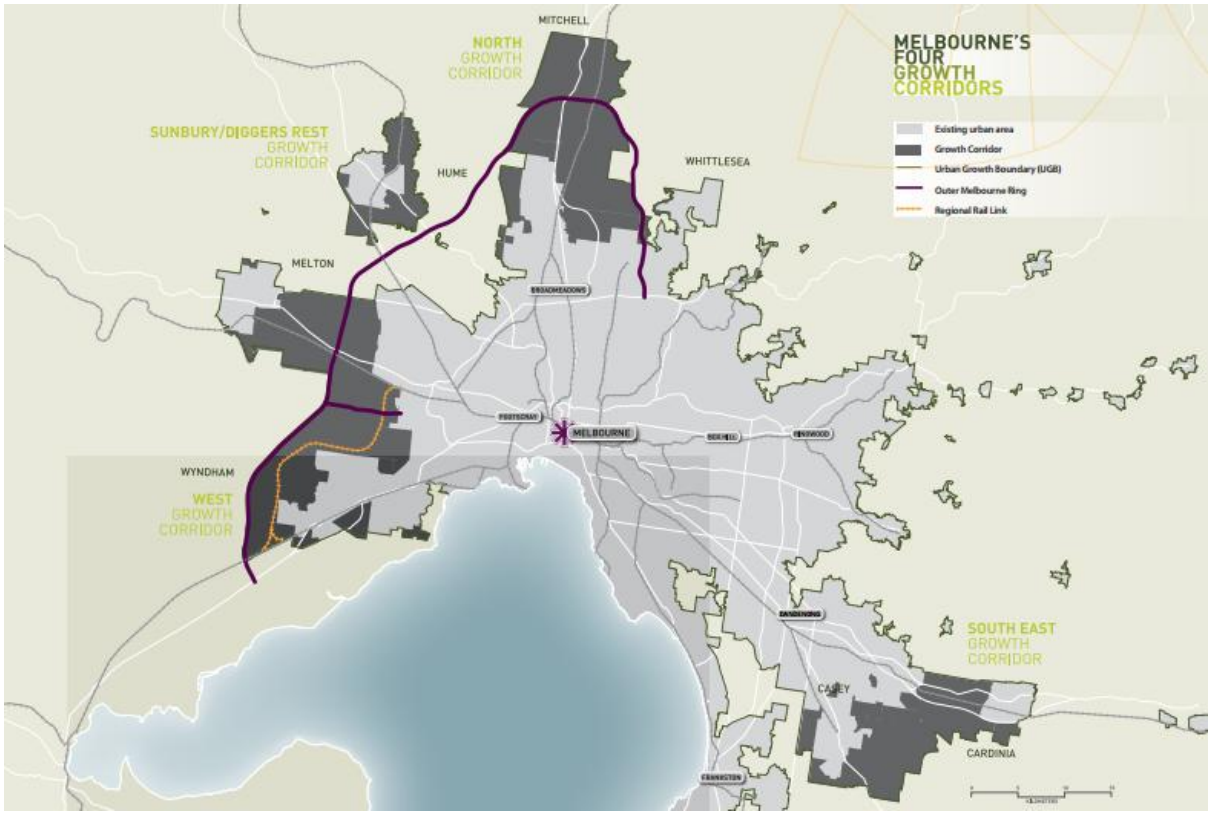
Source: Various Sources

While an urban growth boundary was legislated in 2002 (and expanded in subsequent years) with the aim of stopping urban sprawl (a key policy direction in Melbourne 2030[5]), the high demand for housing from a rapidly growing population has led to multiple expansions of the boundary in subsequent years. This growing population and expanding footprint continues to place stress on existing infrastructure, which is increasingly struggling to accommodate the additional demand.

The changes to Melbourne's Urban Growth Boundary over the last decade are presented in Figure 7. The currently sparsely populated northern corridor of Melbourne is one of the city's fastest growing areas, with a future estimated population capacity of up to 330,000 people and job capacity of up to 105,000[6]. This is expected to place additional pressure on the north east transport network in the coming years.

[5] Melbourne-2030-Planning-for-sustainable-growth, Policy 2.1, *Establish an urban growth boundary to set clear limits to metropolitan Melbourne's outward development*
[6] Growth Corridor Plans, VPA

Figure 7 Expansion of the Urban Growth Boundary between 2002 and 2017



Source: Growth Corridor Plans, Victorian Planning Authority

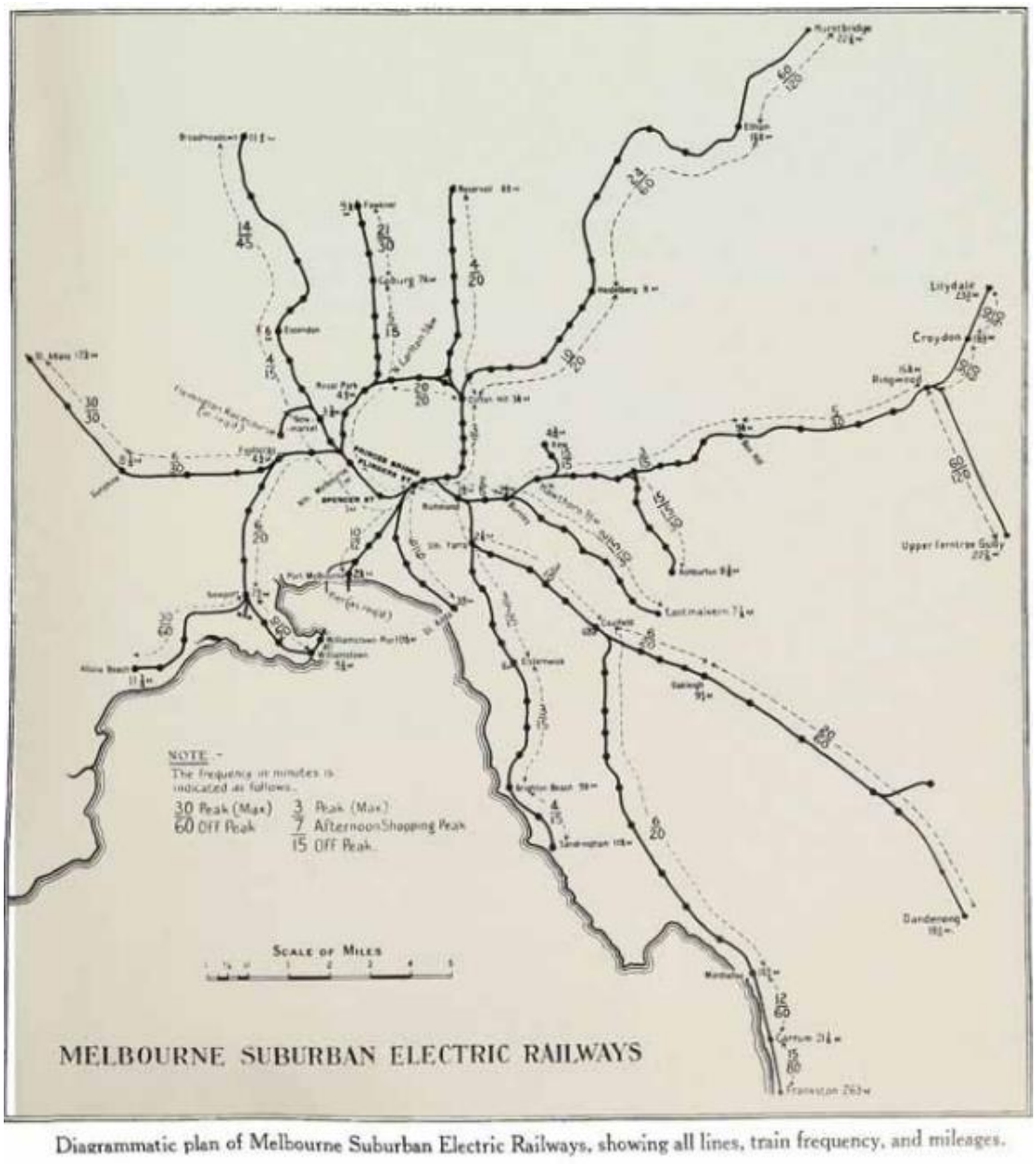
2.2 Early 20th century Melbourne – the monocentric city

Despite its large geographical footprint, Melbourne originally developed as a monocentric city with its residents travelling from the outer suburbs to jobs clustered in and around the central business district (CBD) and inner-city areas. Services, jobs and key amenities have been traditionally located in the CBD, with the suburbs consisting mainly of housing.

Fast and efficient access to the CBD from all areas of Melbourne was made possible by investment in a radial rail transport network; rail trips generally started or ended at Flinders Street station, branching out along the radial lines towards the suburbs. Further rail investment in the early 20th century entrenched this monocentric structure, with growth and demand for radial trips enabled by the construction of new rail links and electrification of the rail network in 1913. The radial nature of Melbourne's early rail network can be seen in Figure 8.

The 1929 Plan for General Development highlighted that Melbourne's railway system had played the greatest influence on the city's suburban development, leaving 'sparse' areas between the routes.

Figure 8 Melbourne's suburban railway network, 1929



Diagrammatic plan of Melbourne Suburban Electric Railways, showing all lines, train frequency, and mileages.

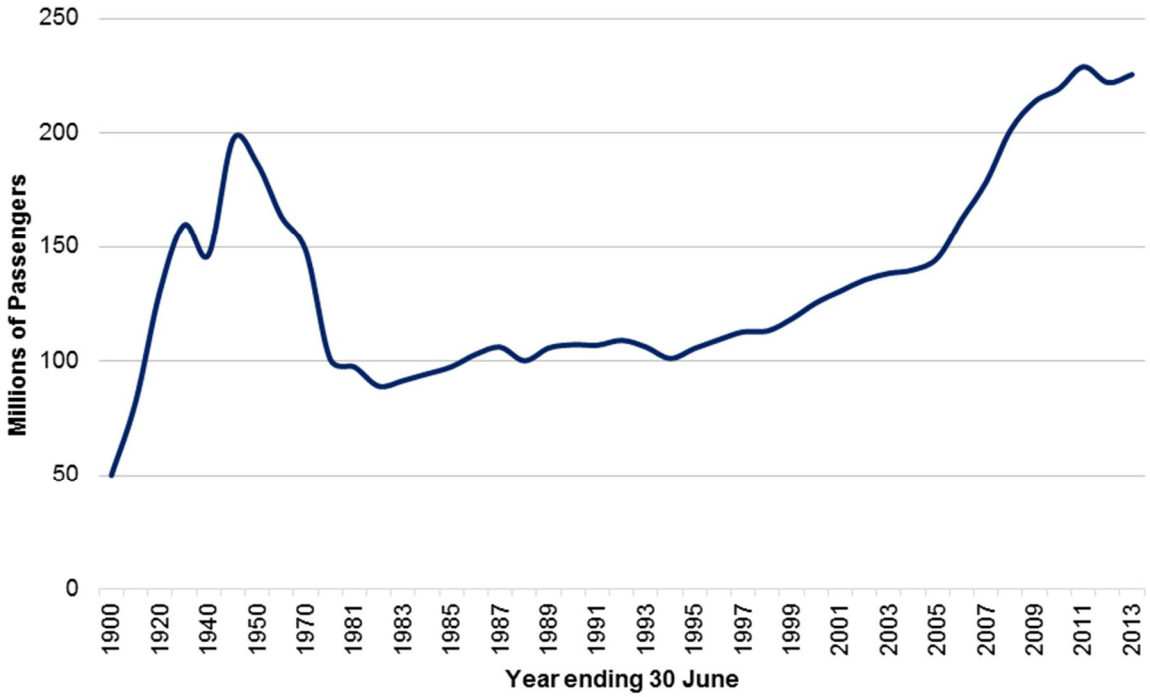
Source: 1929, Plan for General Development, Metropolitan Town Planning Commission.

Post-World War II, Melbourne experienced a population boom, with the city in the 1950s growing by 40 percent from 1.3 million to 1.8 million people[7]. This boom coincided with the mass uptake of the private automobile, which opened up large parcels of land that were not previously serviced by rail, further encouraging urban sprawl. The expansion of Melbourne at the height of the popularity of car travel entrenched the sprawling low-density city structure, with new suburbs planned primarily around cars.

[7] Australian Bureau of Statistics, Australian historical population statistics, 2014, catalogue number 3105.0.65.001, Greater Melbourne (GCCSA)

The convenience offered by private vehicles, which had become increasingly more affordable in the late 1940s, was responsible for falling demand for rail trips. Patronage on Melbourne's rail network peaked in 1949-50 with passenger numbers falling from nearly 180 million in 1947 to 150 million 10 years later[8]. This level of demand was not reached again until the late 2000s, as presented in Figure 9.

Figure 9 Melbourne metropolitan train patronage, 1990 to 2013



Source: Bureau of Infrastructure, Transport and Regional Economics – Long-term trends in urban public transport

With increased demand for private vehicle travel came higher levels of congestion on Melbourne's road network. By the 1950s, Melbourne's inner suburbs were becoming congested, with infrastructure that was ill-equipped to deal with traffic volumes generated by travel demand at the time, which was still primarily CBD-orientated.

The following decades saw a large investment in the road network, aimed at accommodating the demand for radial trips. Major transport infrastructure was built including the construction of the Tullamarine Freeway, South Eastern Freeway, Mulgrave Freeway (now the Monash Freeway), West Gate Freeway (including the West Gate Bridge) and the Eastern Freeway.

[8] Infrastructure Victoria Learning from the past, 2016

2.3 Decentralisation, orbital investment and the rise of the polycentric city

By the late 1960s and early 1970s, Melbourne's continued growth was placing additional pressure on infrastructure and services. Congestion had stifled further growth of the CBD, while increasing land values in the inner-city areas had begun to push industry further out to areas such as Dandenong[9]. Car-based retail developments in the outer suburbs such as Chadstone, Knox, Doncaster, Northland and Highpoint also brought key services to the suburbs for the first time.

Even as this decentralisation was beginning to take place, investment was still primarily focused on catering for radial CBD trips, for which infrastructure had lagged behind in previous years. The 1980s saw the extension of the Mulgrave Freeway, the South Eastern Freeway and West Gate Freeway, and the construction of the Princes Freeway East and West, and the Melbourne Underground Rail Loop.

This slow decentralisation and transformation from a monocentric city to a polycentric city started to accelerate significantly following the opening of the Western Ring Road in the late 1990s. The ring road – Melbourne's first orbital freeway, allowed cross-city movement bypassing the city centre. Further investments such as the completion of CityLink and EastLink in the 2000s continued this transformation away from a largely radial network.

A map showing the development of the freeway network in Melbourne is presented in Figure 10.

Figure 10 Development of Melbourne's freeway network from 1970 to present day

[9] A heritage study of selected properties within the boundaries of the City of Greater Dandenong

These new orbital routes were the catalyst for significant land use change and intensification, with high levels of industrial and commercial development along these corridors. Outer suburban activity centres and industrial hubs such as Dandenong, Monash, Ringwood, Greensborough and Tullamarine experienced rapid growth due to the increased accessibility provided by the orbital roads.

2.4 Present day Melbourne

Present-day Melbourne is a rapidly evolving and growing city, still largely monocentric in nature, but gradually evolving into a polycentric city. This transition is still constrained by the past radial investments of the 20th century.

As the population continues to grow and additional pressure is placed on existing transport infrastructure, there is limited ability to accommodate additional demand across the network. Travel times and general congestion will continue to increase unless strategic investments are made, allowing improvements in the efficiency of the transport network and the ability to unlock the full potential of underutilised assets.

2.4.1 Over reliance on the M1 corridor

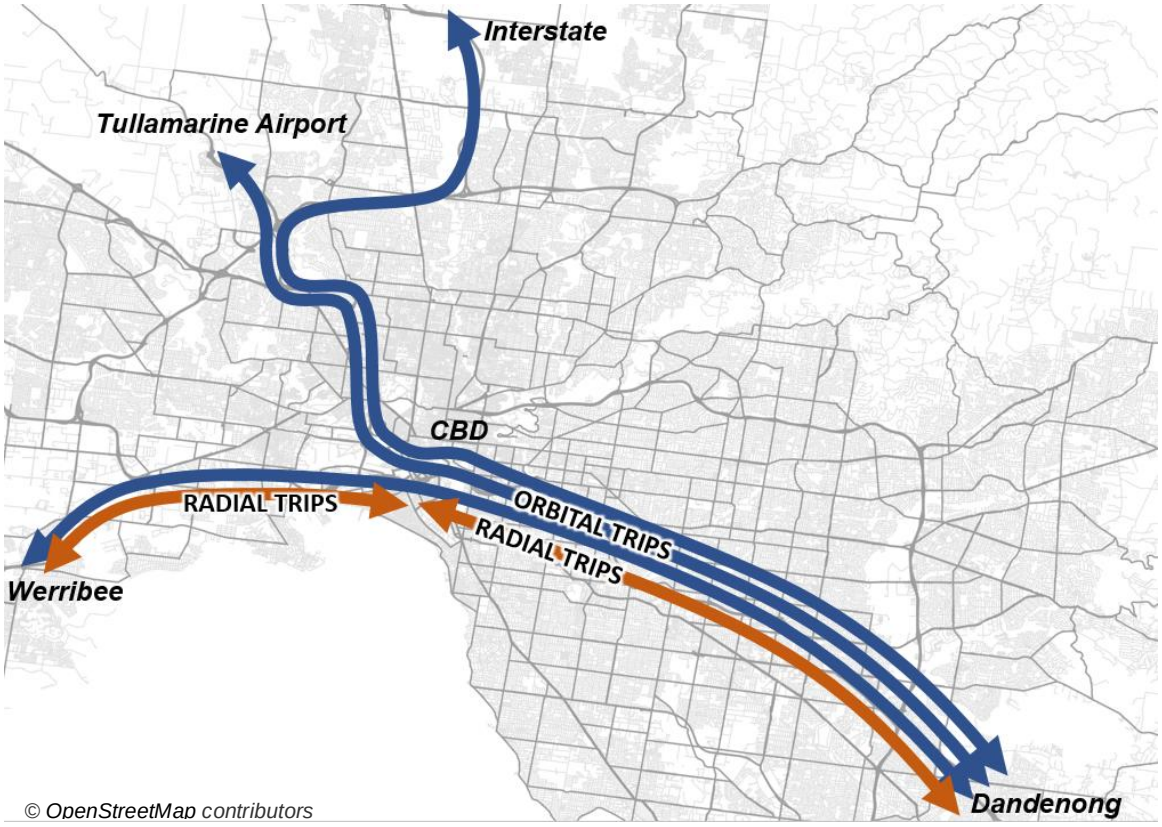
The M1 carries over one million people a day across its length[10], linking Pakenham and Dandenong in the east to the CBD, and to Werribee in the west. While it was originally built with radial trips between the suburbs and the CBD in mind, the construction of CityLink (an inner-city bypass) and the lack of suitable alternative routes means the M1 acts in a dual orbital and radial capacity.

People wishing to complete cross-city orbital trips such as a trip between Dandenong in the south eastern suburbs and the airport in the north west are forced to use the M1 and CityLink to complete their journeys, competing for road space with radial CBD-bound motorists, as presented in Figure 11. Orbital trips are being funnelled into an already congested inner city transport network and these trips use up valuable radial network capacity.

Because of the convergence of orbital and radial trips in the inner city, the entire road network has become extremely susceptible to incidents in locations such as the Domain and Burnley Tunnels or on the West Gate Freeway. The impacts of these incidents can 'ripple out' across the city's road network, constraining trips across all of Melbourne.

[10] VicRoads Managed Motorways Framework, Network Optimisation and Operations Rationale and Technical Requirements, March 2017

Figure 11 Competing orbital and radial demands on the M1 corridor



3 The north eastern suburbs

3.1 Overview of the north east

The north east of Melbourne is a diverse region, ranging from the tree-lined suburbs of Ivanhoe and Heidelberg to the newer modern-day estates north of the M80 and the 'tree change' suburb of Warrandyte along the Yarra River. Today, the north eastern suburbs are home to approximately 947,000 residents, 20 percent of Melbourne's population[11].

Housing is typically in the form of low density detached dwellings, with higher density development clustered around the key employment and retail precincts of Greensborough, Ringwood, Heidelberg, La Trobe, Box Hill and Doncaster.

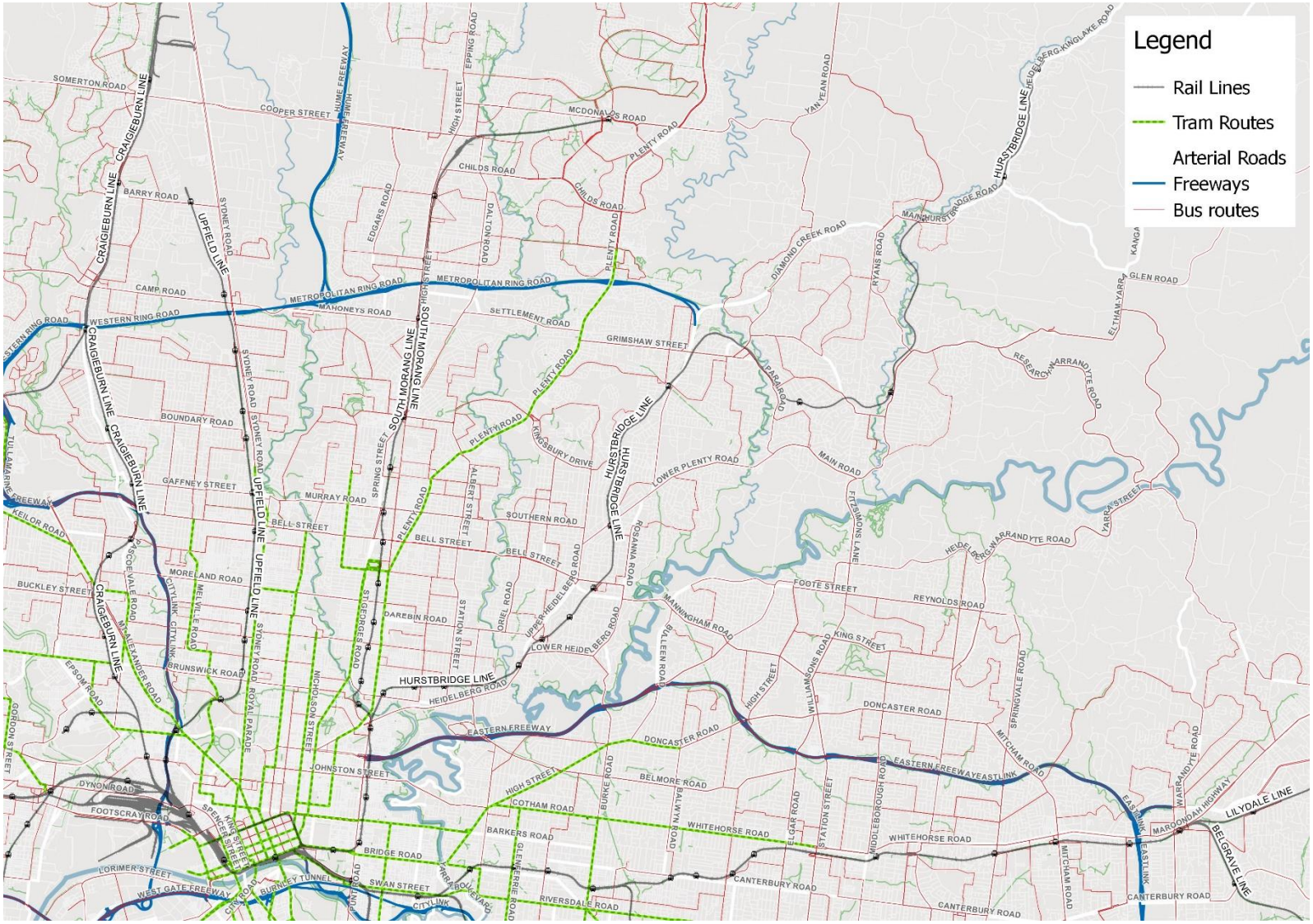
The transport network in the north-east is vastly different to other regions in Melbourne; unlike the south-eastern suburbs, there is a lower reliance on trams and freeways, and a more disjointed and less permeable arterial road network. The transport network is presented in Figure 12. Compared to the south eastern suburbs (shown at the bottom of Figure 12), the north east has limited access to tram and rail services.

The Eastern Freeway and the M80 are the two freeways in the north east; however, a high proportion of road-based transport is via the arterial road network.

The Hurstbridge rail line services an area north of the Yarra River, while an extensive radial SmartBus and Doncaster Area Rapid Transit (DART) bus network operates throughout the area. Due to the low density and large geographical reach of the north eastern suburbs, there is a high reliance on the on-road bus network compared to trains and trams, particularly in the Doncaster and Templestowe areas.

[11] Victoria in Future 2016 (VIF2016)

Figure 12 **North eastern suburbs transport network**



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3.2 Land use, population and jobs

3.2.1 Land use

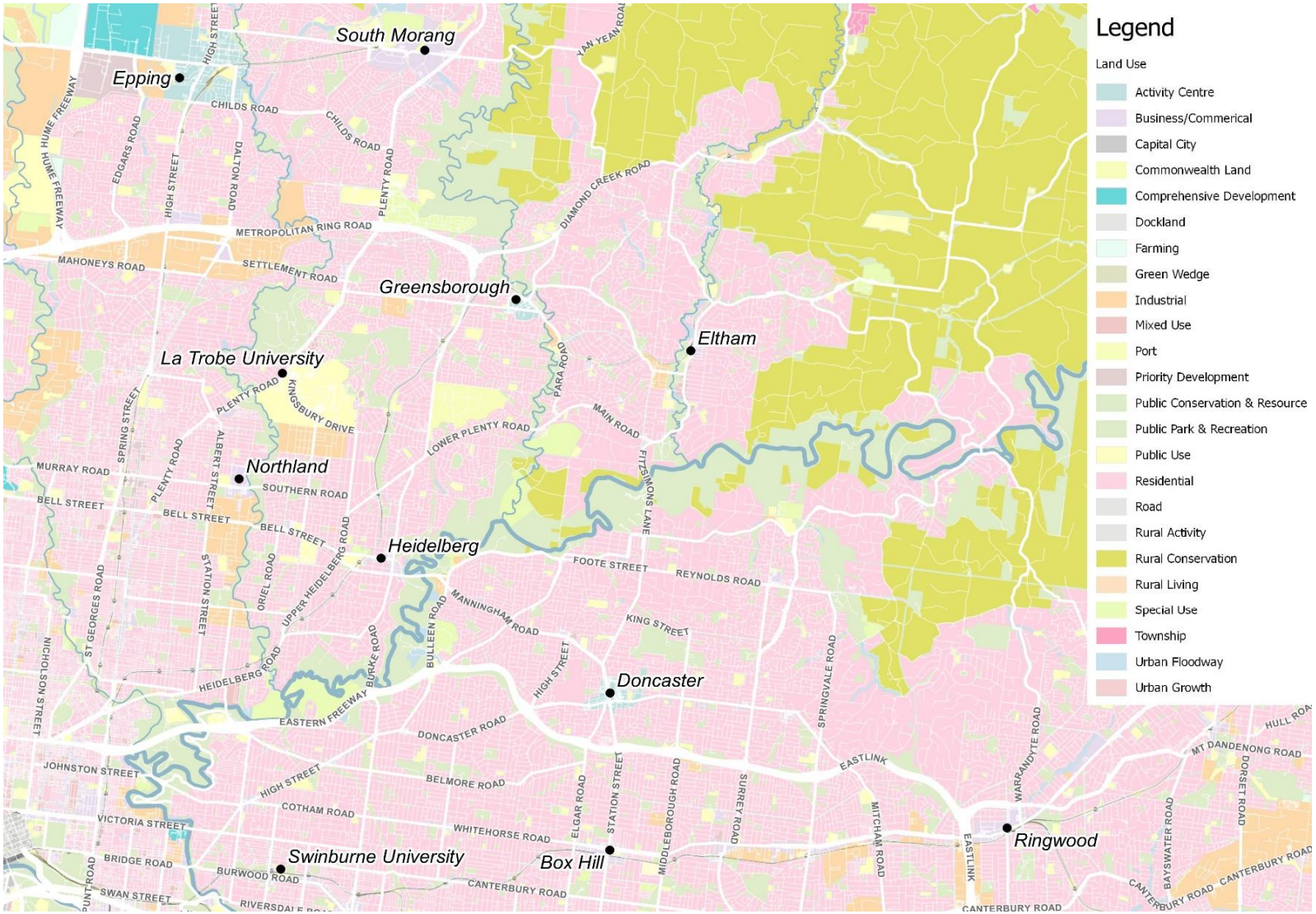
Land use in the north east is primarily residential, with commercial and retail clustered around the key activity centres. Large industrial precincts are also located in Preston, Heidelberg West, Reservoir, Somerton and Epping. Similar to the inner west of Melbourne, many of these industrial precincts in the north east are surrounded by residential land uses, which can often lead to conflicts between trucks accessing these precincts and the residential amenity of surrounding areas.

The limits imposed by the Urban Growth Boundary, parklands along the Yarra and rural conservation zoning in the north east have resulted in large areas of land that are undeveloped or limited to very low density dwellings. This land use zoning prevents further significant development or densification in the future. Land use in the north-east is presented in Figure 13.

Figure 13 **Land use in the north-east**

© OpenStreetMap contributors

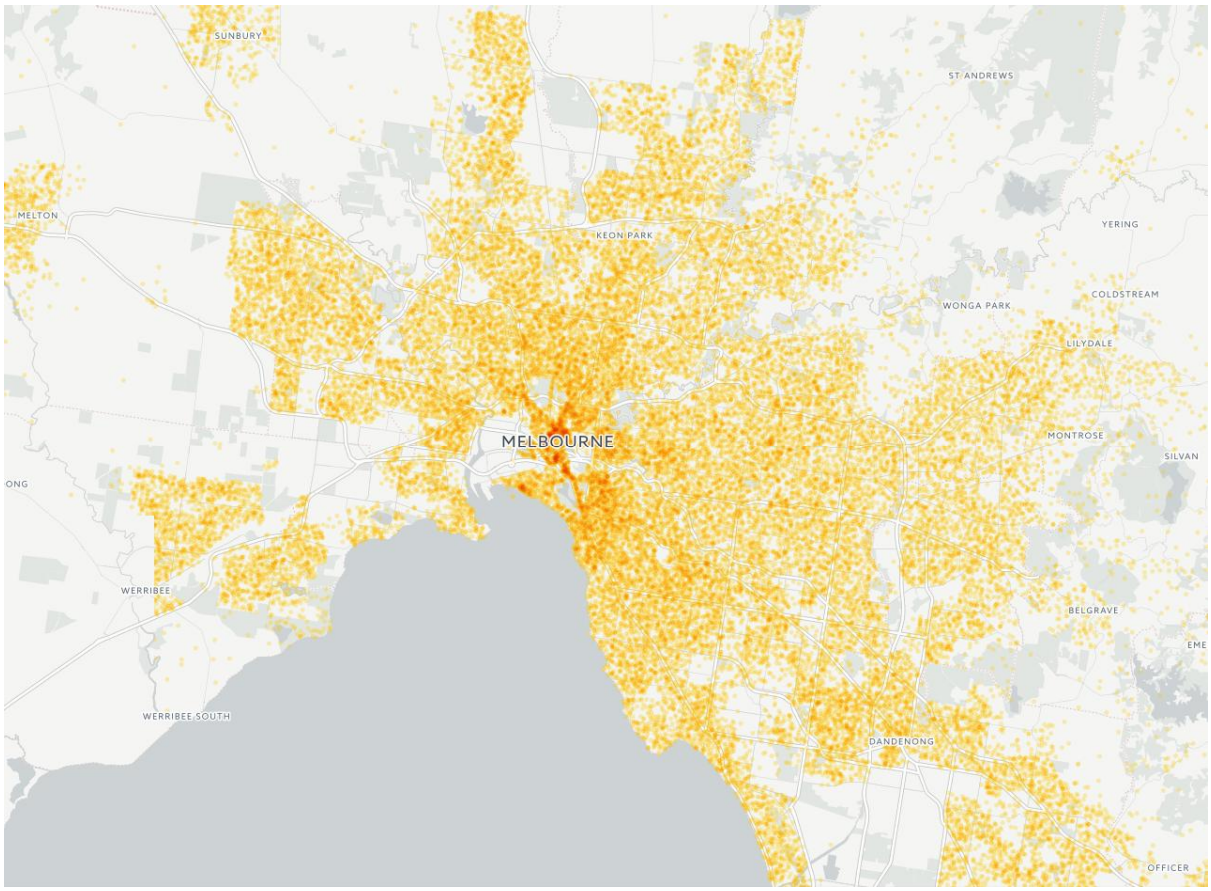
Source: The State of Victoria, Department of Environment, Land, Water & Planning 2017Population and jobs



The 947,000 people in the north east are overwhelmingly concentrated within the Urban Growth Boundary. While the residential population is relatively evenly dispersed throughout the north east as presented in Figure 14, employment is generally clustered around activity centres and industrial precincts. These employment clusters can be seen in Figure 15, with high concentrations of jobs in Box Hill, Doncaster, Heidelberg, Ringwood and a very large concentration of jobs in the CBD and surrounding suburbs.

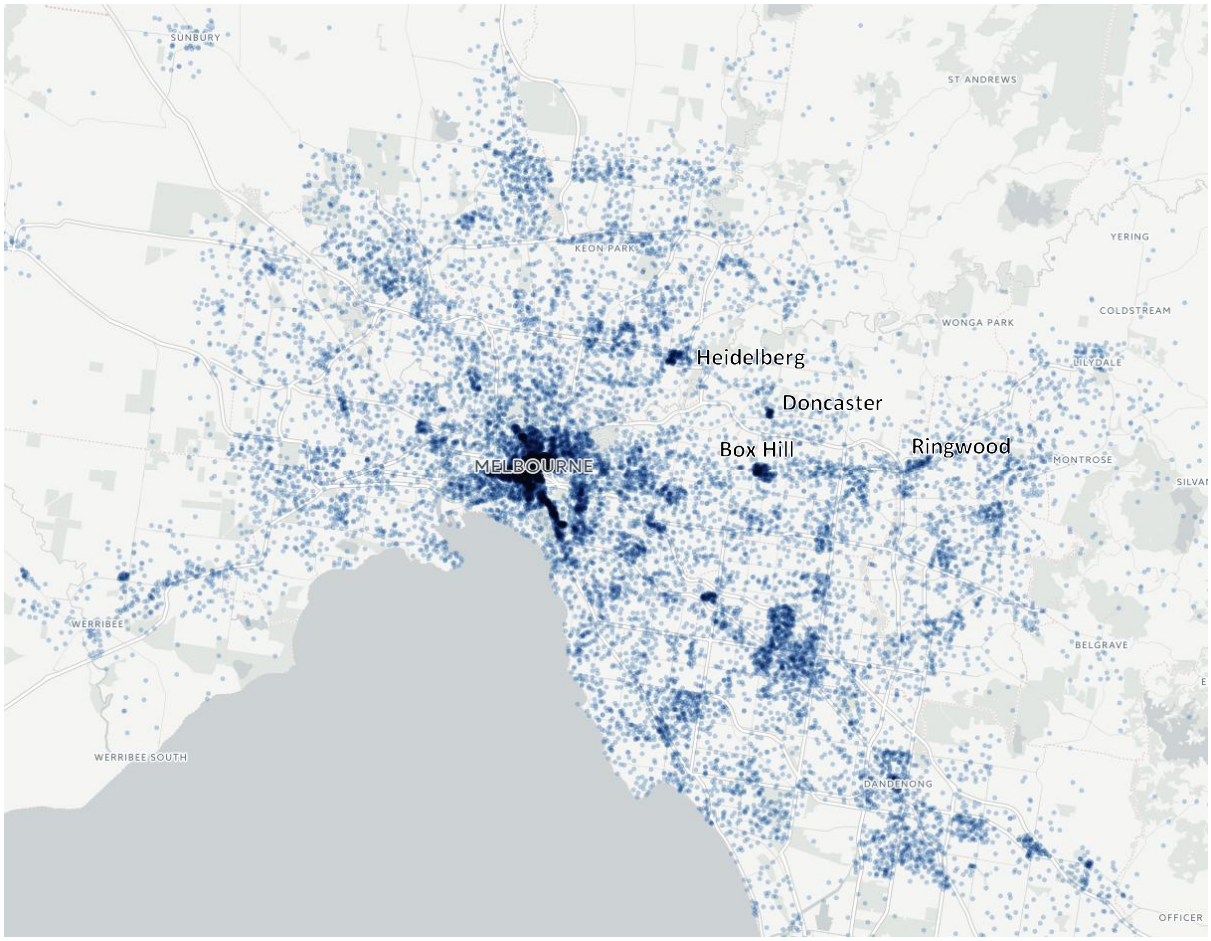
By and large, the majority of the north east can be considered 'commuter suburbs', resulting in large tidal flow movements across the transport network away from the region.

Figure 14 Population density plot



Source: Veitch Lister Consulting, Victoria in Future 2015

Figure 15 Employment density plot

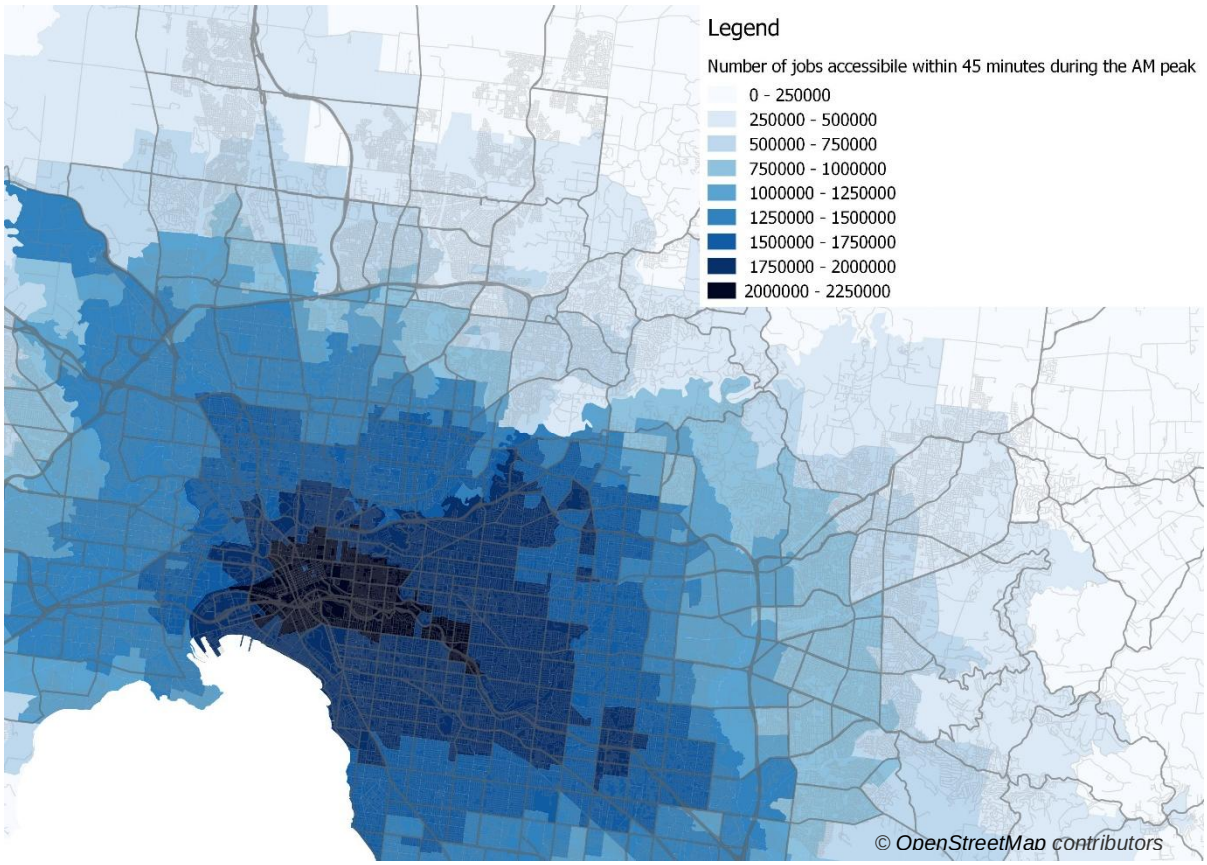


Source: Veitch Lister Consulting, Victoria in Future 2015

As a large proportion of jobs are concentrated in the inner city areas, job accessibility for residents in the north east decreases further away from the CBD. The number of jobs within a 45-minute journey time during the AM peak period is presented in Figure 16. The further away a person's place of residence is from the CBD, the fewer jobs are available. This means that compared to someone living in the inner-city, a person in the north east typically has fewer local employment opportunities, forcing them to either travel further or longer for work.

Additionally, locations along the M80 (a similar distance to the CBD) have access to a higher number of jobs compared to the north east.

Figure 16 Number of jobs accessible within a 45-minute catchment during the AM peak, based on place of residence



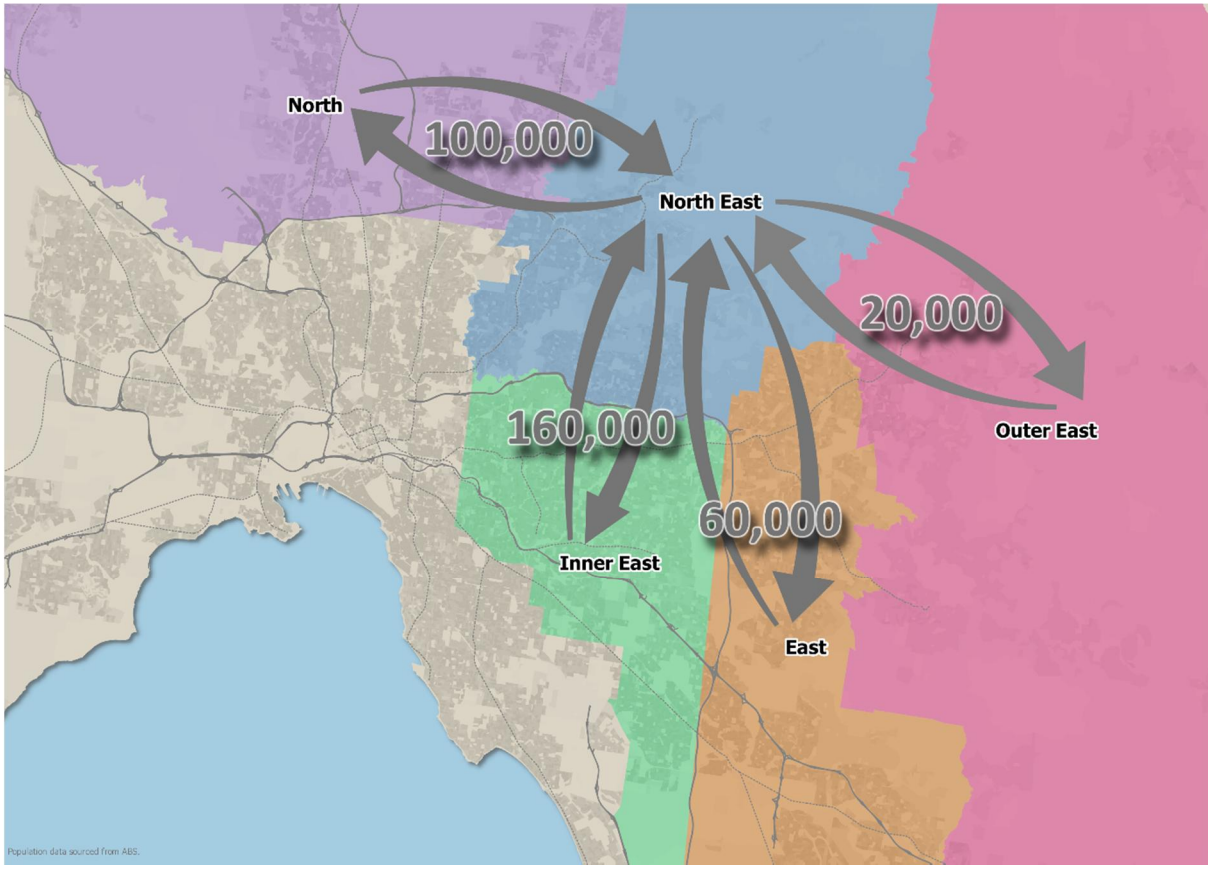
Source: Veitch Lister Consulting

3.3 Transport trends in the north-east

3.3.1 Trip patterns

While a large proportion of jobs are concentrated in the inner-city areas, non-CBD destinations make up a large proportion of all trips in the north-east. Approximately 250,000 radial trips are made between the north-east and inner Melbourne areas each day, as presented in Figure 17. However, demand for orbital travel in the north-east is larger than this radial demand to and from inner-Melbourne; the combined number of trips between the north of Melbourne and the north-east (100,000 trips per day), the inner-east and the north-east (175,000 trips per day), or the outer-east and the north-east (25,000 trips per day) are larger than trips to and from the inner-city.

Figure 17 Daily trip movements across Melbourne to and from the north-east

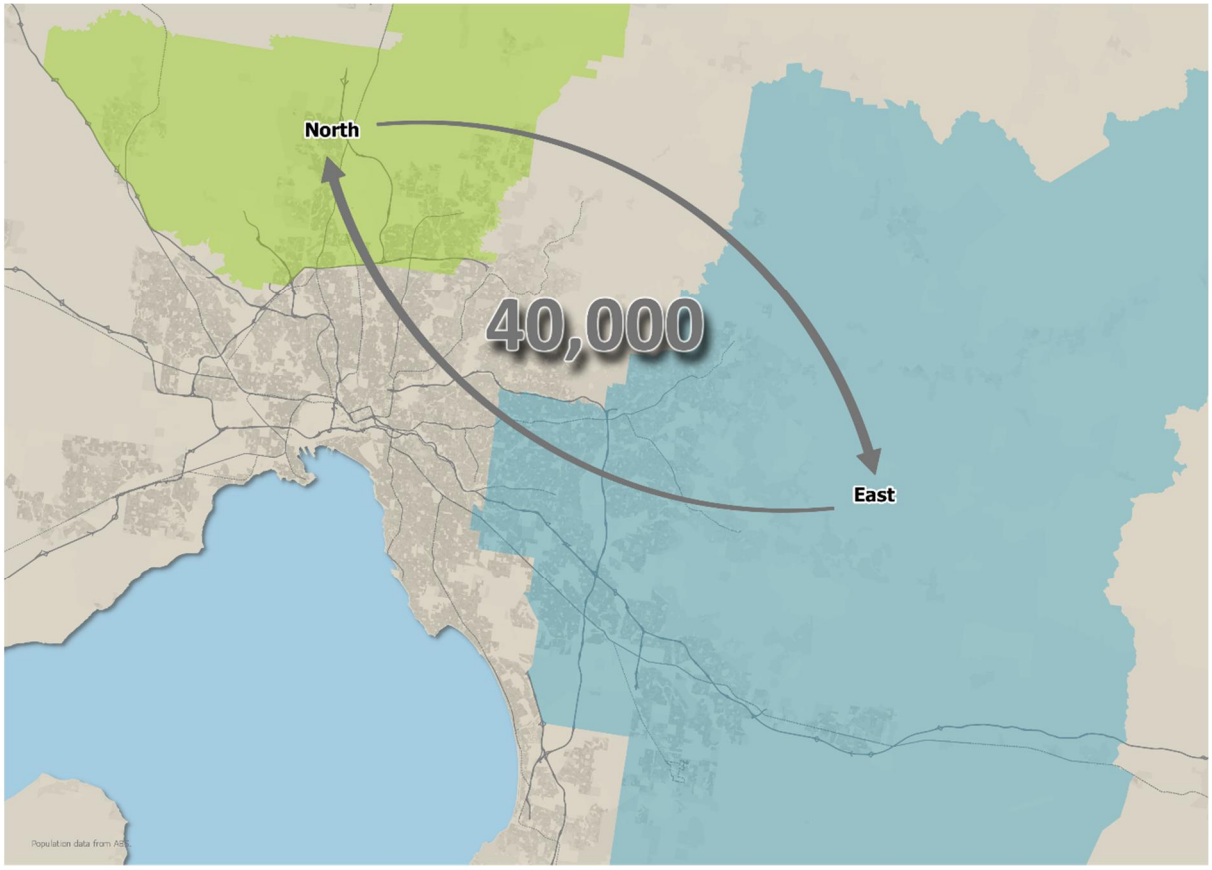


Source: Veitch Lister Consulting, Zenith Model

In addition to these 300,000 orbital trips to and from the north-east, there is demand for orbital travel that involves travelling through the north-east without stopping, as presented in Figure 18. Across a day, approximately 40,000 trips are made between the eastern suburbs and the northern suburbs. These are trips that travel through the north-east without stopping.

This means that there are 340,000 orbital trips a day through the north-east; journeys that overwhelmingly rely on the congested arterial road network.

Figure 18 Daily trip movements between the east and north.



Source: Veitch Lister Consulting, Zenith Model

3.3.2 High proportions of private vehicle use

Motor vehicle travel is the primary transport mode in the north east, responsible for 84 percent of all trips originating within the study area. Public transport trips have an average mode share of approximately 14 percent, while walking and cycling trips are only a very small proportion of all trips. The transport mode share of trips originating in the north-east is presented in Figure 19.

As presented in Figure 20, compared to the Melbourne Statistical Division, there is a higher reliance on car travel in the north-east (84 percent compared to 76 percent) and a lower reliance on public transport (14 percent compared to 19 percent). This is consistent with the distance to employment and the relative lack of public transport.

Figure 19 Transport mode share in the north-east

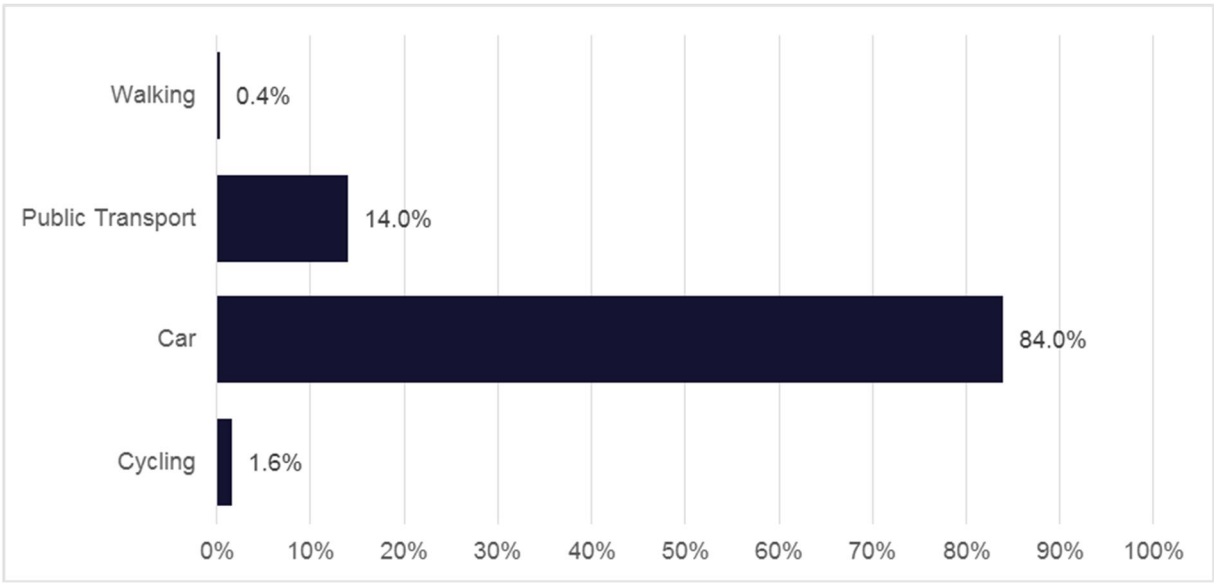
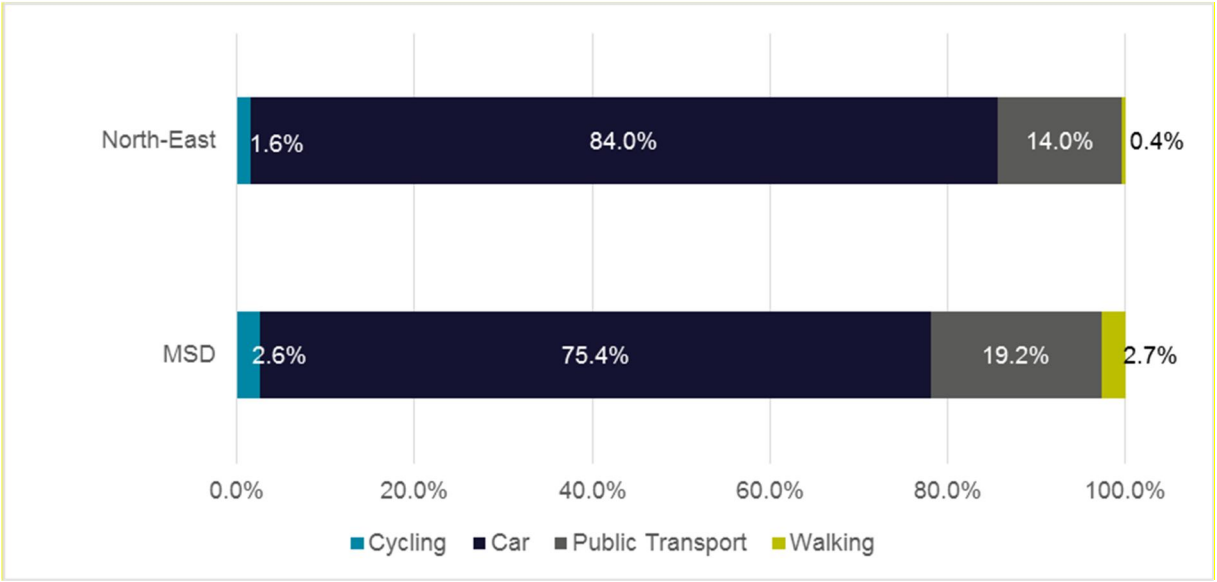


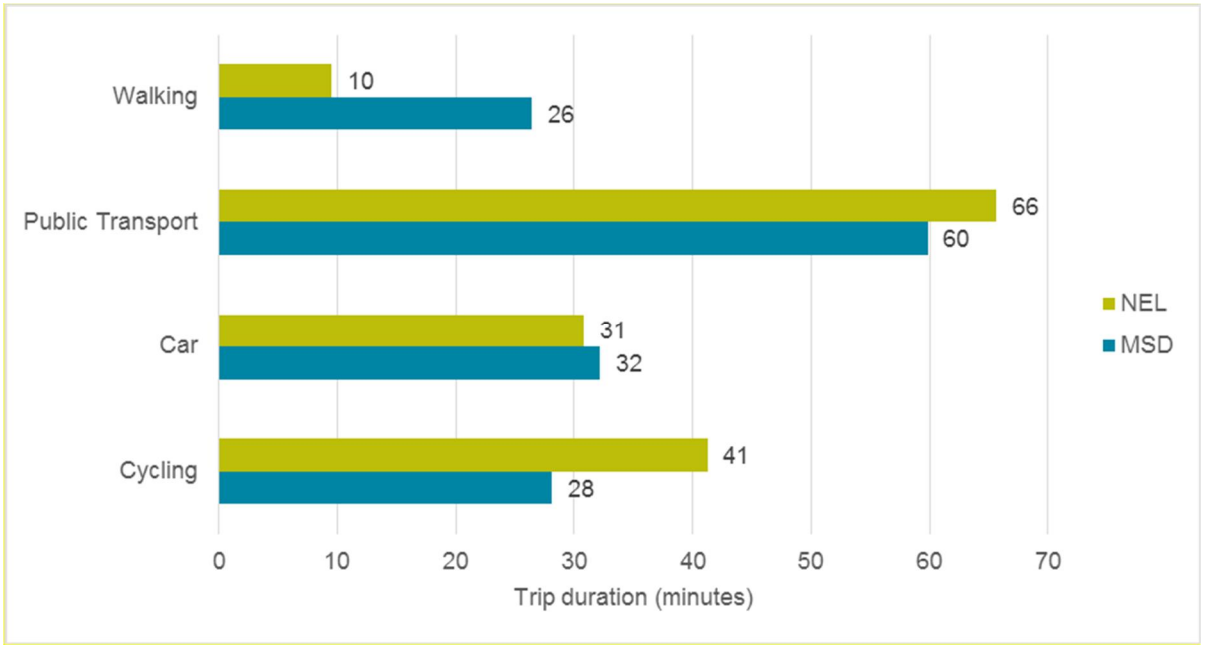
Figure 20 Transport mode share in the north-east vs Melbourne



The higher car mode share in the north-east reflects the fact that many trips in the outer suburbs can be completed faster and more efficiently by car compared to public transport. While the public transport network is efficient for radial trips in and out of the CBD, orbital trips are often better suited to car travel. The equivalent public transport orbital trip is reliant on the SmartBus network, which is generally slower due to mixing with road traffic, frequent stopping for boarding and alighting, and the routing required to connect to all rail stations along the route, negating any travel time advantages.

Overall, people in the north east are not travelling for longer periods of time or longer distances (presented in Figure 21), but are choosing the most efficient mode to reach their destinations. Car and public transport trip durations in the north east are on par with the rest of Melbourne; however, there is a higher preference for car travel.

Figure 21 Average trip duration by transport mode



3.3.3 Public transport use correlates to proximity to the CBD and rail lines

Transport mode share is not uniform throughout the entire north east study area. Generally, public transport use declines and car travel increases the further away a trip originates from the CBD, as presented in Figure 22 and Figure 23. In inner city public 'transport rich' suburbs, car mode share is between 30 and 40 percent, with the middle suburbs sitting around 40 to 60 percent, and the outer suburbs with a 60 to 80 percent car mode share.

However, public transport mode share is higher in suburbs along the Hurstbridge rail corridor in the north east and the Belgrave-Lilydale Rail corridor in the east compared to other suburbs a similar distance from the CBD. For people living near these corridors, public transport is the most efficient mode for many (radial) trips. While it may seem that proximity to the city is correlated to higher uptake of public transport, it is in fact accessibility to public transport and the efficiency of the public transport mode that is the key driver. Due to the low population densities in the outer suburbs, it is not always possible for public transport to provide an efficient (direct and timely) alternative to car travel.

Figure 22 Percentage of people driving to work by suburb

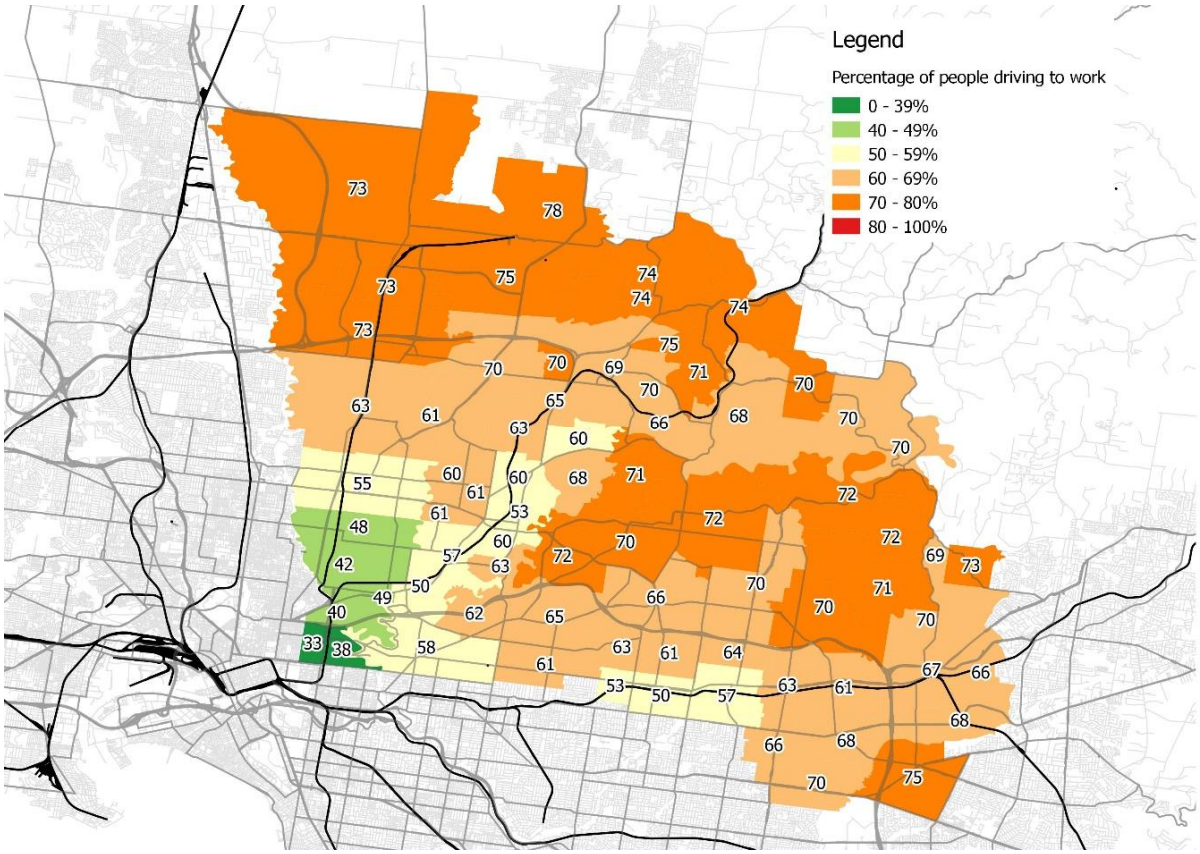
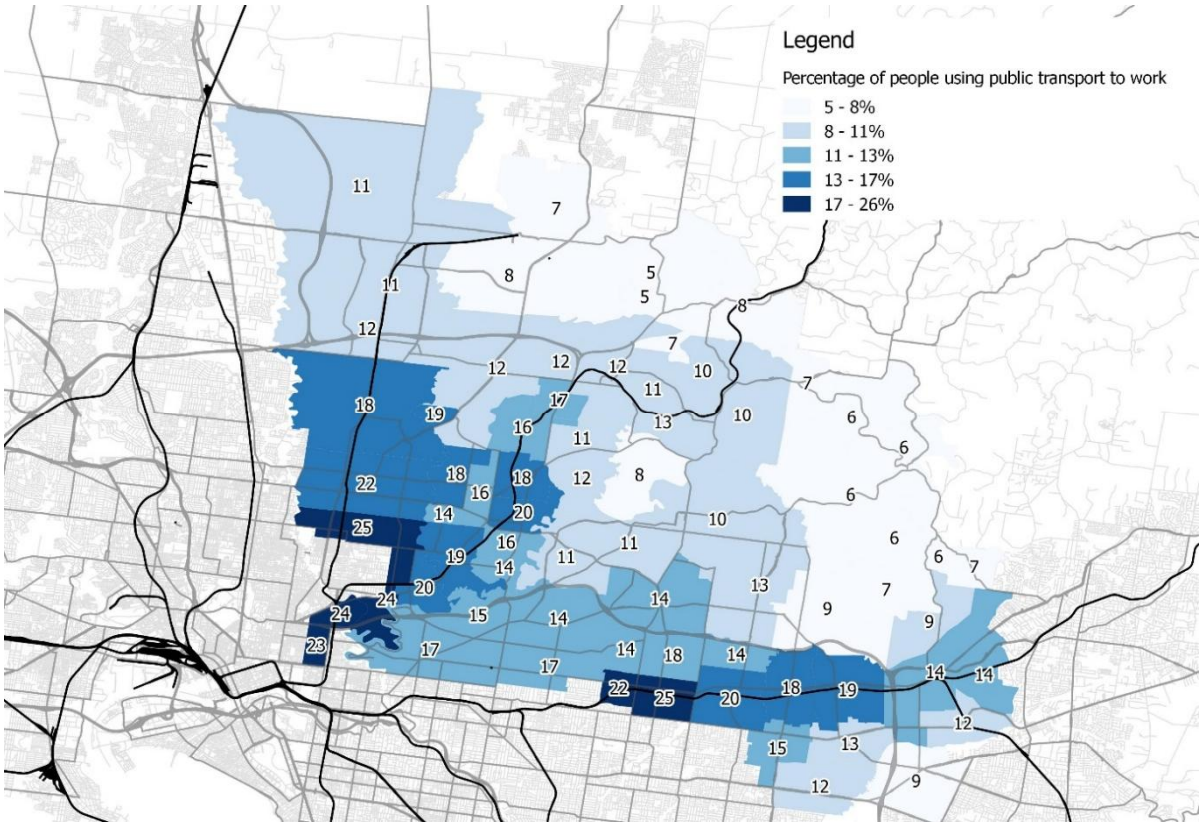


Figure 23 Percentage of people taking public transport to work by suburb



Public transport utilisation can also be a factor of the destination of the user. A large proportion of the public transport network is focused on providing access to key destinations, such as the CBD. However, if people are not intending to travel to these hubs, public transport may not be the most suitable mode for them.

Table 1 provides a summary of the proportion of trips made to the City of Melbourne in the morning peak period from municipalities across the east and north east of Melbourne. It shows that, on average, 18 percent of trips made in the morning peak from these municipalities are destined for the City of Melbourne. This would support the high utilisation of cars to drive to work as the bulk of workers across the study area are not destined for the CBD.

Table 1 Proportion of trips to the City of Melbourne

Council	Travelling to city
Banyule	19%
Boroondara	27%
Darebin	26%
Manningham	18%
Maroondah	11%
Nillumbik	13%
Whitehorse	18%
Whittlesea	12%
Average	18%

4 Road transport in the north east

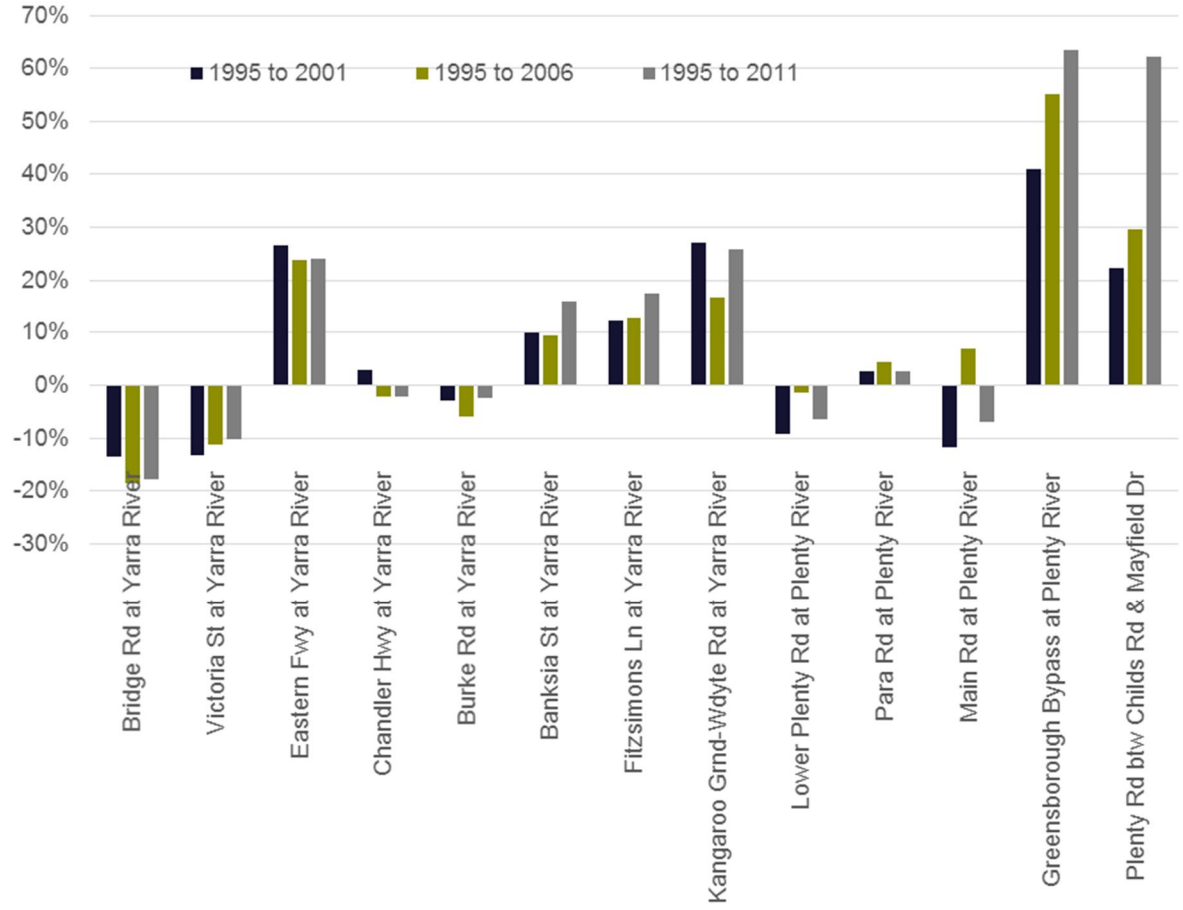
4.1 An overview of road transport in the north-east

4.1.1 Growth in the outer suburbs, stagnant in the inner suburbs

As demonstrated previously in Figure 19, residents and workers in the north east overwhelmingly rely upon the road-based transport network for travel (either using private vehicles or buses). This reliance on the road network has become more entrenched as traffic volumes on the outer suburban north east arterial road network have grown over the past decade, compounding the issues of traffic congestion and delays, as presented in Figure 24.

While traffic volumes in the inner city (Eastern Freeway, Chandler Highway, Burke Road) have generally decreased between 1995 and 2011, traffic volumes in the north east (Fitzsimons Lane, Greensborough Bypass, Plenty Road) have grown significantly. The growth in traffic volumes in the outer north east is primarily due to the corresponding development that has occurred in this area. However, this population growth has not been matched with equivalent development in the road network and public transport infrastructure, resulting in greater dependence on car travel. A reduction in traffic volumes in the inner city has likely been due to increases in operating costs of private vehicles and greater access to public transport resulting in a mode shift away from private vehicles.

Figure 24 Daily traffic growth on north eastern roads



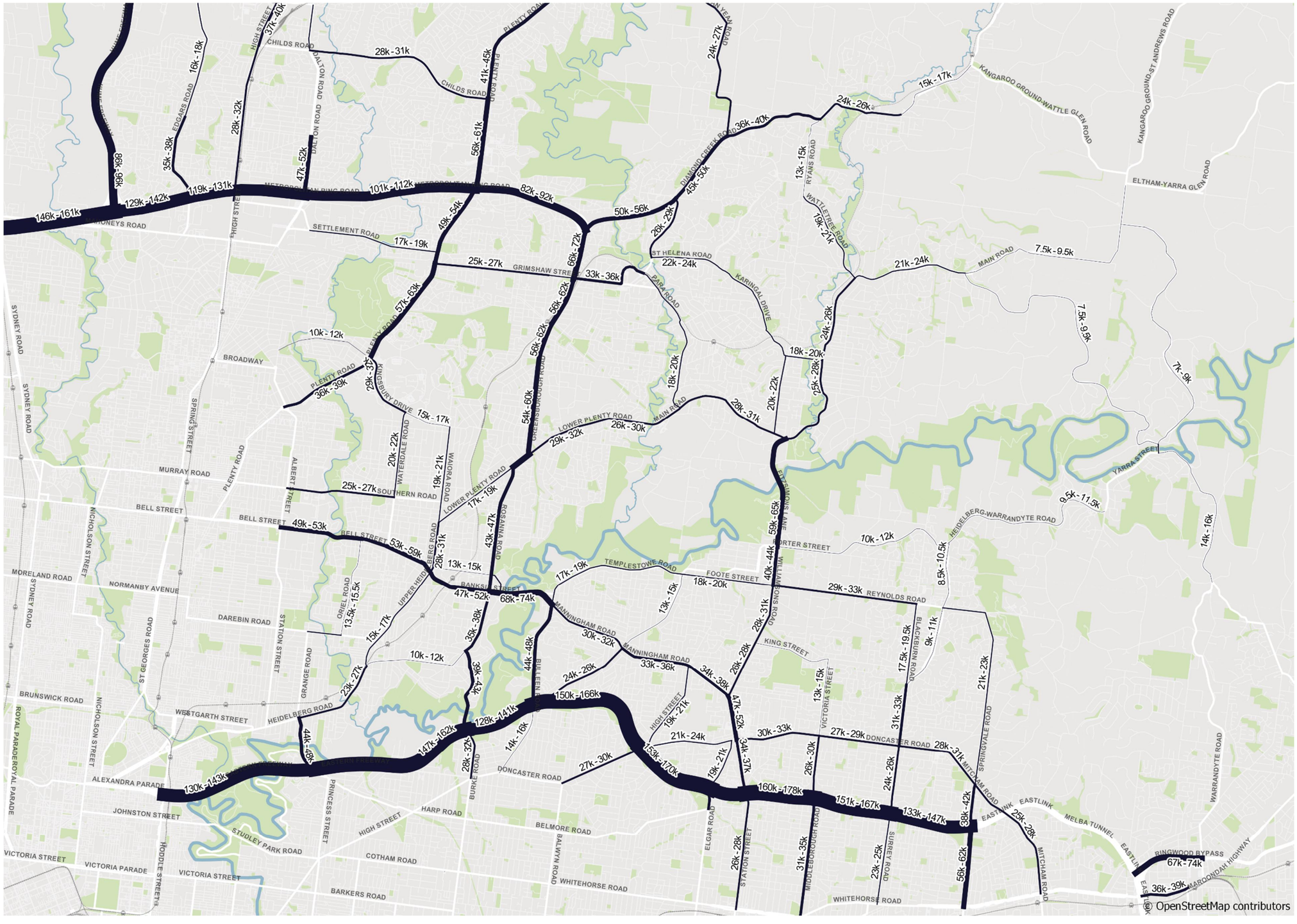
4.1.2 A disjointed arterial road network

The north east relies on only a handful of key arterial roads for movement, lacking the grid-based resilience found in the south-eastern suburbs. Rather than having multiple routes for north-south or east-west travel, trips are heavily reliant on one or two arterial roads, such as Bell Street for east-west movements and Plenty Road, Rosanna Road and Fitzsimons Lane for north-south movements. These key routes are presented in Table 2, with daily traffic volumes in the north east presented in Figure 25.

Table 2 Daily traffic volumes on key arterial roads

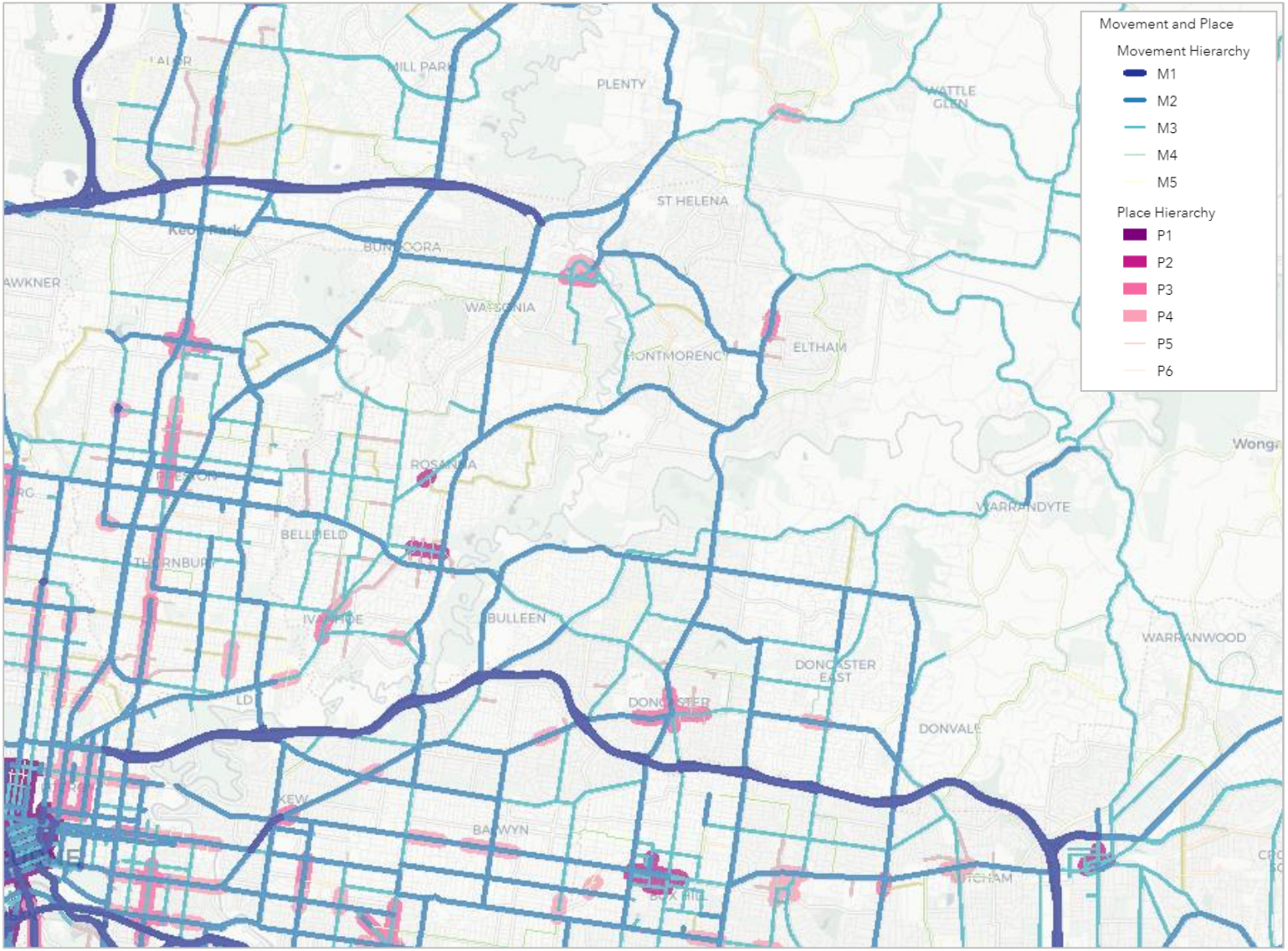
Road	Number of traffic lanes	Two-way weekday daily traffic volume
Bulleen Road between the Eastern Freeway and Manningham Road	4	44,000 – 48,000
Bell Street between Upper Heidelberg Road and Waterdale Road	4 – 6	53,000 – 59,000
Fitzsimons Lane between Porter Street and Main Road	4	59,000 – 65,000
Greensborough Road between Lower Plenty Road and Grimshaw Street	4 - 6	54,000 – 62,000
Lower Plenty Road between Greensborough Road and Para Road	4	29,000 – 32,000
Manningham Road / Banksia Street between Rosanna Road and Bulleen Road	6	68,000 – 74,000
Plenty Road between Kingsbury Drive and Grimshaw Street	6	57,000 – 63,000
Rosanna Road between Banksia Street and Lower Plenty Road	4	43,000 – 47,000

Figure 25 **Daily traffic volumes in the north east**



This high reliance is also evident in the draft Transport for Victoria Movement and Place map, presented in Figure 26. There are very few high rated movement traffic corridors within the north east, with no single road for north-south and east-west movements. For example, the main movement route between the Eastern Freeway and the M80 Ring Road involves travelling along five separate roads – Bulleen Road, Banksia Street, Rosanna Road, Lower Plenty Road and Greensborough Road.

Figure 26 **Draft Movement and Place Hierarchy**



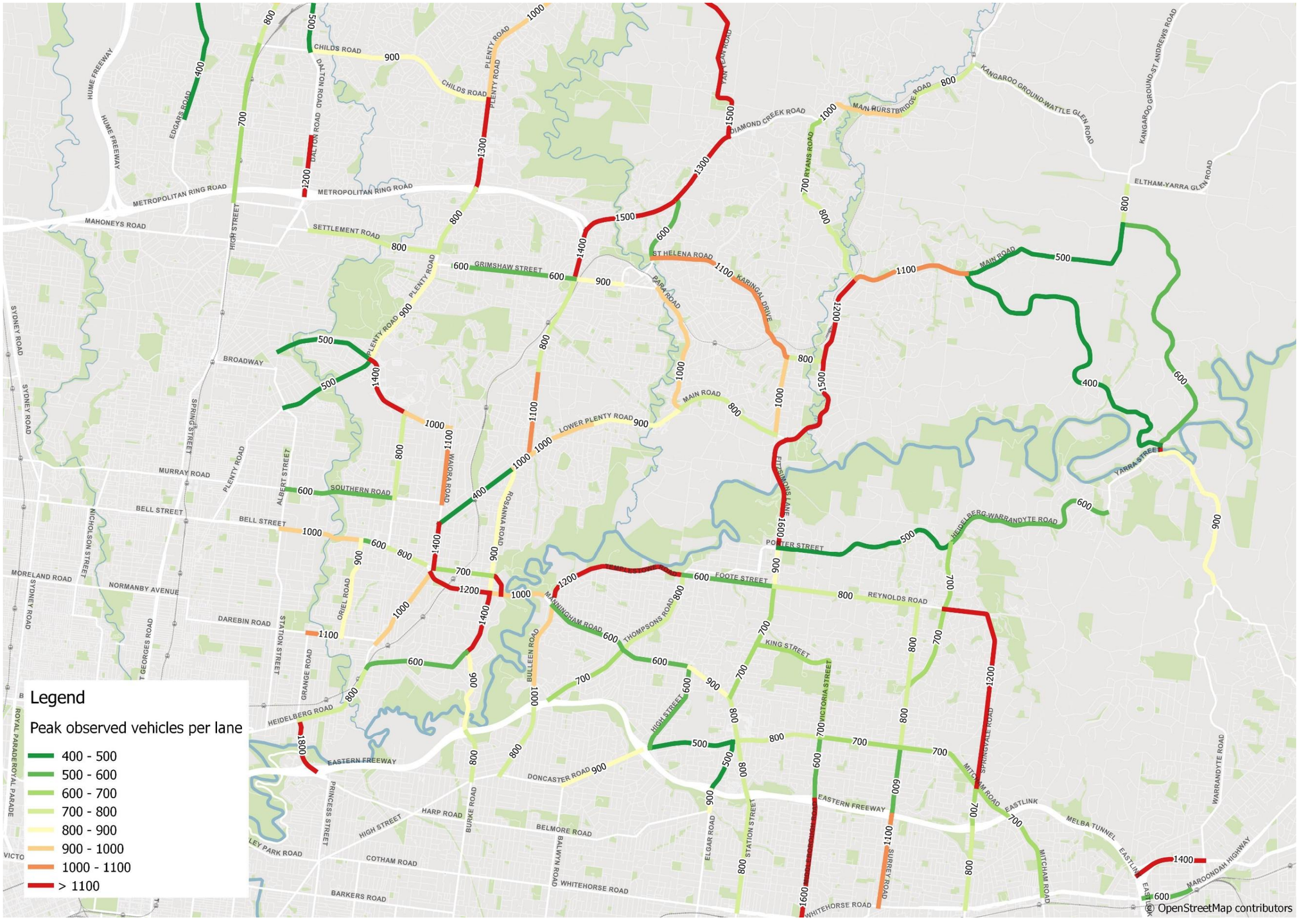
4.1.3 The arterial road network is at capacity

During peak hour, the majority of the road network in the north-east is already at capacity. A typical arterial road with interrupted flow is considered to be over capacity when the hourly demand in each lane exceeds 800 to 900 vehicles; however as demonstrated in Figure 27, arterial road volumes on many roads in the north-east are often in excess of 1,000 vehicles per lane.

The busiest locations on the north-east arterial road network are typically at the bridge crossings of the Yarra River (Chandler Highway, Burke Road, Manningham Road, Fitzsimons Lane, and Kangaroo Ground-Warrandyte Road), which is discussed further in section 4.2. Other heavily congested locations are Middleborough Road (1,600), Greensborough Road (1,500), Yan Yean Road (1,500), and Main Road (1,500 vph/lane).

Traffic data for these roads indicates that they are often close to, or at capacity during peak times. The capacity issues on many of the arterials which cater for the movement of significant traffic volumes are exacerbated by the fact many of these roads serve an access function. As a result, they can often interface with numerous property accesses, priority intersections and signalised intersections. These local property accesses serve to impact road capacity and reduce traffic throughput relative to a modern, access-controlled arterial road.

Figure 27 Peak vehicles per lane per hour



4.1.4 Peak hour

The peak demand for travel was assessed on the arterial road network – the times of the day where the greatest stress is placed on the road network.

In the morning, the peak demand for travel occurs at 8:00 am, with 71 percent of arterial roads surveyed recording the peak demand for travel during this hour, as presented in Figure 28. Twenty one percent of roads recorded a morning peak hour at 7:00 am. Peak demand for travel during the morning roughly coincides at the same time.

Peak hour in the evening is more widely dispersed between 3:00 pm and 6:00 pm; however, peak demand for travel occurs between 5:00 pm and 6:00 pm, as presented in Figure 29. This reflects the fact that the time of travel differs depending on the trip purpose (such as school pick-ups at 3:00pm and travelling home from work at 5:00 pm).

However, the peak demand for travel on the arterial road network is not necessarily the same as the freeway network, as trip patterns are typically different. This is covered further in section 4.4.

Figure 28 AM peak hour on the north east arterial road network

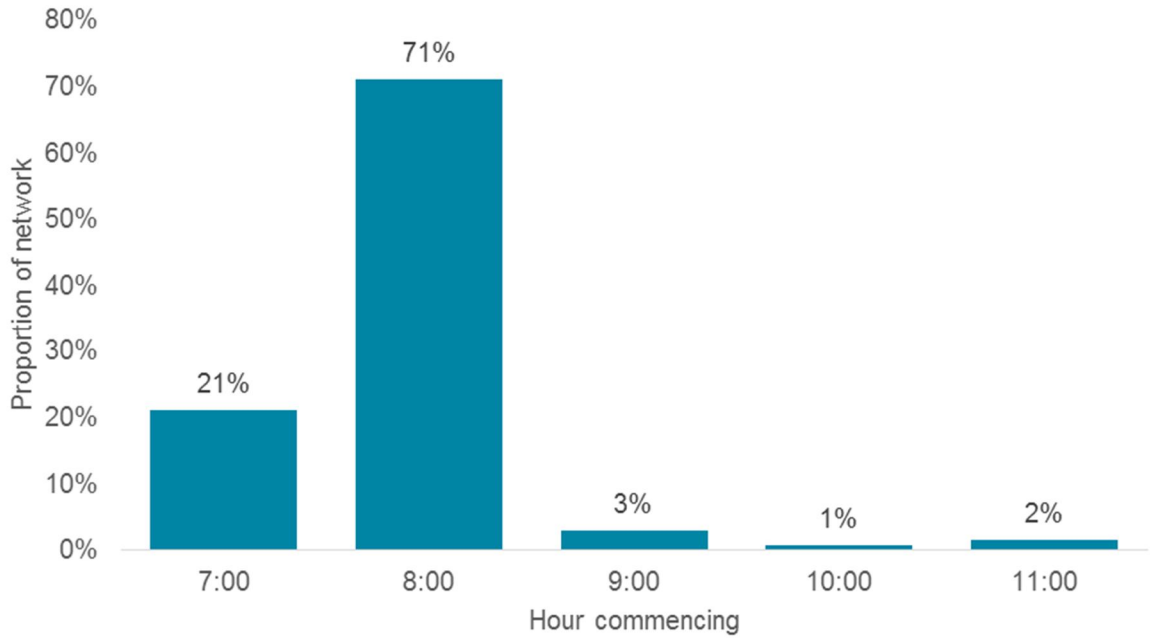
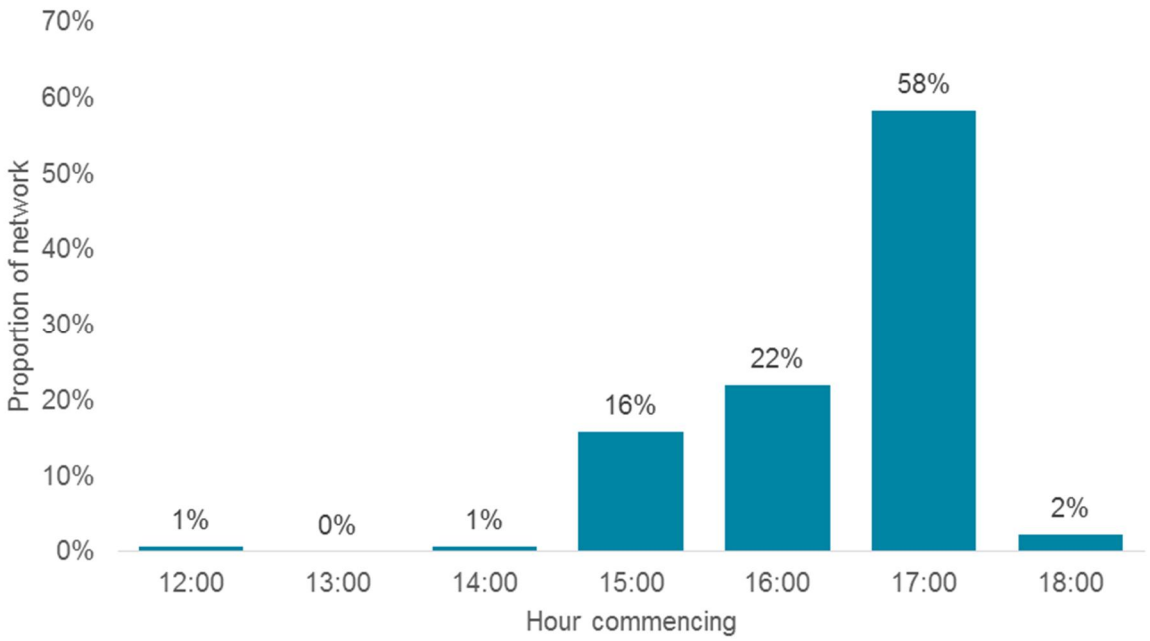


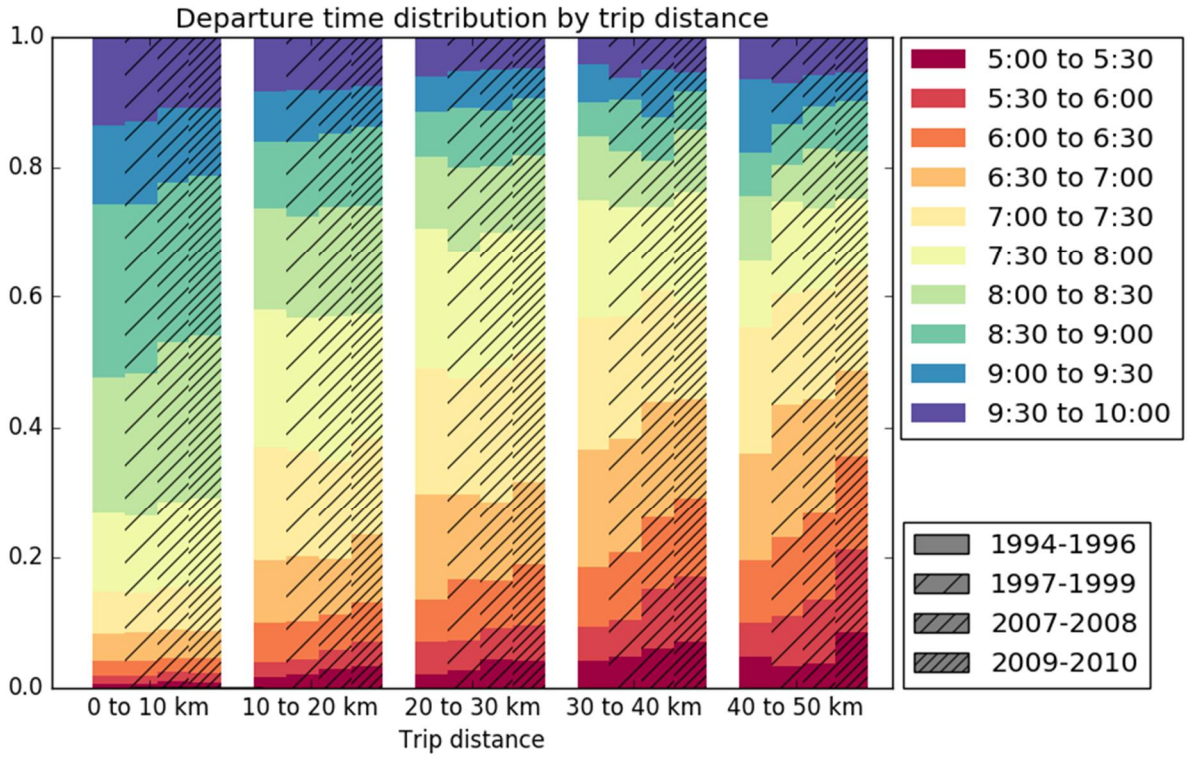
Figure 29 PM peak hour on the north east arterial road network



4.1.5 Peak spreading and the interpeak

The demand for road-based travel during peak periods has reached a point where there is very limited spare capacity; as a result, in the morning peak period people are beginning their trips earlier to avoid the congested roads and travel time delays. This phenomenon, known as peak-spreading, is evident in Figure 30, comparing trip distributions between 1994 and 2010. For trips 40 to 50 kilometres in length, the proportion of trips starting before 7:00 am has increased from approximately 35 percent in 1994-1996 to over 45 percent in 2009-2010. This means today's peak periods now last longer (between two to three hours whereas previously it was a single to two-hour peak).

Figure 30 Peak spreading during the morning peak in Melbourne



Source: Veitch Lister Consulting – VATS and VISTA household travel surveys.

Even the interpeak period (the time period between the AM and PM peaks) experiences high levels of delay and congestion in certain locations. A typical traffic volume profile across the day is presented in Figure 31, showing high volumes in the AM peak and PM peak and moderately high traffic volumes in the interpeak period.

However, in 30 percent of locations surveyed in the north east, there is no longer a drop-off in traffic volumes during the interpeak period, as presented in Figure 32. On roads such as Plenty Road, Chandler Highway, Manningham Road, Greensborough Road and Lower Heidelberg Road, traffic volumes do not drop below 85 percent of the peak traffic volume until well into the evening. This constant demand demonstrates the strategic importance of these arterial roads.

Figure 31 Typical weekday traffic volume profile

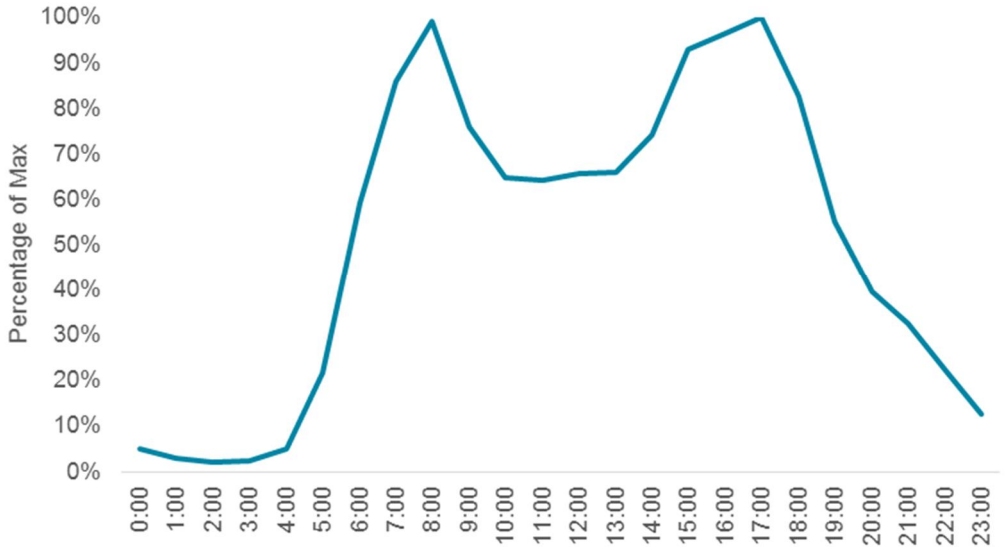
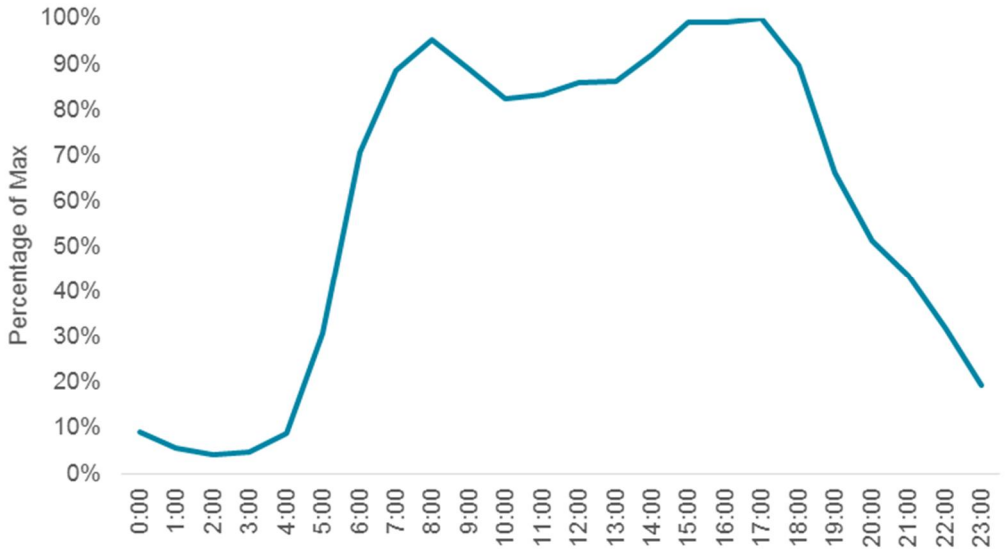


Figure 32 Profile of locations with high interpeak volumes



Despite peak spreading occurring, the morning and evening peak periods are still responsible for a high proportion of all trips recorded throughout the day. In the north-east, 29 percent of all vehicle travel recorded during the weekday occurs during two peak periods: 7:00 am to 9:00 am and 4:00 pm to 6:00 pm, despite these four hours only representing 17 percent of the day.

This is reflective of the high demand for commuter travel for work and school trips all at the same time of the day, placing high amounts of stress on the road network. The breakdown of vehicle travel throughout the day in the north east is presented in Table 3. The concentrated demand for travel during a core period of time during the day is also reflected in the off-peak period, a 13-hour period from 6:00 pm to 7:00 am. This time period represents 54 percent of the day, yet only carries 30 percent of traffic.

Table 3 Breakdown of traffic across the day

Road	Percentage of daily traffic
AM peak 7:00 am to 9:00 am	14%
Inter-peak 9:00 am to 4:00 pm	41%
PM peak 4:00 pm to 6:00 pm	15%
Off-peak 6:00 pm to 7:00 am	30%

4.1.5.1 Rosanna Road and the 14-hour peak period

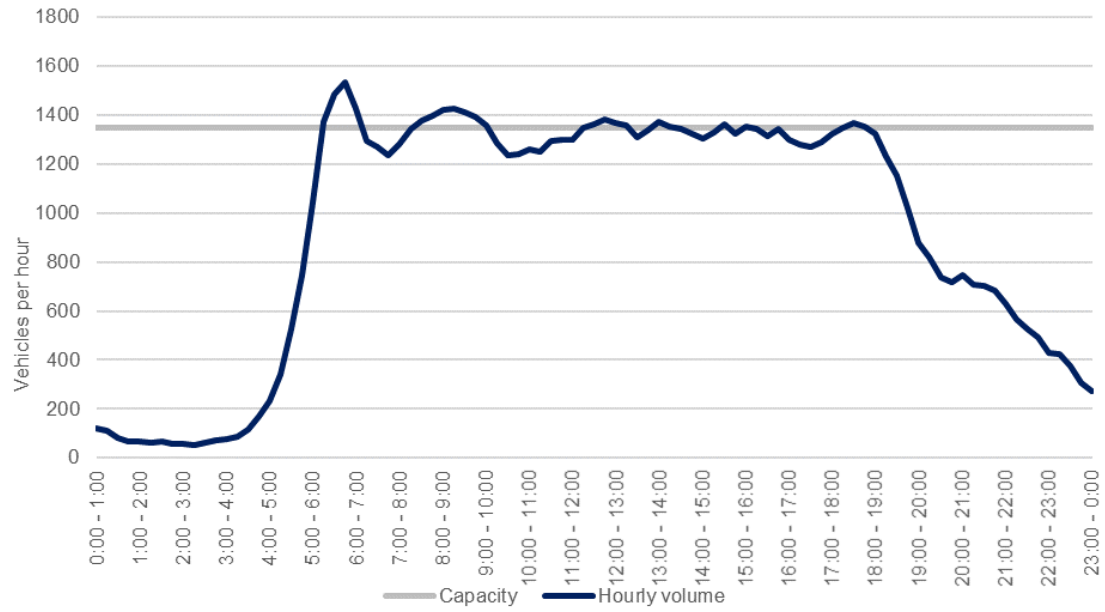
Rosanna Road is one of the busiest north-south arterial roads in the north-east of Melbourne, carrying up to 47,000 vehicles per day, of which roughly seven percent are commercial vehicles. It is a four-lane, two-way undivided road, with low density residential dwellings along both sides of the road. The origins and destinations of trucks using Rosanna Road are discussed in Section 6.1.3.

Despite the predominantly residential land uses fronting the road, Rosanna Road is designated as part of the Principal Freight Network (PFN), over-dimensional network (OD route 1), placarded load network and is a B-Double route. The resultant truck traffic that uses this road are often ill suited due to the narrow lane widths of the road and the lack of separation between on-coming traffic or between the road and the footpaths, leading to poor amenity outcomes for nearby residents.

Additionally, the lack of alternative north-south routes in the area means that there is a high degree of reliance on Rosanna Road for general traffic movement through the north east. This means that there are significant periods of congestion throughout the day.

The hourly traffic flows over a typical weekday on Rosanna Road (in the southbound direction) are presented in Figure 33. Across the two lanes of traffic, the road can accommodate approximately 1,350 vehicles an hour (due to capacity constraints at the Lower Plenty Road and Banksia Street intersections). This means that the road reaches capacity at around 5:00 am in the morning and remains busy all day until 7:00 pm at night; for 14 hours a day there is significant delay and congestion on Rosanna Road.

Figure 33 Hourly traffic volumes on Rosanna Road (southbound)



This is in contrast to a more typical road such as Bulleen Road presented in Figure 34, and Fitzsimons Lane presented in Figure 35. Both Bulleen Road and Fitzsimons Lane in the southbound direction have a large spike in demand during the morning peak, but traffic quickly drops off in the late morning. These roads are only at capacity for about two to three hours during the AM peak (in the southbound direction) and the PM peak (in the northbound direction).

Figure 34 Hourly traffic volumes on Bulleen Road (southbound)

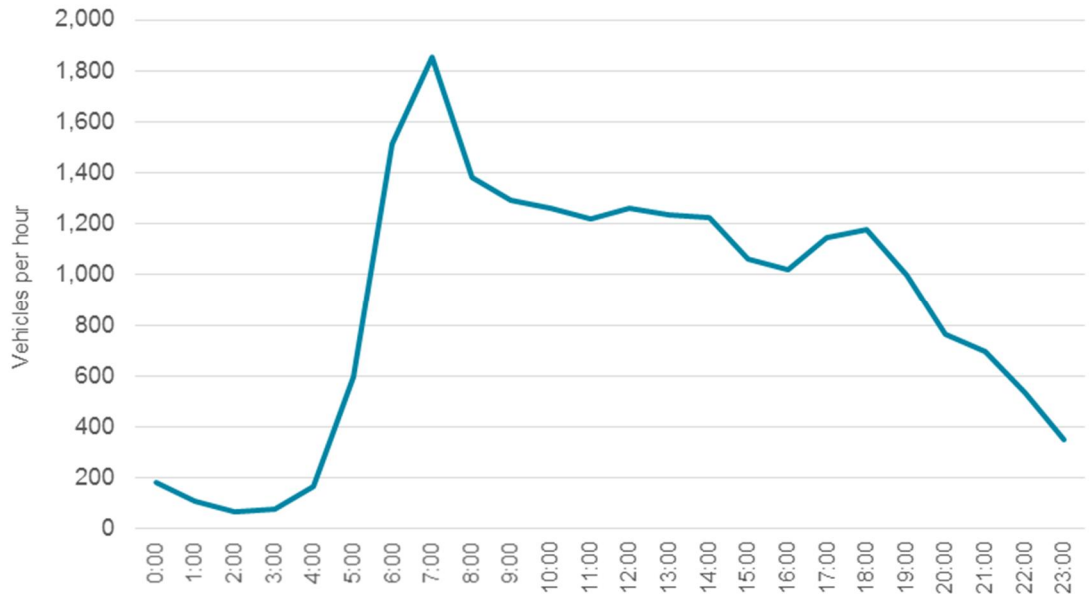
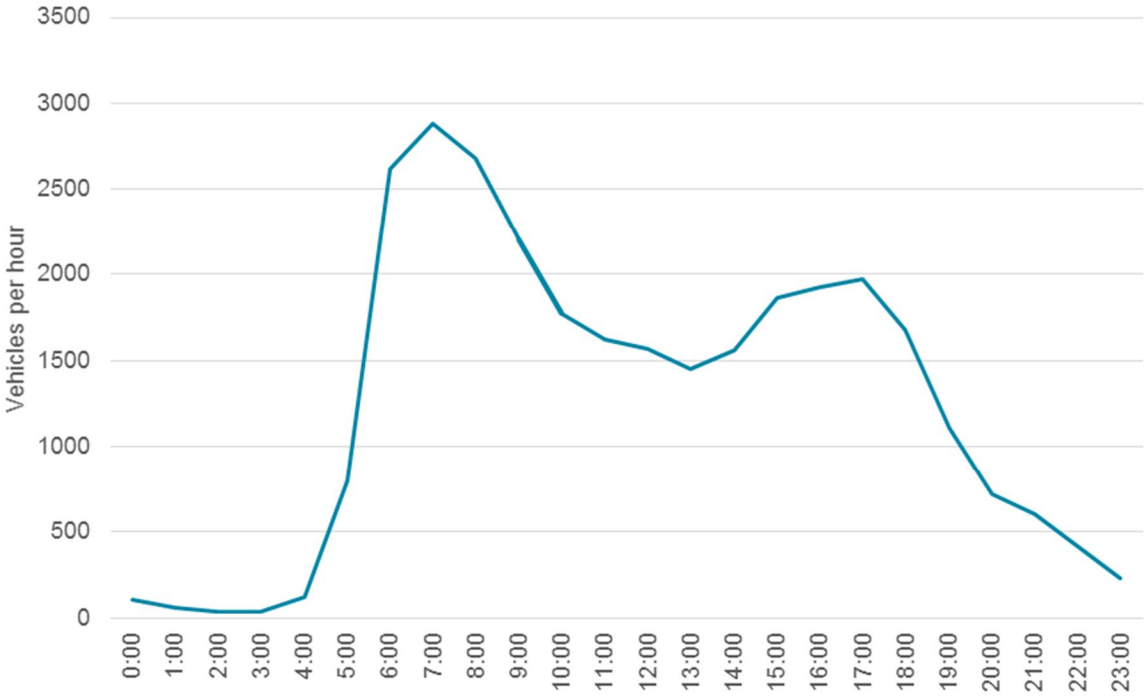
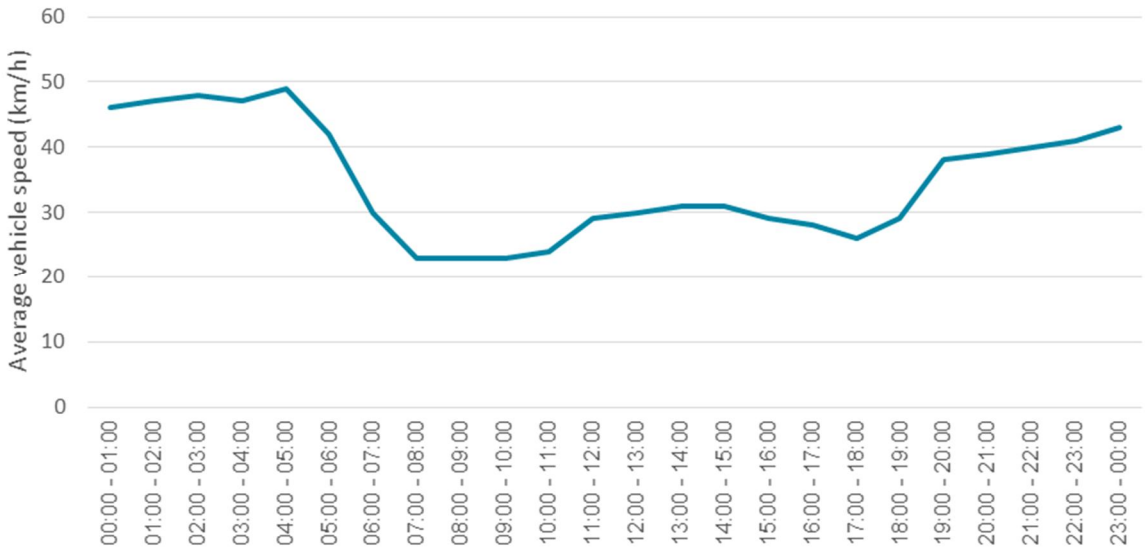


Figure 35 Hourly traffic volumes on Fitzsimons Lane (southbound)



The constant congestion throughout the day on Rosanna Road is also reflected by the low vehicle speeds across the day. The free-flow speed on Rosanna Road is about 60 kilometres an hour midblock and approximately 50 kilometres an hour, taking into account delays at intersections. However, from 5:00 am to 7:00 pm, the average speed drops to around 25 to 30 kilometres an hour, as presented in Figure 36. This means it takes twice as long to travel along Rosanna Road during the day compared to night times.

Figure 36 Average vehicle speeds on Rosanna Road (southbound)



4.1.6 Weekend peak periods

Where the weekends were once a quiet time on the road network and roads could be closed for maintenance or construction work, this is no longer the case. On Saturdays and Sundays, the traffic volumes recorded on the arterial road network can rival that of the weekday peak periods.

Overall, on average, weekend traffic volumes in the north east reach 72 percent of the weekday peak volumes. On many of these roads, traffic congestion is often worse on the weekend peak period due to the lack of weekend clearway periods, reducing road capacity and traffic throughput. Even though peak traffic volumes may be 30 percent lower than the weekday peak, a typical road with two lanes in each direction may have 50 percent less capacity due to on-street parking on weekends.

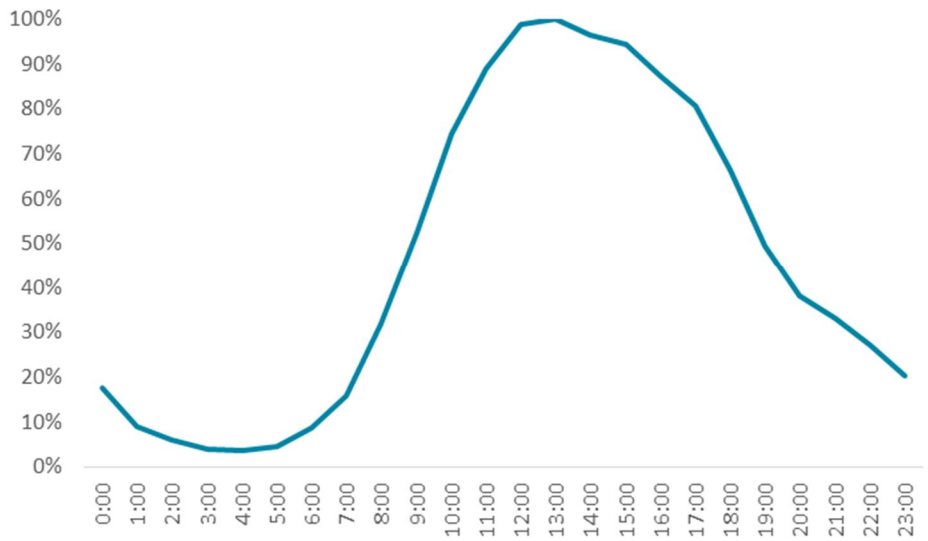
Locations with similar weekend and weekday peak volumes are presented in Table 4. These locations often experience high levels of congestion throughout the week, including weekends.

Table 4 Weekend peak vs weekday peak

Road	Weekend peak as a percentage of the weekday peak
Murray Road at Darebin Creek (WB)	103%
Jika Street (NB)	101%
Williamsons Road between Foote Street and Warrandyte Road (SB)	101%
Bridge St at Diamond Creek (WB)	100%
Bolton St between Bridge Street and Main Road (SB)	100%
Edgars Rd south of Cooper Street (NB)	98%
Banksia St between Studley Road and Rosanna Road (EB)	98%
Williamsons Road between Doncaster Road and Manningham Road (SB)	96%
Main Road between Wattletree Road and Bridge Street (SB)	96%
Doncaster Rd between Middleborough Road and Station Street (EB)	95%
Blackburn Road between Doncaster Road and Anderson Creek Road (NB)	95%
Greensborough Rd between Yallambie Road and Watsonia Road (NB)	94%
Chandler Hwy at the Yarra River (SB)	93%
Plenty Rd at Darebin Creek (EB)	93%
Main Hurstbridge Road at Diamond Creek (EB)	93%

Unlike weekdays, there is typically only one peak period on weekends, occurring around midday, as presented in Figure 37. Traffic volumes are high either side of the peak period unlike weekday volumes, which ramp up and drop off quickly. Generally, traffic reaches at least 80 percent of the peak volume between the hours of 10:00 am and 5:00 pm.

Figure 37 Typical weekend traffic volume profile



4.2 The Yarra River screenline – a barrier to movement

4.2.1 The five river crossings

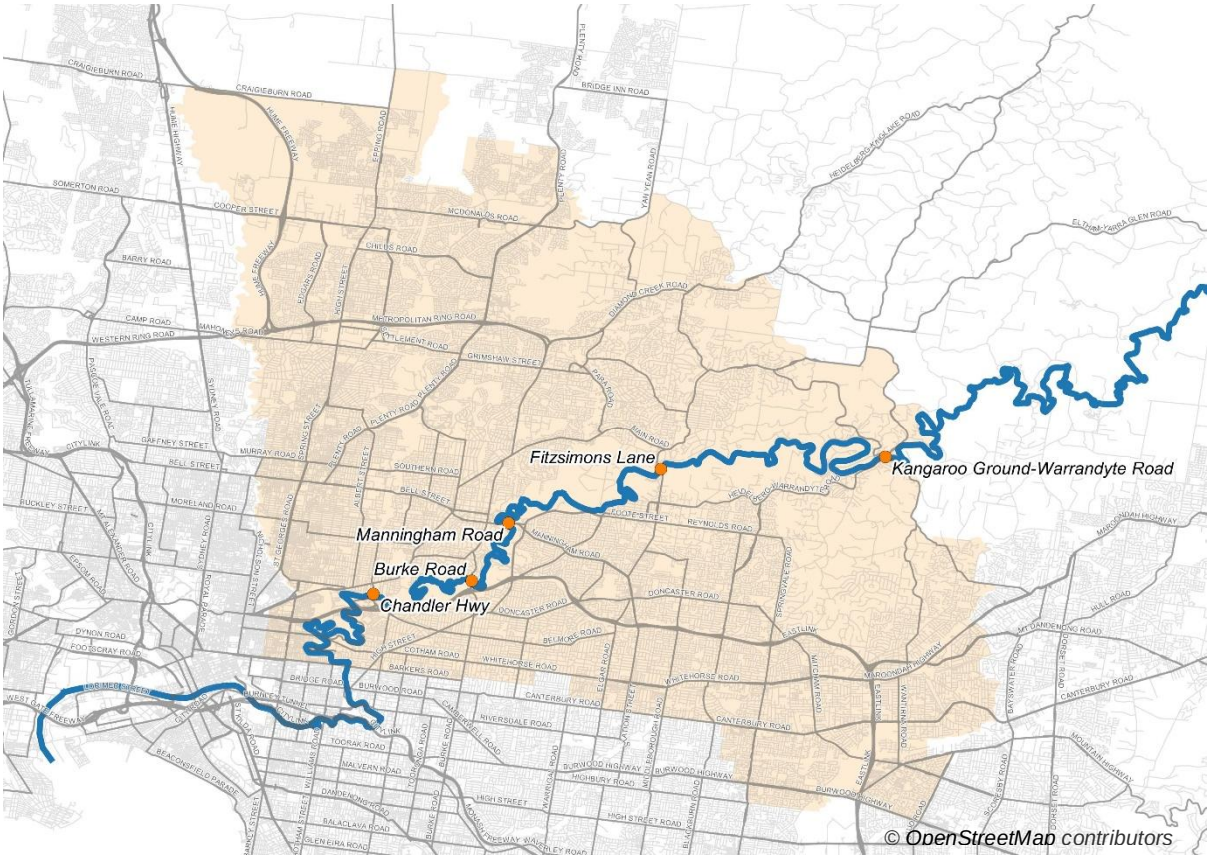
The north eastern suburbs have one shared constraint with the western suburbs – road transport capacity across rivers. Where the Yarra River and Maribyrnong River are a major barrier to movement in the west, the Yarra River is the main constraint in the north east.

The Yarra River and the parklands surrounding the river restrict the number of north-south road links in the area, with only five river crossing points between Alphington near the CBD and Warrandyte in the east, over a distance of nearly 20 kilometres. Each of these crossings are spaced three to eight kilometres apart, a stark contrast to the south eastern suburbs where the major arterial roads are spaced roughly one mile apart (1.6 kilometres), even across the Yarra River.

The five river crossings in the north east are presented in Figure 38 and are as follows:

- Chandler Highway;
- Burke Road;
- Manningham Road / Banksia Street;
- Fitzsimons Lane; and
- Kangaroo Ground-Warrandyte Road.

Figure 38 Yarra River bridge crossings



The number of lanes and daily traffic volumes for each crossing point is presented in Table 5. Across these five river crossings, there are nine traffic lanes in each direction (18 in total), with the busiest bridge (Manningham Road/Banksia Street) carrying up to 74,000 vehicles a day. However, on a per lane basis, the Chandler Highway bridge is the busiest location, carrying up to 24,000 vehicles per lane each day.

Table 5 Yarra River crossing traffic volumes and number of lanes

Road	Number of lanes	Daily traffic volume
Chandler Highway	2	44,000 – 48,000
Burke Road	4	39,000 – 43,000
Manningham Road / Banksia Street	6	68,000 – 74,000
Fitzsimons Lane	4	59,000 – 65,000
Kangaroo Ground-Warrandyte Road	2	18,000 – 20,000

4.2.2 Feeder routes are constrained by bridge capacities

Additional pressure is placed on the five Yarra River crossings due to the higher capacity of the surrounding feeder arterial roads on both sides of the river. These roads, which have a combined capacity that can be many times the capacity of the bridges, effectively funnel traffic into these choke points.

For example, the bridge over the Yarra River in Warrandyte has two feeder routes on the north side - Kangaroo Ground-Warrandyte Road (one lane), and Research-Warrandyte Road (one lane), narrowing down to a single lane across the river. On the south approach, two lanes from the east and west of Yarra Street narrow down to a single lane across the river.

The funnelling of traffic into fewer lanes across the bridges results in some of the highest traffic throughput per lane in the north-east. The traffic volumes per lane across the five bridges are presented in Table 6. These traffic volumes, significantly above the typical arterial road volumes of between 600 to 900 vehicles per lane per hour, result in high levels of congestion and queuing, susceptible to flow breakdown and lengthy delays.

Table 6 Comparison of river crossing capacity and feeder routes

River crossing	AM peak vehicles per hour per lane	PM peak vehicles per hour per lane
Chandler Highway	1,600	1,800
Burke Road	900	750
Manningham Road	950	850
Fitzsimons Lane	1,450	1,600
Kangaroo Ground-Warrandyte Road	1,000	1,200

4.2.3 Traffic movements across the Yarra River

Due to the relatively large distances between the Yarra River crossings, each of the bridges generally service different population catchments in the north east. The origins and destinations of traffic crossing the Yarra River in the southbound direction during the AM peak period is presented in Figure 39 to Figure 43:

- Traffic travelling southbound across Chandler Highway generally originates from either side of Grange Road and Station Road, with destinations in Kew, Hawthorn and Balwyn. Origins and destinations are generally local trips near to Chandler Highway due to high levels of congestion on the surrounding road network.
- Traffic travelling southbound across Burke Road originates in a fairly narrow band following Rosanna Road and Greensborough Road/Bypass. Destinations in the south are again mainly near to the bridge due to the high levels of congestion in Kew and Balwyn making other bridge crossings more attractive for longer distance trips to the south eastern and eastern suburbs.

- The Manningham Road bridge over the Yarra River has the widest dispersal of origins and destinations of the five river crossings. Origins in the north east are widely dispersed between the Bell Street and Greensborough Road corridors. Destinations south of the Yarra River are also widely dispersed, with many destinations in the south-eastern suburbs via EastLink. The wide spread of origins and destinations at the location reflects the fact that there are few alternatives to this bridge crossing in the area.
- Fitzsimons Lane bridge over the Yarra River has a relatively compact catchment area for origins in the north, but a dispersed range of destinations in the south. The small catchment area in the north is due to Manningham Road offering a more suitable route for many trips starting in the west.
- Kangaroo Ground-Warrandyte Road over the Yarra River also has a very dispersed pattern of origins and destinations. With the next crossing eight kilometres west and 16 kilometres to the east, the bridge services a very large catchment area.

Figure 39 Origin and destinations of traffic crossing Chandler Highway during the AM peak

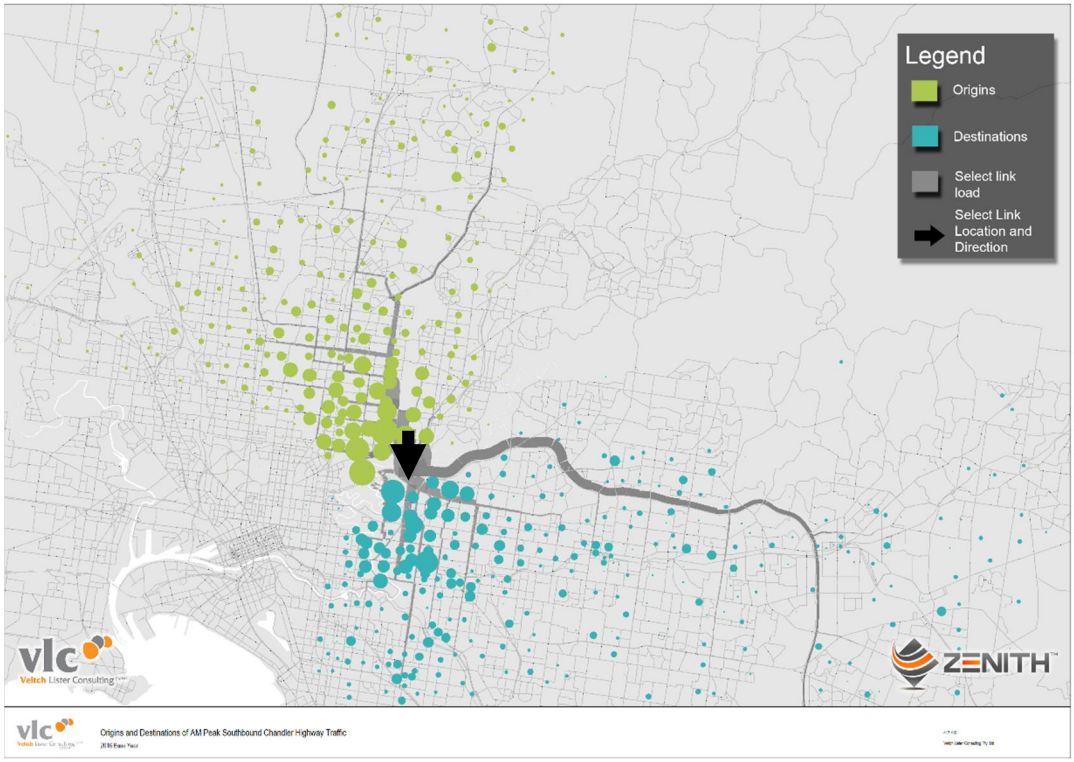


Figure 40 Origins and destinations of traffic crossing Burke Road during the AM peak

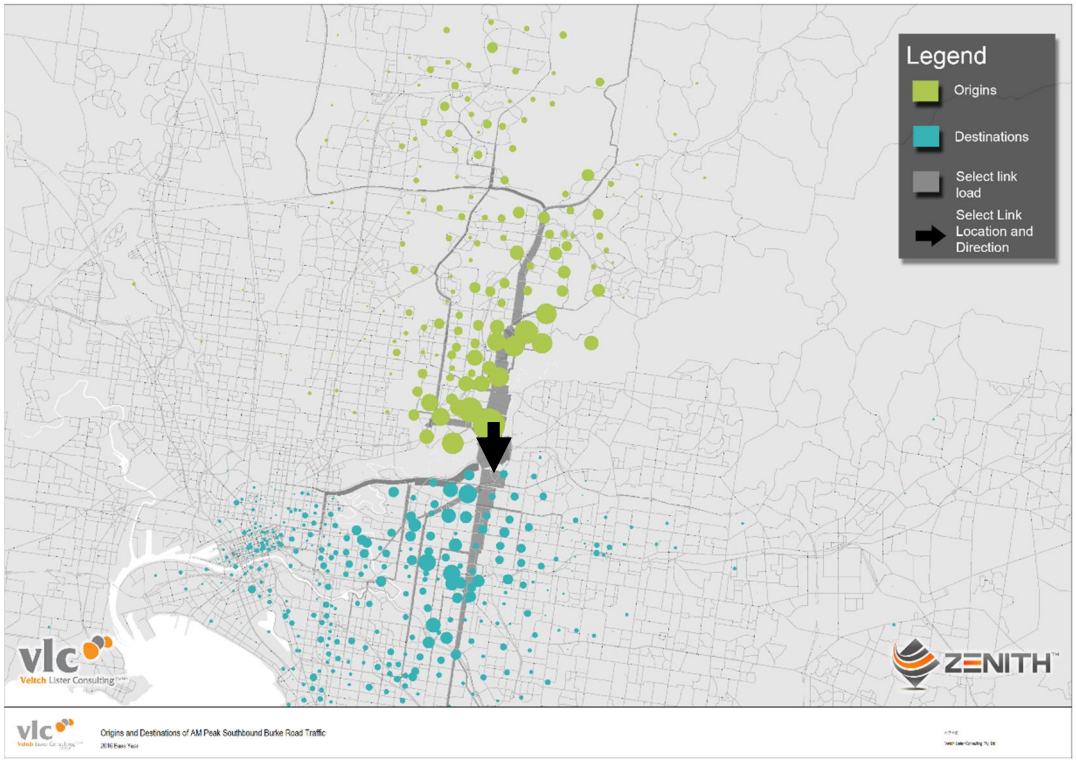


Figure 41 Origins and destinations of traffic crossing Manningham Road during the AM peak

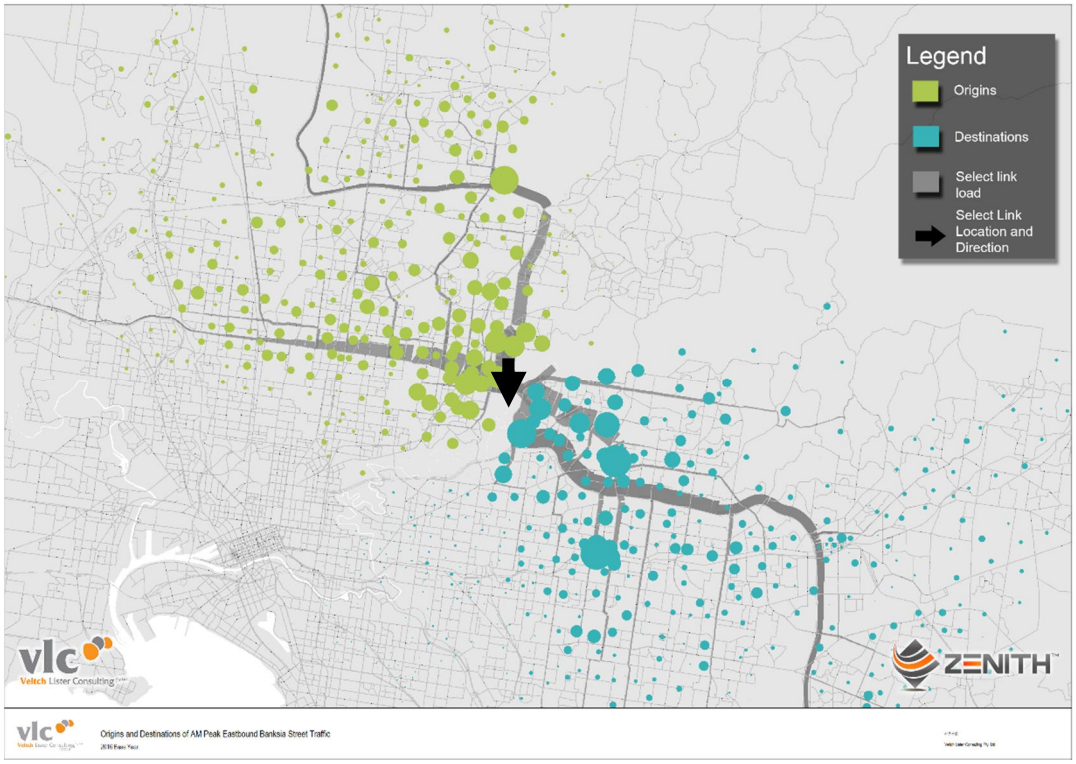


Figure 42 Origins and destinations of traffic crossing Fitzsimons Lane during the AM peak

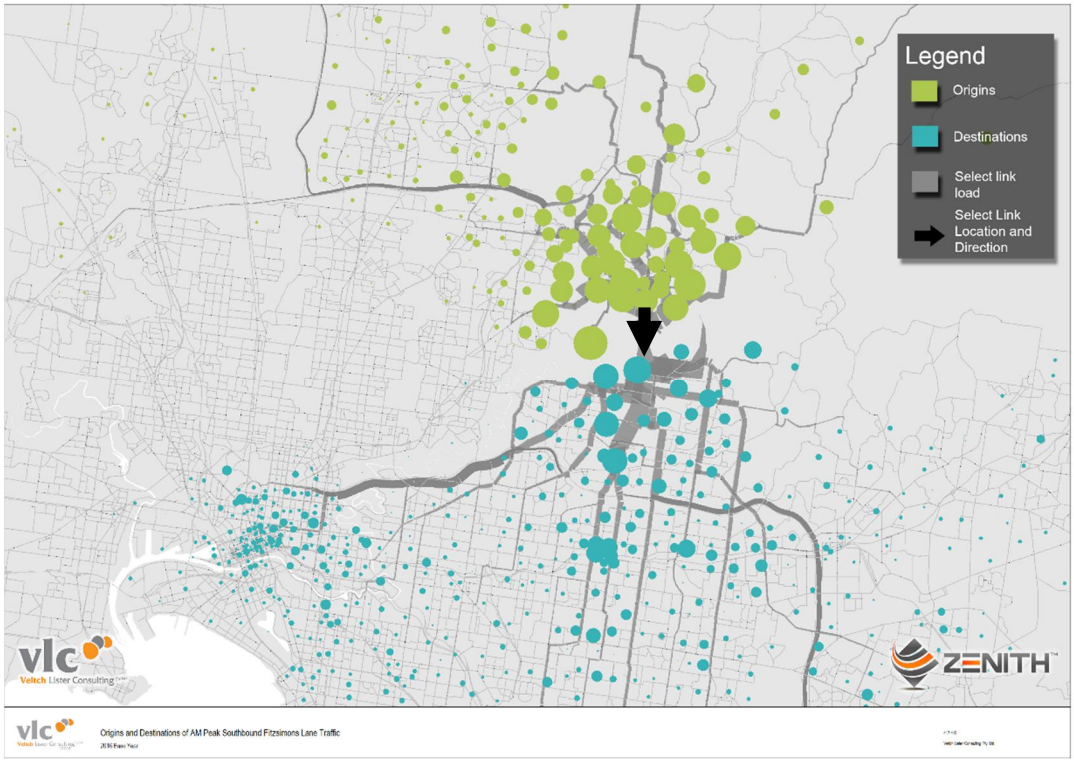
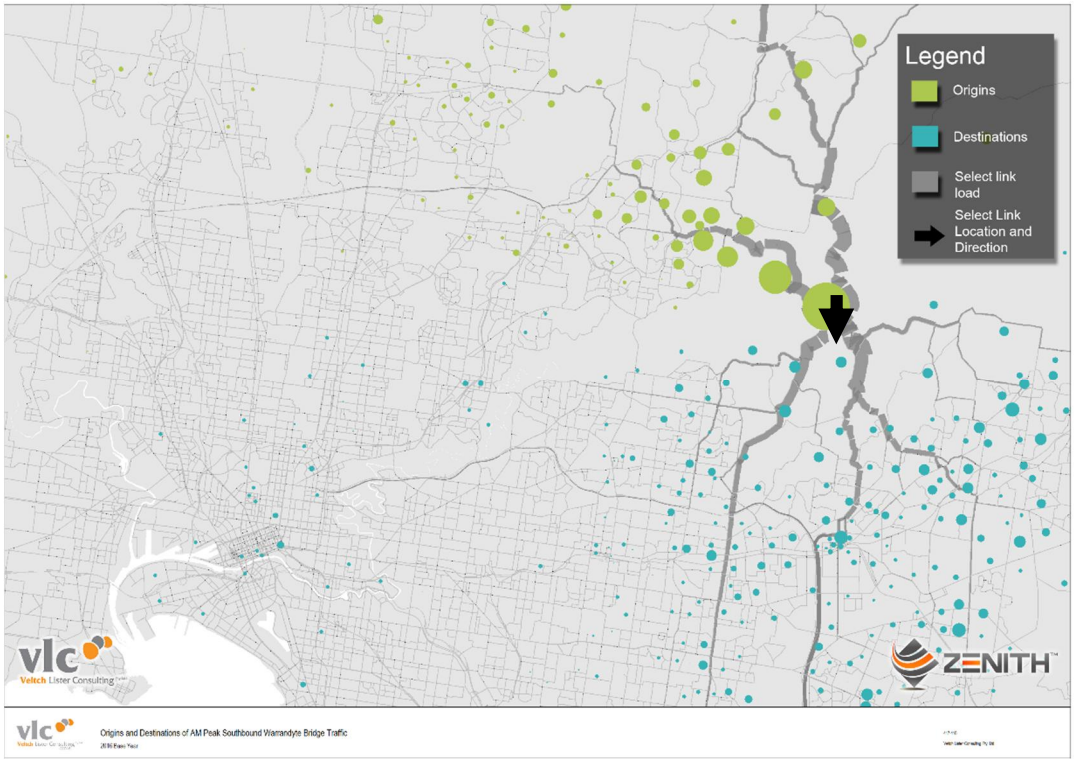


Figure 43 Origins and destinations of traffic crossing Warrandyte bridge during the AM peak



4.2.4 Excess demand is diverting to less suitable routes

The consequence of the high levels of traffic trying to cross the Yarra River, is that some traffic is diverting to less direct and less appropriate routes to avoid areas of congestion. River crossings such as Manningham Road and Fitzsimons Lane often experience queuing in excess of a few kilometres during the peak periods and. as a result, traffic is pushed out further east to Warrandyte, which can be a faster route despite being significantly longer in distance.

An example of this behaviour can be explained by a person commuting from South Morang to Box Hill, as presented in Figure 44. Three routes are typically taken: either via Manningham Road, Fitzsimons Lane or Kangaroo Ground-Warrandyte Road. The most direct route is through Montmorency and Templestowe via Fitzsimons Lane (30km) or through Heidelberg and Manningham Road (29km); however, these trips can often take up to two hours in the morning peak periods. Instead, many people are travelling further east to Kangaroo Ground and Warrandyte to cross the Yarra River before backtracking to Springvale Road and then to Box Hill via the Eastern Freeway (42km). This trip will typically take between one to one and a half hours, a significant travel time saving.

This is placing extreme pressure on the Warrandyte bridge crossing, a two-way, two-lane bridge not designed to cater for large through trips and commuter flows. The fact that a route nearly 50 percent longer in distance can still be faster than the logical 'direct' routes is a consequence of the high levels of congestion along these river crossings.

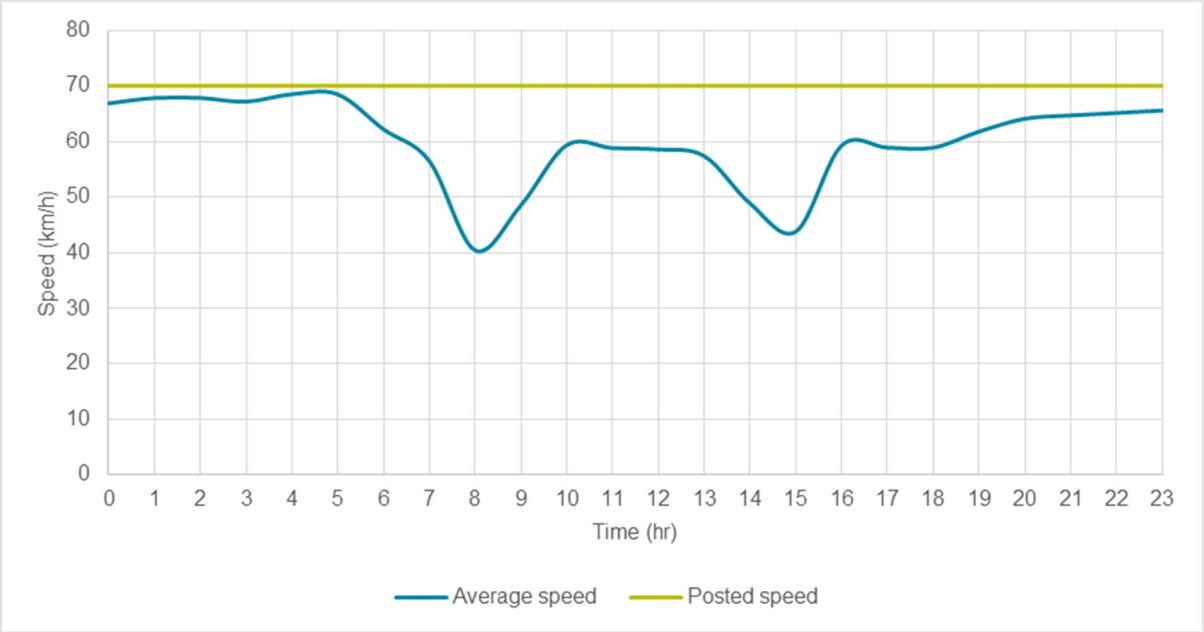
Figure 44 Traffic routes between South Morang and Box Hill

4.3 Network speeds and travel time reliability

4.3.1 The peak hour slow-down

Demand for travel on the road network in the north east fluctuates across the day, with periods of high demand during the morning and evening peak periods affecting network speeds, travel times and journey reliability. This variability can be demonstrated on a midblock section of Bulleen Road, presented in Figure 45, with large reductions in speeds around 8:00 am and 3:00 pm, coinciding with periods of increased demand for travel. During these peak periods, the average midblock speed can reduce to nearly half the posted speed limit due to congestion.

Figure 45 Average weekday speeds on Bulleen Road



Delays at intersections during peak periods are also contributing factors to the high levels of congestion across the network. On the same section of Bulleen Road, when taking into account intersection delays at the Eastern Freeway interchange, average vehicle speeds between Manningham Road and the Eastern Freeway can get as low as 8 km/hr. A southbound trip along Bulleen Road starting from Manningham Road typically takes three minutes in uncongested conditions. However, during the AM peak, this can take as long as 15 minutes, five times slower than free flow conditions.

Similarly, analysis of VicRoads Bluetooth data has shown that the average morning peak hour speed on Rosanna Road during a typical weekday is 23 km/hr. However, a comparable trip in uncongested traffic conditions can be as fast as 60km/hr.

This peak hour 'slow-down' is replicated across the entire north eastern arterial road network.

4.3.2 Travel time variability during peak periods

Even within the peak periods, there is a high level of variability in travel times. For the key routes in the north-east highlighted in Figure 46, the travel time variability can be demonstrated by 'box and whisker' plots, presented in Figure 47.

Travelling southbound along Kangaroo Ground-Warrandyte Road (Route B), the median morning peak trip was approximately nine minutes long; however, the longest trip recorded was twice as long as the median, at approximately 21 minutes.

Travelling southbound between Lower Plenty Road and Manningham Road via Fitzsimons Lane (Route D), the median morning peak trip took approximately 11 minutes. The longest trip recorded along this route was approximately 75 percent longer in duration than the median travel time, at 19 minutes.

This variability in travel times is demonstrated by the long 'whiskers' of the box plots, representing the minimum and maximum observed travel times. Along Bulleen Road, Rosanna Road and Greensborough Road (Route F), the slowest trip recorded was over twice the length of the fastest trip, with minimum and maximum travel times varying by approximately 30 to 35 percent from the median.

Figure 46 Study area travel time routes

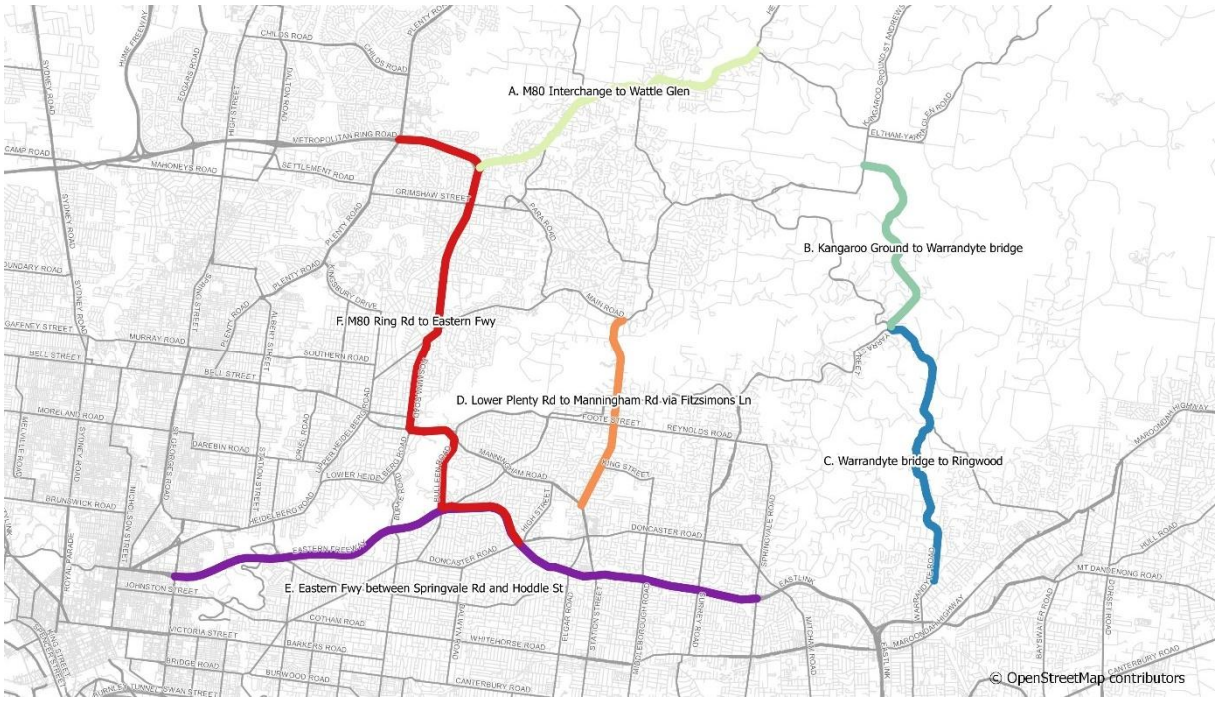
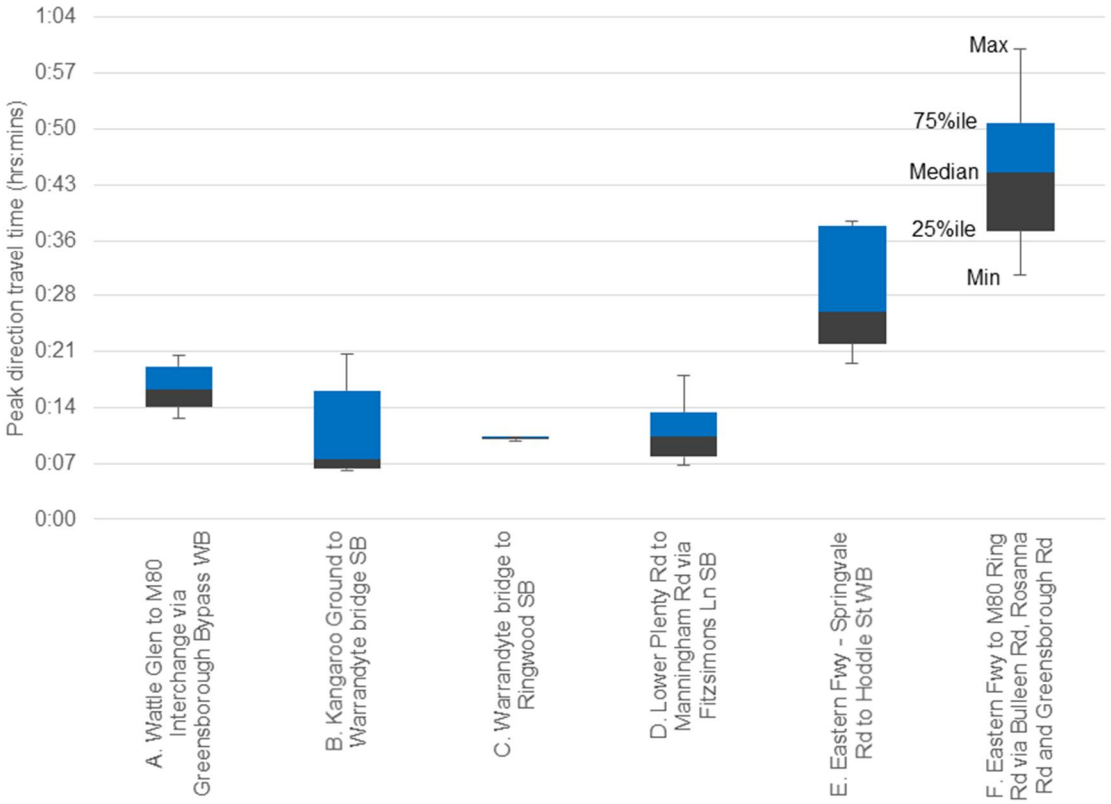


Figure 47 AM peak travel time variability across selected north-east traffic routes

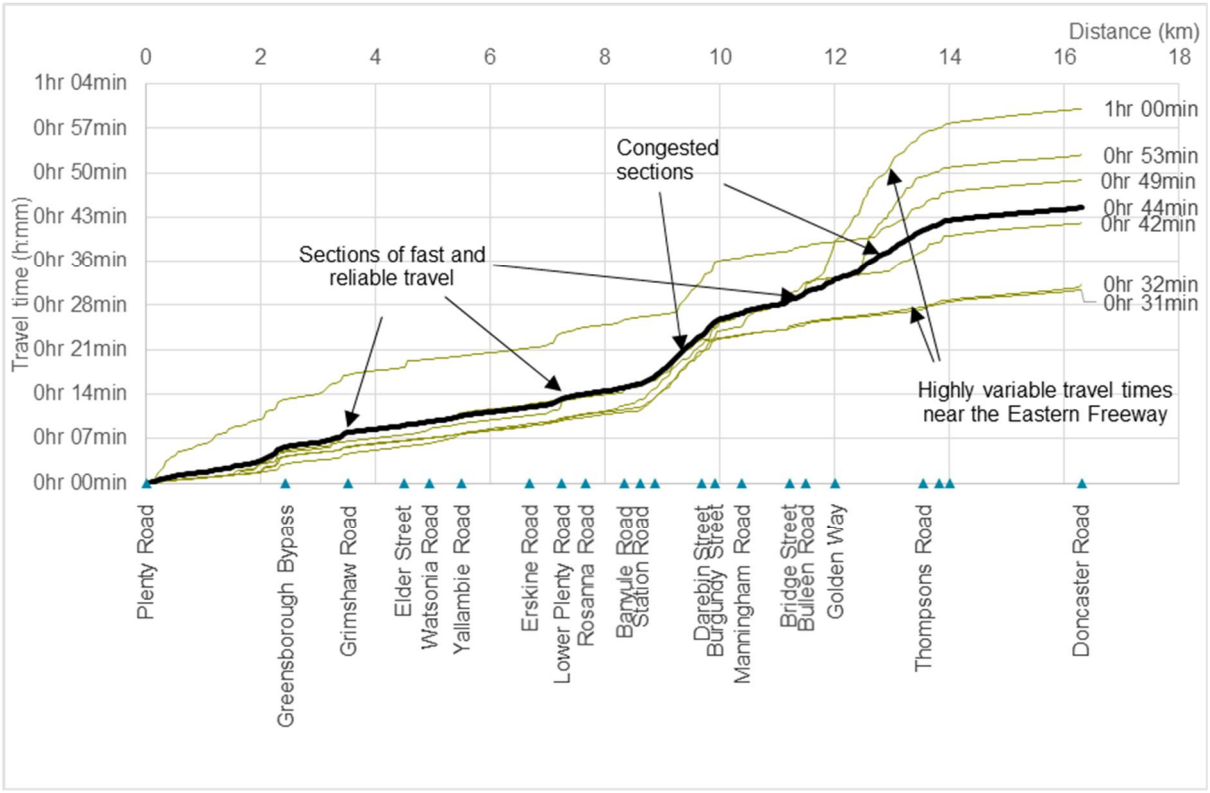


One of the most heavily congested routes is the M80 Ring Road to Eastern Freeway Route (Route F) via Greensborough Road, Rosanna Road and Bulleen Road, characterised by high travel time variability shown by the long bars in Figure 47.

A graph of travel times along Route F is presented in Figure 48. Individual travel time 'runs' along this route are presented as the thin orange lines, while the average travel time is highlighted in black.

Sections of the route with relatively consistent and fast travel times such as along the M80 Ring Road and Greensborough Road are shown by the narrow bandwidths and flat gradients of the lines. Areas of high congestion such as along Rosanna Road, near the Manningham Road intersection and Bulleen Road near the Eastern Freeway on-ramp are reflected in the graph by steeper gradients, representing longer travel times (and lower average speeds). Travel time variability is the highest on Bulleen Road near the Eastern Freeway, with the individual travel time runs diverging the most at this location.

Figure 48 Travel time between M80 Ring Road at Plenty Road to Eastern Freeway at Doncaster Road SB via Greensborough Rd, Rosanna Rd and Bulleen Rd AM peak



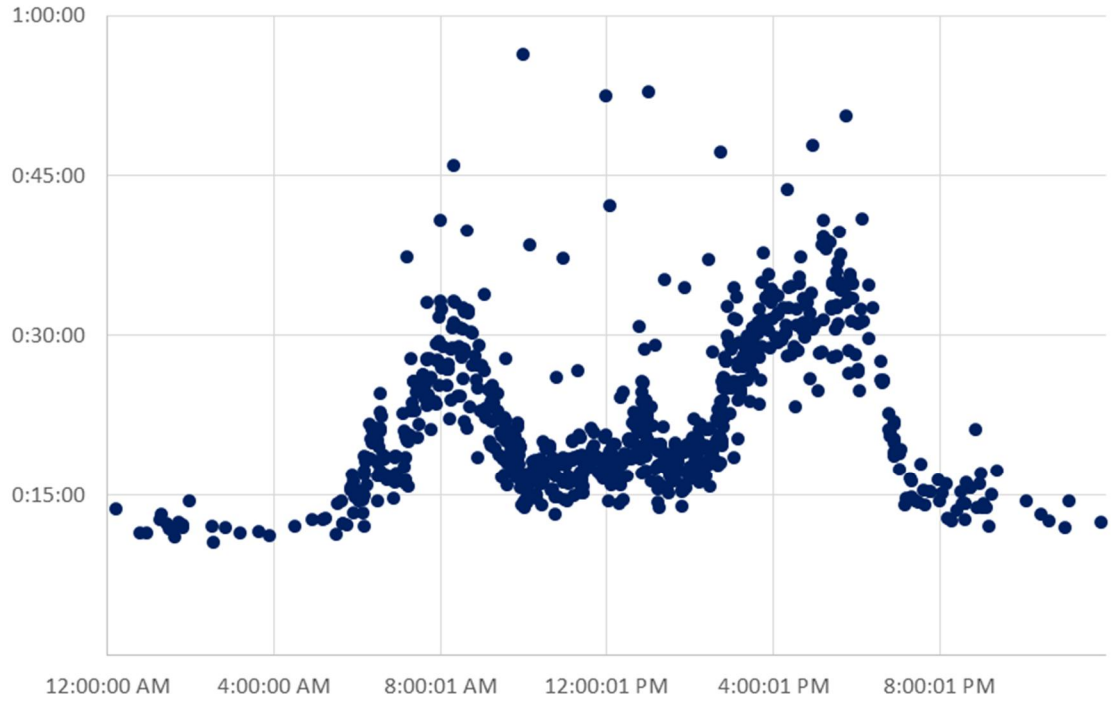
4.3.3 Travel time variability across the day

Travel times across an entire day are constantly in flux; variability in travel times are not just restricted to travel during peak periods. Travel times for vehicles travelling between Bulleen Road and the M80 (a section of Route F previously described) is presented in Figure 49 for the northbound direction and Figure 50 for the southbound direction during a single day.

These charts show that while travel times more than double during the morning and evening peaks, there is still a high degree of travel time variability during the inter-peak periods (typically between 9:00 am and 4:00 pm). These trips during the middle of the day can be as fast as 15 minutes or as slow as 25 minutes depending on factors such as time spent waiting at traffic lights or demand for travel on the road at that particular time.

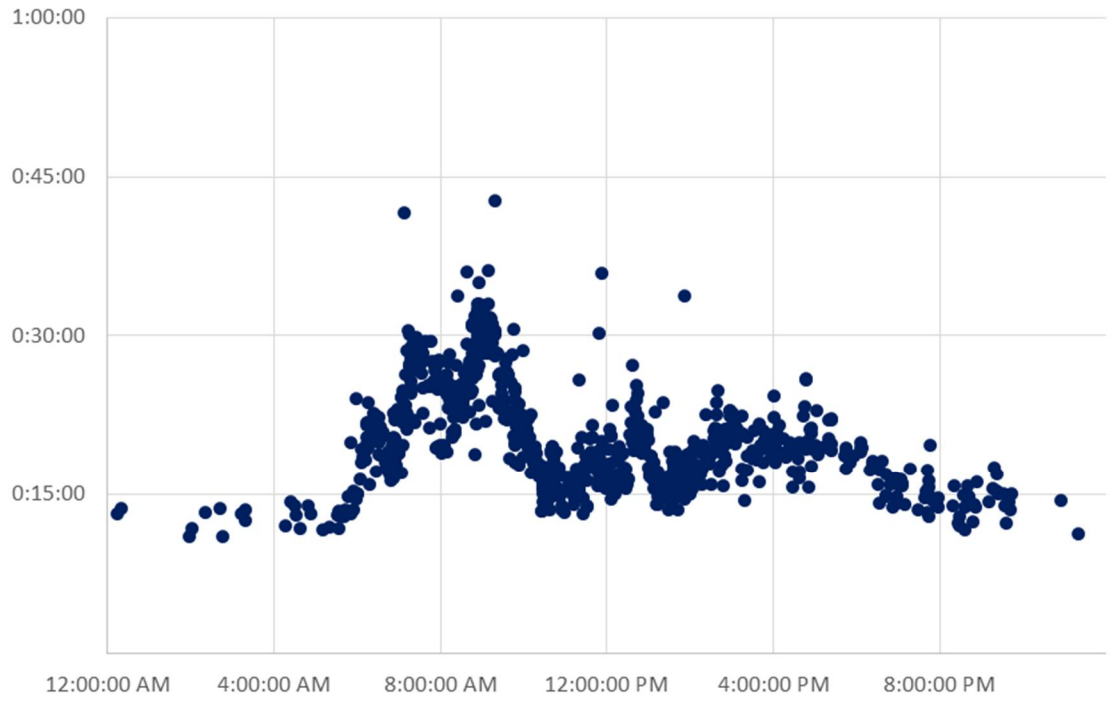
Regardless of when travel is undertaken on the arterial road network, it is hard to gauge exactly how long the trip will take. While this may be a minor inconvenience for commuters or other car trips, it has a particularly significant impact on the freight and logistics industry where travel time reliability is a critical factor in day to day operations.

Figure 49 Travel time between Bulleen Road and M80 northbound



Source: NELA origin-destination truck surveys, 2017

Figure 50 Travel time between M80 and Bulleen Road southbound



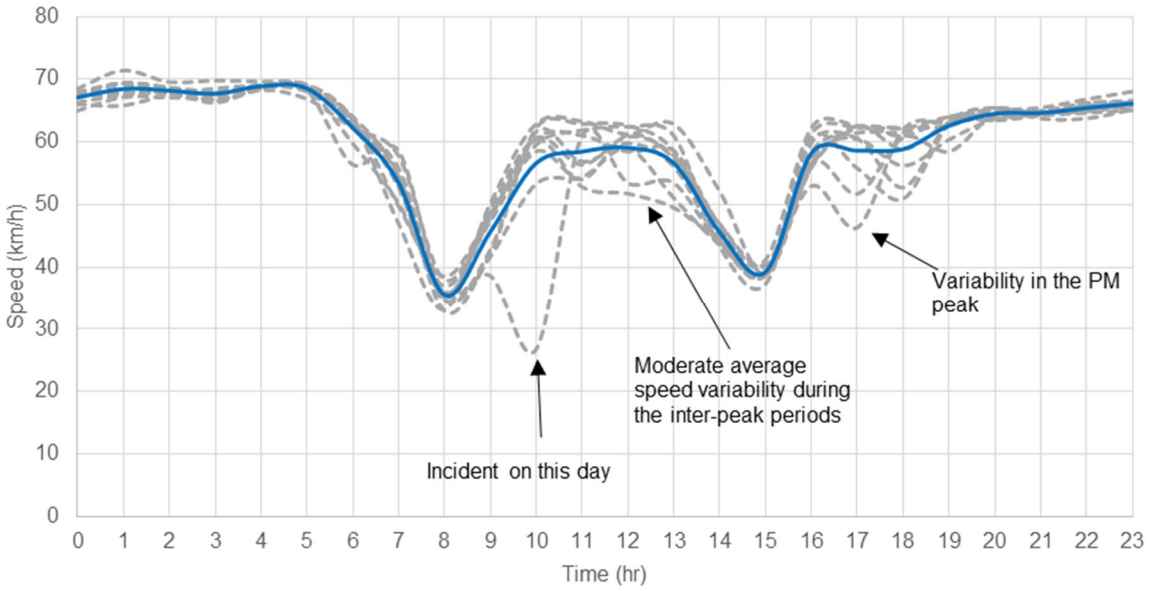
Source: NELA origin-destination truck surveys, 2017

4.3.4 Day to day travel time variability

While average speeds and travel times may fluctuate throughout the day, there is also a high degree of variability from day to day. The weekday average hourly speeds on Bulleen Road across a two-week period is presented in Figure 51. Average hourly speed profiles for each weekday are shown as dashed grey lines, with the average weekday speed represented by the solid blue line.

From day to day, speeds at the same time of day can differ by up to 40 kilometres per hour (the result of an incident on the network), with day to day variance highest during the AM, interpeak (midday) and PM peak periods.

Figure 51 Individual weekday average speeds on Bulleen Road



4.3.5 The implications of travel time variability and congestion

Travel time variability has a major effect on the travel behaviour of road users. Unreliability across a transport network places uncertainty in travellers before any trip or commute. Depending on the level of uncertainty anticipated in a trip, road users change their travel behaviour patterns, such as departure times, route choices or mode choices. This results in less efficient time management and productivity for travellers. Travel time is also a major contributor of transport costs and unreliability, with the length of a trip or unexpected delays increasing costs.12

Studies have shown that travellers generally prefer rail-based modes of public transport to buses.[13] The perceived benefits of rail over bus travel include network knowledge and expectations of reliability, priority and speed.[14] Signals and sharing the road with traffic increase the supposed variability in bus travel, proving the potential benefits of bus priority lanes and BRT initiatives.

[12] Transportation Cost and Benefit Analysis II – Travel Time Costs Victoria Transport Policy Institute (www.vtpi.org)
[13] Modal image: candidate drivers of preference differences for BRT and LRT
[14] Research perspectives on the merits of Light Rail versus Bus, Professor Graham Currie

4.4 The Eastern Freeway

The Eastern Freeway, connecting Alexandra Parade and Hoddle Street in the inner city to EastLink in the eastern suburbs, is a vital radial transport corridor for the eastern suburbs. It is a high capacity freeway ranging from three to five lanes in width, with fully grade separated interchanges and a posted speed limit of 100 km/hr. Sections of the freeway also have a dedicated peak period bus and taxi lanes in the road shoulders in locations.

Daily weekday traffic volumes along the Eastern Freeway range from 128,000 to 178,000 vehicles per day, with the busiest section between Middleborough Road and Tram Road. This is comparable to the Monash Freeway, which carries up to 180,000 vehicles a day near Warrigal Road, but is less than the West Gate Freeway, which carries approximately 200,000 vehicles a day across the West Gate Bridge.

Average annual weekday daily traffic volumes for each section of the freeway (two-way volumes) are presented in Table 7

Figure 52 Eastern Freeway alignment

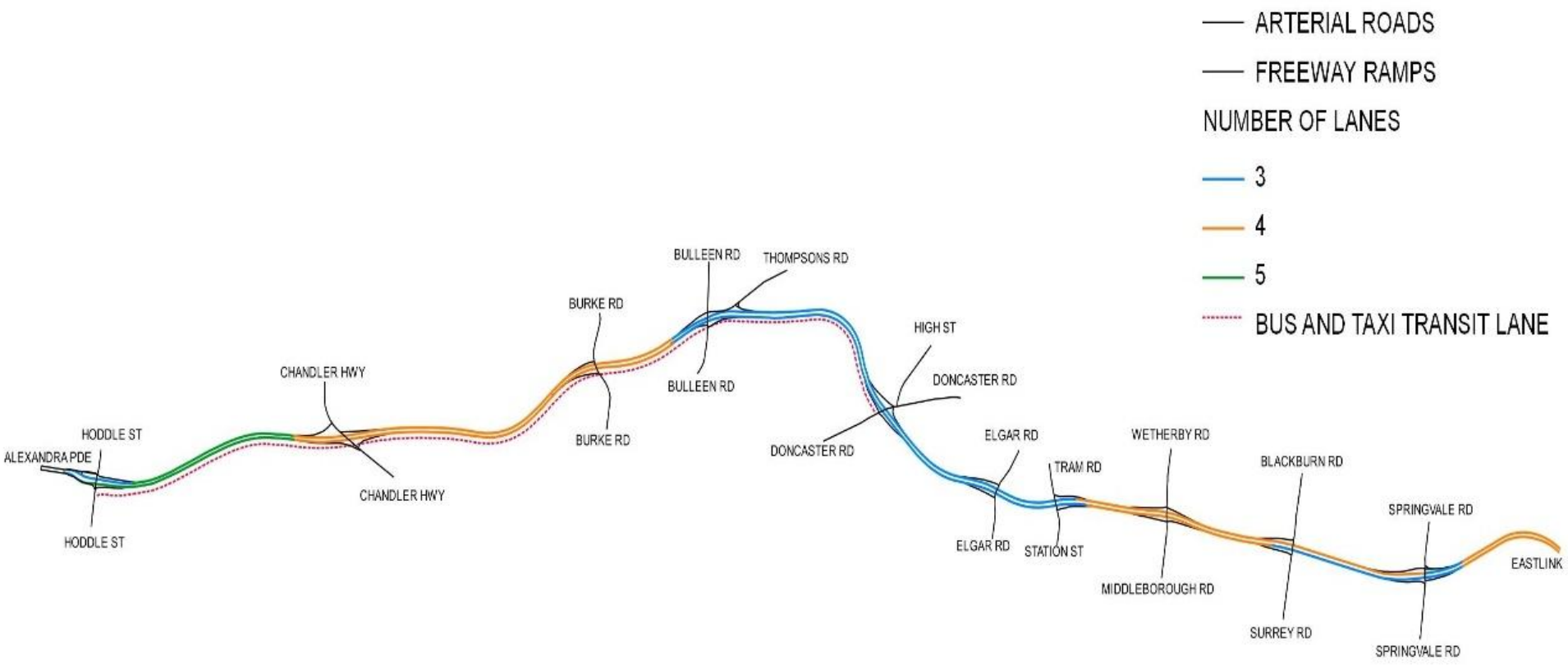


Table 7 Eastern Freeway average traffic volumes

Section	Average annual weekday daily traffic volume (two-way)
Between Springvale Rd and Blackburn Rd	133,000 - 147,000
Between Blackburn Rd and Middleborough Rd	151,000 - 167,000
Between Middleborough Rd and Tram Rd	160,000 - 178,000
Between Tram Rd and Elgar Rd	135,000 - 150,000
Between Elgar Rd and Doncaster Rd	153,000 - 170,000
Between Doncaster Rd and Bulleen Rd	150,000 - 166,000
Between Bulleen Rd and Burke Rd	128,000 - 141,000
Between Burke Rd and Chandler Hwy	147,000 - 162,000
Between Chandler Hwy and Hoddle St	130,000 - 143,000

4.4.1 Peak demand on the Eastern Freeway

Peak hour on the Eastern Freeway occurs at a different time compared to the rest of the arterial road network; freeways are generally used for longer distance trips, whereas the arterial road network is used for a range of trips including short distance such as trips to the shops and schools.

The highest volumes on the Eastern Freeway occur earlier than on the arterial road network; during the morning, peak hour occurs at 6:00 am and the evening peak occurs at 3:00 pm (as opposed to 8:00 am and 5:00 pm on arterial roads in the north-east). However, this does not necessarily coincide with peak demand for travel.

A typical daily profile for the Eastern Freeway (average of all midblock locations) is presented in Figure 53 for the inbound direction and Figure 54 in the outbound direction.

Figure 53 Eastern Freeway average daily profile inbound

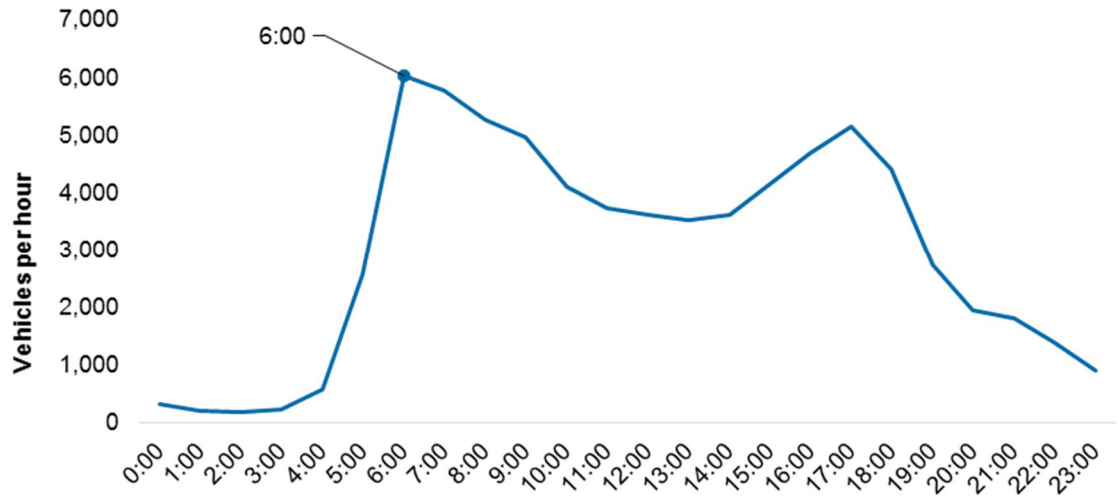
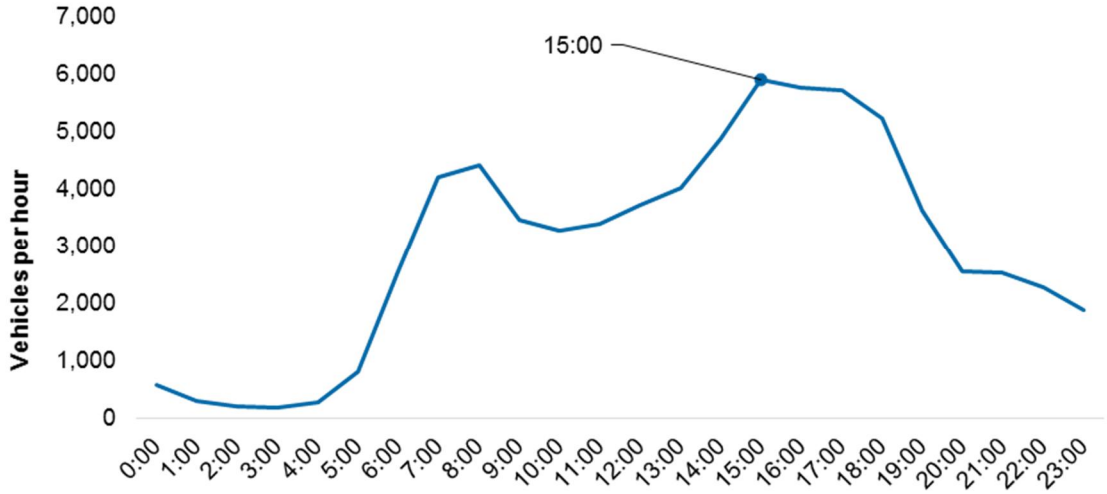


Figure 54 Eastern Freeway average daily profile outbound

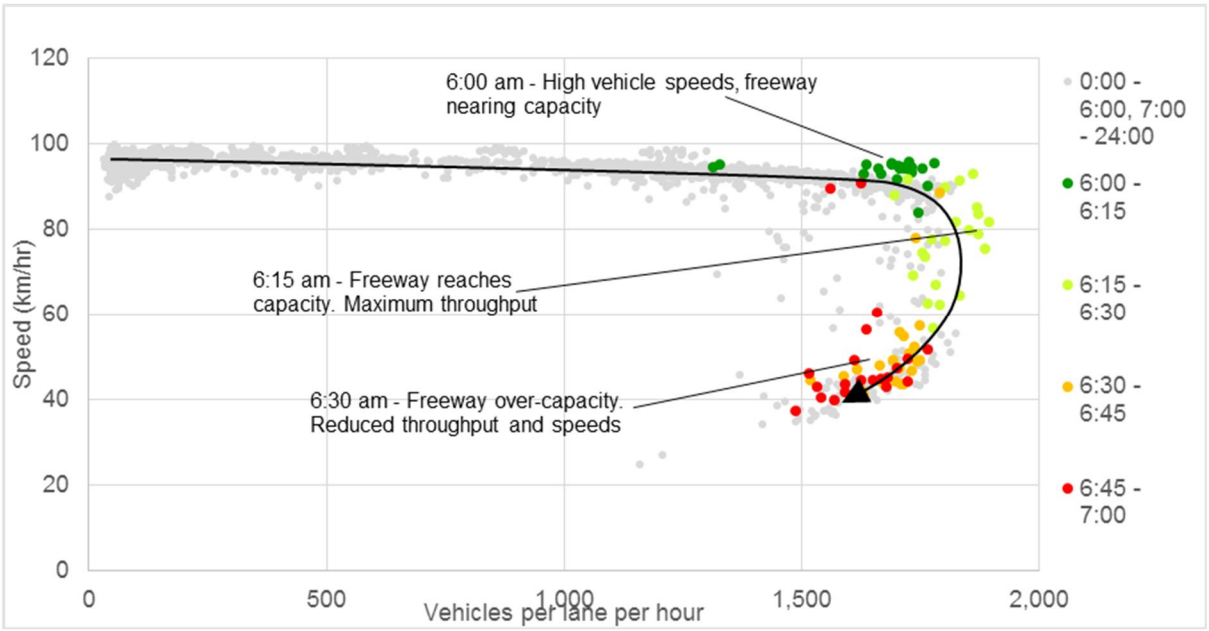


The highest throughput occurs at 6:00 am to 7:00 am in the morning and 3:00 pm to 4:00 pm in the afternoon due to the freeway being overcapacity in the subsequent hours, resulting in flow breakdown that limits the amount of throughput. In the first 15 minutes of the 6:00 am hour, the freeway starts to approach full capacity, reflected by the high throughput and high average speeds, as presented in the speed-flow curve in Figure 55 (with 6:00 am to 6:15 am highlighted in dark green). In the next 15 minutes (6:15 am to 6:30 am), demand continues to increase, reaching a point where the freeway hits capacity; vehicles on the freeway begin to slow slightly due to vehicles merging from the entry ramps. This 15-minute period represents the highest throughput on the freeway, but with slightly reduced vehicle speeds (light green).

In the following 30 minutes (6:30 am to 7:00 am, highlighted in orange and red respectively), vehicle speeds and capacity are significantly affected as the traffic cannot physically fit onto the freeway. Vehicles are forced to slow down further to allow merging traffic to enter as there are no free gaps in traffic.

Reduced speeds and throughput are experienced for the subsequent hours, until demand eases off at approximately 9:00 am to 10:00 am. While the highest throughput is achieved at 6:00 am, demand for travel is still high (and potentially higher) at 7:00 am and 8:00 am.

Figure 55 Speed flow curve Eastern Freeway inbound between Middleborough Road and Tram Road



Additionally, the peak period of demand is not necessary just a single hour. As presented in Table 8, demand for travel on along the Eastern Freeway remains high either side of the peak hour. The peak period (where traffic is at least 85 percent of the peak hour volume), can last for between two and four hours during the morning peak and three to five hours during the evening peak.

Table 8 Peak periods on the Eastern Freeway

Count location	AM peak	AM peak duration	PM peak	PM peak duration
Between Springvale Rd and Blackburn Rd	6:00 am to 9:00 am	3	3:00 pm to 7:00 pm	4
Between Blackburn Rd and Middleborough Rd	6:00 am to 9:00 am	3	3:00 pm to 7:00 pm	4
Between Middleborough Rd and Station St	6:00 am to 10:00 am	4	3:00 pm to 7:00 pm	4
Between Station St and Elgar Rd	6:00 am to 9:00 am	3	2:00 pm to 7:00 pm	5
Between Elgar Rd and Doncaster Rd	6:00 am to 10:00 am	4	3:00 pm to 7:00 pm	4
Between Doncaster Rd and Bulleen Rd	6:00 am to 9:00 am	3	3:00 pm to 7:00 pm	4
Between Bulleen Rd and Burke Rd	6:00 am to 8:00 am	2	3:00 pm to 7:00 pm	4
Between Burke Rd and Chandler Hwy	6:00 am to 8:00 am	2	3:00 pm to 6:00 pm	3
Between Chandler Hwy and Hoddle St	6:00 am to 8:00 am	2	3:00 pm to 6:00 pm	3

Source: 2016 VicRoads STREAMS data

4.4.2 Flow breakdown during peak periods

The Eastern Freeway is a highly-utilised corridor, with frequent peak hour congestion along many sections, especially at its western terminus at the Alexandra Parade - Hoddle Street freeway exit. Due to the freeway abruptly terminating at an arterial road at its western end, the section of the Eastern Freeway between Chandler Highway and Hoddle Street has the lowest average vehicle speed of all freeways in Melbourne[15].

A number of factors contribute to flow breakdown along the Eastern Freeway. These can largely be attributed to merging and weaving at the freeway interchanges, the lack of ramp metering along the corridor and the lack of midblock capacity.

4.4.2.1 Merging and weaving at the freeway interchanges

The capacity of freeway on-ramps depends on the ramp configuration, which can be broadly classified into three types:

- A standard merge, where on-ramp traffic is required to merge into the left-most lane of the freeway – this merge type has a typical capacity of 1,200 vehicles per hour;
- An added lane, where on-ramp traffic merges onto the freeway in its own dedicated lane that continues on the freeway – this merge type has a typical capacity of 1,800 vehicles per hour; and
- An added lane plus merge, where the on-ramp merges with the freeway in two lanes, with one lane continuing as a traffic lane on the freeway – this merge type has a typical capacity of 2,400 vehicles per hour.

At locations such as Springvale Road and Thompsons Road, the ramp traffic volumes far exceed the theoretical capacities, as presented in Table 9. When significant volumes of traffic try and merge onto the freeway, flow breakdown can occur as traffic on the freeway is forced to slow down to accommodate the merging traffic.

Exacerbating the issue is that all the on-ramps (except for the Doncaster Road inbound on-ramp and the Thompsons Road outbound on-ramp) are not ramp-metered, which allows traffic to enter the freeway freely, impeding traffic flow on the main carriageways. Ramp metering regulates the rate and spacing of traffic entering onto the freeway with traffic lights, and is proven to improve the overall performance (vehicle speeds and capacity) of a freeway network[16]. Intermittent ramp metering does not provide the traffic performance benefits noted above.

[15] *Eastern Freeway Melbourne's slowest, morning speed below 10km/h, Adam Carey*
[16] VicRoads Managed Freeways – Freeway Ramp Signals Handbook, July 2013

Table 9 Summary of Eastern Freeway on-ramps

On-ramp	Merge type	Peak volume	Ramp metered?
Inbound			
Springvale Rd inbound ramp	Standard merge	1,800	No
Blackburn Rd inbound ramp	Added lane	1,000	No
Middleborough Rd inbound ramp	Standard merge	900	No
Elgar Rd inbound ramp	Standard merge	950	No
Doncaster Rd inbound ramp	Standard merge	550	Yes
Bulleen Rd inbound ramp	Added lane + merge	1,350	No
Burke Rd inbound ramp	Standard merge	600	No
Chandler Highway inbound ramp	Added lane + merge	500	No
Outbound			
Chandler Highway outbound ramp	Standard merge	1,500	No
Thompsons Road outbound ramp	Standard merge	1,600	Yes
Doncaster Road outbound ramp	Standard merge	850	No
Tram Road outbound ramp	Added lane	1,600	No
Middleborough Road outbound ramp	Standard merge	600	No

In addition to the freeway on-ramps operating at capacity, the short distances between each of the interchanges affect the performance of the Eastern Freeway. Freeways operate efficiently when lane changing is minimised – the short distances between many of the interchanges result in an elevated amount of lane changing in a relatively short section of road.

There are five interchanges on the Eastern Freeway within a 5.5 kilometre length of road between Elgar Road and Springvale Road. As a result, there is a high degree of pressure placed on the left-most lanes of the freeway, as vehicles position themselves to exit the freeway in advance of their exits and, at the same time, traffic is merging onto the freeway. The combination of excessive lane changing and merging and weaving of traffic reduces the performance of the freeway, leading to reduced vehicle speeds and congestion during peak periods of demand.

4.4.2.2 Lack of midblock capacity

The number of lanes of traffic on some sections of the Eastern Freeway also constrain the overall capacity; some sections of the freeway only have three lanes in each direction. A typical capacity for a single lane on a freeway is approximately 1,800 vehicles per hour; however, a freeway can sometimes operate to an equivalent of around 2,000 vehicles per hour for short periods of time.

Compared to typical freeway capacities, sections of the Eastern Freeway often operate significantly over capacity, as presented in Table 10. These sections over capacity are all three-lane sections of the freeway: between Station and Elgar Road, between Elgar Road and Doncaster Road, between Doncaster Road and Bulleen Road in the PM peak and Springvale Road and Blackburn Road in the AM peak.

The high traffic throughput on these sections mean there is no spare capacity to travel on the Eastern Freeway during peak hours – additional demand in future years must either travel outside peak hour or take alternative routes.

Table 10 Average vehicles per lane during peak hour

Midblock location	Volume per lane per hour	
	Inbound: AM max	Outbound: PM max
Between Springvale Rd and Blackburn Rd	1,950	1,400
Between Blackburn Rd and Middleborough Rd	1,650	1,600
Between Middleborough Rd and Station St	1,700	1,700
Between Station St and Elgar Rd	2,050	1,900
Between Elgar Rd and Doncaster Rd	2,100	2,050
Between Doncaster Rd and Bulleen Rd	1,600	1,800
Between Bulleen Rd and Burke Rd	1,700	1,400
Between Burke Rd and Chandler Hwy	1,750	1,750
Between Chandler Hwy and Hoddle St	1,150	1,250
Average	1,750	1,650

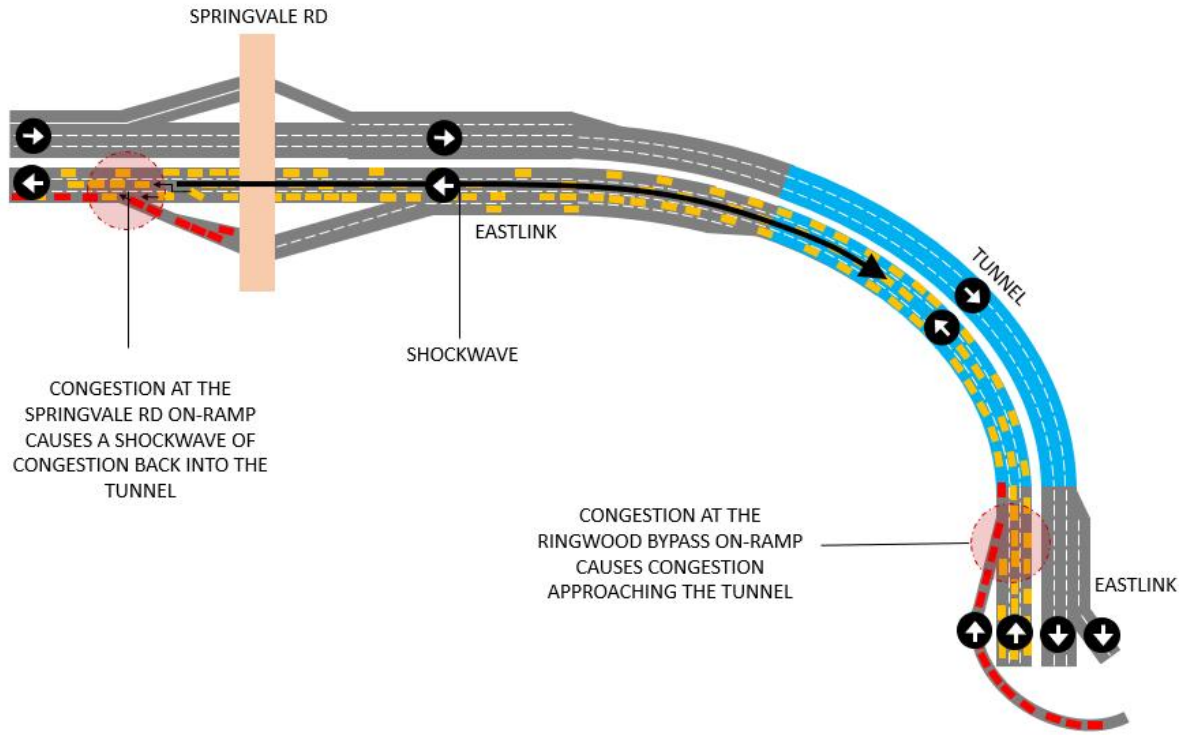
4.4.2.3 EastLink tunnels

Traffic flow in the vicinity of the EastLink tunnels often breaks down in the peak periods, impacting performance and creating queues. However, the flow breakdown that occurs in the tunnel is not due to a lack of capacity in the tunnel, but rather upstream and downstream bottlenecks, as presented in Figure 56.

In the morning peak period, the inbound Springvale Road on-ramp carries a significant volume of traffic that enters the freeway without the control of ramp signals. This uncontrolled entry causes flow breakdown on the Eastern Freeway, which then sends a congestion 'shockwave' back through the EastLink tunnels. This shockwave creates flow breakdown in the tunnel, reducing performance.

This morning peak period flow breakdown is also exacerbated by the unmetered traffic entering from the Ringwood Bypass onto EastLink prior to the tunnel. This high-volume movement is very close to the tunnel portal and when combined with the congestion caused by the Springvale Road entry ramp, average speeds in the tunnel drop significantly.

Figure 56 AM peak congestion in the EastLink tunnels



In the afternoon peak, the three lanes outbound under Blackburn Road create the first location of flow breakdown as the freeway narrows from four lanes to three lanes. Additional flow breakdown occurs at the outbound exit to Springvale Road due to high traffic volumes exiting the freeway. The weaving of through vehicles attempting to access the EastLink tunnels and exiting vehicles in the left-most lanes further increases congestion and flow breakdown.

Through the tunnels, there is a single lane exit to the Ringwood Bypass immediately after exiting the tunnel. This high-volume exit lane results in a large amount of traffic travelling in the left lane within the tunnel. This overloads the left lane, creating flow breakdown. Vehicles that cannot enter the left lane to exit to the Ringwood Bypass due to high volumes change lanes after the tunnel, creating a weave near to the tunnel portal that also impacts tunnel performance.

4.4.3 Average speeds

The significant demand for travel on the Eastern Freeway during peak periods means that there is often severe congestion and delays. While the average speeds on the freeway throughout the day are often close to the signposted speed of 100 km/hr, during peak hour the average speed can drop to around 45 km/hr in some sections.

The average speeds across a typical weekday for different sections of the Eastern Freeway is presented in Figure 57 for the inbound direction, and Figure 58 for the outbound direction. During times of peak demand, the average speed is typically half the free-flow speed during uncongested periods.

Figure 57 Average weekday speeds by section of the Eastern Freeway inbound

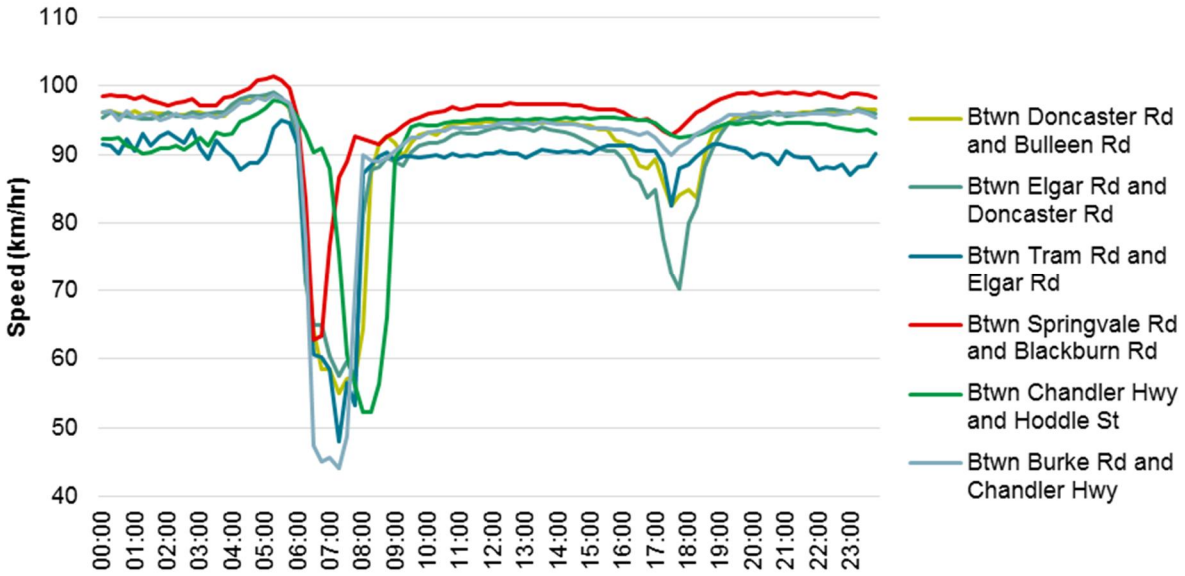
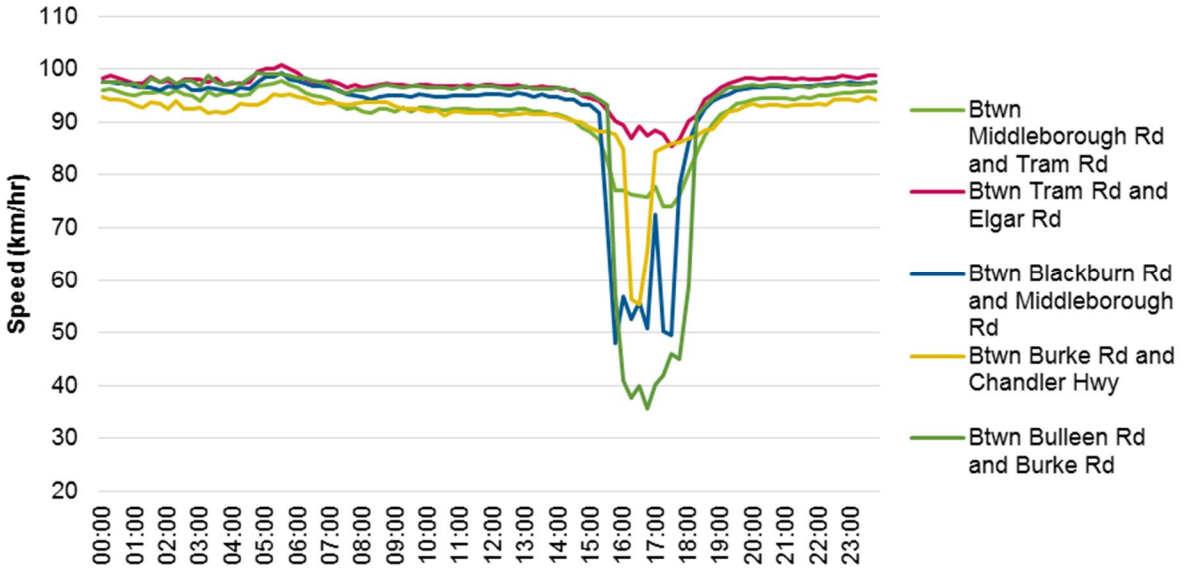


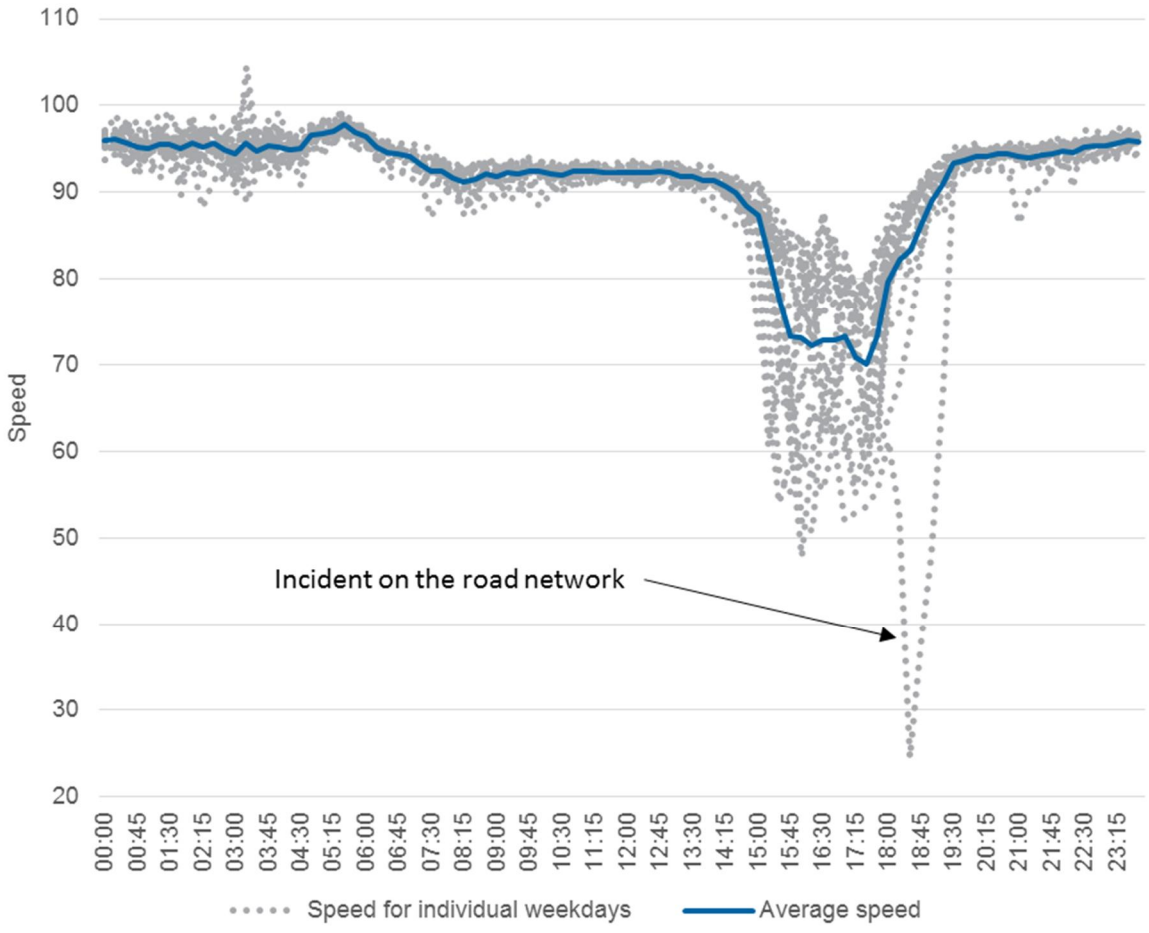
Figure 58 Average weekday speeds by section of the Eastern Freeway outbound



However, during peak periods, the speed on a day-to-day basis may be significantly above or below the average speed depending on a range of variables such as upstream or downstream congestion, individual driver behaviour (such as a driver braking heavily) or incidents such as a crash closing a lane of traffic. The average speed on the Eastern Freeway (inbound) between Middleborough Road and Tram Road for each weekday in May 2017 is presented in Figure 59. While the average speed during the PM peak is around 70 kilometres an hour, the speed can be as low as 50 kilometres an hour and as high as 90 kilometres an hour.

Additionally, when an incident on the freeway occurs (highlighted in Figure 59), the average vehicle speed can drop to as low as 25 kilometres an hour, significantly lower than the average speed of 80 to 90 kilometres an hour typically expected at 6:30 pm in the evening.

Figure 59 Average daily speeds on the Eastern Freeway outbound between Middleborough Road and Tram Road



5 Road safety

A crash analysis of the study area has been undertaken using the data available from the VicRoads CrashStats database. This provides a summary of the location, type and severity of crashes. The crashes within CrashStats are typically only those that have required emergency services attendance. As such, it is likely that the number of crashes within the study area are slightly higher than those presented in this assessment.

5.1 Crash history

5.1.1 2012 to 2016

An assessment of the number of crashes that have occurred over five years between 2012 and 2016 are presented in Table 11. The yearly number of crashes that have occurred within the study area has remained relatively constant over this time period, with yearly fluctuations being approximately plus or minus five percent. The total change in the number of crashes between 2012 and 2016 is less than one percent.

Table 11 Crashes recorded within study area 2012 to 2016

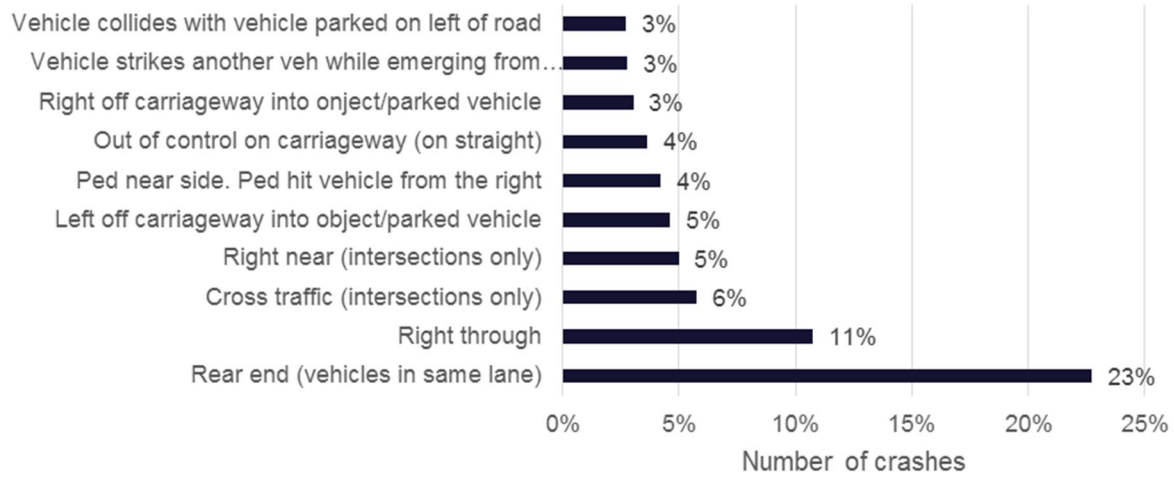
Year	Fatal	Serious injury	Other injury	Total
2012	20	492	1,143	1,655
2013	10	488	1,091	1,589
2014	12	461	1,222	1,695
2015	13	434	1,295	1,742
2016	19	387	1,264	1,670
Total	74	2,262	6,015	8,351

5.1.2 Types of crashes

The most common type of accidents that occurred between two vehicles was a rear-end collision between vehicles in the same lane. This type of common collision suggests a high level of congestion on roads, with suddenly stopping traffic resulting in this type of collision.

Vehicles turning right at an intersection and colliding with opposing through vehicles was the second most frequent movement in the recorded crashes. These right through crashes are also likely due to congestion, resulting in frustrated drivers picking inadequate gaps in the traffic. The ten most frequent accident movements have been classified and presented in Figure 60.

Figure 60 Top crash types 2012 to 2016 within the north-east



5.1.3 Vehicles involved in crashes

The types of vehicles that are involved in crashes across the study area are presented in Table 12. It shows that passenger vehicles account for the bulk of vehicles involved in crashes. It also shows that heavy vehicles are only represented in two percent of crashes. As presented previously in Figure 25, heavy vehicle percentages are typically around six to eight percent of all vehicles using the road network. This would indicate that heavy vehicles are underrepresented in crashes within the study area.

Table 12 Types of vehicles involved in crashes

Vehicle type	Proportion
Passenger vehicle	91%
Motorcycle	6%
Heavy vehicle	2%
Public vehicle (bus/tram)	1%

5.2 Crash hotspots

An analysis of crash hotspots has been performed for the study area. The hotspot analysis has been performed separately for all vehicles, trucks and pedestrians/cyclists.

5.2.1 All vehicles

The all vehicle hotspot analysis is presented in Figure 61. It shows a significant hotspot in the southwestern corner of the study area which is at the edge of the inner city. This hotspot would be due to the focus of traffic at this location with increased levels of congestion.

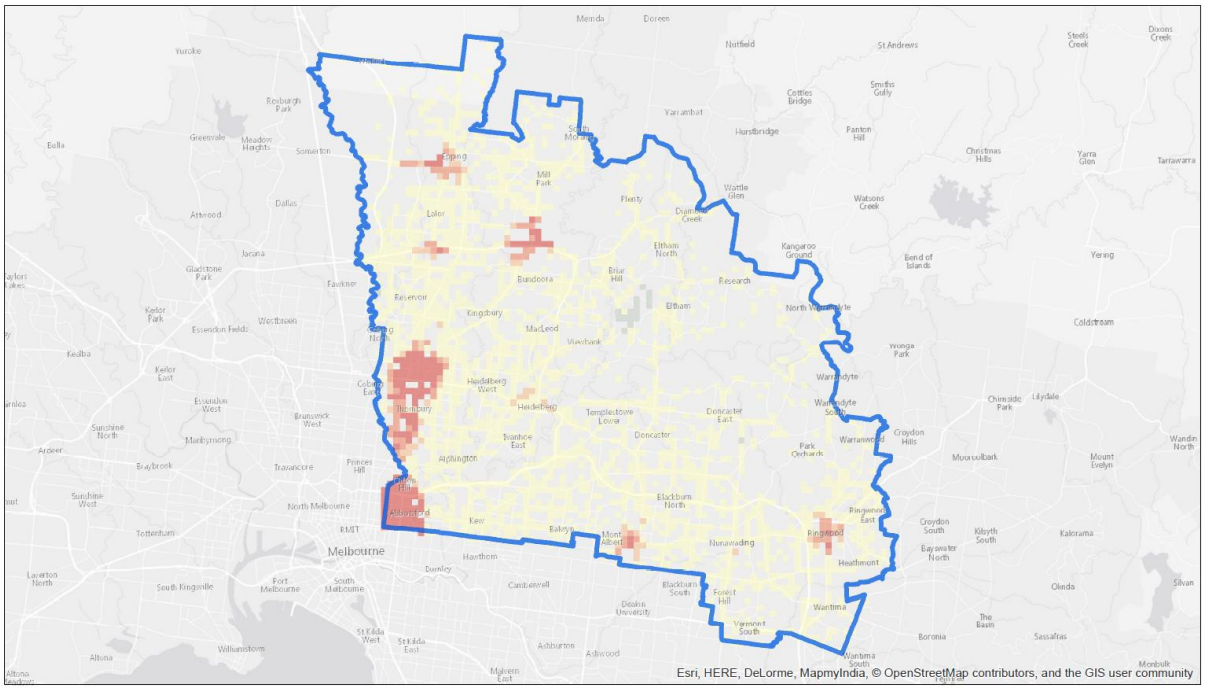
Other locations of hotspots include:

- M80 Ring Road and Plenty Road;
- Whitehorse Road in Box Hill; and
- Maroondah Highway in Ringwood.

The hotspots in Box Hill and Ringwood can be mainly attributed to the activity centres and the congestion that occurs in this area. These locations generally have a greater number of intersections and turning movements at both intersections and midblock.

The hotspot along the M80 and Plenty Road can be attributed to the high levels of congestion that occur at this interchange, particularly in the PM peak period. Collisions with pedestrians represented almost 20 percent of the crashes in these areas.

Figure 61 Hot spots of all vehicle crashes 2012 to 2016



5.2.2 Heavy vehicle hot spots

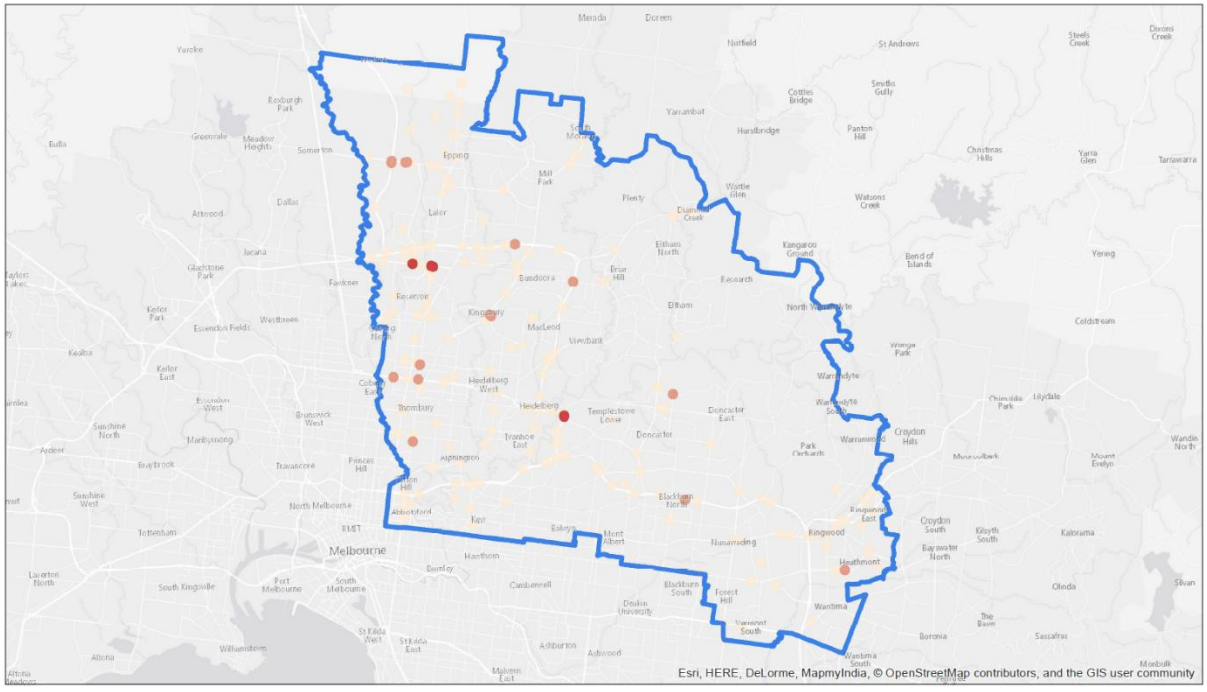
The heavy vehicle hotspots are presented in Figure 62 and generally align to locations of high heavy vehicle volumes. The following locations are the key hotspots in the study area:

- M80 Ring Road, Edgars Road and Mahoneys Road; and
- Bulleen Road, Banksia Street and Manningham Road.

Due to the low number of crashes involving heavy vehicles (approximately two percent of all crashes), trends between hot spot locations varied. Freeway locations often resulted in crashes involving multiple vehicles due to their high volume and high speed of vehicles, while arterial locations were typically between two vehicles.

However, there was some trends in the types of crashes occurring. The most common cause of crashes involving heavy vehicles were rear end collisions, and were typically between a heavy vehicle and passenger vehicle. The next most common cause of crashes was due to lane changing. These crashes can be attributed to congestion, with flow breakdown causing rear end collisions and heavy traffic causing lane changing and side swipe incidents.

Figure 62 Hot spots of crashes involving heavy vehicles 2012 to 2016

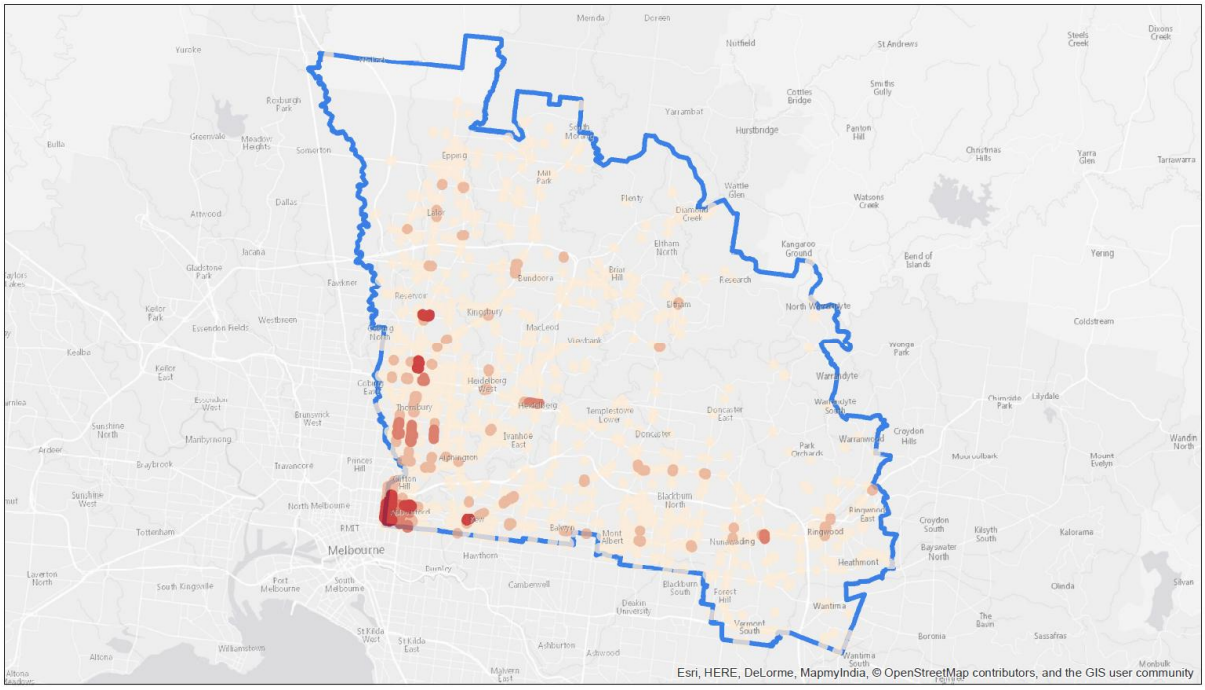


5.2.3 Pedestrian/cyclist

Pedestrian and cyclist crashes are mainly occurring at the western edge of the study area. This concentration of crashes in this section of the study area aligns with established facilities and a higher concentration of users. Areas further north and east did not have many hot spots due to the low utilisation of bicycles in these areas.

Crashes involving cyclists generally occurred during daylight hours; however, they also resulted in low severity or no injury. Cyclist crashes typically occurred as a cyclist was attempting to cross the road rather than rear end collisions. This is mainly attributed to cyclists preferring not to travel on-road due to the high speed nature of the road network, high levels of congestion and a lack of on-road bicycle facilities.

Figure 63 Hot spots of crashes involving cyclist or pedestrians 2012 to 2016



6 Freight

6.1 Overview of freight

6.1.1 Freight precincts

Freight movements between the east/south east of Melbourne and the north of Melbourne form a key element of industrial and commercial activity, reflecting the importance of links between industrial processes and the presence of logistics operators in industrial precincts. Major industrial precincts relevant to movements through the north east suburban area are presented in Figure 64.

Figure 64 Major relevant industrial precincts

Links between these industrial precincts are required for component and parts supply, and for industrial services, which provide key interactions supporting business. While some major manufacturing has relocated overseas, a strong local industry continues to manufacture domestic products and provide service support within the industrial precincts. Many of these firms support businesses across the precincts and use the most efficient links to support their business needs. The precincts most relevant to the east to north connections are:

- Melbourne Airport precinct;
- Campbellfield/Somerton;

- Bundoora;
- Melbourne Market;
- Ringwood/Mitcham;
- Bayswater;
- Scoresby; and
- Dandenong and surrounding precincts.

Connections between these locations are a critical part of business efficiency for logistics companies, retailers and other distributors across the city. The minimisation of travel distance and time for deliveries is a key cost efficiency measure for these businesses.

Businesses in the east of Melbourne generally access the north via the Eastern Freeway and Bulleen Road, viewing this as the most direct and efficient link. Businesses further to the south east may choose to use the Monash Freeway and Tullamarine Freeway in the off-peak; however, the risk of inner city congestion along these freeways is increasingly driving businesses to consider options along EastLink and through the arterial road network to the north.

Businesses travelling to and from Dandenong have the opportunity to make a choice between travelling along the M1 or EastLink to access the north of Melbourne. Often this choice is made based on the conditions along the M1 at the time, with the route susceptible to congestion and flow breakdown. To avoid this route means using the arterial road network to travel through the north east, conflicting with local traffic and contributing to high levels of congestion throughout the day.

Roads across the north east are not typically suited for freight. The topography of the area results in some significant grade issues on a number of key roads, restricting access to some heavy vehicles. This places pressure on other roads where the grades are less of an issue for heavy vehicles, however these roads are typically lined with residential properties creating a land use conflict. This has resulted in the implementation of truck curfews which can impact route choice and the time of day that freight is moved.

6.1.2 Freight routes and movements

There are two primary routes that heavy vehicles typically use when travelling from a location in the south east to the north:

- The M1 through the city via the Tullamarine Freeway and the M80 (72 km); or
- Via EastLink, the Eastern Freeway, Bulleen Road and Greensborough Road and the M80 (64 km).

Travel distances are shorter via the orbital route along EastLink; however, travel times vary significantly during the day. The variations in traffic and congestion impact freight route choices that are dependent on the 'normal traffic conditions' on either route. Travel times obtained by tracing an example journey through Google indicate that northbound:

- The morning peak and off-peak evening times are quicker via the EastLink route than via the M1 route to the M80;
- The M1 route is slightly quicker throughout the morning;
- The EastLink route is faster in the afternoon until the evening peak when the lower standard roads suffer from high congestion; and
- In the evening off-peak, the EastLink route to the M80 again becomes quickest.

Southbound, the M1 route is generally quicker during the peak periods and throughout the day.

This example indicates an indicative origin for travel from the south east, which is effectively a decision point for freight and logistics movements much further to the south east. Reaching the EastLink (M3)/M1 intersection, freight transport operators will choose either option as the key route based on time of day and traffic conditions.

While this is a key decision point in the south east, many of the businesses in the east of Melbourne are located further north from this point (such as in the Scoresby and Bayswater precincts), further reducing the travel times along EastLink and providing increased benefits in taking the EastLink/Bulleen Road route.

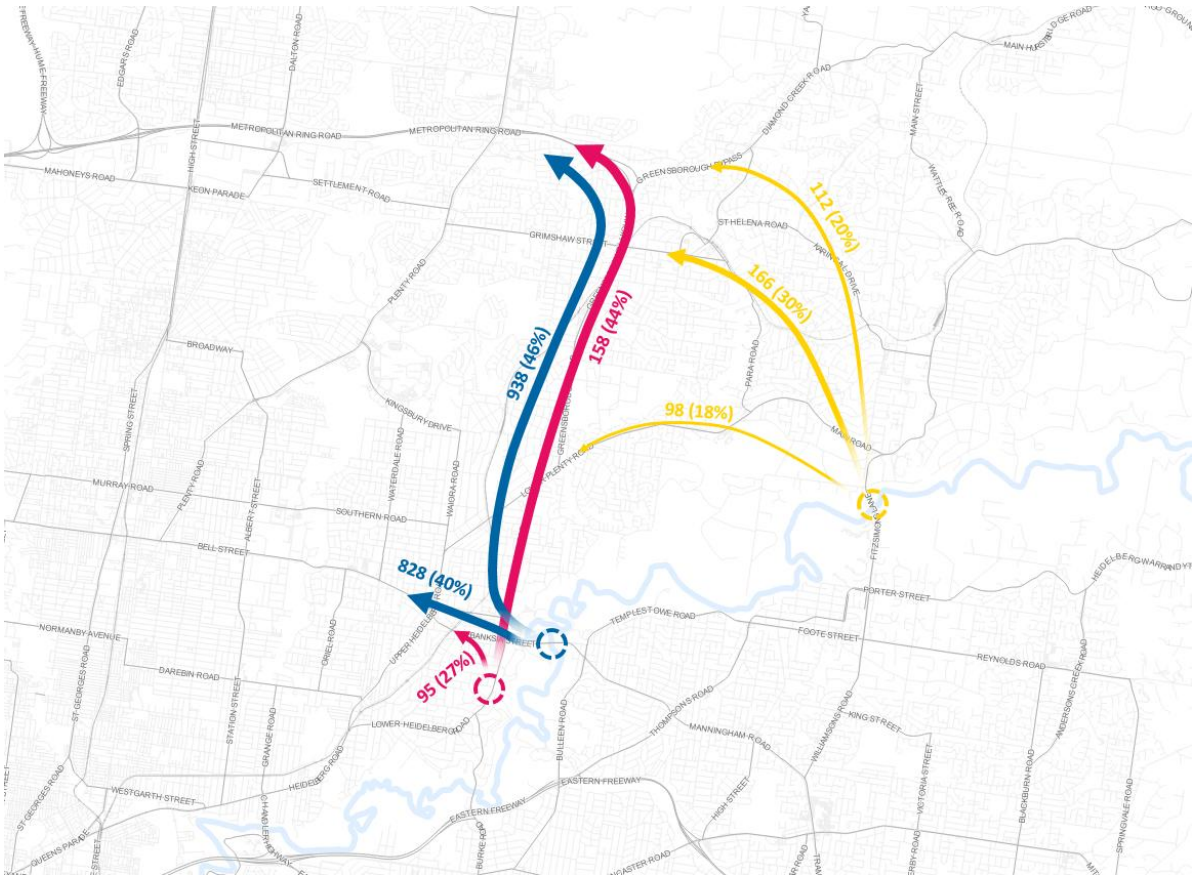
Logistics companies monitor these travel times and reliability, and use the best routes and times to distribute freight. Despite the poorer road conditions along part of the EastLink/Bulleen Road route, its use provides cost benefits to logistics companies, which is a key component of their business opportunities and profits.

6.1.3 Origins and destinations of freight through the north east

Truck origin and destination surveys have been undertaken to assess the movement of heavy vehicles on the arterial road network in the north east. The following provides a summary of the results from this survey.

The major movement for trucks crossing the Yarra River is a 'through' movement in a north-south direction, heading towards the M80 Ring Road, as presented in Figure 65. However, for heavy vehicles crossing the Yarra River at Banksia Street, a high proportion (40%) continues westbound towards Bell Street.

Figure 65 Main truck movements across the Yarra River



Source: NELA truck origin-destination surveys, 2017

In order to access the M80 Ring Road, freight from the east and south east using the Eastern Freeway or EastLink is likely to take either of two routes:

- Exiting the Eastern Freeway at Bulleen Road and crossing the Yarra River via Banksia Street; or
- Exiting the Eastern Freeway at an interchange prior to the Bulleen Road exit, and crossing the Yarra River via Fitzsimons Lane.

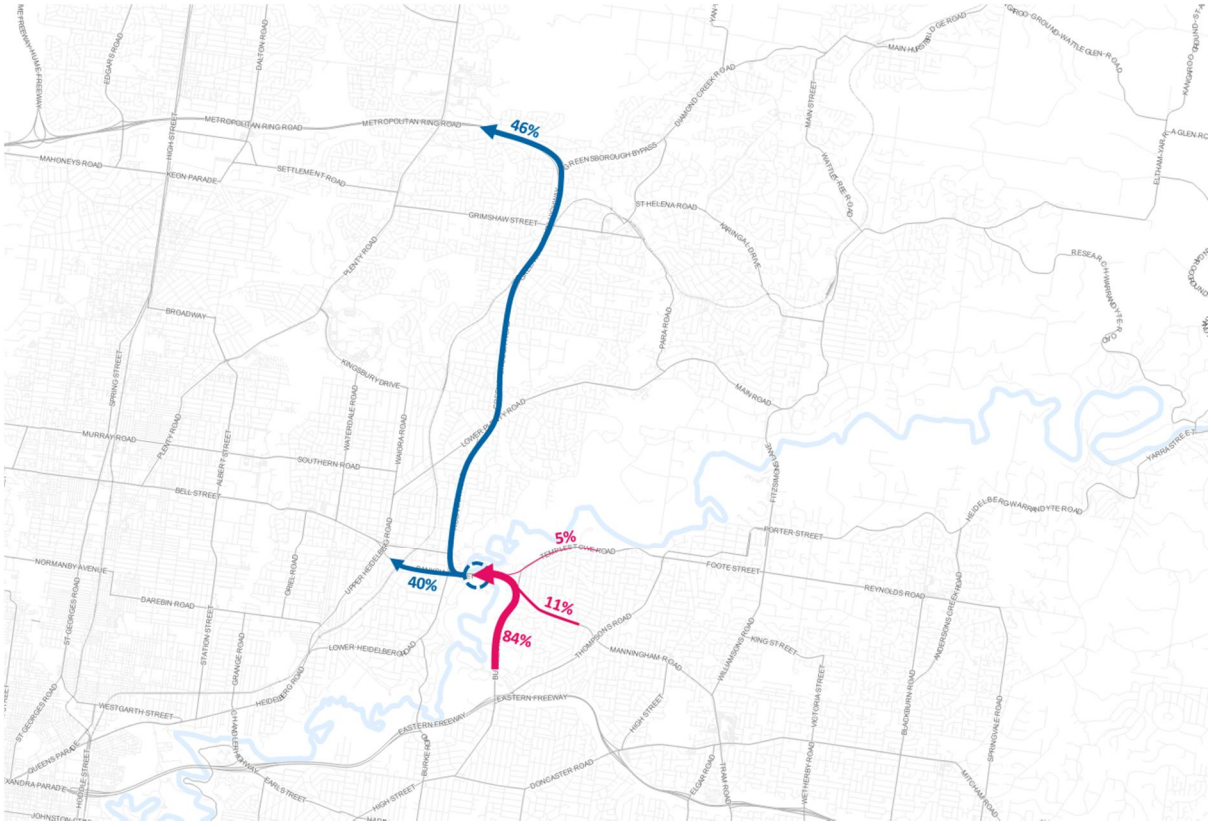
Although Burke Road also provides a point of access over the Yarra River, freight traffic is limited due to B-double restrictions on Burke Road bridge north of the freeway, as well as the half diamond interchange at the Eastern Freeway, which does not have westbound exit ramps or eastbound entry ramps.

The origin-destination truck surveys conducted reveal that the Bulleen Road route is the preferred route. Over a 24-hour period, trucks were three times as likely to use Bulleen Road rather than Fitzsimons Lane to travel between the Yarra River and the M80 Ring Road.

6.1.3.1 Destinations of heavy vehicles on Banksia Street

For heavy vehicles heading westbound on Banksia Street, 40 percent of trucks continue west on Banksia Street, while 46 percent travel north to the M80 Ring Road, as presented in Figure 66. The majority of this freight originates from Bulleen Road (84 percent), with only 11 percent from Manningham Road and five percent from Templestowe Road.

Figure 66 Origins and destinations of trucks across Banksia Street at the Yarra River



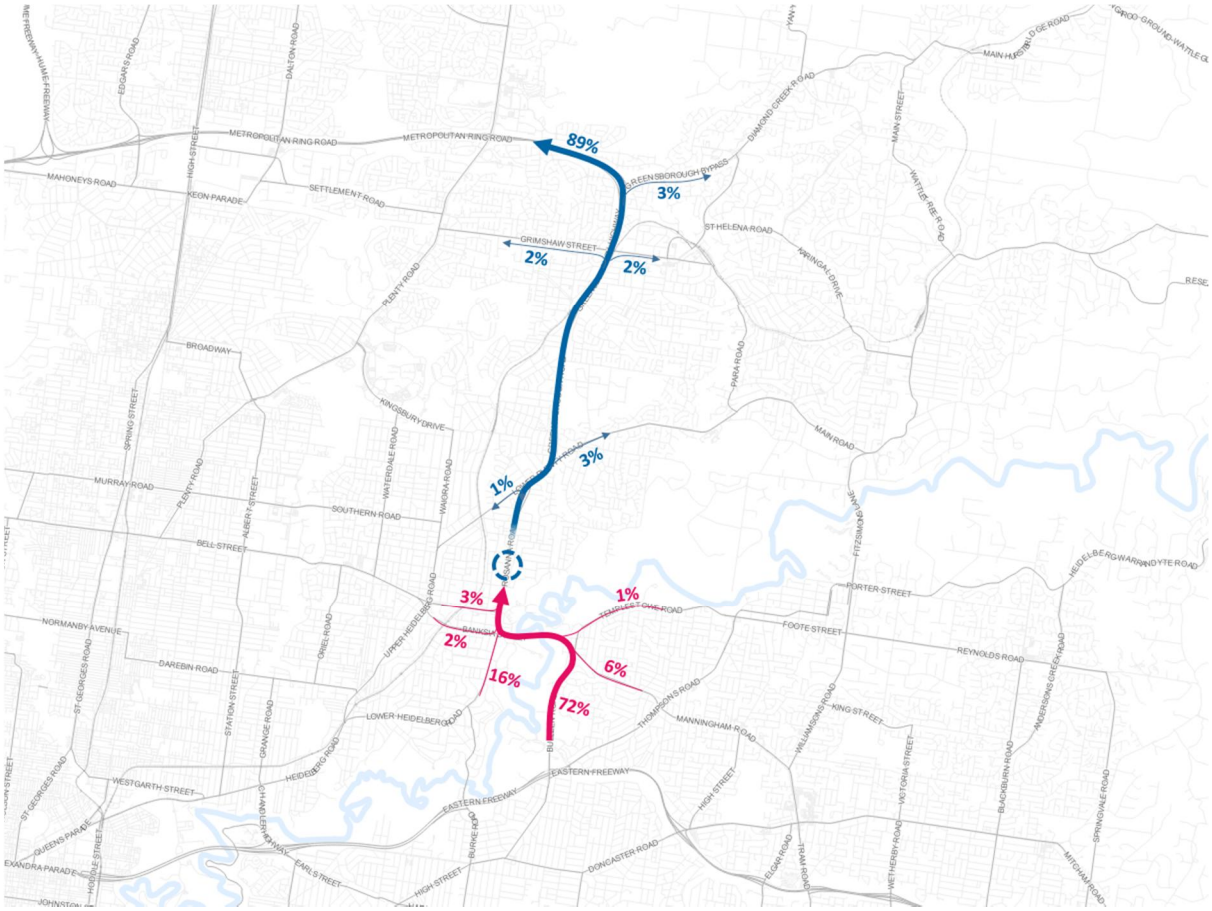
Source: NELA truck origin-destination surveys, 2017

6.1.3.2 Destinations of heavy vehicles originating from Rosanna Road

Once freight reaches Rosanna Road, the overwhelming majority (89 percent) travel northbound and onwards to the M80 Ring Road, as presented in Figure 67. Similar to Banksia Street a high proportion (72 percent) originates from Bulleen Road, while Burke Road (16 percent) and Manningham Road (6 percent) are less utilised.

This means that the majority of freight on Rosanna Road is 'through' traffic – trucks that have no local origin or destination. These trucks would likely divert away from Rosanna Road if a higher quality alternative route was provided.

Figure 67 Origins and destinations of trucks on Rosanna Road



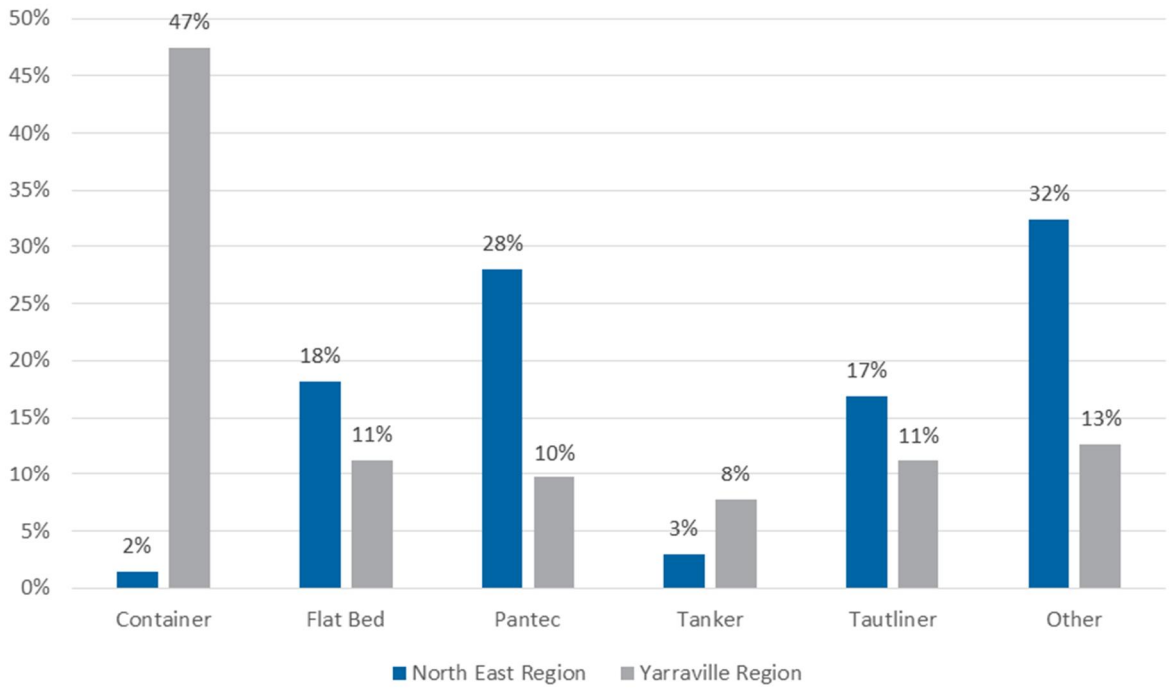
Source: NELA truck origin-destination surveys, 2017

6.1.4 Freight fleet mix

The truck loads carried and the size of trucks within the north east region are vastly different compared to an area such as the inner-west of Melbourne.

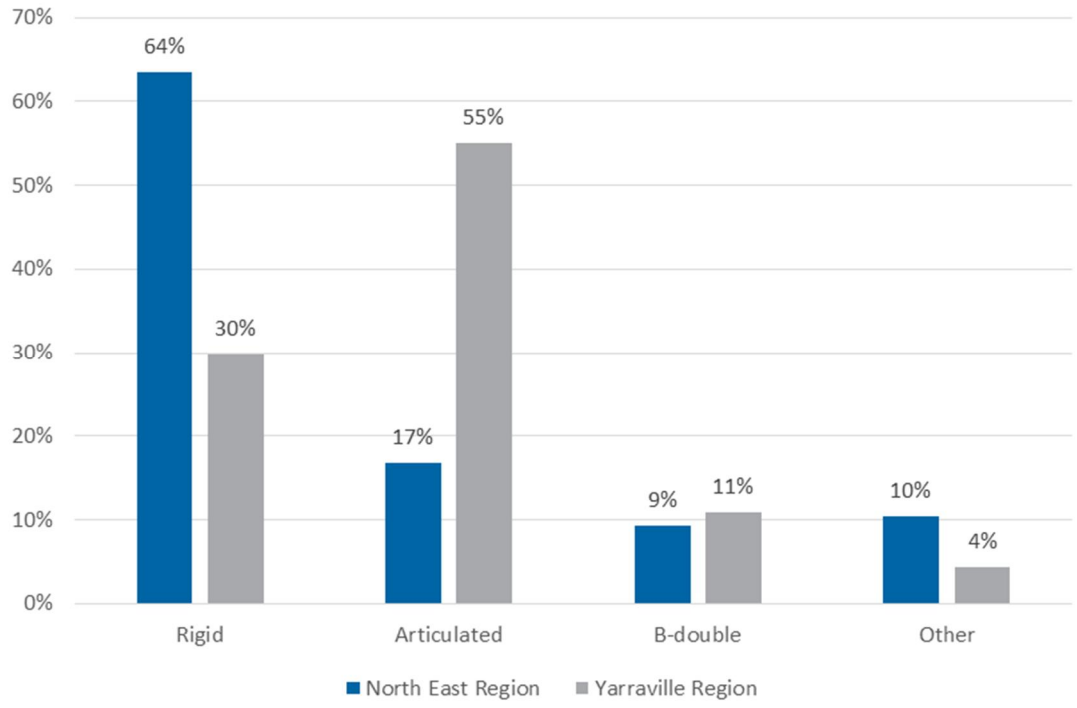
The differences in freight types is highlighted in Figure 68 and Figure 69. In the north east, freight load types are varied, with approximately 28 percent pantec trucks, 18 percent flat beds and 32 percent other types of heavy vehicles such as car carriers, concrete trucks and buses. In the Yarraville area, containers are the primary load being transported by heavy vehicles, making up over 45 percent of freight in the area, largely due to the area's proximity to the Port of Melbourne.

Figure 68 Truck load breakdown



Approximately 64 percent of heavy vehicles in the north east region are classed as rigid trucks, which are generally smaller than articulated or B-double trucks. In contrast, in the Yarraville region, the majority of heavy vehicles are classed as articulated trucks. Overall, this means that trucks in the north-east are smaller than those in the west.

Figure 69 Truck sizes



6.1.5 Demand and freight volumes

The Eastern Freeway is a key freight route that provides connections between EastLink and industrial areas in the east (Bayswater, Mitcham and Scoresby) to the M80 in the north. Freight from these areas seeking access to the north has few options other than using the Eastern Freeway to access secondary road connections to destinations in the northern suburbs or regional and interstate. The alternative is a longer journey through the city zone with potential additional delays and costs impacting business efficiency and returns.

Freight from the south east also uses the EastLink and Eastern Freeway connections to the north, depending on destination and assessment of alternative routes and travel times. This includes horticultural products from the south-eastern areas near Koo Wee Rup with a destination at the Melbourne Fruit and Vegetable Market and Woolworths retail distribution linking to the northern suburbs and regional areas.

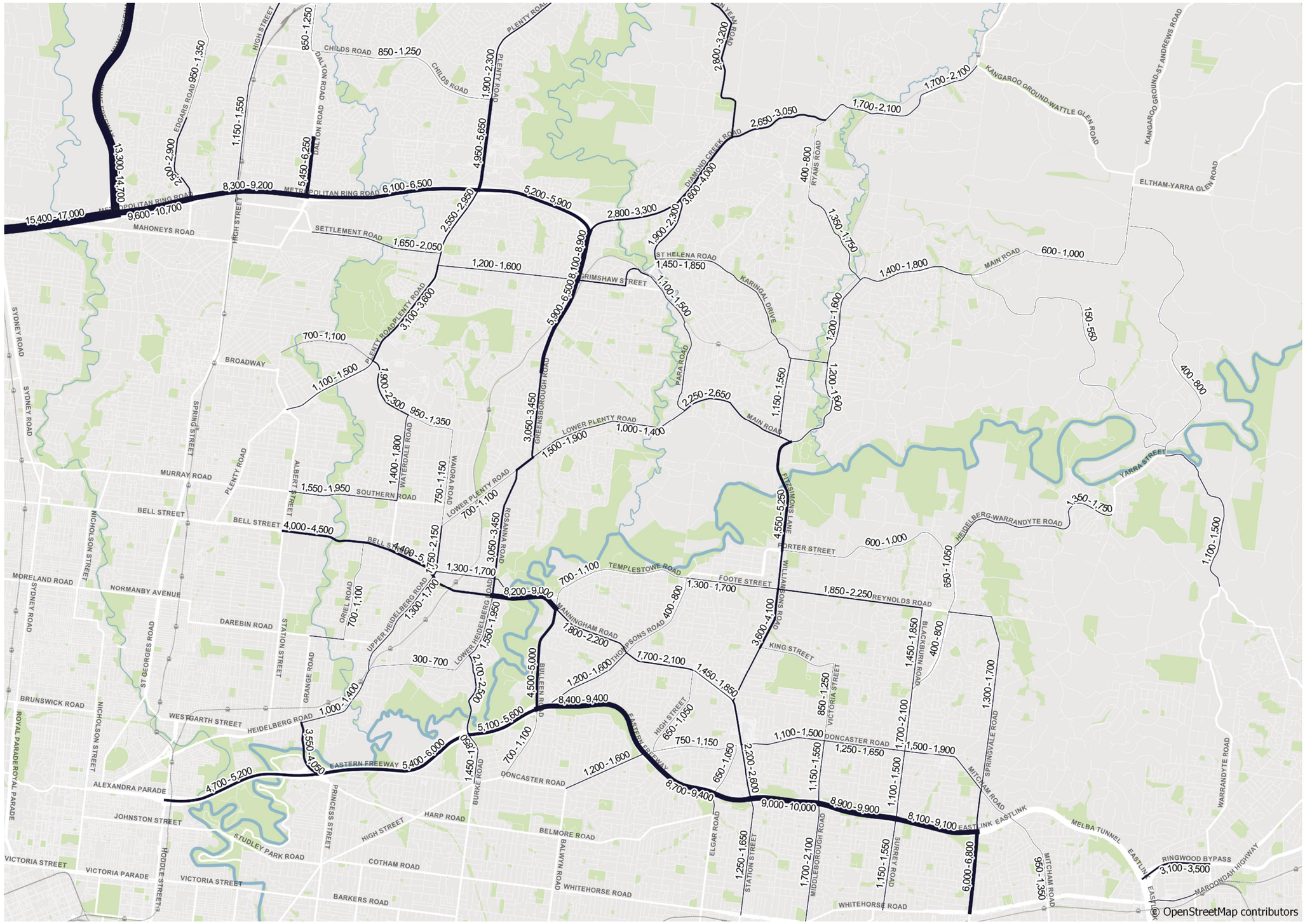
The typical truck volumes for each road section (midblock) on the Eastern Freeway is presented in Table 13. The midblock with the highest number of truck of volumes is between Middleborough Road and Tram Road, with up to 10,000 trucks per day.

Table 13 Daily truck volumes on the Eastern Freeway

Eastern Freeway section	Daily two-way volume
Between Springvale Rd and Blackburn Rd	8,100 - 9,100
Between Blackburn Rd and Middleborough Rd	8,900 - 9,900
Between Middleborough Rd and Tram Rd	9,000 - 10,000
Between Tram Rd and Elgar Rd	8,100 - 9,000
Between Elgar Rd and Doncaster Rd	8,700 - 9,400
Between Doncaster Rd and Bulleen Rd	8,400 - 9,400
Between Bulleen Rd and Burke Rd	5,100 - 5,600
Between Burke Rd and Chandler Hwy	5,400 - 6,000
Between Chandler Hwy and Hoddle St	4,700 - 5,200

The trend of northbound trucks accessing the Eastern Freeway from EastLink, Springvale Road interchange or Blackburn Road interchange is further highlighted in Figure 70. Most heavy vehicles travelling westbound on the Eastern Freeway use the exit ramp on Bulleen Road, followed by the exit at Chandler Highway. A number of trucks also exist the freeway at Station Street and travel north via Manningham Road.

Figure 70 Truck volumes in the north east (2017 daily weekday volume)



The Bulleen Road exit on the Eastern Freeway provides the most efficient use of the secondary road network to reach the M80. The Chandler Highway link provides northerly access to the Preston retail and industrial precincts, Northland retail and a link to the M80.

Freight demand on the Bulleen Road northerly routes is quite broad with a mix of construction vehicles (truck and dog), interstate B-Double and semi-trailer traffic, retail distribution vehicles and general truck traffic. The links provide some challenges with limited width carriageways between Bulleen Road and Greensborough Bypass and some uneven surfaces through the Rosanna Road area, which increase risks in the peak periods with high traffic volumes and a mix of larger trucks and passenger vehicles.

The Chandler Highway access northbound links to Grange Road, with access over the rail corridor at Alphington. Connectivity is restricted through a number of 'T' intersections, which reduces the attractiveness of this route for heavy vehicles.

Other notable roads carrying trucks in the north-east include:

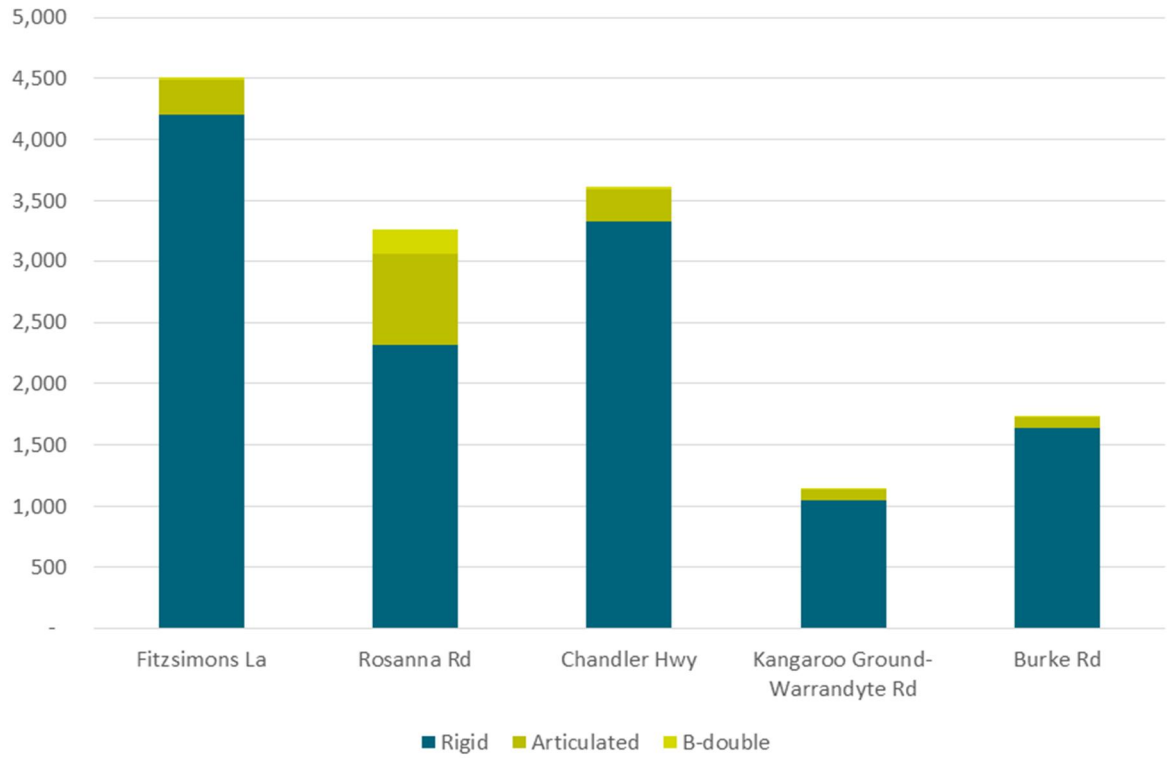
- Fitzsimons Lane - 4,550 to 5,250 trucks a day;
- Springvale Road - 6,000 to 6,800 trucks a day;
- Bulleen Road - 4,500 to 5,000 trucks a day;
- Rosanna Road - 3,050 to 3,450 trucks a day;
- Greensborough Road north of Grimshaw Street - 8,100 to 8,900 trucks a day; and
- Plenty Road at Darebin Creek - 3,100 to 3,600 trucks a day.

The topography and connectivity of the road network in the north east region influences the type of freight vehicles that use different roads. A summary of the types of trucks using key roads in the north east is provided in Figure 71.

While Fitzsimons Lane carries a large amount of freight vehicles each day, the bulk of these are smaller rigid trucks and not articulated trucks. This is due to the steep roads that connect to Fitzsimons Lane, particularly north of the Yarra River, which make this route unsuitable for larger vehicles.

Rosanna Road has less trucks per day than Fitzsimons Lane, however it carries significantly more articulated or B-double trucks due to its connectivity to the freeway network and more suitable grades for larger vehicles. Rosanna Road typically carries three times as many articulated trucks when compared to other key north-south roads within the north east region.

Figure 71 Truck type at key locations



6.2 Freight flows and orbital demand

Freight flows within the north eastern transport corridors are driven by a number of key nodes and freight corridors that are used to provide the most efficient connections between freight locations (nodes).

The existing industrial precincts, highlighted previously, form the key origins and destinations for much of the freight within the north east transport corridors. These include transport and logistics activities such as:

- The Melbourne Metropolitan Fruit and Vegetable Market;
- Coles and Woolworths retail Distribution centres in the north of Melbourne in the Hume/Somerton areas
- The Hume freeway access to and from regional areas and Sydney/Brisbane
- Distribution centres to the east and south east of Melbourne including Woolworths, Waverley and proposed Lyndhurst DCs and Bunnings
- Melbourne Airport Industrial precinct (including major parcel, internet sales distribution centres and horticulture goods).

Woolworths and Coles operate approximately 230 stores (each) in Victoria. Woolworths distribution operates generally from the north and east/south east of Melbourne while Coles distribution centres are in the north and west of Melbourne. The cross-city orbital route provides direct access to northern stores, regional areas and its regional distribution centre near Wodonga, particularly for Woolworths.

There is a demand for orbital movements connecting the eastern and south eastern areas to the north including the Hume Highway. South eastern industrial precincts in the Dandenong area provide engineering and support services for many industries including mining and rural industry engineering needs. National truck manufacturers Kenworth and Paccar in Bayswater distribute products Australia-wide. Access to the Hume Highway provides a key link to these markets.

The automotive based manufacturers and distributors in the eastern, south eastern and northern industrial precincts have similar input needs and the provision of efficient movements for parts and services between these precincts. While these industries will be the subject of change in the short term, a number of caravan and domestic vehicle component manufactures remain in these areas, which may continue to service the local demand.

The freight (truck) flows between the east and northern suburbs along the Bulleen Road, Rosanna Road and Greensborough Bypass link to the M80 provide a solid addition to private vehicle traffic during peak periods (up to 10 percent of traffic), although many operators are using 'shoulder peak' and mid-peak periods to gain the most efficient operation along the secondary road routes. The commercial vehicle traffic flows are more focused during the morning and mid-peak periods, away from the curfew period overnight, although some use is made of the pre-curfew period for retail distribution when traffic volumes have reduced.

The use of orbital traffic routes is essential to the industrial, retail and logistics companies to the east and north of Melbourne to access key areas, services and markets. While other alternatives are available through the city for businesses further south, the flexibility of orbital options during peaks and restricted access periods provide key opportunities for efficiency now and in the future. The current traffic volumes during peak periods are negating some efficiency for commercial traffic, while longer journeys on alternative routes remain unviable.

6.3 Truck curfews

A truck curfew trial is currently in place across several roads in the north-eastern suburbs to reduce truck traffic through the area at night and potential impacts on the community. VicRoads introduced a curfew trial during 2015 followed by adjusted parameters for the restrictions. The curfews initially restricted vehicles in excess of 4.5 tonnes from access to the area at night; however, adjustments have now been made to limit trucks in excess of 16.5 tonnes from the area between the hours of 10:00 pm and 6:00am. The map in Figure 72 indicates the roads where restrictions apply.

Figure 72 Current north eastern suburban truck curfew locations

Source: VicRoads.vic.gov.au

The curfews restrict access across the following roads:

- Greensborough Bypass – Rosanna Road (Grimshaw Street to Banksia Street)
- Lower Plenty Road (Greensborough Road to Waiora Road)
- Waiora Road (Kingsbury Drive to Bell Street)
- Waterdale Road (Kingsbury Drive to Bell Street)
- Lower Plenty Road – Main Road (Wattletree Road to Greensborough Road)
- Para Road (Grimshaw Street – Lower Plenty Road)
- St. Helena Road – Karingal Drive
- Bolton Street
- Ryans Road - Wattletree Road.

The curfews restrict the use of the Fitzsimons Lane access across the Yarra River and require a longer route to access river crossings at Banksia Street and Burke Road. Trucks making local deliveries within the curfew area are exempt from the restrictions.

These curfews reduce the number of Yarra River crossings available to heavy vehicles during the curfew period, effectively closing the Fitzsimons Lane and Banksia Street crossings to north-south heavy vehicle traffic. Heavy vehicles are unlikely to travel further east to use the Kangaroo Ground – Warrandyte Road crossing and therefore either head west towards CityLink via Bell Street or use the M1 corridor and travel through the city.

6.4 Lack of HPFV network

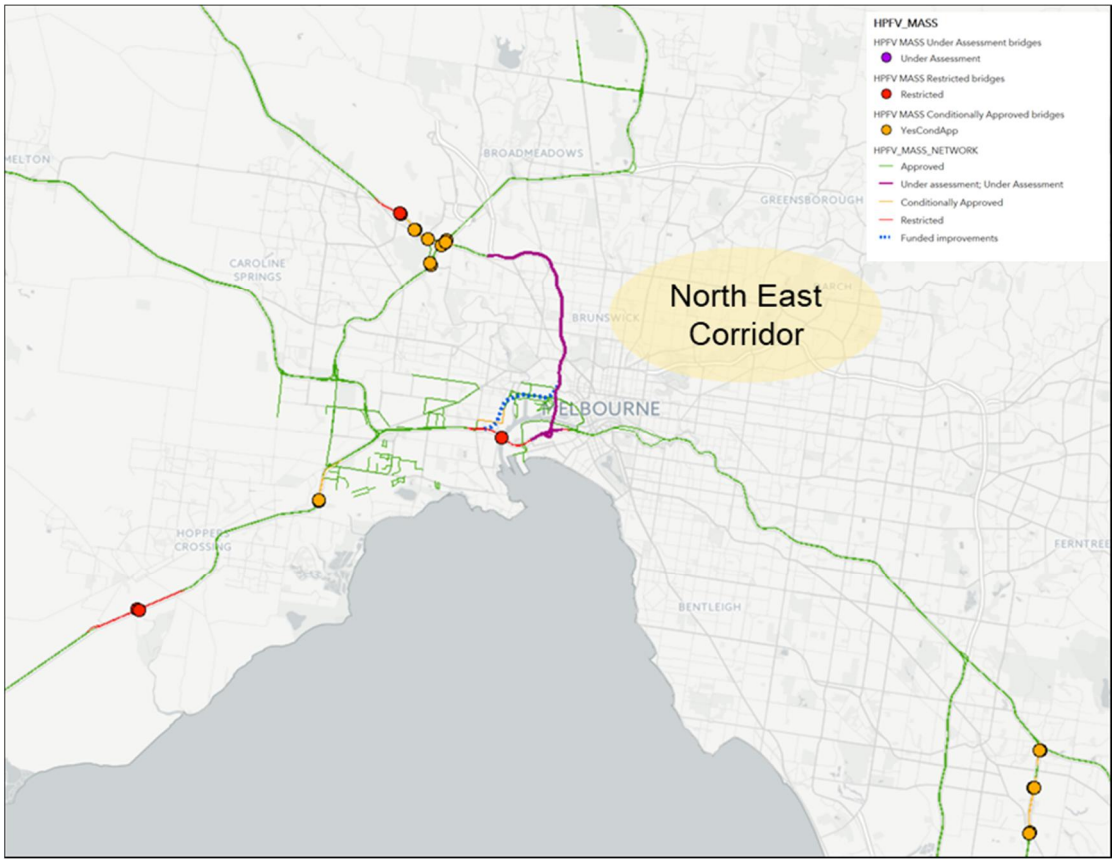
High Productivity Freight Vehicles (HPFV) allow operators to move increased volume and mass on approved routes by using larger, safer and more productive trucks. HPFVs help to alleviate pressure on the infrastructure network and give operators more flexibility to select the most suitable vehicle configuration to transport goods efficiently.

Currently, there is a lack of HPFV access along the north east corridor, unless operators take a longer diverted route through Melbourne's CBD. The HPFV network is presented in Figure 73. The road network within the north east is not suited to heavy vehicles, with weight limits along the Eastern Freeway and curfews on arterial roads.

As the north east corridor plays an integral role in facilitating interstate line haul from and to the south east region, the lack of HPFV access creates multiple issues and implications:

- More vehicles are required to complete large interstate transfers
- Cost to serve for industries located in the south east may be higher than counterparts in the west.

Figure 73 Melbourne HPFV network



Source: VicRoads.vic.gov.au

6.5 Somerton and the northern freight precinct

The Somerton and northern suburbs freight precincts have been the subject of progressive development aligned to both the general development of the area (providing employment for local communities) and the development of new industrial land.

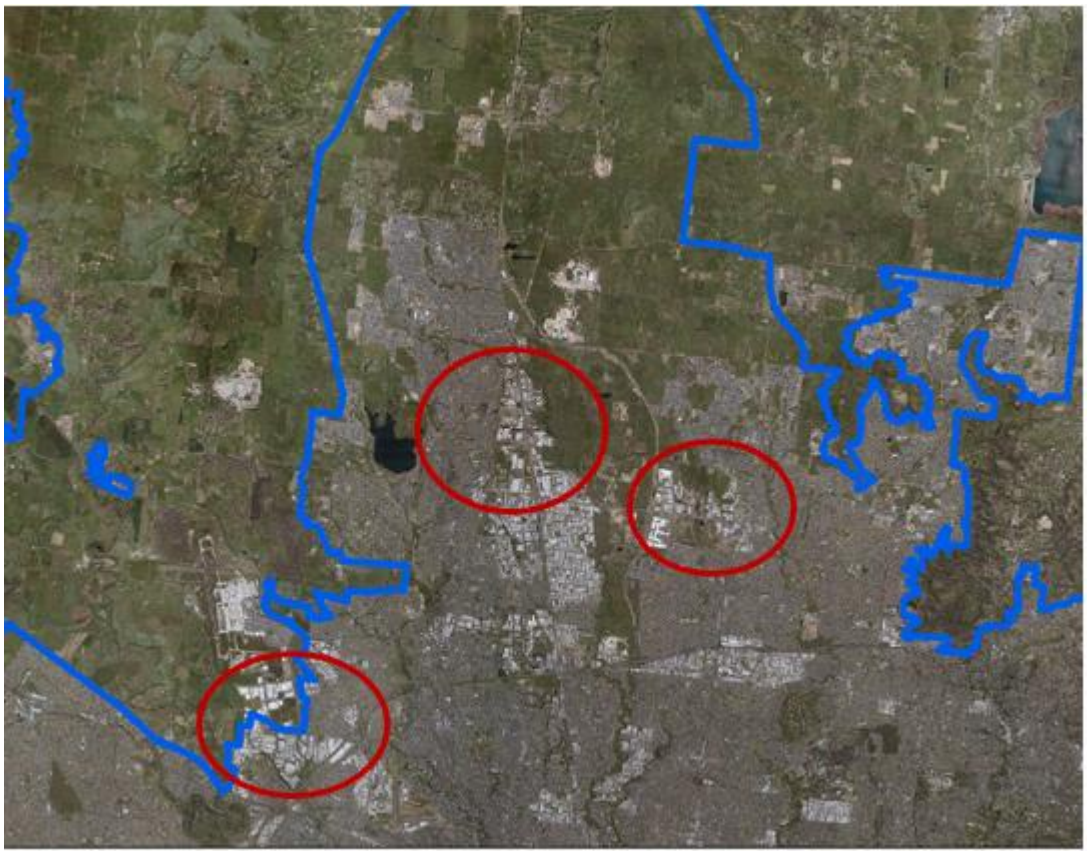
The Coolaroo and Somerton precincts have become progressively more dense, incorporating a solid base of automotive- and truck-related industries in and around the Ford facility and other automotive manufacturers and suppliers. As with many industrial precincts, an increase in logistics-based facilities has developed in the area including a key logistics-based development north of Somerton Road with direct access to a rail terminal and Sydney Road. This development is planned to take advantage of further rail- and road-based distribution of containerised products in the area and includes a Coles distribution centre and other warehouses on the site that generate significant traffic seeking access to broader networks.

Further south within the Campbellfield area, a Woolworths distribution centre provides similar traffic outputs within a high density industrial precinct. As these older precincts densify, new precincts are developing in Epping and around the Melbourne Fruit and Vegetable and Flower Market, and in and around the Melbourne Airport industrial precinct

Aerial photography for the area from 2009 to 2017 indicates a greater density of industrial development in the northern sections of the Somerton and Coolaroo precincts and new developments in the Epping and airport industrial areas. This change in development is presented in Figure 74 and Figure 75.

Figure 74 Aerial view of the northern precincts 2009 (urban development boundary shown in blue)

Figure 75 Aerial view of Northern Industrial areas 2017 (key growth areas indicated)



These developments are placing further pressure on local and surrounding road networks, including significant impacts in the Sydney Road area.

Traffic volumes taken from VicRoads data and local traffic counts indicate that commercial vehicle traffic in the Sydney Road area is approaching the levels on the M80, with commercial vehicle movements off Sydney Road and the Hume Freeway along the Somerton Road/Cooper Street corridor around the Melbourne Fruit and Vegetable Market also impacting the area. The Melbourne Fruit and Vegetable Market also generates average entries of 2,700 vehicles per day[17] (approximately 5,400 trips) of which the majority are commercial operators.

Future planning for the northern industrial precincts include significant growth in the area, as indicated in Figure 76 and Figure 77 showing 2015 and 2040 planned land use. Industrial areas are indicated in brown and the Urban Growth Boundary in blue.

This growth, coupled with residential development, will create increased traffic volumes and the need for flexibility within local networks to manage competing travel and freight demands.

[17] Melbourne Market Authority 2015/16 Annual report.

Figure 76 Northern precincts land use 2015

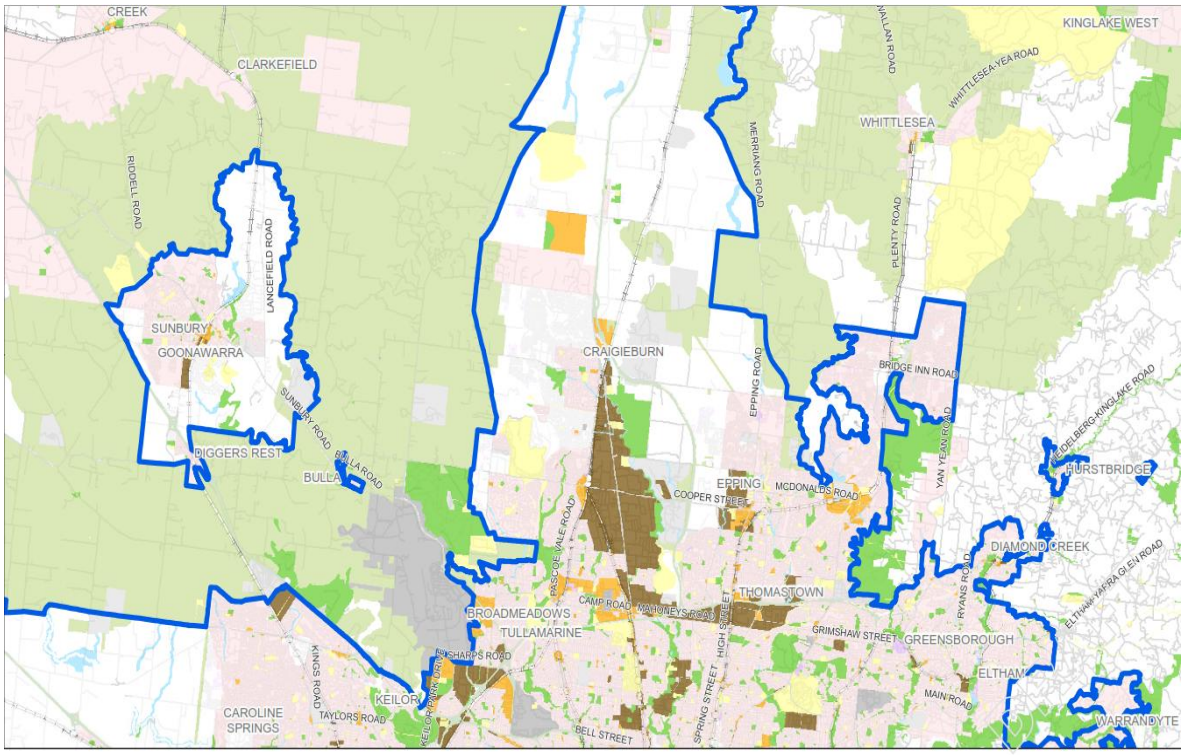
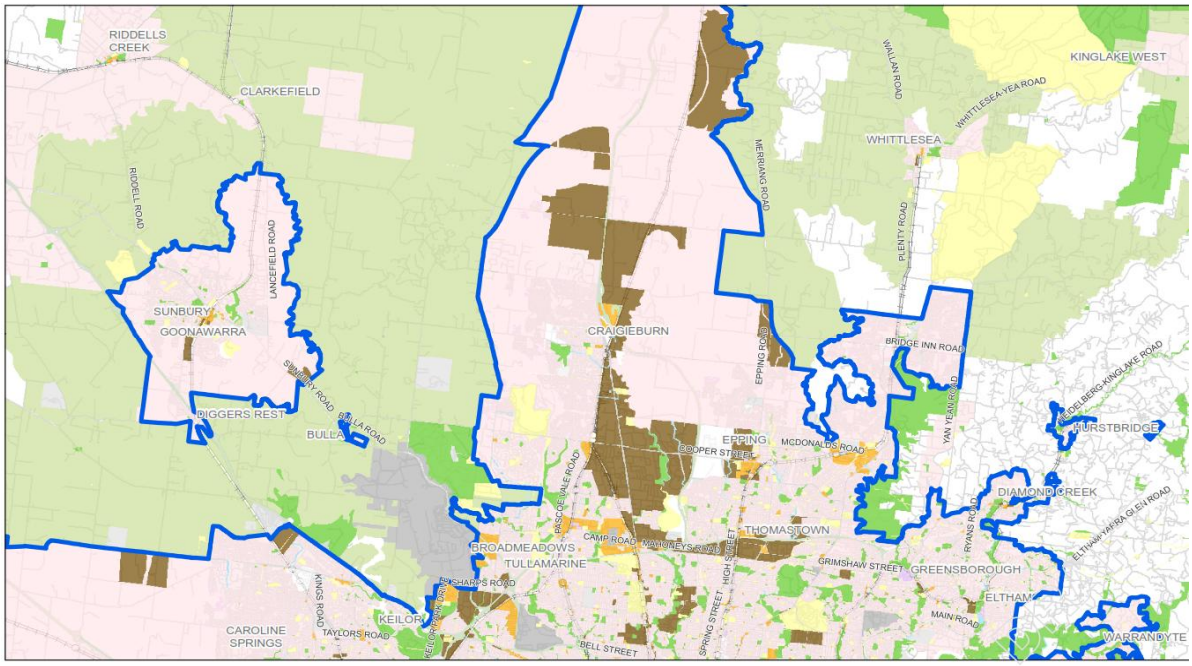


Figure 77 Future northern precincts planned land use 2040



6.6 Placarded loads in the north-east

Australia uses a system of classification and labelling for dangerous goods (HAZMAT) based on the United Nations system. Except for very small quantities, all packages, shipping containers, unit loads and tankers that hold dangerous goods for transport must display the class label. Substances are assigned to one of nine classes, each of which has its own diamond-shaped label that must be displayed when the vehicle is on the road. These classes include explosives, gases and flammable liquids. Placarded goods can be transported on a range of vehicles and are not restricted to trucks; however, trucks are typically used due to the size and weight of goods being transported.

Current Victorian laws ban placarded loads of dangerous goods from travel in the CityLink and EastLink tunnels.

The movement of placarded freight vehicles between the north and east of Melbourne is limited within the current network at the EastLink tunnels where placarded loads are prohibited from entry. Placarded vehicles can bypass the constraint via alternate routes between EastLink and the Eastern Freeway using Canterbury Road or Maroondah Highway and Springvale Road.

A significant percentage of placarded loads are fuel tankers, which are based within the Yarraville and Newport area and are sourcing fuels via local pipelines and import connections from Holden Dock at the Port of Melbourne. Distribution from this area to the north and east tends to be on separate direct routes along the M80 or the Eastern Freeway and then using arterial roads to access destinations.

Surveys were performed in May 2017 to assess the percentage of placarded vehicles using key arterial routes. Fitzsimons Lane, Plenty Road and Lower Plenty Road were all surveyed for four hours between 10am and 2pm, which is typically the peak truck operating period as it is outside of the commuter and school peaks. The results of the surveys are presented in Table 14.

Table 14 Placarded vehicle numbers 10am-2pm

Road	Total observed truck volume	Number of placarded vehicles	Percentage placarded vehicles
Fitzsimons Lane at Yarra River	518	3	0.5%
Plenty Road at Darebin Creek	266	4	1.5%
Lower Plenty Road at Rosanna Road	1,092	14	1.3%
Total	1,876	21	1.1%

As presented in Table 14, 1,876 trucks were observed within the four-hour survey period with just over one percent of those (21 trucks) being placarded vehicles. This volume of placarded vehicles is very low and is mainly due to the lack of fuel terminals located in the north east of Melbourne. The placarded vehicles recorded are unlikely to be through vehicles; rather, they are likely to be serving petrol stations or local destinations within the north east.

Additionally, based on truck classification surveys, 127 tankers were observed at 12 locations during a 24-hour period out of 8,994 trucks, which represents 1.4 percent of all trucks in the north east.

7 Public Transport

7.1 Overview of public transport network

Metropolitan train services cover much of the north west and southern portions of the study area. The Hurstbridge line travels through the north east and the Lilydale line through the eastern area. Spatially, there is a five to 20-kilometre gap between these two lines moving outward from the city, leaving the centre of the study area unserved by metropolitan trains.

Tram lines are clustered in the western edge of the study area as they proceed radially from the CBD. Tram route 86 to Bundoora RMIT, route 48 to North Balwyn and 109 to Box Hill are the key routes that operate within the study area.

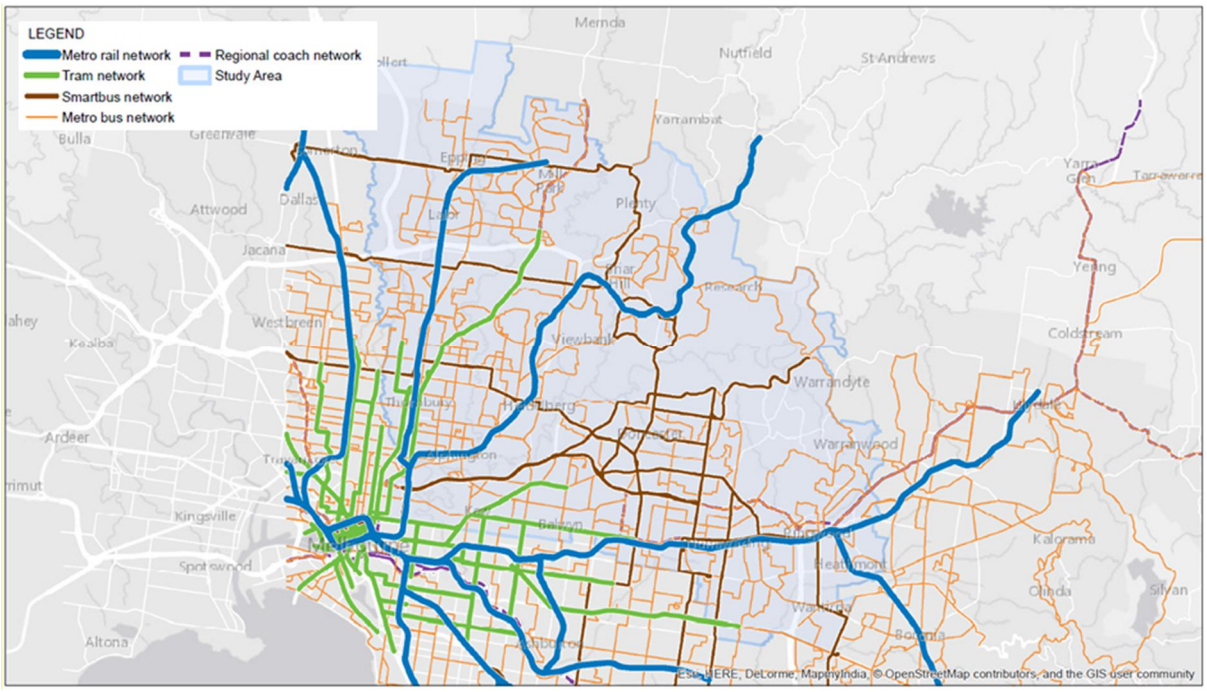
Bus routes have the greatest coverage of the study area and consist of radial, orbital and cross-town services. This coverage reduces somewhat due to the limited road network around areas such as Warrandyte. DART (Doncaster Area Rapid Transport) bus services provide four major arterial bus routes operating at high frequency throughout the day, connecting the eastern suburbs to the CBD. The DART bus operates along the Eastern Freeway, running in the emergency lane and having priority over general traffic. Other bus route such 303, 305 and 309 also use the Eastern Freeway corridor between Hoddle Street and Doncaster Road.

SmartBus orbital routes operate within and access the study area. These high frequency services provide a cross-town service that connects activity centres and train lines, rather than servicing the CBD.

Train and tram services operate unimpeded as they travel within their own separated corridors through the study area. However, bus services are often impacted by general congestion on the road network due to a limited provision of bus lanes and the need to share road space with general traffic. This creates travel time variability that can impact decisions to use the service by patrons.

The routes for all types of public transport are presented in Figure 78. It shows that the bulk of the public transport network is radial and is designed to connect the outer suburbs to the CBD. Some SmartBus services provide an orbital coverage with a high frequency throughout the day. No trams or trains provide an orbital service.

Figure 78 Public transport routes



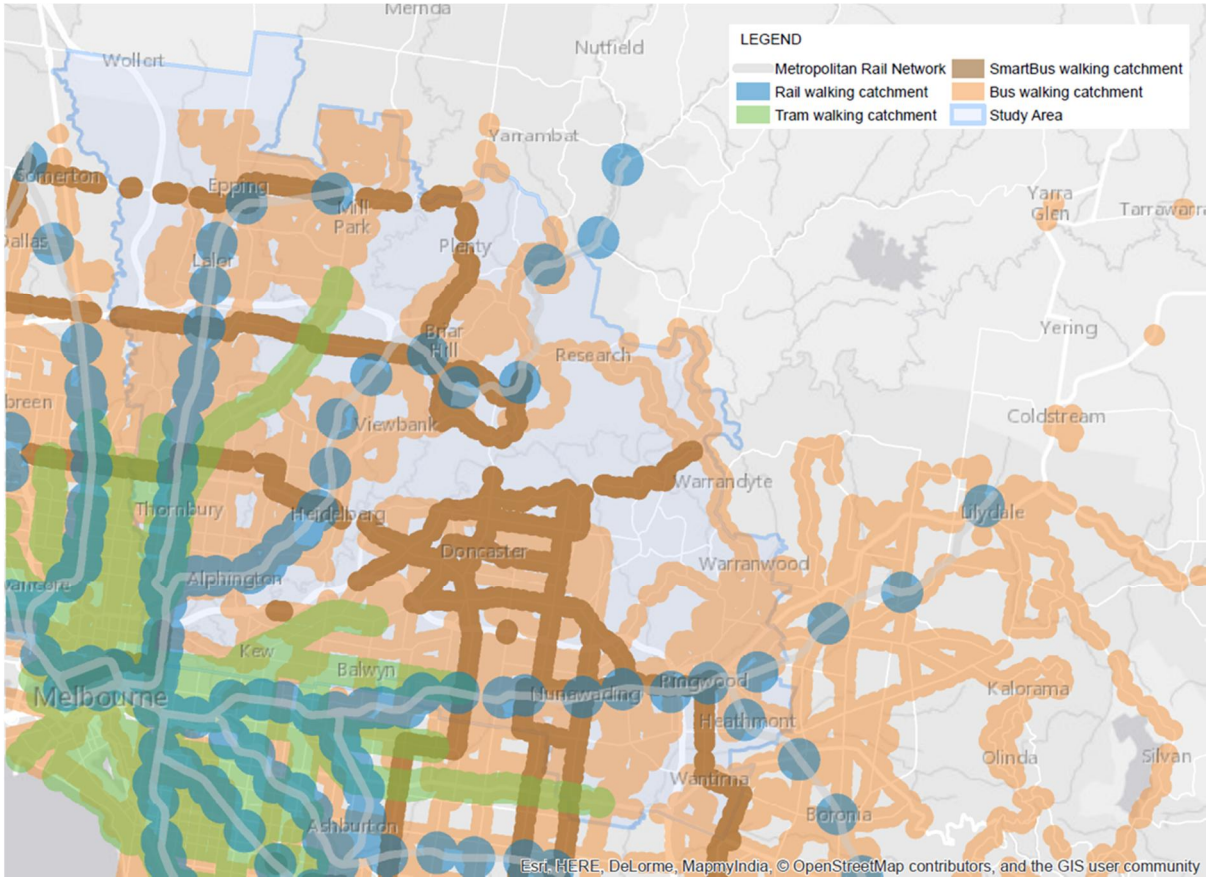
7.2 Demand and use

The public transport coverage across the north-east study area is generally good, as presented in Figure 79. The bulk of the study area is covered by at least one mode of public transport, except for the area surrounding the Yarra River, which is a 'green wedge' and without much residential development.

However, while the coverage is good, the service type and frequency may not meet the needs of passengers. As presented in Figure 20, the study area has a public transport mode share of 14 percent compared to 19 percent for all of Melbourne, even though the coverage is generally good. This could be because most of the coverage comes from bus services and these services typically run on-road, sharing space with general traffic. As discussed previously, there are high levels of congestion across most of the road network and this congestion impacts the performance of on-road bus services.

Bus service frequency is also an issue. Premium services such as the DART and SmartBus services have a frequency of 10 to 15 minutes throughout the day. However, other more local bus services have a frequency of 20 to 30 minutes. This reduced frequency and buses travelling along congested roads may be part of the reason for the low mode share of public transport within the study area.

Figure 79 Public transport coverage

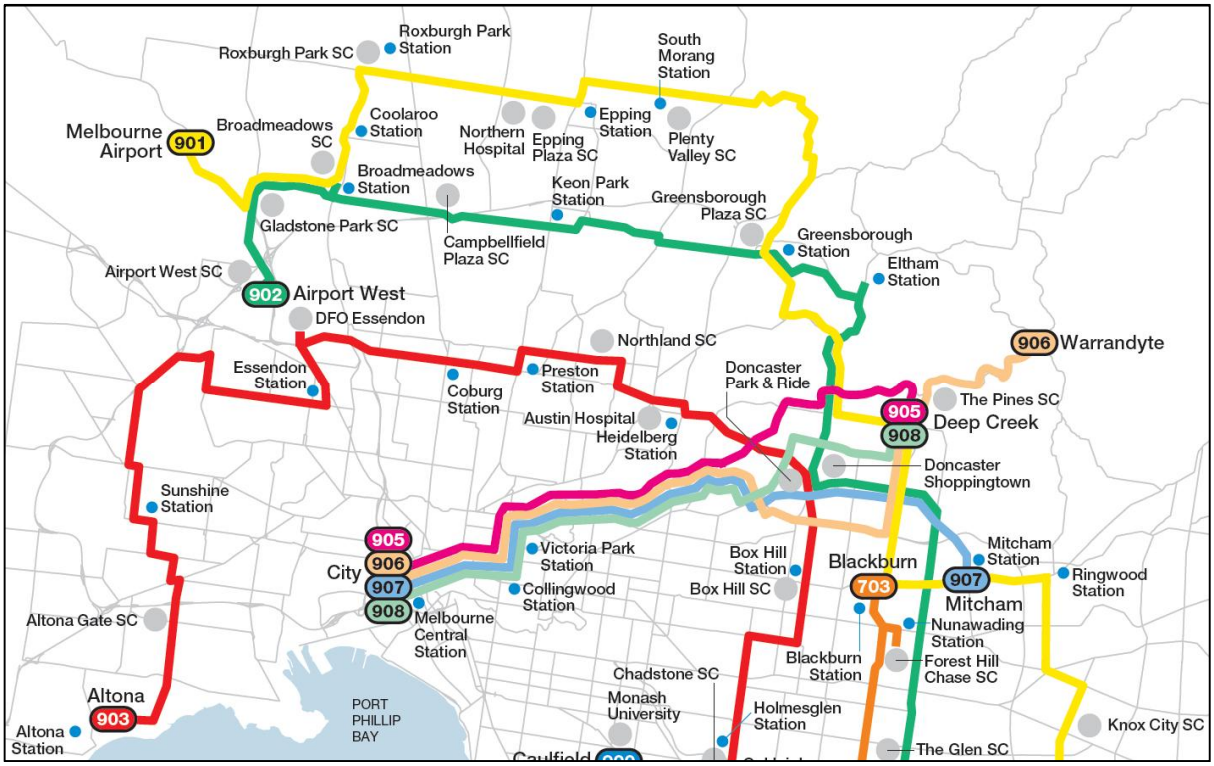


7.3 SmartBus

SmartBus is a high frequency service providing a cross town and orbital service around Melbourne. Key aspects of SmartBus are extended timetables, real time information at bus stops and priority at signalised intersections.

A number of SmartBus routes travel through the study area. These include routes 901, 902 and 903. Additional SmartBus services also run through the area, however these are referred to as the DART bus routes (905, 906, 907 and 908). The SmartBus routes are presented in Figure 80.

Figure 80 SmartBus routes



7.3.1 Route 901

Route 901 is a SmartBus service that travels between Frankston and Melbourne Airport via the study area.

Its route includes a significant stretch of bus-only lanes along Stud Road near the Knox City and Stud Park shopping centres. However, bus lanes are not present along most of the route and at some critically congested intersections.

The peak frequency for this service ranges from 10 to 14 minutes from approximately 8:30 am to 10:00 am, with consistent 15-minute service during off-peak periods. The service operates at 30-minute headways on Saturdays and Sundays.

Travel time exhibits a modest degree of variation based upon traffic and loading conditions, with timetabled journey times that range from 107 to 115 minutes between Epping Plaza shopping centre and Stud Park shopping centre. This variation is partly tempered by the long-range nature of the routes, meaning that many trips span the peak and non-peak periods. As an orbital route, there is also less of a consistent commuting pattern (as opposed to radial routes) and a high degree of connectivity to shopping destinations that exhibit mid-day and weekend peak traffic patterns.

Average weekday patronage was approximately 14,000 passengers per day (including all passengers on any portion of the route) according to PTV data available for 2016.

7.3.2 Route 902

Route 902 is a SmartBus service that travels between Chelsea and Airport West via the study area.

Its route includes a significant stretch of bus-only lanes along Doncaster Road in the City of Manningham. However, bus lanes are not present along most of the route and at some critically congested intersections.

Peak frequencies are scheduled at approximately every 15 minutes at the route's endpoints, but vary from 10 to 19 minutes within the interior section of the route (i.e. through the study area) due to variations in running times throughout the day. The service operates at 30-minute headways on Saturdays and Sundays.

Travel time exhibits a modest degree of variation based upon traffic and loading conditions, with timetabled journey times that range from 101 to 117 minutes between Campbellfield Plaza shopping centre and Glen Waverley Station. As an orbital route, there is less of a consistent commuting pattern in comparison with radial routes and a high degree of connectivity to shopping destinations that exhibit less clearly defined directional traffic peaks.

Average weekday patronage was approximately 14,000 passengers per day (including all passengers on any portion of the route) according to PTV data available for 2016.

7.3.3 Route 903

Route 903 is a SmartBus service that travels between Altona and Mordialloc via the study area.

Its route includes small sections of bus-only lanes throughout its running length but no consistently long stretches like those on routes 901 and 902.

Peak frequencies are scheduled at approximately every eight minutes between Mentone Station and Heidelberg Station and approximately 12 minutes for the wider length of the route, with consistent 15-minute service during the weekday off-peak periods. Saturday headways vary from 10 to 20 minutes between Mordialloc and Box Hill and from 20 to 30 minutes for the remainder of the route. The service operates at consistent 30-minute headways on Sundays.

Travel time exhibits a modest degree of variation based upon traffic and loading conditions, with timetabled journey times that range from 113 to 122 minutes between Chadstone shopping centre and Essendon Station. As an orbital route, there is less of a consistent commuting pattern in comparison with radial routes and a high degree of connectivity to shopping destinations that exhibit less clearly defined directional traffic peaks.

Average weekday patronage was approximately 18,000 passengers per day (including all passengers on any portion of the route) according to PTV data available for 2016.

7.4 Doncaster Area Rapid Transit

The Doncaster Area Rapid Transit (DART) is a series of SmartBus services focused on providing high frequency service within Manningham, as well as between Manningham and the city. DART bus routes are routes 905, 906, 907 and 908.

The DART services were created from the modification of existing bus services to better service the city of Manningham, by providing a wider coverage of direct north-south and east-west connections and a faster route into the city. Because of the lack of train services in the wider Doncaster area, the DART routes are consistently one of Melbourne's busiest bus routes.

7.4.1 The DART network

The DART services all have a western terminus on Lonsdale Street near King Street within the CBD. However, each route provides different connectivity through the eastern suburbs, as presented in Figure 81. The terminus locations for all of the DART routes are:

- Route 905 - The Pines Shopping Centre (via Thompsons Road and Warrandyte Road);
- Route 906 – Warrandyte (via Blackburn Road);
- Route 907 - Mitcham Station (via Doncaster Road); and
- Route 908 - The Pines Shopping Centre (via High Street and King Street).

All four bus routes travel along the Eastern Freeway before exiting onto Hoddle Street, Victoria Parade and Lonsdale Street.

Figure 81 DART bus routes

7.4.2 Boardings

Daily patronage numbers at individual stops on the DART network within Manningham are presented in Figure 82. It shows that there are key locations where people are boarding the bus network such as the Doncaster Park & Ride and the Pines Shopping Centre.

Daily boarding figures at Mitcham Station are in excess of 400 passengers. While it is not possible to determine where these passengers are heading to, it is likely that they are travelling to employment in the vicinity of Doncaster Hill.

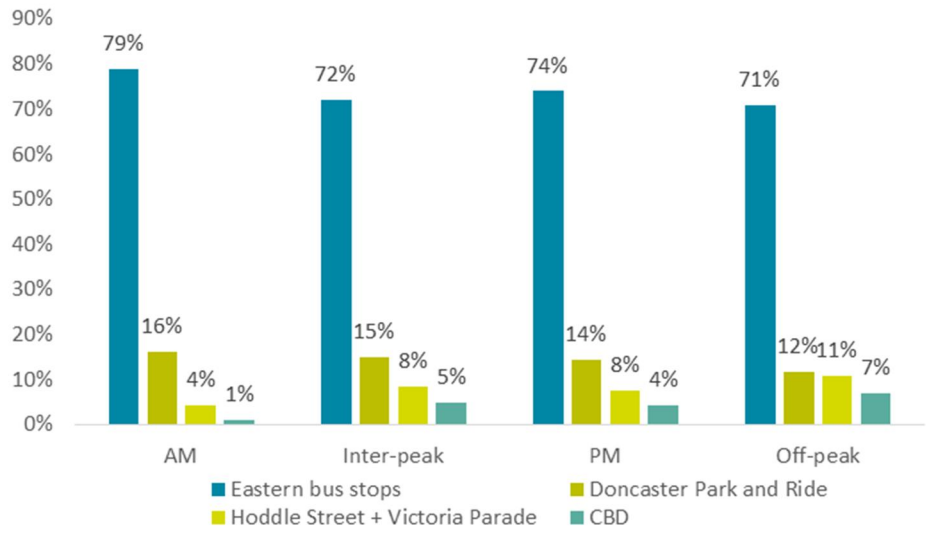
Daily patronage for each of the routes for 2016 is as follows:

- Route 905 – 4,000
- Route 906 – 5,000
- Route 907 – 6,000
- Route 908 – 3,000.

Figure 82 Daily DART boardings (within Manningham)

The origins of citybound (westbound) passengers are roughly consistent throughout the day, as presented in Figure 83. Ten to 15 percent of all citybound passengers typically board from the Doncaster Park & Ride stop.

Figure 83 Westbound DART boardings location by time of day



An assessment of eastbound boardings highlights the fact that a high proportion of users travel between the CBD stops and the east, as presented in Figure 84. A high proportion of people, especially during the PM and off-peak periods board the DART services in the city. The moderate proportion of people boarding at 'eastern bus stops' (all bus stops north/east of the eastern freeway) shows that there are a number of people using the service to travel within Manningham and not between the eastern suburbs and the CBD.

Figure 84 Eastbound DART boardings location by time of day

7.4.3 The Doncaster Park & Ride

The Doncaster Park & Ride facility is located on Doncaster Road, on the northern edge of the Eastern Freeway. It provides 400 car parking spaces and is serviced by ten different bus routes including the 907 and 908 DART services. Typical travel time to the CBD is approximately 40 minutes, with the greatest delays occurring along Hoddle Street and Victoria Parade.

The facility is highly used and is often full prior to 7:00 am. There are also high numbers of queuing passengers waiting to board buses due to crowding on these buses, meaning that passengers may have to wait for multiple buses before they are able to board.

7.4.4 DART bottlenecks

The DART bus services have a relatively high patronage compared to other bus services, with approximately 18,000 daily boardings across the four routes. However, elements of the services may be limiting the number of passengers using them.

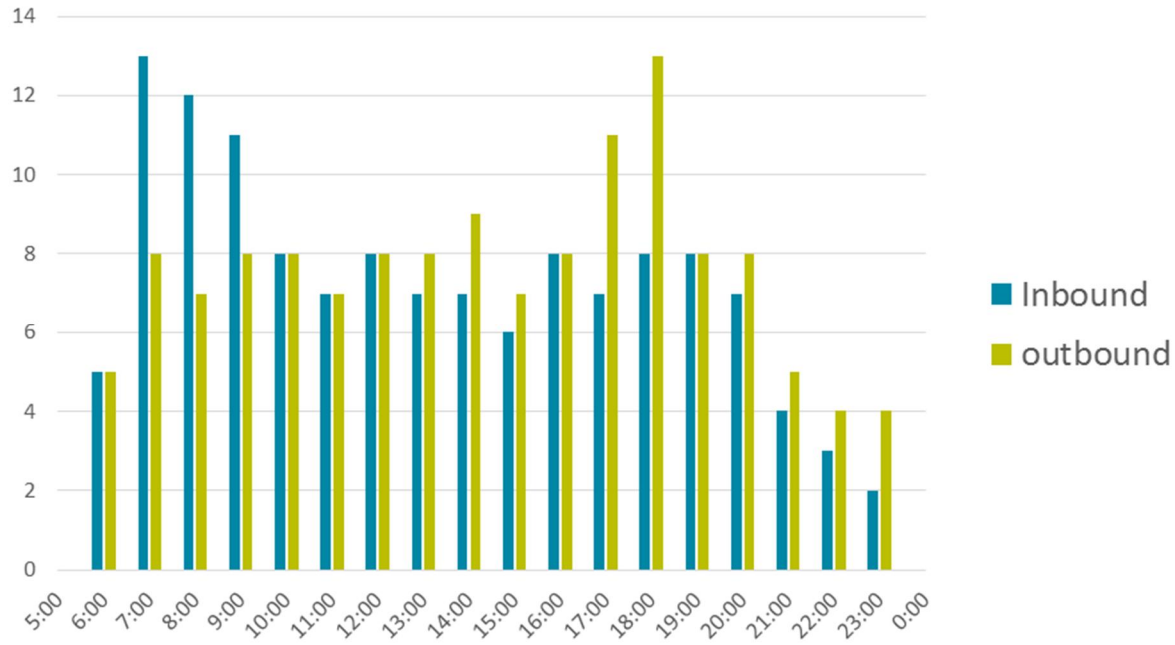
7.4.4.1 Service frequency

Service frequency is generally high, with headways of six minutes in the peak periods, However, overcrowding on the bus services during these periods means that passengers may need to wait for multiple buses before they are able to board.

Additional services run during the morning and evening peak periods, with up to 13 buses travelling through the Park & Ride in the morning and evening peaks, compared to approximately eight services an hour during the rest of the day.

The number of services passing through the Doncaster Park & Ride facility each hour is presented in Figure 85.

Figure 85 DART number of services at the Doncaster Park & Ride (route 907 and 908)



7.4.4.2 Bus capacity

The DART buses operate at capacity during the peak periods, with high numbers of passengers standing for the 40-minute trip to the terminus in the CBD from Doncaster Park & Ride. Passengers who cannot board the bus due to overcrowding are required to wait for the next service, which can also be resulting in long delays.

7.4.4.3 Park and ride capacity

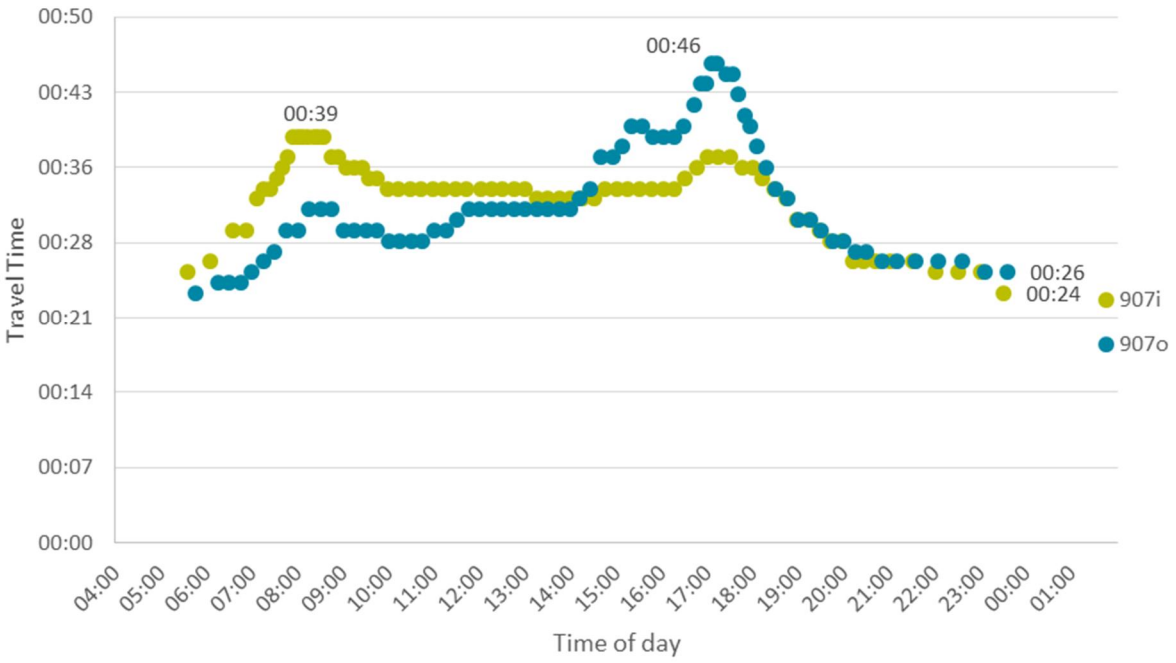
The Doncaster Park & Ride is often full by 7:00 am on weekdays, requiring passengers to park in adjacent roads, sometimes up to one kilometre away.

7.4.4.4 Congestion

The 12-kilometre trip from the Doncaster Park & Ride to Hoddle Street takes approximately 12 minutes in the peak period. However, the 4.6-kilometre trip from Hoddle Street to the terminus at King Street takes 22 minutes. This highlights the delays that are experienced due to the congestion along Hoddle Street and Victoria Parade.

The 907 citybound service is approximately 60 percent slower in the AM peak compared to off-peak periods, while the eastbound service is 75 percent slower. As presented in Figure 86, PM peak travel times are slower than the AM peak travel times.

Figure 86 Doncaster to City travel times from Doncaster Park & Ride



Note: 907i – citybound / westbound services. 907o – eastbound services

8 Walking and cycling

8.1 Overview of the active transport network

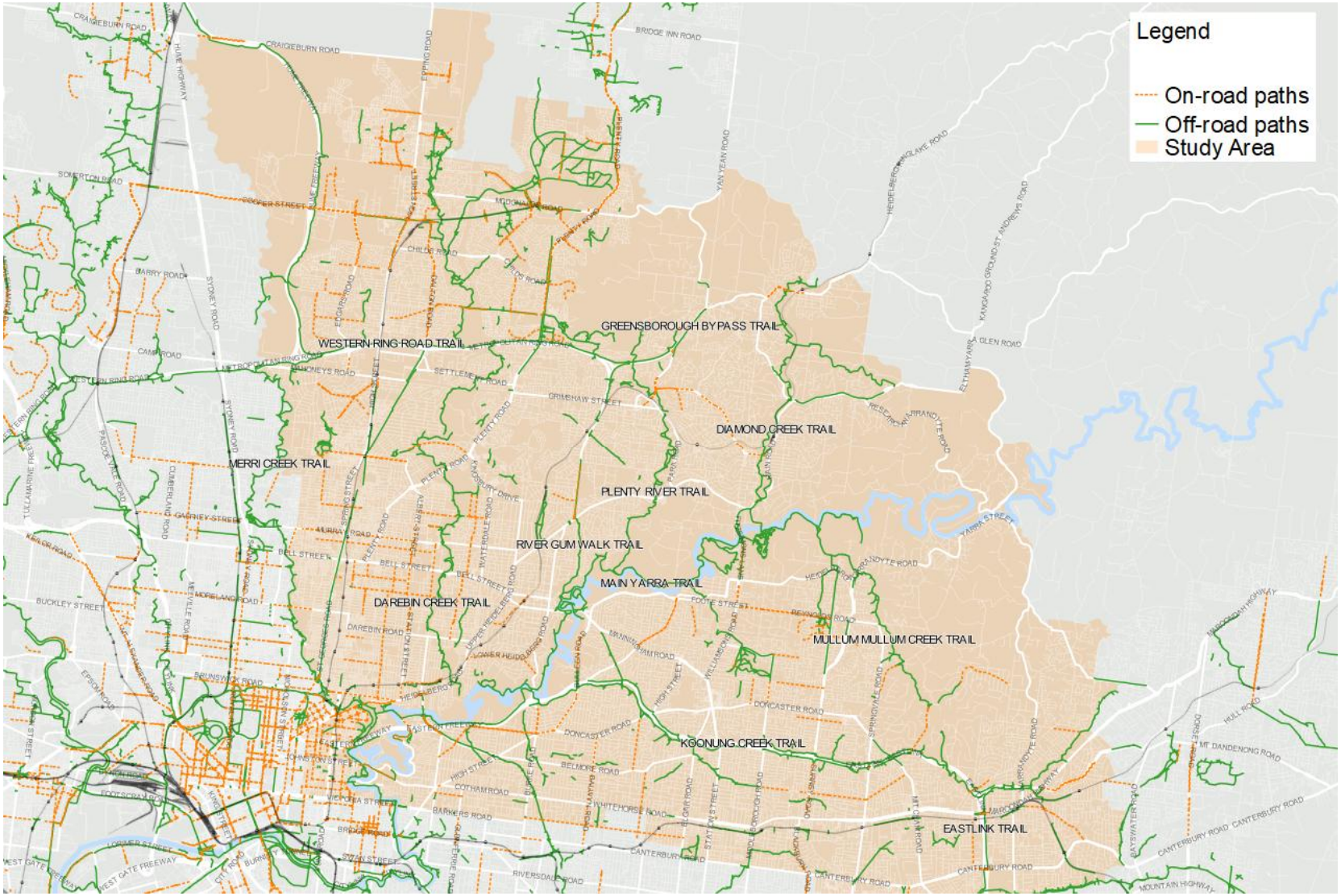
The north-east has an extensive network of walking and cycling shared use paths throughout the study area, generally running in parallel to creeks, rivers and freeways. With trails following Diamond Creek, Plenty River and Darebin Creek running north-south connecting to the Main Yarra Trail along the Yarra River, walkers and cyclists are able to move between Melbourne's CBD and the M80 or Greensborough completely off-road.

Due to most shared use paths following creek alignments, the walking and cycling network is geared towards recreational uses, rather than providing direct routes for local access or commuters.

The bicycle paths within the north east are presented in Figure 87. The key main trails highlighted in this figure are:

- The Main Yarra Trail – a shared user path that starts in Templestowe at the Mullum Mullum Creek and follows the Yarra River through the north-eastern suburbs;
- Plenty River Trail – a shared user path following the Plenty River through Greensborough and Lower Plenty;
- Diamond Creek Trail – a 12-kilometre-long shared user path linking Diamond Creek with the Main Yarra Trail. It starts at Nillumbik Park and joins the Main Yarra Trail in Candlebark Park;
- Darebin Creek Trail – a shared user path that runs from Ivanhoe to the M80 in Bundoora;
- Koonung Creek Trail – a shared user path running along the Eastern Freeway from Springvale Road to Burke Road, where it connects with the Main Yarra Trail; and
- EastLink trail – a 28-kilometre-long shared path that follows the EastLink toll way from Ringwood to Dandenong.

Figure 87 North-east walking and cycling trails and on-road paths



8.2 Cycling demand in the north-east

8.2.1 8.2.1 How many people cycle

The proportion of people cycling and walking to work is relatively low in the north east, with only 1.6 percent cycling and 0.4 percent walking to work each day. This is lower than the Melbourne average of 2.6 percent mode share for cycling and 2.7 percent mode share for walking. The low mode share can be attributed to a low population and development density, the prominence of single-use land use and low levels of walking and cycling accessibility.

Bicycle Network's Super Tuesday data provides an indication of where there are high concentrations of cycling activity within several councils in the north east:

- In Banyule, cycling activity is concentrated around the southern border of the Local Government Area, with the most cyclists observed around the Heidelberg and Ivanhoe activity centres. Ridership towards the northern end of the area (such as Greensborough) is generally low.
- Boroondara has the highest volume of cyclists observed over the two-hour period, with locations of note including the Koonung Creek Trail (Eastern Freeway), Gardiners Creek Trail in the south and Yarra Boulevard – the main route into the city from the eastern suburbs due to a missing cycling link west of Chandler Highway.
- Ridership in Nillumbik is generally low, due to its distance from the city, low population densities and relatively sparse bicycle network. Counts were conducted on the two main trails in the area – Diamond Creek Trail and the Greensborough Bypass Trail/Diamond Creek Road.
- Whitehorse has a very limited on and off-road bicycle network – reflected in the low ridership numbers in the Super Tuesday counts. The highest volumes were observed along the Koonung Creek Trail in the north of the Local Government Area.
- In Whittlesea, ridership is also fairly low, with the majority of cyclists observed on the off-road trail network along the M80, Hume Freeway and Cheddar Road.

8.3 Challenges and opportunities

8.3.1 20-minute neighbourhoods

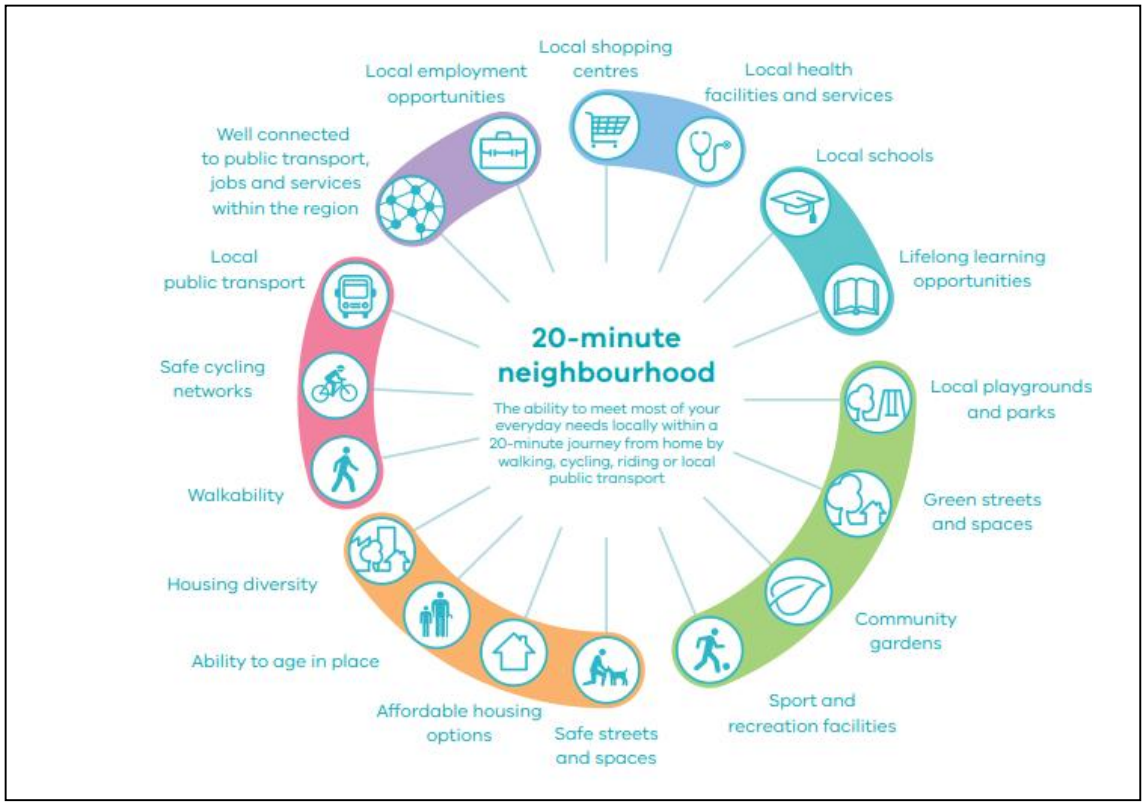
The concept of 20-minute neighbourhoods envelops the practice of 'living locally' whereby people can meet most of their daily needs within a 20-minute walk or by travelling faster by bicycle or public transport.

Within Plan Melbourne, 20-minute neighbourhoods are supported by further policy directions such as improving local travel options (Direction 3.3) and integrating place-making practices into road-space management (Policy 4.1.2). These directions acknowledge that local travel is different to journey-to-work travel and is based around accessing local services, shops and recreation and education (as presented in Figure 88). It also acknowledges that such travel occurs through the day and that it is important for all residents, regardless of age or ability, to be able to access local services.

The design of local streets plays a large role in enabling people to make more sustainable travel choices for local trips. This also aligns with VicRoads' Movement and Place approach, which is based upon principles relating to 'movement and place', to better engage with the community in considering how streets should perform their movement and place function. This assists in determining what types of movement should be prioritised in each location, and encourages greater interaction between people and places.

Another aspect of 20-minute neighbourhoods is locating schools and other facilities near existing public transport and providing safe walking and cycling routes and drop-off zones (Plan Melbourne Policy 3.3.4).

Figure 88 The 20-minute neighbourhood



Source: Department of Environment, Land, Water and Planning

The degree to which neighbourhoods in the north east support the 20-minute principle is determined by the:

- Intensity and distribution of land uses;
- Quality of walking, cycling and public transport connections;
- Character of the connecting street and path networks; and
- Level of barriers (real and perceived) to walking and cycling activity.

8.3.2 20-minute neighbourhoods in the north-east

An analysis of the 1.6km walking catchment around activity centres in Melbourne's north east is presented in Figure 89. It should be noted that the map only indicates the physical extents accessible within a 20-minute walk and does not necessarily mean the catchment areas display the characteristics of a 20 minute neighbourhood. That is, an area may be within a 1.6km walking catchment of an activity centre but if the amenity and walkability around the area is poor, then the area is not representative of the 20-minute neighbourhood concept, as it would not be attractive to walk to local services.

In general, the 20-minute neighbourhood concept is more readily matched to the more urbanised neighbourhoods in the southern and western portions of the study area than to the more diffuse development of the far north east, due to their more compact development patterns and finer-grained street and path networks. However, some of these neighbourhoods, particularly those located on or near main highways, have their 20-minute catchment areas disrupted by physical or psychological barriers to safe and comfortable walking and cycling.

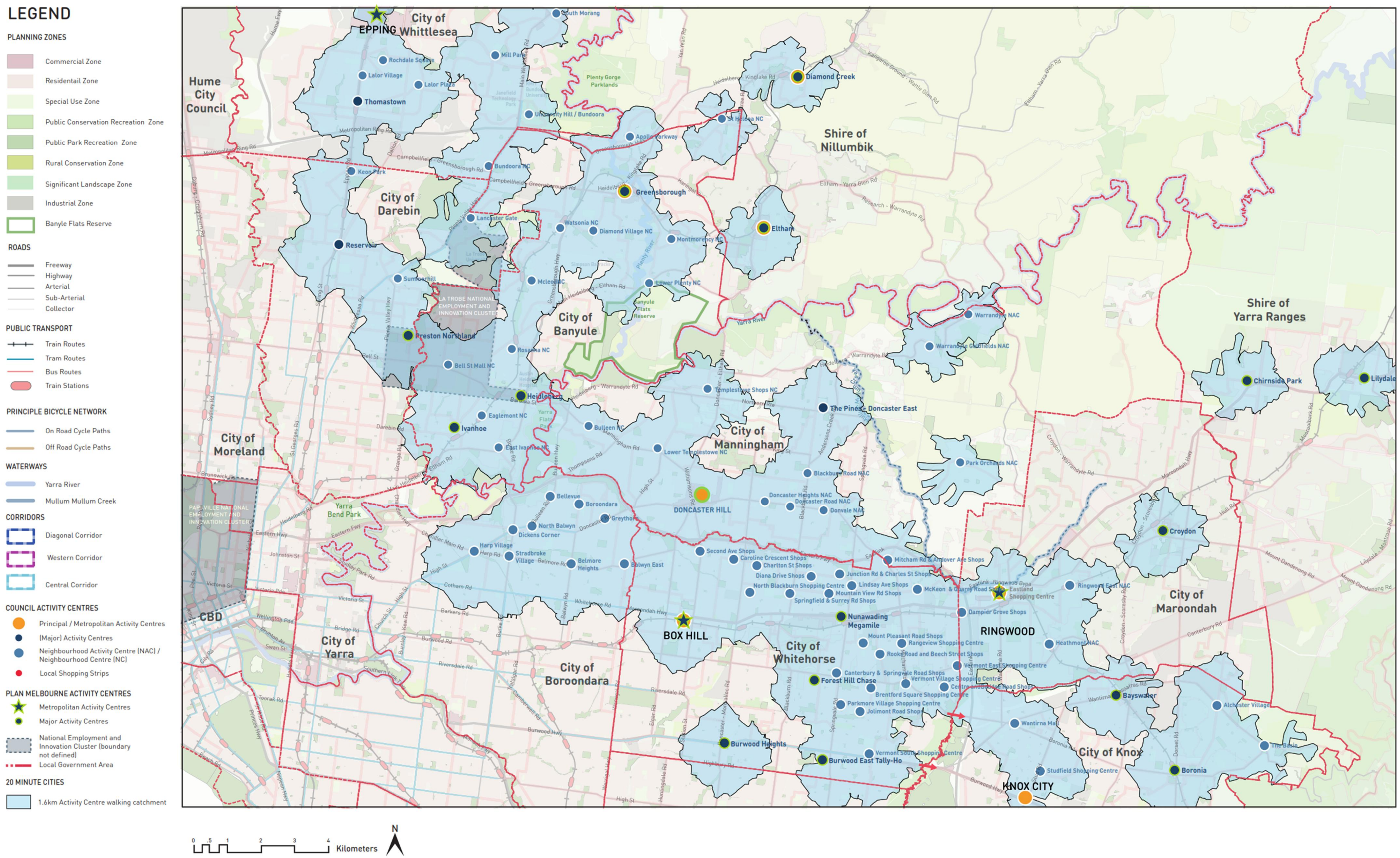
Neighbourhoods in the northern and eastern reaches of the study area are handicapped by sparser development patterns, wider dispersal of neighbourhood centres and topographical qualities that increase the difficulty of walking and cycling for a large proportion of the population.

Major activity centres throughout the study area exhibit various degrees of connectivity with the cycling network, although few that are located north of the Eastern Freeway are connected via commuter-quality cycling facilities.

Similarly, neighbourhood activity zones throughout the study area – consisting of shopping strips and community facilities – have varying degrees of cycling accessibility. While most are supported by some level of cycle access, many of those in the northern and eastern portions of the study area – particularly along Maroondah Highway – are only peripherally connected by designated cycling facilities.

However, the spatial coverage of the 1.6-kilometre catchments demonstrates the potential for 20-minute neighbourhoods to be realised across the north east.

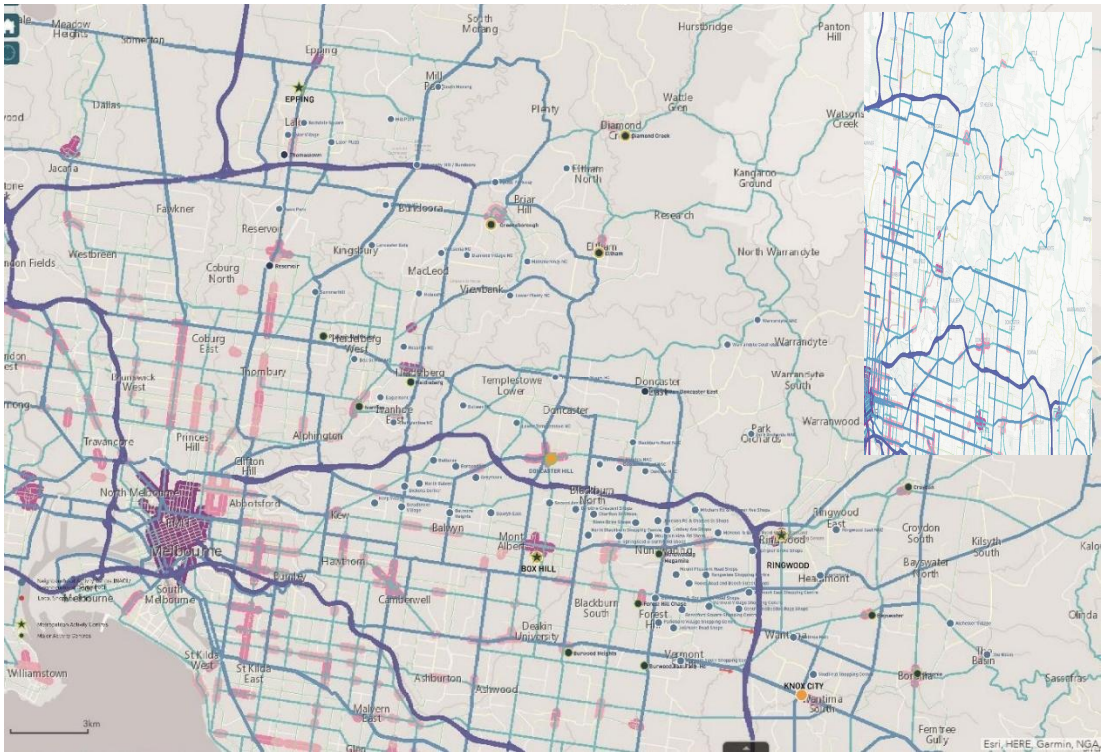
Figure 89 20-minute neighbourhood catchments



8.3.3 Barriers to walking and cycling

Due to the car-oriented nature of much of the study area – along with high traffic levels associated with daily commuting and circulation needs – pedestrians and cyclists in the north east often encounter roadways of an unsafe or barrier-like nature. The magnitude of these barriers is generally represented through a high 'movement' rating in the VicRoads Movement and Place Framework, as presented in Figure 90. Roads with a high 'movement' function prioritise traffic movements and are represented by a dark blue colour. The largest of these barriers generally have cross-sections of six lanes or more, plus varying degrees of grade separation. Roads in lighter blue also have a high 'movement' function and can be barriers to pedestrian and cycling movement.

Figure 90 Movement and Place Framework



These roadways often represent barriers to both linear travel (i.e. along the roadways) and travel across them. In the former sense, road space allocation is generally very heavily favoured toward cars and trucks at the expense of pedestrians and cyclists, whose space may be limited to minimal footpaths (if any) and narrow cycle lanes directly adjacent to high-speed car traffic.

An example of a location where the high movement function of a road is at conflict with the amenity of the local area is Rosanna Road. Due to the high volume of trucks and general traffic using the road each day, Rosanna Road is a barrier to movement, segregating the communities on the east side of the road from the Heidelberg Activity Centre.

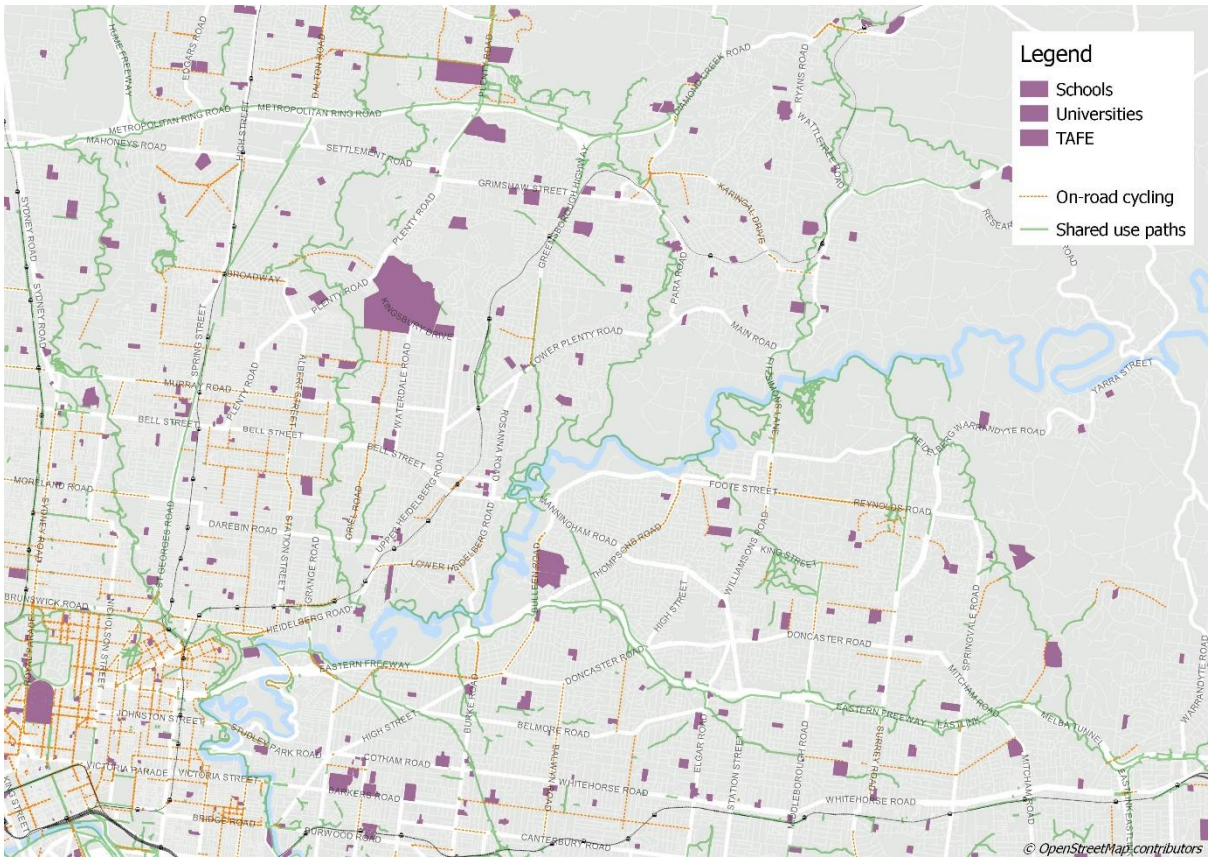
8.3.4 Access to schools

Another key aspect of 20-minute neighbourhoods is locating schools and other facilities near existing public transport and providing safe walking and cycling routes and drop-off zones (Plan Melbourne Policy 3.3.4).

This is a further challenge within the north east due to the discontinuous nature of safe corridors. While access within contiguous residential neighbourhoods is generally safe for students, many walking or cycling trips to school in the north east require travelling along or traversing high-volume or high-speed traffic thoroughfares.

It is apparent from Figure 91 that many schools are not directly served by the designated cycling network. While some of these schools are located within the rolling terrain and more sparsely populated areas in the northeast quadrant of the study area, many others sit within gaps in the existing cycling network within the inner portions of the study area. The degree to which these gaps fall within contiguous residential areas will affect the relative degree of safety for student cyclists.

Figure 91 Distribution of schools along the cycling network in the north-east



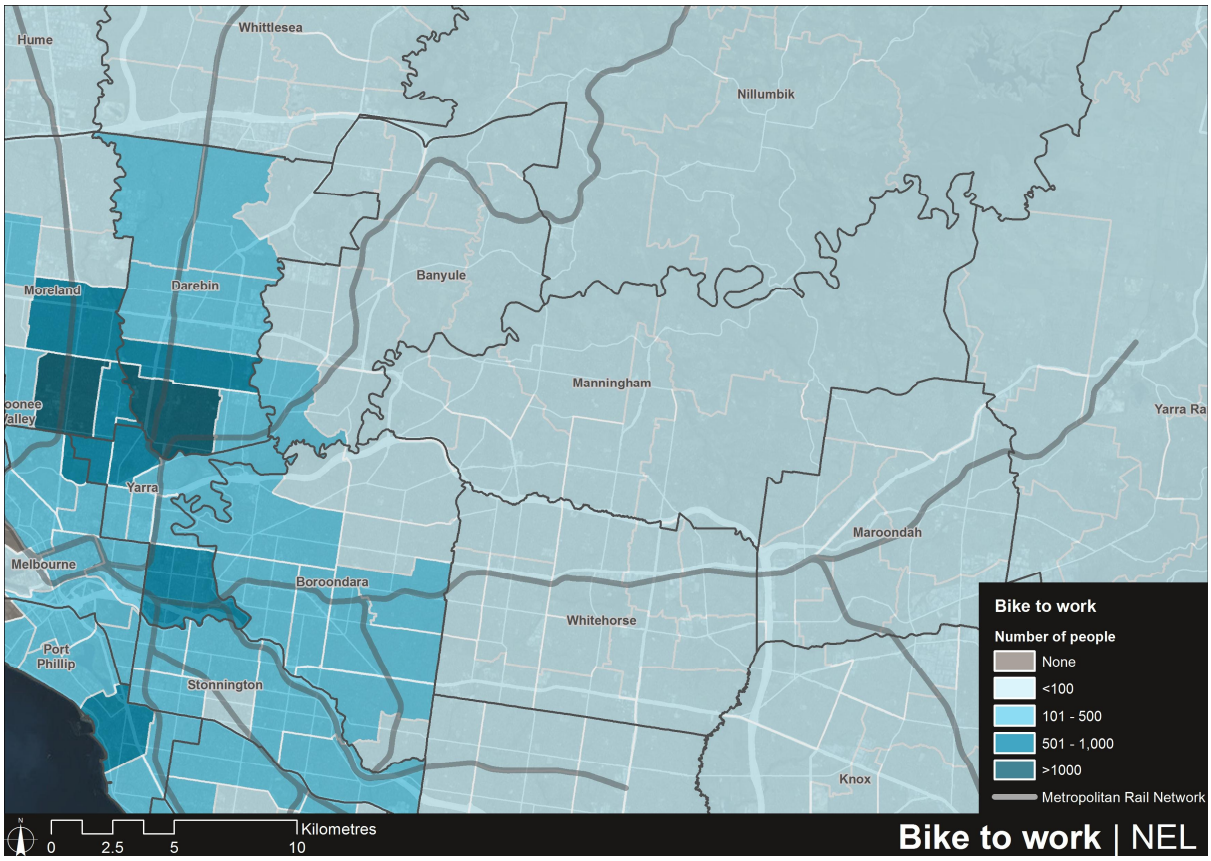
8.3.5 Commuter cycling

Cyclist commuter demand within the north east is generally low, with just 1.6 percent of all trips to work made using bicycles – lower than the Melbourne average of 2.6 percent. This lower use is typically a result of:

- Indirect bicycle routes between residential and employment areas;
- General congestion of the roads and lack of on-road bicycle paths;
- Type of material that existing bicycle paths are constructed of; and
- Topography of the land within the northeast.

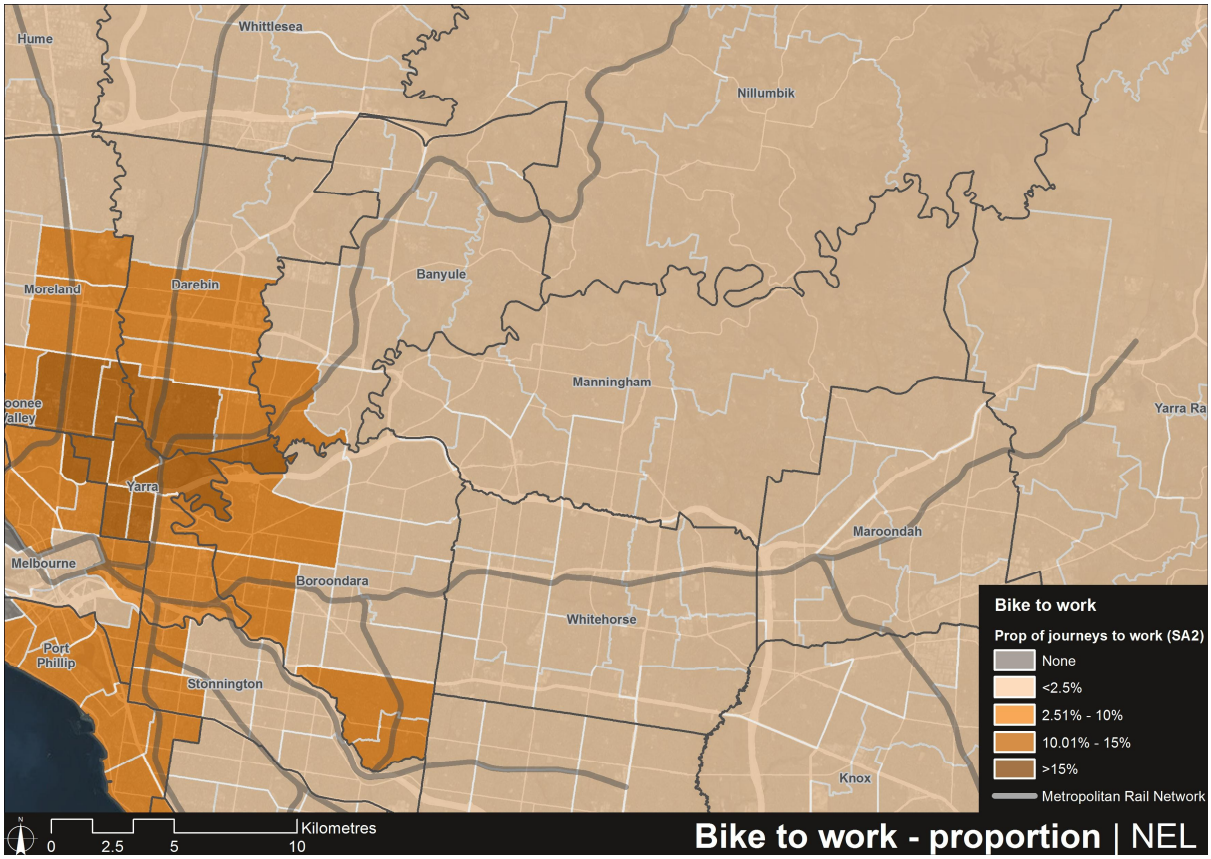
Figure 92 and Figure 93 show the numbers and proportions of residents in these areas who cycle to work. These numbers are generally lower than the numbers who walk to work and are primarily concentrated in the western portion of the study area surrounding inner Melbourne where cycling to jobs in the CBD and surrounding neighbourhoods is a viable option for a considerable proportion of the work force.

Figure 92 Daily number of residents (by SA2 statistical area) that cycle to work



Source: ABS Census 2011

Figure 93 Proportion of residents (by SA2 statistical area) that cycle to work



Source: ABS Census 2011

8.3.6 Recreational cycling

Across Melbourne, significantly more people cycle for recreational purposes than for transport reasons: 88 percent to 12 percent (Austroads, 2015). It is likely this trend is even stronger in the north east given that:

- Existing uninterrupted commuting-quality routes are limited in their extent and continuity;
- Sparser distribution of destinations (compared with inner Melbourne) leads to fewer opportunities for utility trips;
- Main public transport corridors are limited to the western and southern portions of the study area, limiting the degree to which cyclists can efficiently connect to long-distance, high-speed public transport; and
- A number of areas in the north east are popular for trail-based cycling and fitness-based cycling, attracting local residents and additional visitors from across Melbourne.

The distribution of trails, recreation areas and nature reserves in the north east lends itself to recreational cycling activity as illustrated previously in Figure 87, with several key continuous green corridors serving the central and eastern portions of the study area.

Figure 94 and Figure 95 show characteristics of typical recreational trails in the north east.

Figure 94 Plenty River Trail at Main Road

Figure 95 Mullum Mullum Creek Trail

Recreational cycling is not strictly limited to trails but can also occur along road corridors, particularly as related to long-distance fitness opportunities supported by the following geographical characteristics:

- Long uninterrupted stretches of roadways – particularly in the northern and eastern portions of the study area – as compared with the inner portions of Melbourne within which the road network is denser with more closely spaced cross-streets
- Challenging topography which, in contrast to its effects on commuter and utility cycling, can be an attractive asset for fitness-minded recreational cyclists.

The Kinglake area in particular is one of the most popular areas near Melbourne for road cycling. Cyclists generally commence cycling from Smiths Gully, Kangaroo Ground or St Andrews while others will ride from various points around Melbourne. From Kinglake, cyclists generally head back along the same route towards St Andrews (sometimes to do multiple hill repeats), head west towards Whittlesea along Whittlesea-Kinglake Road (C724) or east to Healesville through Toolangi via the Healesville-Kinglake Road (C724).

There are suitable shoulders or lanes for cyclists on:

- Heidelberg-Kinglake Road (C746) between Wattle Glen and Hurstbridge
- Kangaroo Ground- St Andrews Road (C728) between Panton Hill and St Andrews.

A number of roads connect these two main routes. Most of these roads are unsealed and not appropriate for road cycling, which tends to concentrate road cyclists along the routes noted above.

The expansion of opportunities for recreational road cycling through road space reallocation and traffic calming could expand the degree to which the north east is perceived as a premium recreational cycling destination.

8.4 Strategic Cycling Corridors

Strategic Cycling Corridors (SCCs) are a new approach to bicycle network planning across Melbourne, with the aim of improving cycling around major activity centres. This is in line with the Plan Melbourne direction of supporting walking and cycling in central Melbourne.

SCCs form a subset of the Principle Bicycle Network. The Strategic Cycling Corridor network is presented in Figure 96. The network is currently in the process of being reviewed and updated by Transport for Victoria.

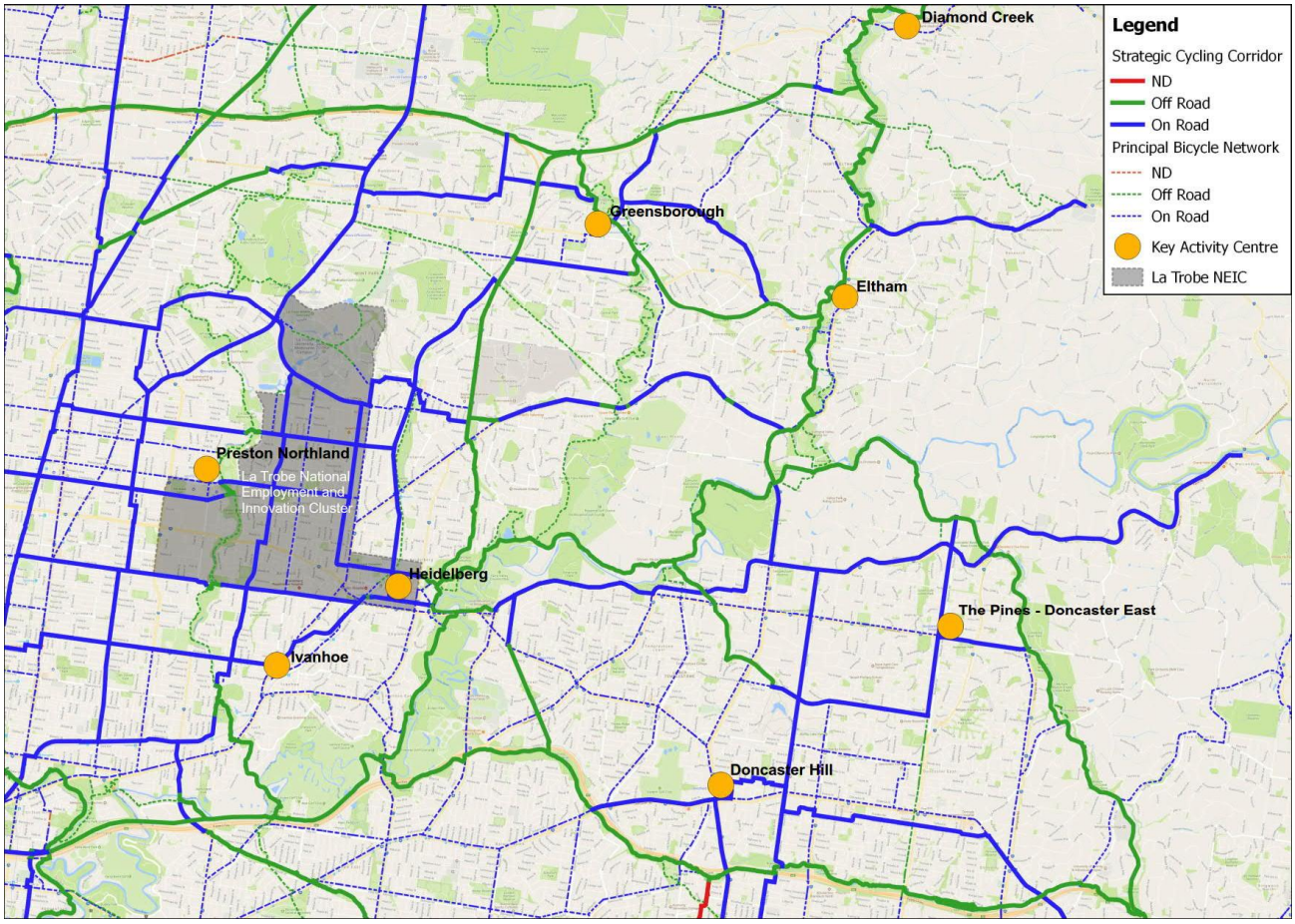
The SCC concept uses principles of a low-stress network to guide decision-making and investment. These principles draw on experience in cities such as Amsterdam, Copenhagen, London, San Francisco and Portland that have implemented low-stress networks and increased cycling participation while reducing crash rates. They are:

- Connectivity – Cyclists need a network of continuous low-stress routes. Protected cycleway design should provide direct and convenient connections, greater priority to people cycling at intersections to minimise deviations and delays, connect at a local and regional scale, and integrate into the larger, multimodal transport network.
- Safety – Cyclists are vulnerable road users because they have less mass, minimal protection in the event of a crash, and travel slower than cars. Protected cycleway design should clearly delineate road space by travel mode, minimise conflict points between modes (e.g. at intersections), reduce speed and enhance visibility at intersections and conflict points.
- Comfort – Attention to cyclists' comfort is an important part of attracting more people to commuter cycling. Protected cycleway design should minimise exposure to traffic noise and pollution by providing horizontal separation from traffic, accommodate side-by-side cycling and passing movements, pass through attractive and safe locations and minimise delay for people cycling, particularly at intersections.

To create a low-stress network, future projects should use a combination of high-quality infrastructure such as:

- Separated and protected cycleways
- Bicycle streets optimised for cycling with low vehicle speeds
- Dedicated off-road paths

Figure 96 Strategic Cycling Corridors (draft)

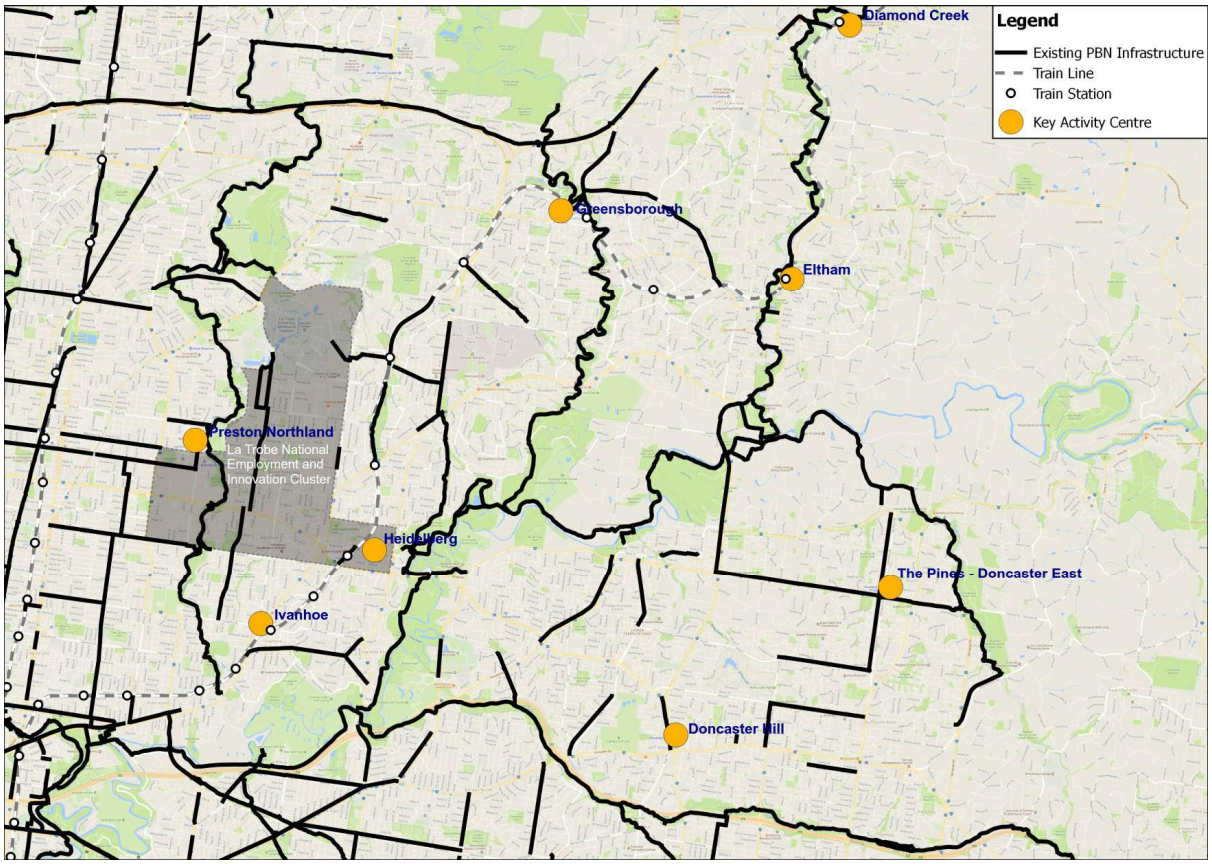


8.4.1 Missing links in the SCC network

If the SSC network is fully realised in the north east, it has the potential to improve accessibility to the key activity centres in the area such as Greensborough and the La Trobe National Employment and Innovation Cluster. However, there are significant gaps in the network.

The current extent of the realised PBN and SCC network is presented in Figure 97. Compared to the proposed SCC network, the current network is disjointed, indirect and does not connect to major activity centres. There are few on-road paths, especially those providing east-west connectivity, with a heavy reliance on the shared-use path network.

Figure 97 Existing cycling infrastructure in the study area (only existing PBN and SCC routes last updated July 2016)



Part 2 –
Future 'No Project' Scenario Report

9 Introduction

North East Link is a proposed new road link between the Eastern Freeway and the M80 Ring Road (M80) in Melbourne's north eastern suburbs. The purpose of this report is to assist the development of the business case and to document the future transport conditions of Melbourne's north east under a 'no project' scenario (where North East Link is not built).

9.1 Study area

This report focuses on two geographical areas:

- The wider metropolitan Melbourne; and
- The local area (henceforth referred to as the study area).

Metropolitan Melbourne

The metropolitan Melbourne area comprises the road network within the Melbourne Statistical Division (MSD), presented in Figure 1. Infrastructure projects of Metropolitan scale such as the North East Link Project have the potential to impact the broader transport network and will generally influence network-wide statistics such as vehicle kilometres travelled (VKT) and average vehicle speeds.

Local area

The study area focuses on Melbourne's north eastern suburbs, spanning from the Merri Creek in the west to Melbourne's outer fringes in the north and east. The study area is presented in Figure 2. This extent covers a wide area between the Eastern Freeway in the south and the M80 in the north to determine the optimal project corridor and transport solution.

While the metropolitan Melbourne assessment focuses on whole-of-network statistics, the local area assessment explores issues related to the arterial and freeway road network, public transport routes and walking and cycling in the area.

9.2 Structure of this report

This report is structured as follows:

- Chapter 2 provides a snapshot of the transport network in Melbourne in a 2036 'no project' scenario
- Chapter 3 provides a summary of transport conditions in the north east in a 2036 'no project' scenario.

Figure 98 **Melbourne Statistical Division**

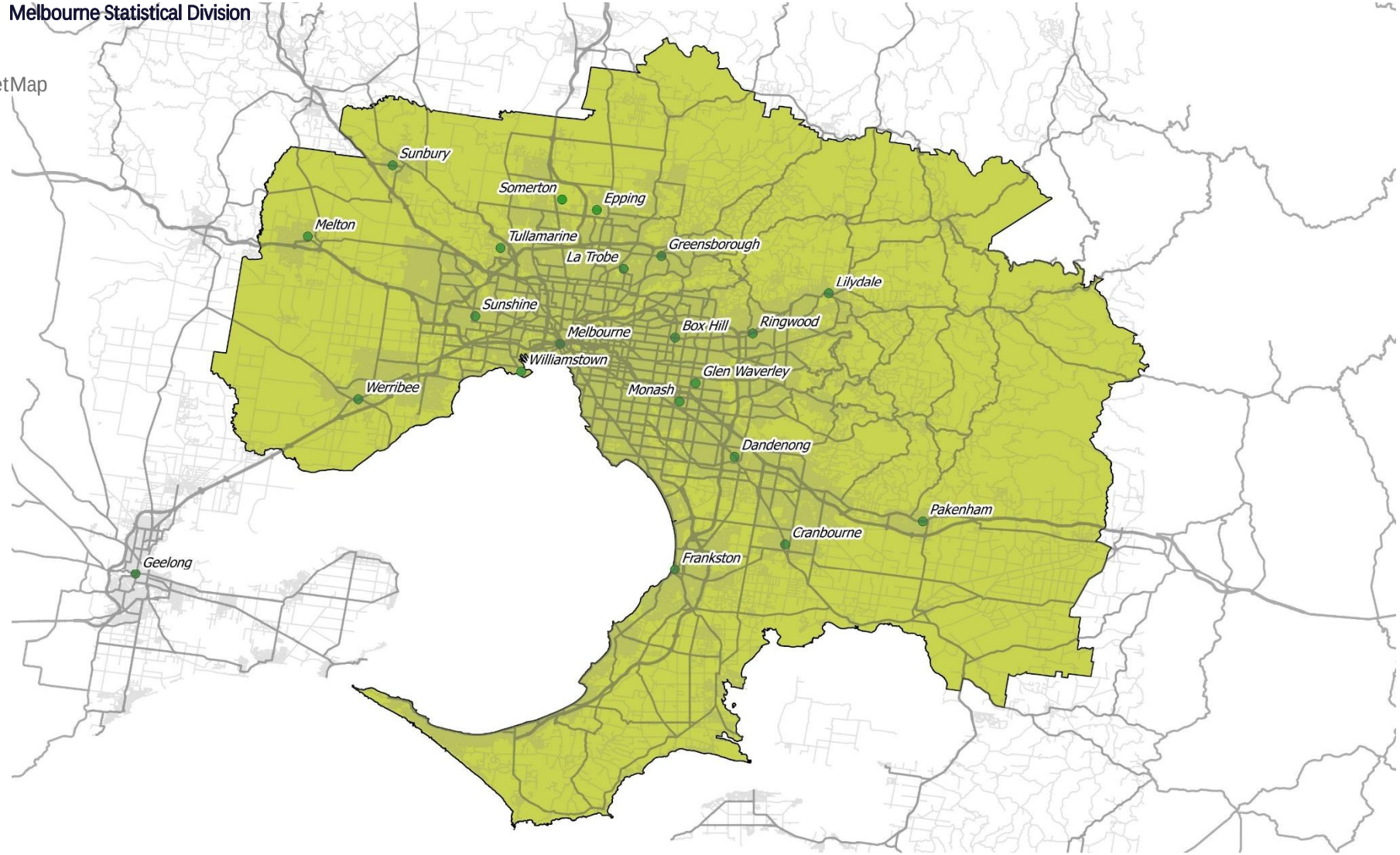
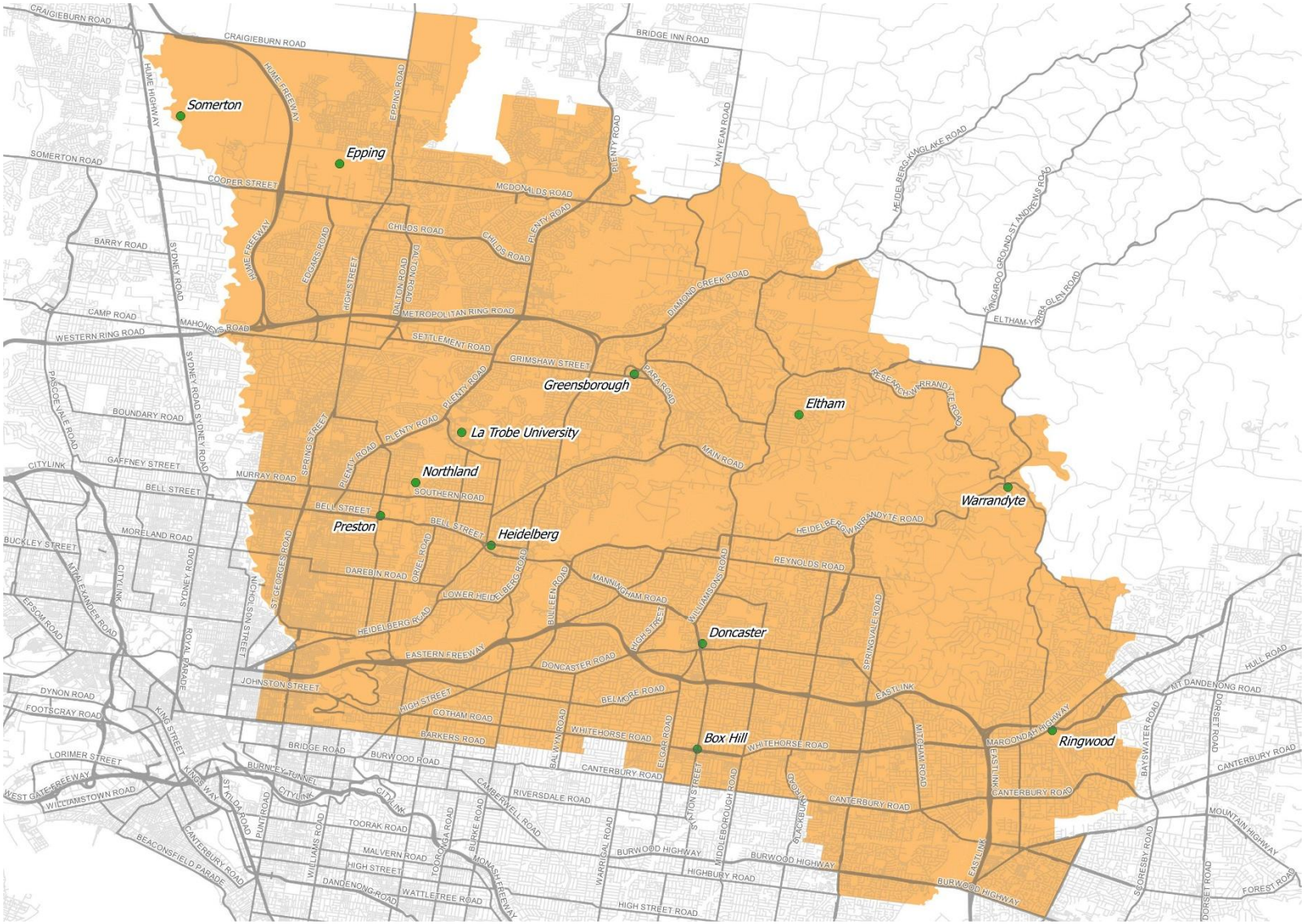


Figure 99 Study area



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10 Melbourne in 2036

10.1 Land use, population and jobs

Melbourne is expected to grow over the coming years, with nearly two million additional people expected to reside within the MSD area between now and 2036. From a population around 4.6 million today, this population will grow to approximately 6.5 million people by 2036[18], an increase of 29 percent, or 95,000 people a year.

This population growth is not distributed evenly throughout the metropolitan area. While some of the growth is expected to be absorbed by the inner city suburbs, the majority of the growth will occur in the outer suburbs: in the north east, west and south eastern suburbs. Nine of top ten suburbs for population growth, presented in Table 15, are located in the outer suburbs – beyond the M80 in the north and west, or beyond EastLink in the east and south east.

These outer suburban areas have been the fastest growing areas over the last decade and will continue to be for the near future; suburbs such as South Morang, Epping and Cranbourne East have been the fastest growing suburbs in Australia for the last three to five years[19]. Beveridge in the outer-north is expected to have the largest population increase in Melbourne over the next two decades, growing by an additional 85,000 people.

Much of the growth in the outer north will be in located in new suburbs that are currently being planned. Precinct Structure Plans (PSPs) have either been completed or are currently being developed in the outer north to accommodate Melbourne's forecast population growth. This includes new parcels of land identified as part of the Victorian Government's 100,000 lot strategy to tackle housing affordability. These PSPs are presented in Figure 100.

This means that in the future, Melbourne's urban fringe will extend continuously north beyond the M80 up to Wallan, about 45 kilometres from the CBD. This is a significant increase from today, where the northern fringe ends at Craigieburn, approximately 25 kilometres north of the CBD.

[18] Victoria in Future 2016 – Greater Melbourne Capital City Statistical Area
[19] ABS 3218.0 – Regional Population Growth, Australia

Figure 100 Northern PSPs

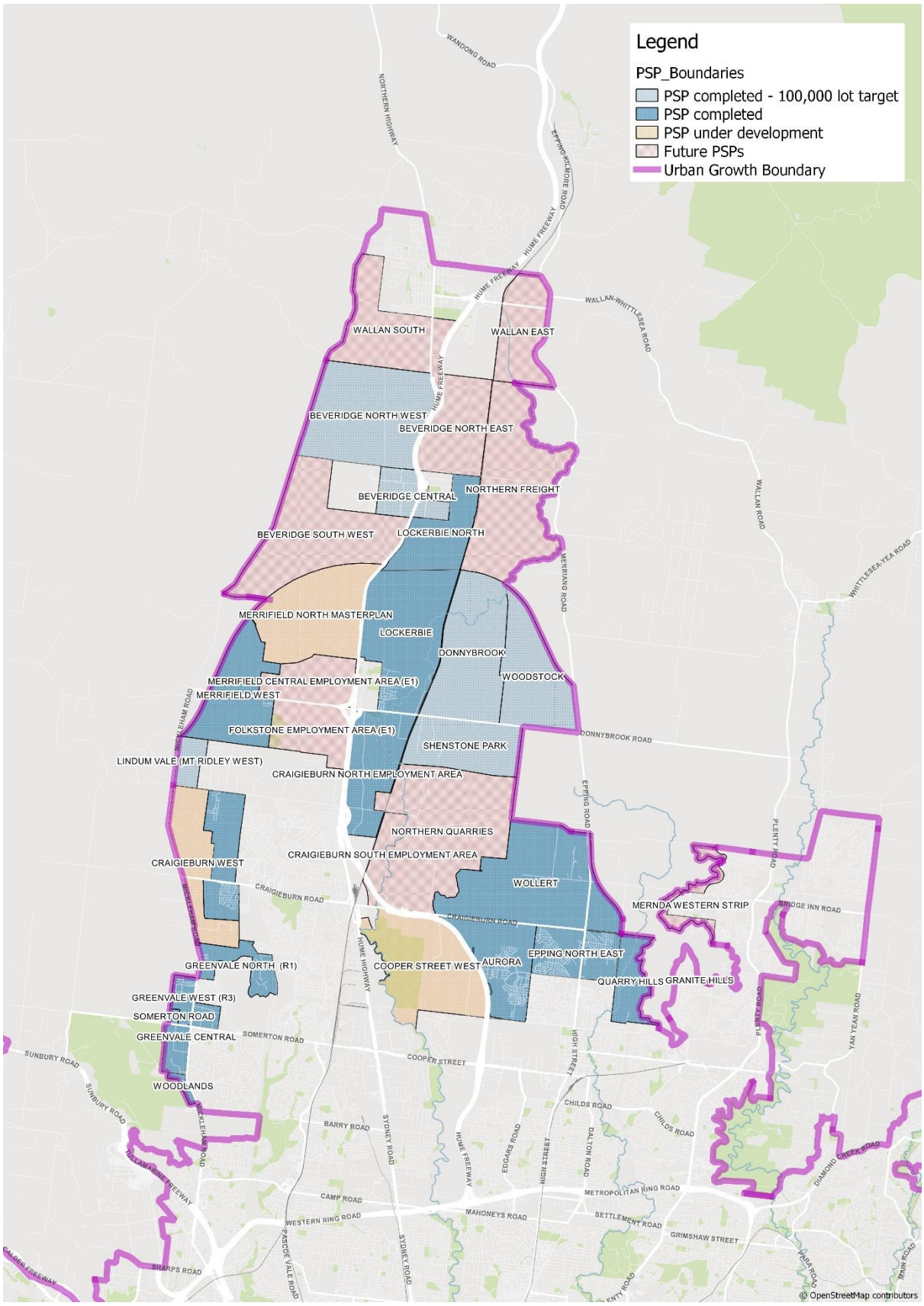


Table 15 Forecast fastest growing suburbs in Melbourne (2016 to 2036)

Rank	Suburb	Location	Change in population
1	Beveridge	Outer north	85,000
2	Clyde	Outer south-east	78,000
3	Laverton North	Outer west	65,000
4	Wyndham Vale	Outer west	59,000
5	Melbourne	Inner	48,000
6	Mickleham	Outer north	46,000
7	Melton South	Outer west	41,000
8	Rockbank	Outer west	40,000
9	Mount Cottrell	Outer west	36,000
10	Epping	Outer north	34,000

Source: VLC Zenith model based on VIF2015 projections and 2006 suburb boundaries

The high growth in these outer suburbs can also be seen in Figure 101, which presents the change in population between 2016 and 2036. The growth areas in the north, south east and west are highlighted by the dark red areas. While high growth is also forecast in the inner city areas, the middle ring suburbs (10 to 20 kilometres from the CBD) are expected to see only moderate increases in population.

However, future job growth is not expected to occur in the same areas as population growth in Melbourne. The majority of employment growth is projected to occur in the CBD and the surrounding inner city suburbs and, to a lesser extent, the middle ring suburbs. A very low percentage of additional jobs are expected to be created in the outer suburbs. Job growth between 2016 and 2036 is presented in Figure 102.

Figure 101 Change in population between 2016 and 2036

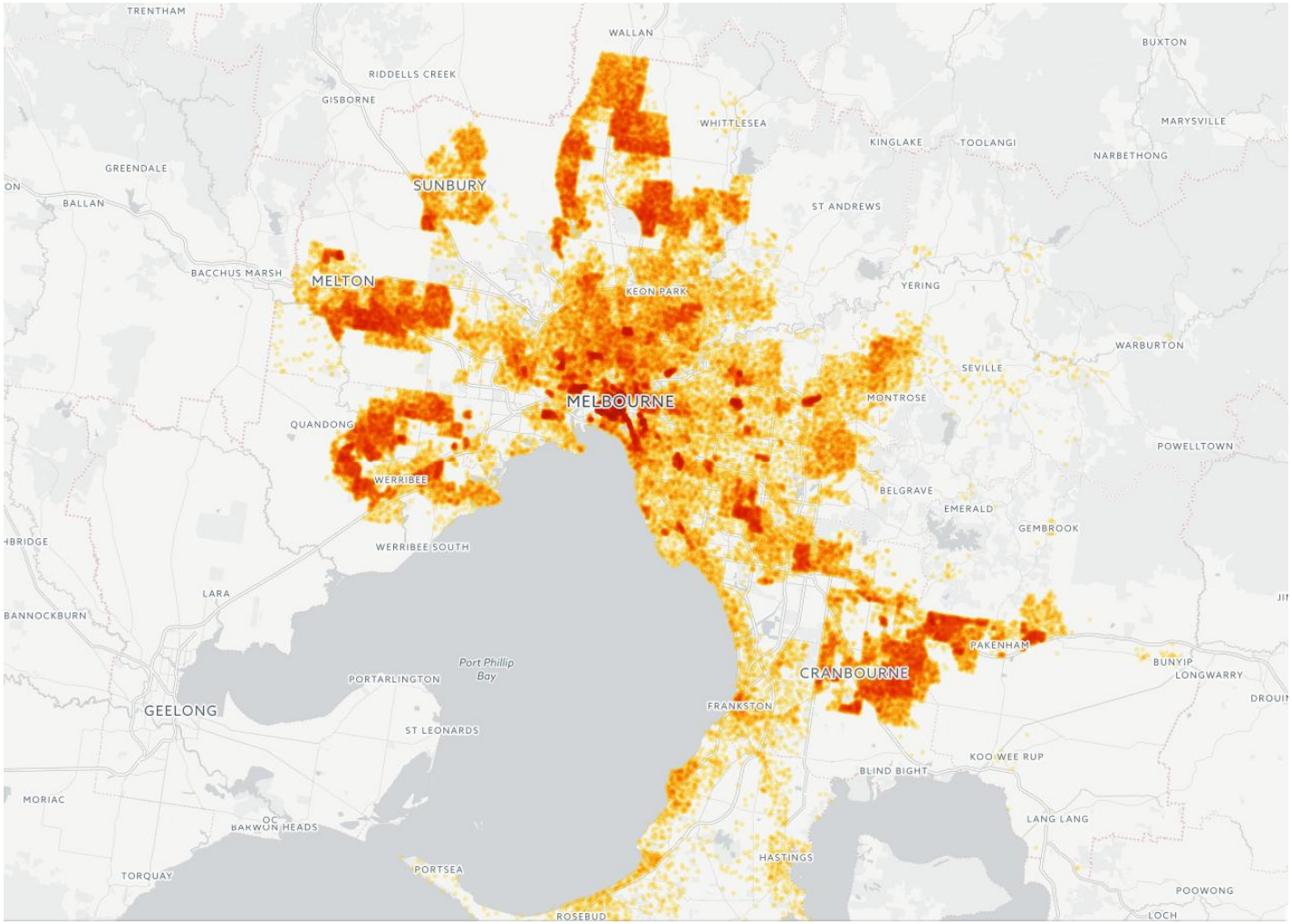
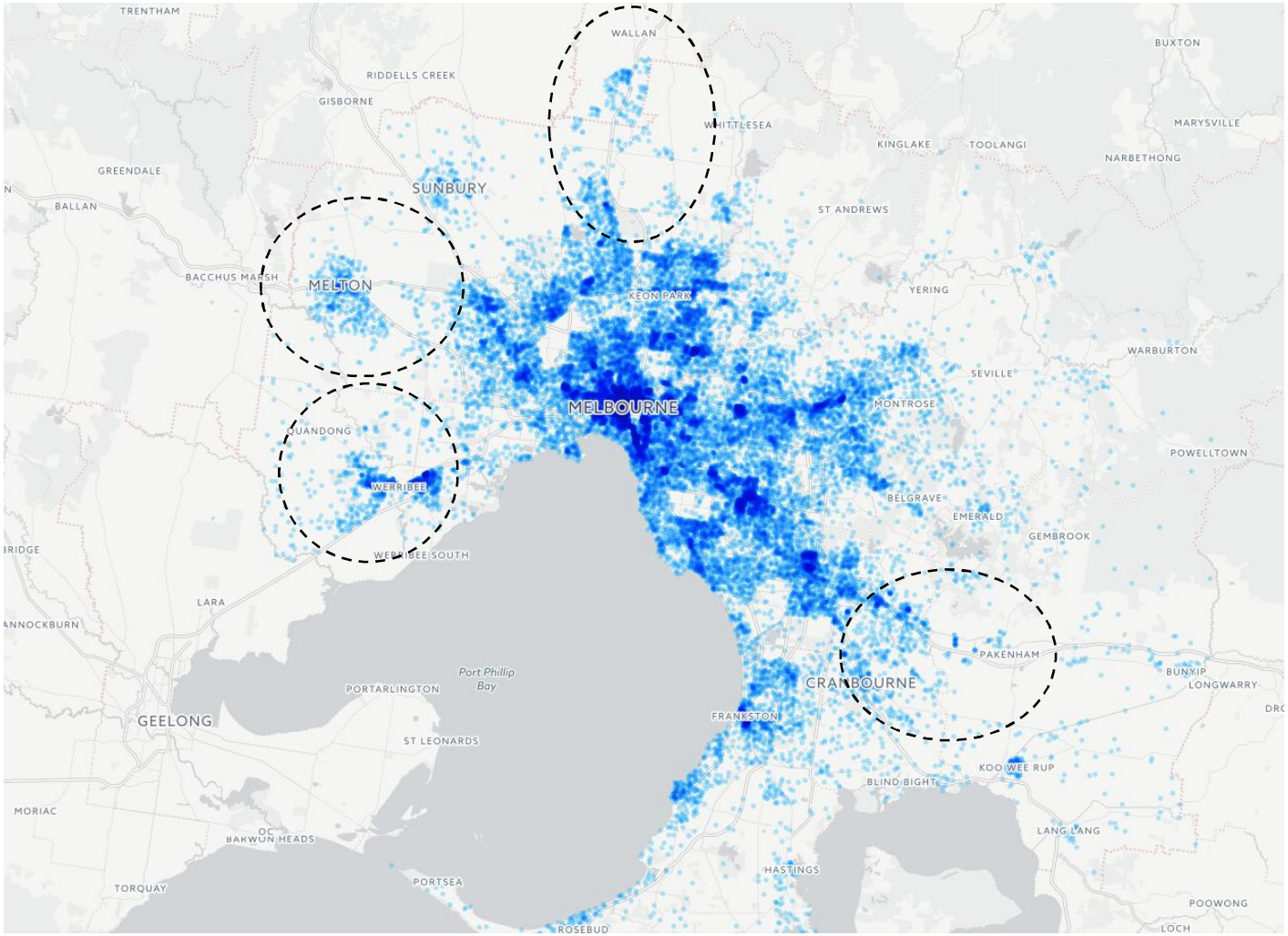


Figure 102 Change in jobs between 2016 and 2036



Areas of high population growth and low employment growth

This imbalance between the spatial distribution of population and employment growth means that there will still be a high demand for radial transport from the outer suburbs to the CBD. A deficit of jobs in the outer suburbs will likely require people from areas such as Epping and South Morang to travel (by either car or public transport) to the inner suburban areas for work.

While the population growth in the middle ring suburbs (including the study area) is not expected to be as high as other parts of Melbourne, it is expected that demand for travel through these areas will be significantly higher in the future due to the additional radial and cross-city orbital trip demand originating from the outer suburbs. This outer suburban 'through' traffic will compete with other local traffic in the area, leading to lengthier peak periods and heavier congestion.

This additional demand will place extreme pressure on the transportation network in the north east, especially during the morning and evening peak periods.

10.2 Transport network

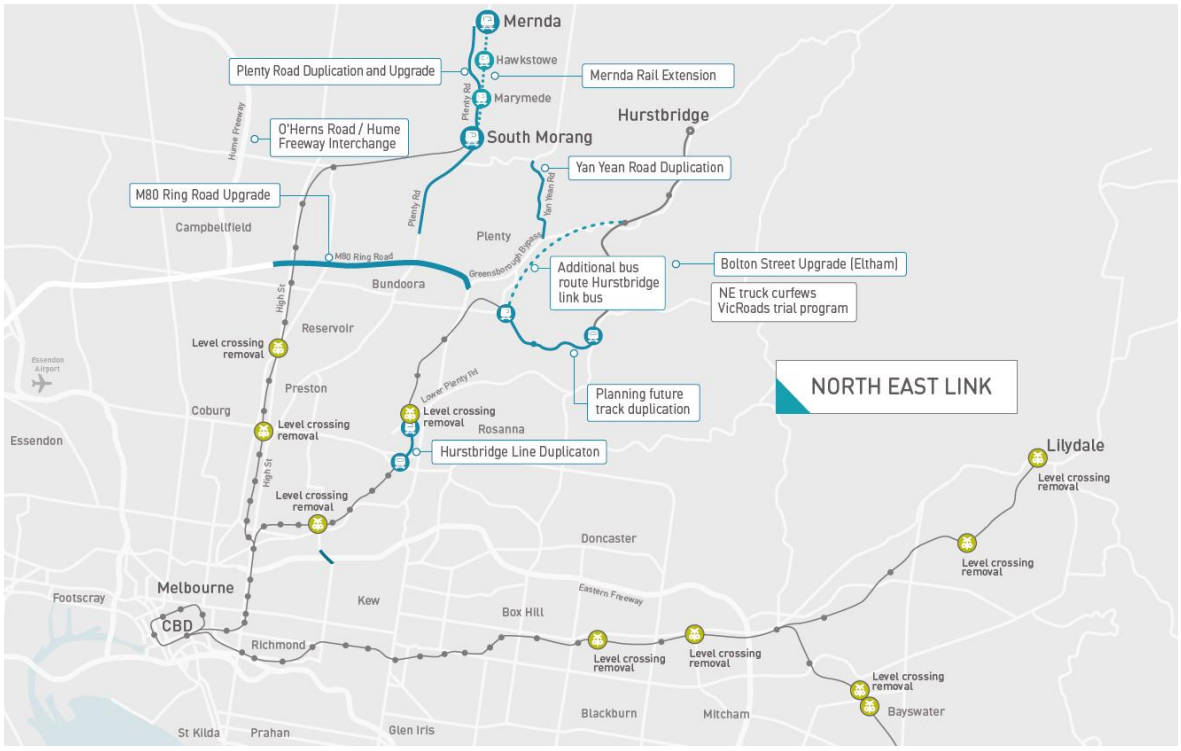
In response to the expected population growth in Melbourne over the coming decades, the transportation network will need to be extensively expanded and upgraded, with major investment required to cope with the future demand for travel. A large pipeline of projects is already underway, with projects currently under construction or at various planning stages to alleviate congestion on the road and rail networks.

As Melbourne continues to grow, the city will need to continue to plan additional infrastructure and services to keep up with the increasing demand for travel across the network.

While the majority of transport infrastructure planned will be located in the fast-growing outer south east, west and outer north of Melbourne, a large proportion of the additional trips generated from the outer suburbs will have to travel through the inner and middle suburbs (such Greensborough and Heidelberg) to access jobs and services. This will place significant pressure on these road networks.

In the north east, a range of new transport infrastructure is planned to help accommodate some of this growth, as presented in Figure 103. Of note are the Hurstbridge Line duplication, Mernda Rail extension, Plenty Road upgrade and Yan Yean Road duplication.

Figure 103 Planned transport upgrades in the north east



10.2.1 Major transport infrastructure

The following is a summary of the major transport projects that are expected to be completed between now and 2036.

The transport projects listed in this section are based on the State Government's Reference Case – a list of committed projects and proposed future 'medium level investment' in arterial road upgrades, rail service upgrades, freeway improvements, tram and bus upgrades and service levels to supply a reasonable capacity in support of future demand.

10.2.1.1 Projects included in the 2036 'no project' scenario

CityLink-Tulla Widening (committed)

The CityLink Tullamarine Widening (CTW) project provides 24 kilometres of upgrades from Melbourne Airport to Power Street in the city. It provides an additional lane in each direction for the full length and includes the conversion to a fully managed motorway.

The project will increase capacity along CityLink and reduce travel time along the corridor and help remove commercial vehicles from surrounding local roads.

Metro Tunnel (committed)

The Metro Tunnel project involves the construction of twin rail tunnels from South Kensington to South Yarra, including five new underground train stations. High capacity trains delivered as part of the project will assist in freeing up capacity across Melbourne's rail network and encourage a shift from private vehicles to trains. The project will improve reliability and service frequency across the rail network.

West Gate Tunnel (committed)

The West Gate Tunnel Project includes the widening of the West Gate Freeway, new twin tunnels under Yarraville and an elevated road that connects the West Gate Freeway with the Port of Melbourne, CityLink and the Melbourne central city.

The project will provide an alternative route to the West Gate Bridge, take trucks off local residential roads and provide a more efficient freight route to and from the Port of Melbourne.

Monash Freeway Upgrade (committed)

The Monash Freeway Upgrade involves the widening and upgrade of the Monash Freeway from Warrigal Road in Chadstone to Clyde Road in Berwick. The freeway will be widened from four lanes to five lanes between EastLink and the South Gippsland Freeway and from two lanes to three lanes between the South Gippsland Freeway to Clyde Road. Other improvements include ramp signalling from Chadstone to Packenham, additional ramp storage and lane use management signs.

Monash Freeway Upgrade Stage 2 (reference case assumption)

Future stages of the Monash Freeway include widening between Warrigal Road and Ferntree Gully Road, including a new connection to Westall Road near Ferntree Gully Road and widening of the freeway to an upgraded Healesville-Koo Wee Rup Road.

Level Crossings Removal Project (committed)

The Level Crossings Removal Project is a package of works around the metropolitan Melbourne area to remove 50 level crossings, improving safety and reducing congestion on the road network.

M80 Ring Road upgrade (committed)

The M80 Ring Road upgrade involves widening and improvements along the full 38 kilometres of the M80 from the Princes Freeway to Greensborough Bypass. The project will reduce congestion by providing additional capacity, improve safety by reducing weaving, reduce travel times and improve traffic flow through the use of a freeway management system.

Widening has been completed between the Western Highway and Sunshine Avenue, Calder Freeway to Sydney Road and Edgars Road to Plenty Road. The remaining sections are Plenty Road to the Greensborough Bypass, Sydney Road to Edgars Road, Sunshine Avenue to Calder Freeway and Princes Freeway to the Western Highway.

Regional Rail Revival Package (committed)

The Regional Rail Revival Package will upgrade a number of regional rail lines, provide additional V/Line train carriages and improve general maintenance of the V/Line network. Major upgrades include the Gippsland Line, the Surf Coast Rail Line (including track duplication at Waurn Ponds), the Warnambool Line and upgrades around Bendigo.

Other freeway upgrades (Reference Case assumption)

Other freeway upgrades expected to occur between now and 2036 are an extension of the Tullamarine Freeway between the airport and Somerton Road, and widening of the Calder Freeway between the M80 and Sunbury.

10.2.1.2 Projects not included in the 2036 'no project' scenario

Other projects in various stages of development and consideration have not been included in the 2036 'no project' scenario. These include:

- Metro Tunnel 2 (Clifton Hill – Fishermans Bend – Newport rail tunnel);
- Outer Metropolitan Ring Road (OMR); and
- Port of Hastings/Bay West.

In addition to the above, the following projects have not been included due to their competing nature with North East Link and the likelihood that if North East Link proceeds, these projects will not: the widening of Fitzsimons Lane, Greensborough Bypass and Diamond Creek Road.

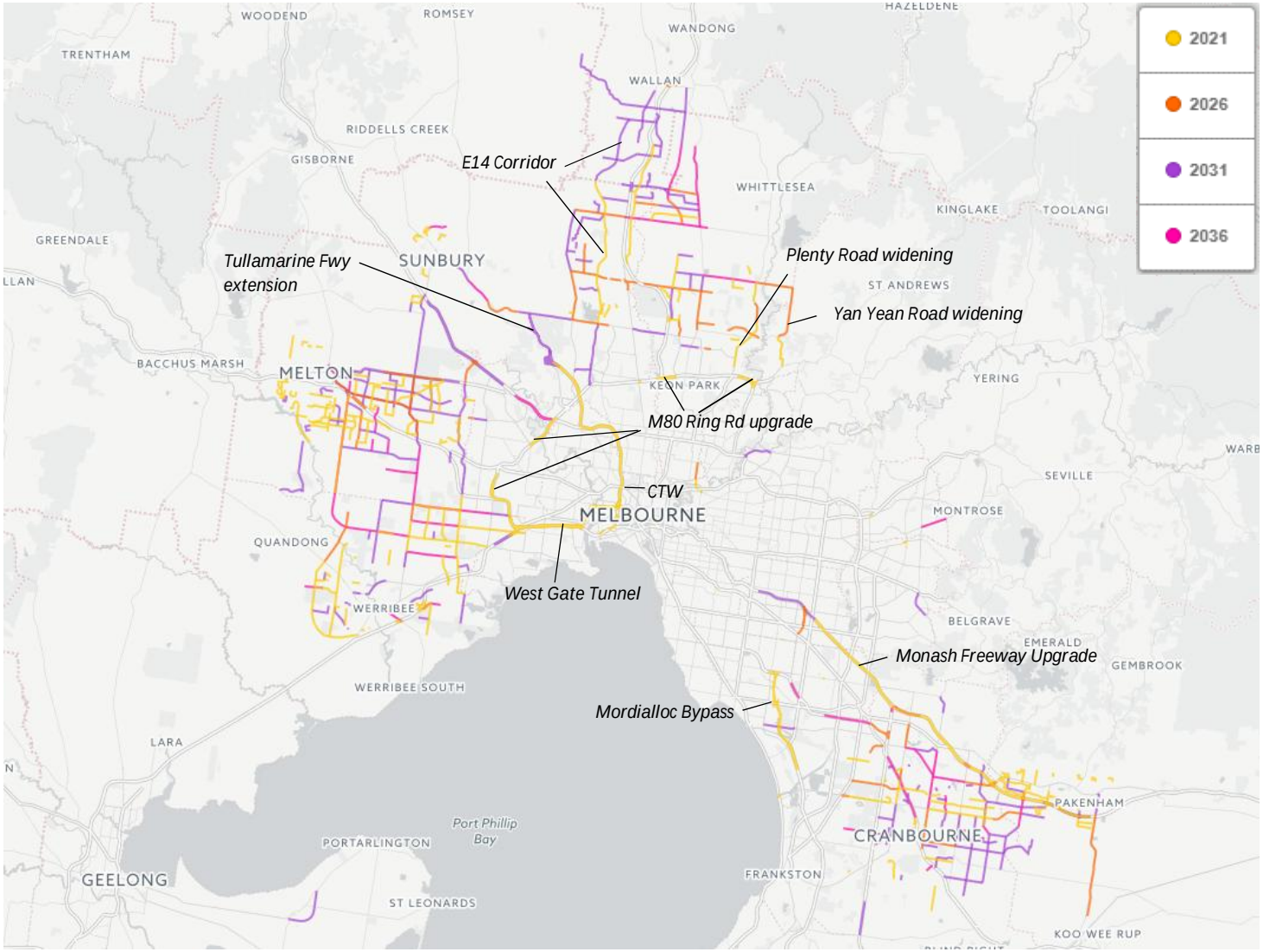
10.2.2 Arterial roads

Forecast improvements to the arterial road network are centred largely around outer suburban areas in the north, south east and west to accommodate the growing populations in these areas. Upgrades to the network (including the projects described in section 10.2.1) are presented in Figure 104.

New and upgraded roads that are expected to be completed between:

- 2016 and 2021 are highlighted in yellow;
- 2021 and 2026 are highlighted in orange;
- 2026 and 2031 are highlighted in purple; and
- 2031 and 2036 are highlighted in pink.

Figure 104 Projected new and upgraded roads (2016 to 2036)



The following sections describe the planned major arterial road upgrades between 2016 and 2036, with a focus on the arterial road network in the north east:

Suburban Roads Upgrade

The Suburban Roads Upgrade project (SRU) combines three packages of arterial road upgrades in the outer suburbs to alleviate congestion and improve travel times on the road network. There are separate packages of works for the western suburbs, south eastern suburbs and northern suburbs.

The package of works for the northern suburbs will help accommodate the expected growth in the region.

Yan Yean Road

It is assumed that Yan Yean Road will be widened in two stages:

- Between Diamond Creek Road and Kurrak Road by 2019 (committed); and
- Between Kurrak Road and Bridge Inn Road by 2026 (Reference Case assumption).

Plenty Road

The widening of Plenty Road is assumed to occur in two stages:

- Between McKimmies Road and Bush Boulevard by 2020 (committed); and
- Between Bush Boulevard and Bridge Inn Road by 2020 (committed).

Chandler Highway / Grange Road

The widening of Chandler Highway by 2018 (committed) and Grange Road by 2026 (Reference Case assumption) will involve the construction of a new bridge adjacent to the existing Yarra River bridge, allowing three lanes in each direction between the Eastern Freeway and Heidelberg Road and two lanes in each direction between Heidelberg Road and Darebin Road.

Kangaroo Ground-Warrandyte Road (Warrandyte bridge)

The widening of the Warrandyte bridge by 2018 (committed) between Yarra Street and Research-Warrandyte Road will increase the number of lanes from one in each direction to three lanes in total (two lanes southbound and one lane northbound).

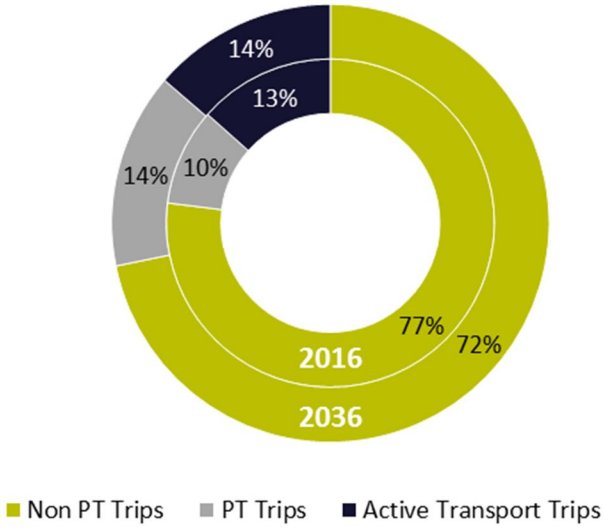
Aitken Boulevard / Mandalay Road

Aitken Boulevard and Mandalay Road, also known as the E14 corridor, is a proposed (assumed Reference Case) north-south arterial road running parallel to the Hume Freeway from the M80 near Gladstone Park in the south to Beveridge in the north.

10.3 Network statistics

Daily vehicle trips across the Melbourne Statistical Division are forecast to increase by 32 percent, while public transport trips are forecast to increase by 111 percent. Despite the large growth in public transport trips, the majority of trips will still be completed via road (cars and trucks) as presented in Figure 105, with almost five times as many trips being undertaken by private vehicles compared to trips on public transport.

Figure 105 MSD mode share 2016 to 2036 'no project' scenario



This increasing level of congestion is also reflected in slower network speeds, with a forecast six percent decrease in vehicle speeds across the day and a 13 to 14 percent decrease during the AM and PM peaks respectively.

While a 13 to 14 percent decrease in vehicle speeds during peak hour might not seem much, it means that a person who travels 60 minutes to work each weekday would likely spend an additional 16 minutes each day, an additional 81 minutes each week or an additional 70 hours every year stuck in traffic. The network statistics are presented in Table 16.

Table 16 Road vehicle trips, 2036 'no project' scenario

Metric	Time period	MSD (percentage change from 2017 in brackets)
Road Vehicle Trips (Car + LCV + HCV)	Daily	12,478,000 (+32%)
	AM Peak (7am - 9am)	1,880,000 (+27%)
	PM Peak (4pm - 6pm)	2,024,000 (+29%)
Vehicle Kilometres Travelled (km)	Daily	173,015,000 (+44%)
	AM Peak (7am - 9am)	26,443,000 (+35%)
	PM Peak (4pm - 6pm)	28,271,000 (+37%)
Vehicle Hours Travelled (hrs)	Daily	4,284,000 (+57%)
	AM Peak (7am - 9am)	882,000 (+56%)
	PM Peak (4pm - 6pm)	896,000 (+59%)
Average Speed (km/h)	Daily	40 (-8%)
	AM Peak (7am - 9am)	30 (-13%)
	PM Peak (4pm - 6pm)	32 (-14%)
Public Transport trips	Daily	3,108,000 (+111%)
VKT per capita (km)	Daily	22.44 (+3%)

Source: VLC Zenith Model

10.4 Traffic volumes

The high population growth in the outer south east, west and northern regions of Melbourne is expected to result in a significant increase in traffic on the surrounding arterial road and freeway networks, and the wider Melbourne road network.

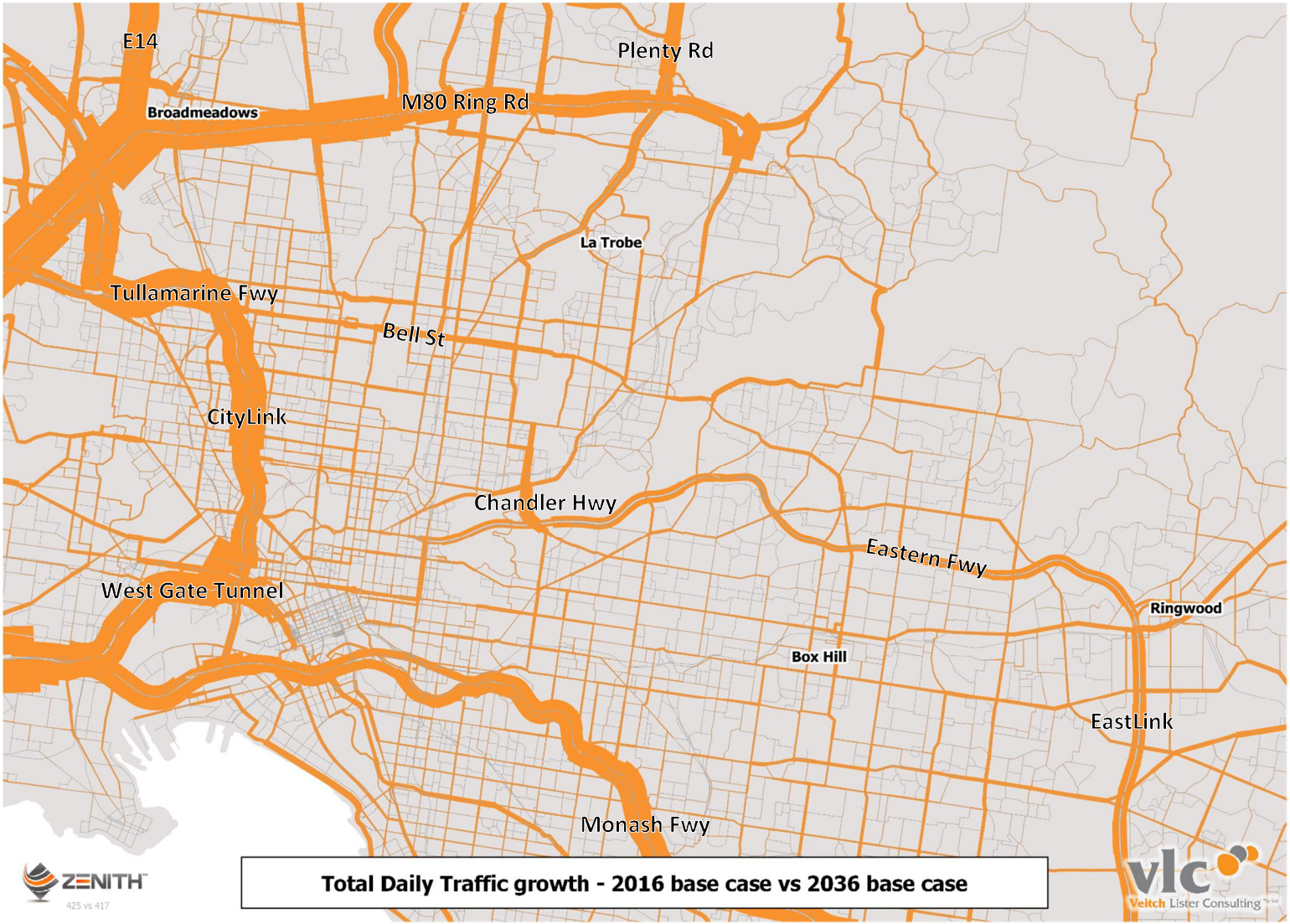
The majority of traffic growth will be able to be accommodated by the additional freeway capacity delivered by major transport infrastructure upgrades on the M80, Tullamarine Freeway, West Gate Freeway (and the West Gate Tunnel) and the Monash Freeway. However, these freeways will be operating at or close to capacity during the peak periods, meaning that the additional growth will be accommodated outside of the peak periods.

The estimated change in traffic volumes between the 2016 and 2036 scenarios are presented in Figure 106.

Changes include:

- Higher growth in the western suburbs compared to the eastern suburbs, largely due to the projected growth in areas like Wyndham and Melton;
- A large increase in traffic for the length of the M80 because of additional road capacity from the M80 upgrade;
- Increases across the freeway network (Deer Park Bypass, Western Freeway, Princes Freeway, Tullamarine Freeway, Calder Freeway, Hume Freeway and Monash Freeway);
- Increases on the arterial roads around Epping and Lalor due to the increased development in this area; and
- Moderate growth on key roads in the north east such as Greensborough Bypass, Banksia Road and Fitzsimons Lane. This growth is limited due to these roads currently operating close to capacity throughout the day.

Figure 106 Change in daily traffic volumes between 2016 and 2036 'no project' scenario



10.5 Public transport

By 2036, the number of trips completed by public transport is expected to double to nearly 3.2 million trips a day. Public transport usage is forecast to grow at a faster rate than road trips – 111 percent compared to 32 percent. This means the proportion of trips completed by public transport in Melbourne is expected to increase from 10.5 percent of all trips today to 14.5 percent of all trips in 2036.

However, the growth of public transport usage will be mainly limited to destinations around the inner and middle ring suburbs, approximately 10 kilometres or less from the CBD. The public transport mode share by destination in 2016 and 2036 is presented in Figure 107 and Figure 108 respectively. Areas with a high proportion of public transport usage are highlighted in purple.

Public transport is expected to continue to serve radial trips into and out of the CBD and inner city areas, with a smaller role in completing orbital journeys. Destinations further away from the CBD will continue to have a low proportion of trips completed by public transport, with dependence on car travel remaining high as private vehicles continue to provide a more direct and faster alternative to buses or trains.

Figure 107 Public transport mode share by destination (2016)

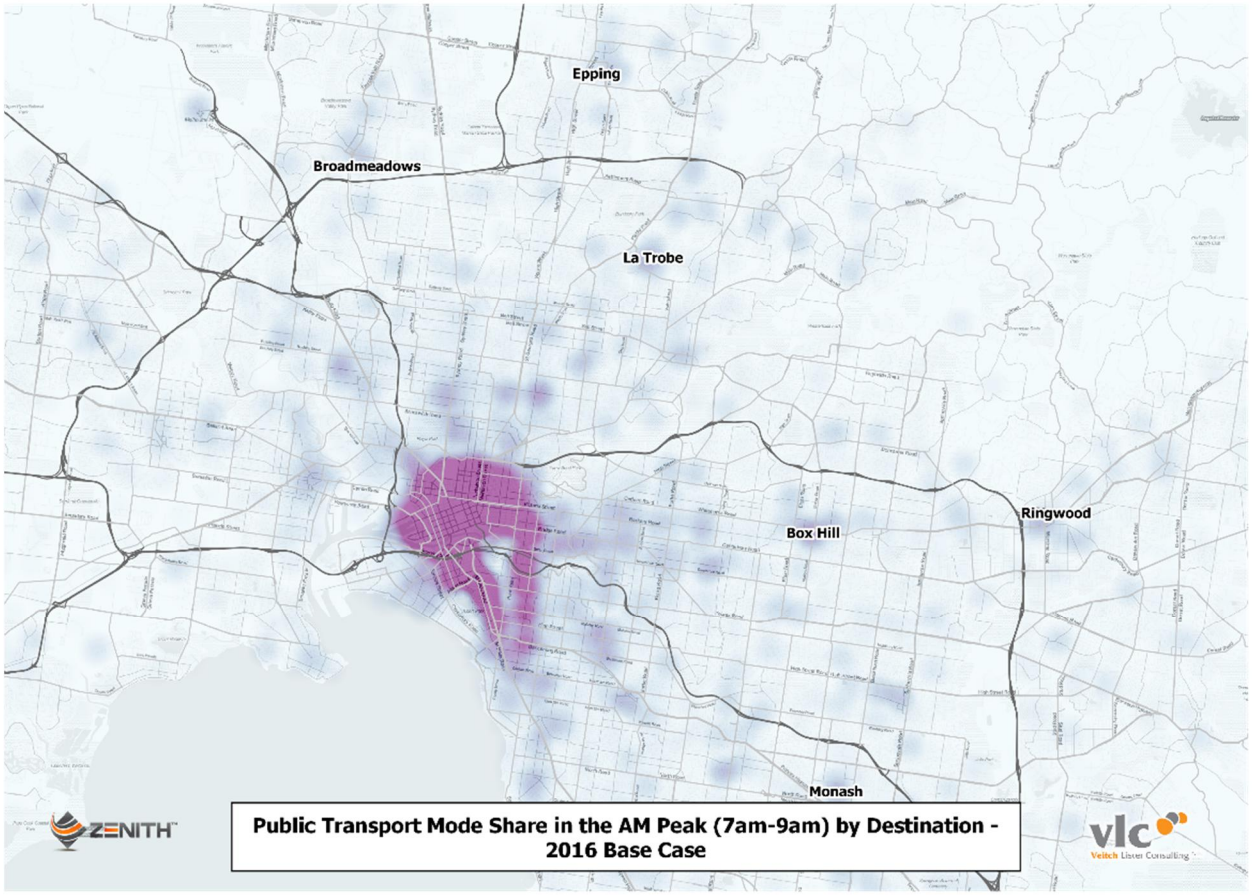
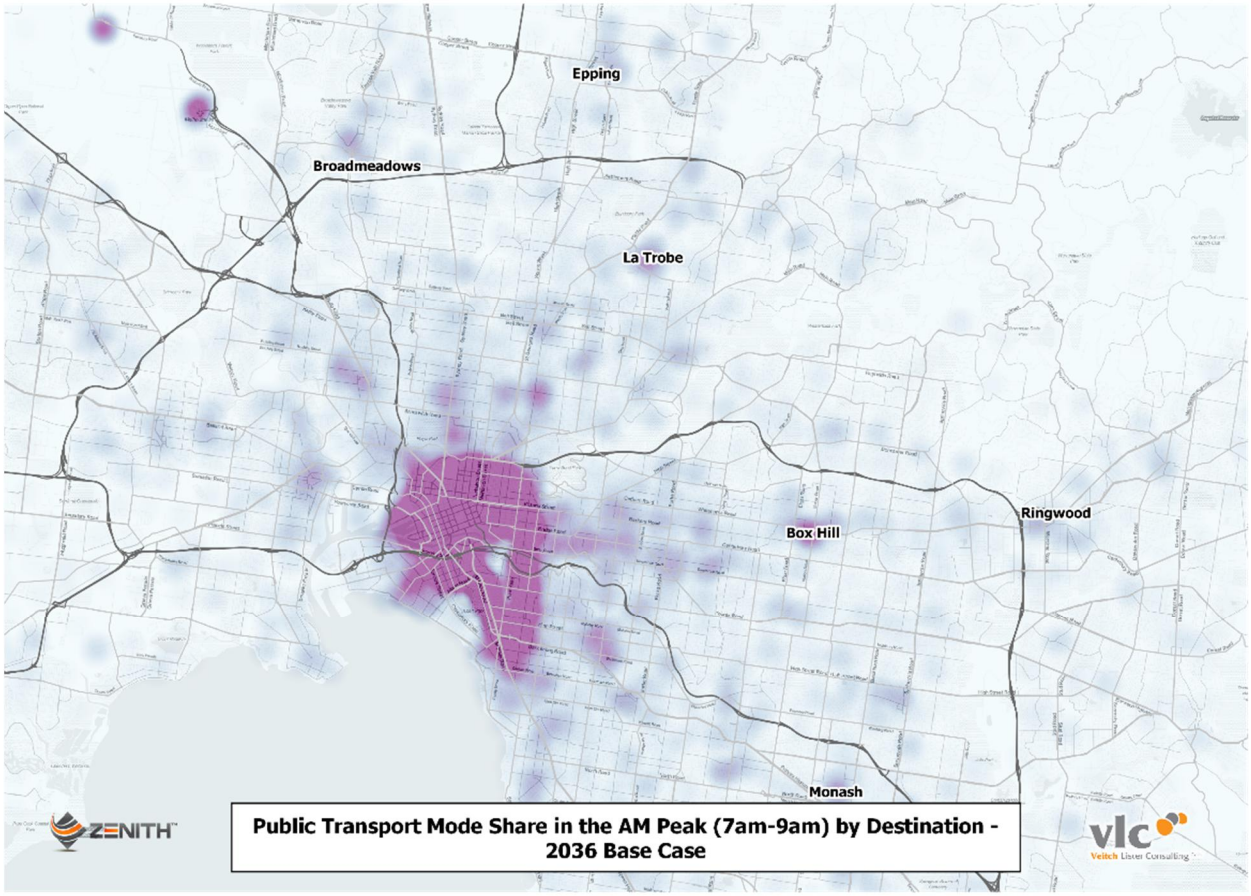


Figure 108 Public transport mode share by destination (2036 'no project' scenario)

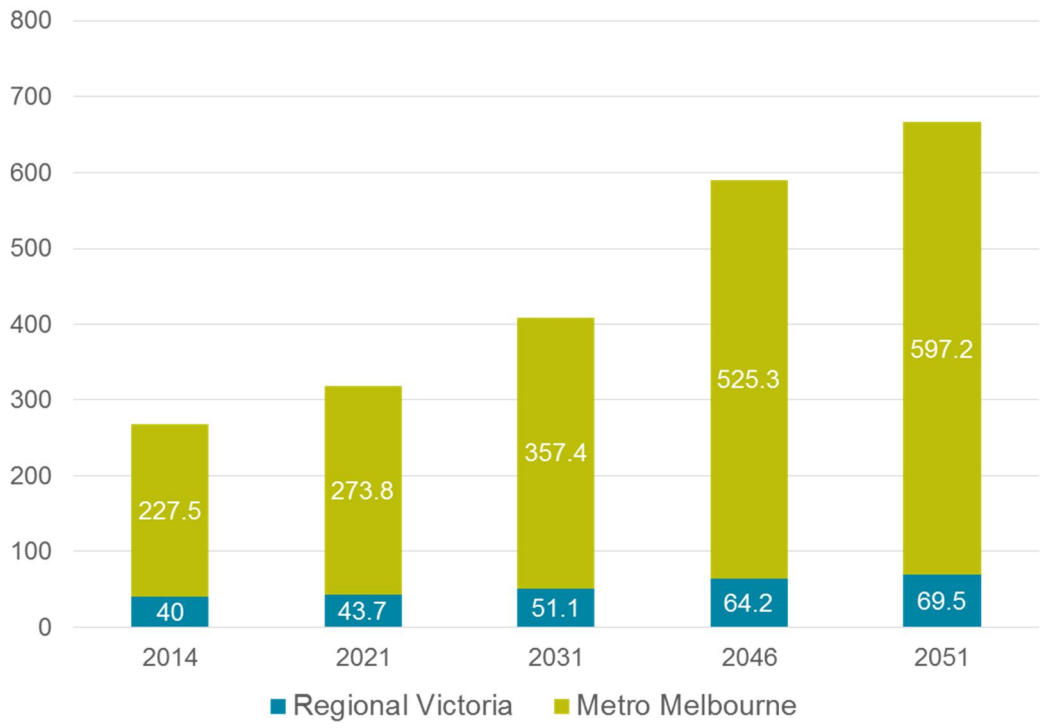


10.6 Freight

Melbourne's freight task will continue to expand in the coming decades, as the Port of Melbourne continues to be the main container port in Australia. Freight activity in Melbourne will continue to be centred around the Port of Melbourne, with significant expansion of the port planned and the construction of a second container port deferred in the near- to medium-term future.

The metropolitan freight task currently makes up around 85 percent of total Victorian freight volumes, at nearly 230 million tonnes in 2014 (Figure 109). That number is forecast to more than double over the next 30 years, growing at around three percent annually.

Figure 109 Victorian freight task 2014 to 2051

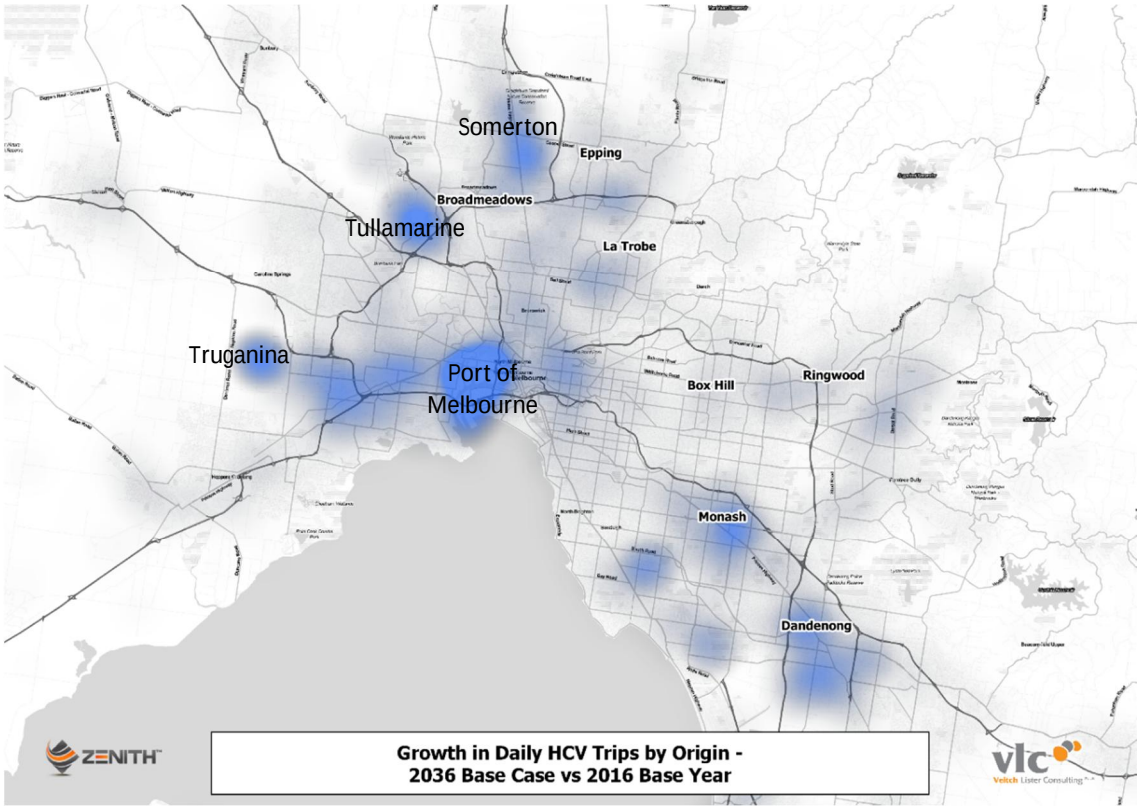


Source: Department of Economic Development, Jobs, Transport and Resources, 2015, Review of Victoria's Freight and Logistics Task

The key industrial precincts in Melbourne will continue to expand, with a high proportion of the freight activity growth located in Dandenong, Monash, Tullamarine, Somerton, Truganina and Laverton. Key developments include the growth of the Somerton and Truganina precincts, as presented in Figure 110.

Freight movements within Melbourne will still be suited to road transport, as modern-day supply chains require the movement of goods to multiple locations across the metropolitan area.

Figure 110 Growth in freight trips by origin (2016 to 2036)

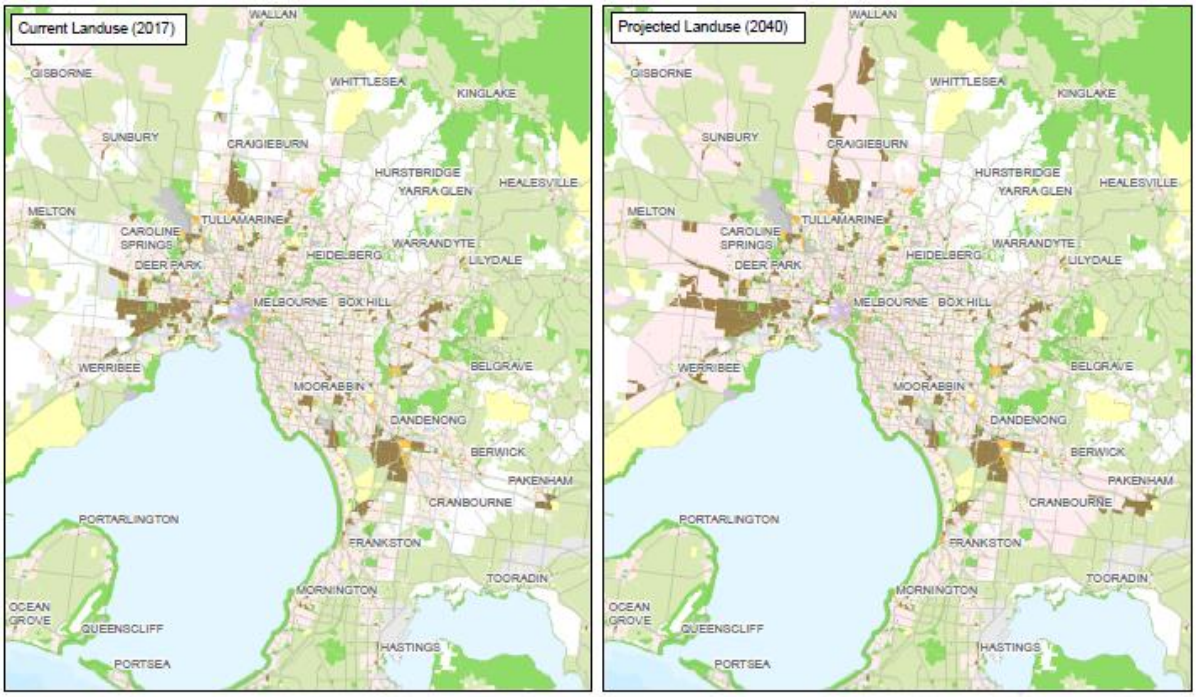


10.6.1 Growth in freight precincts

Melbourne's industrial precincts provide a foundation for much of the freight movement around the city, whether driven by industrial or logistics-based activities. As some manufacturing activities has shifted to overseas locations, an increasing percentage of industrial land is being used by the warehousing and transport task rather than primary product creating activities. However, a solid base of local industrial activities continues to support the maintenance and development of local products and industry in Australia's manufacturing base, which is developing and expanding into new, knowledge-based areas.

Industrial land areas are planned to change over the next 25 years alongside projected land use development across Melbourne. Large changes in land use are predicted within the north, south east and western precincts, as shown in Figure 111. The growth in the northern and south eastern precincts (highlighted in brown) may have an impact on the operation of roads within the north east due to the movement of freight between these locations.

Figure 111 Projected land use change 2017 to 2040

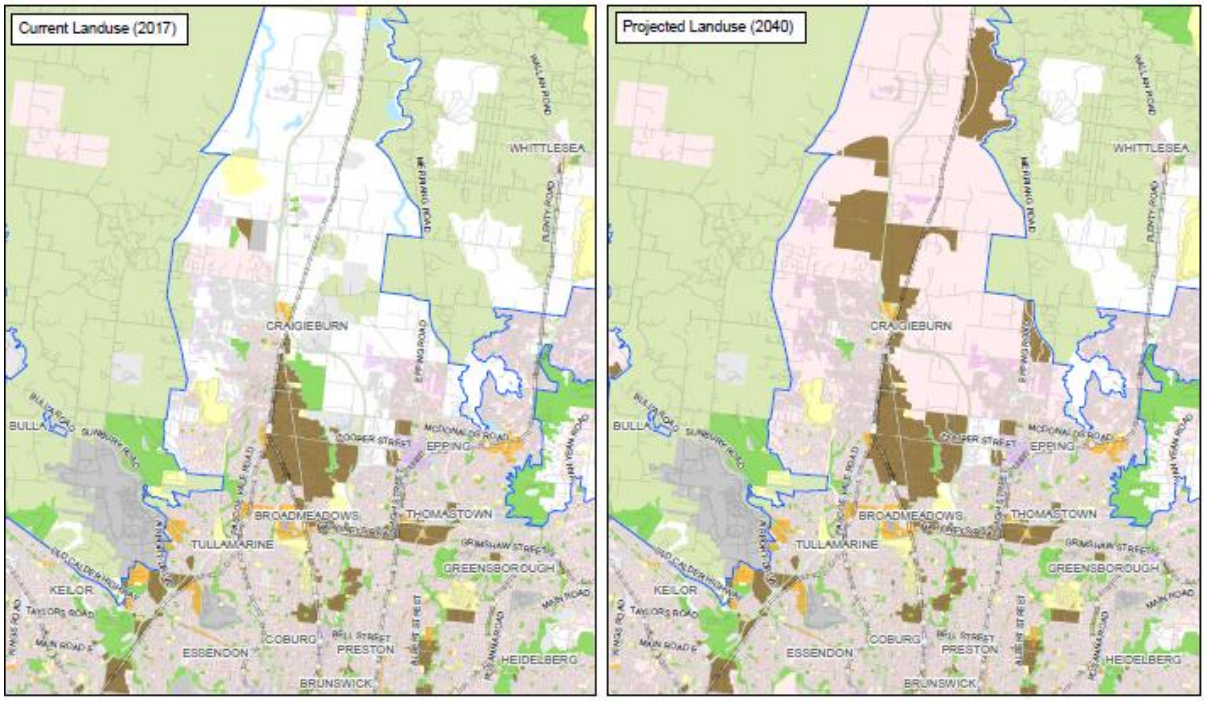


10.6.1.1 Northern industrial precincts

Northern industrial precincts are planned to expand from the existing Somerton and Campbellfield areas to the north of the Craigieburn commercial centre, beyond the current Epping and Melbourne Market area and ultimately into the Beveridge area. This expansion is presented in Figure 112. The northern precincts provide benefits of direct access to regional and interstate markets.

This Northern precinct also includes several retail distribution centres (DCs) including Coles and Woolworths DCs in the Campbellfield and Somerton area.

Figure 112 Northern land use precinct planning 2017 to 2040

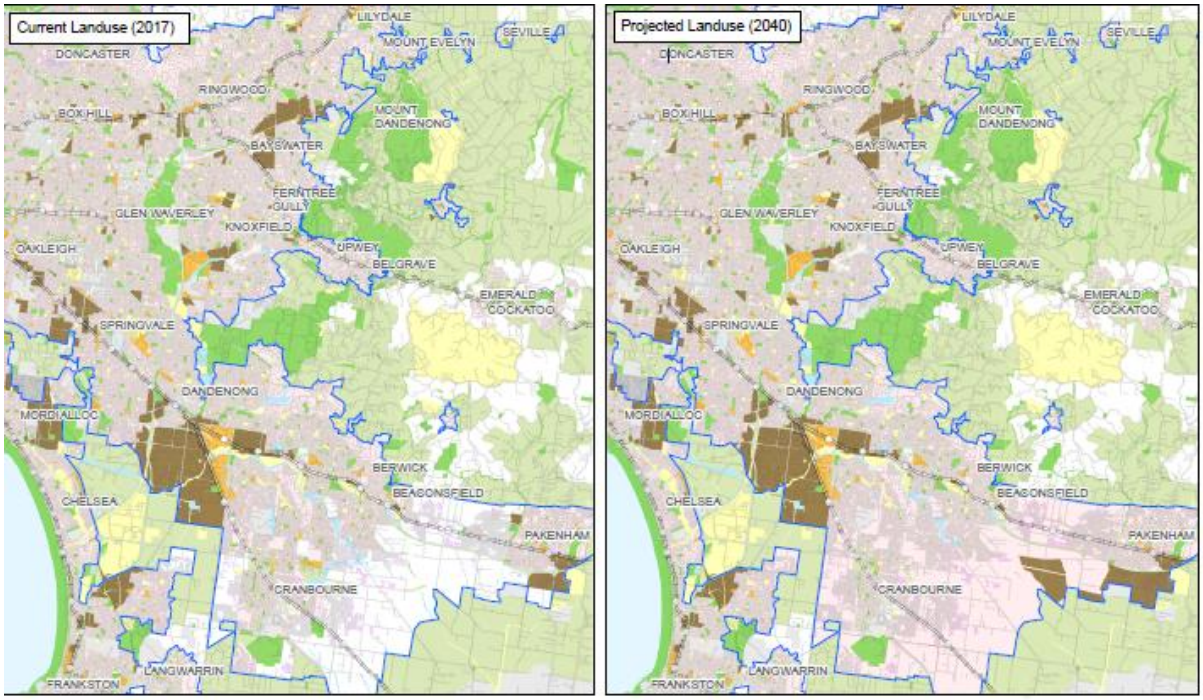


10.6.1.2 South eastern industrial precincts

South eastern industrial precincts are also predicted to expand, extending the current large Dandenong cluster further south to Lyndhurst, further development of the Pakenham and Officer areas and the development of Cranbourne East and Casey developments east of Thompson Road. This growth is shown in Figure 113.

Many industrial businesses in the south east provide services to a range of industries beyond their local precincts and extending interstate to mining and other industry groups. While some larger manufacturers have relocated offshore, there remains a solid mid-size manufacturing and engineering base in the south east responding to domestic Australian markets. Development of new industrial precincts are receiving strong government support to provide jobs within local suburban areas and create environments where travel and infrastructure costs are minimised. Additional distribution centre activity is generated from the major Woolworths site at Waverley, with further DC development by Woolworths progressing at Lyndhurst.

Figure 113 South eastern land use precinct planning 2017-2040



11 The north east in 2036

11.1 Network statistics

Much like the rest of Melbourne, travel times and vehicle speeds within the north east (study area) are expected to deteriorate by 2036. While the changes within the study area are broadly similar to the rest of Melbourne (as presented in Table 17), there are some subtle differences:

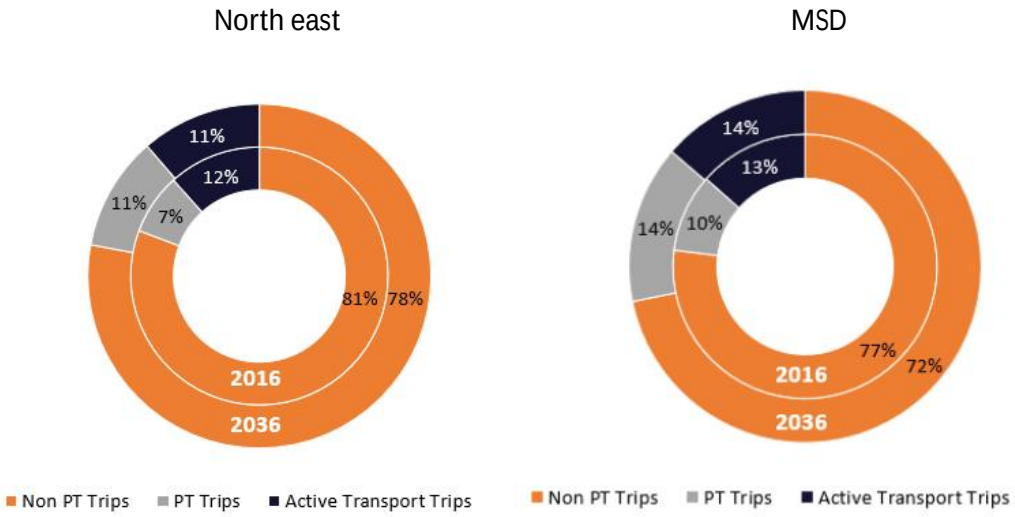
- The total number of trips, total vehicle kilometres travelled and total vehicle hours travelled are expected to increase (by 27, 30 and 46 percent respectively), but not by as much as the Melbourne average (32, 44 and 57 percent). This is largely due to a lower forecast population growth rate within the study area.
- Average trip lengths are not forecast to increase within the study area unlike the rest of Melbourne. The increase in the number of trips (27 percent) is fairly consistent with the increase in vehicle kilometres travelled (30 percent), suggesting that average trip lengths within the north east will remain constant.
- While the growth in vehicle trips in the north east is lower than the rest of Melbourne, average vehicle speeds are expected to decline at a faster rate than the rest of Melbourne, highlighting the continued congestion experienced on the roads within this area. This is largely due to the limited capacity on the road network and relatively little infrastructure upgrades planned to accommodate the additional growth. Average vehicle speeds are expected to decline by up to 16 percent during the peak periods (compared to a 13 to 14 percent decline in the Melbourne average), which means an already slow commute in the north east (compared to the rest of Melbourne) will be even slower in the future.
- The growth in public transport usage is also lower in the north east (79 percent) when compared to Greater Melbourne (111 percent). The lower growth is primarily due to the limited access to public transport facilities in the area, with the majority of public transport being on-road bus services. As these services generally do not have dedicated lanes, buses sit in congestion, making them a less desirable alternative to the private vehicle. As a result, public transport mode share is expected to increase only marginally from 7.5 to 10.5 percent, as presented in Figure 114, which is lower than the estimated 2036 Melbourne average of 14.5 percent.

Table 17 Road vehicle trips, 2036 'no project' scenario

Metric	Time period	North east	Greater Melbourne
Road vehicle trips (Car + LCV + HCV)	Daily	2,283,000 (+27%)	12,478,000 (+32%)
	AM Peak (7am - 9am)	338,000 (+20%)	1,880,000 (+27%)
	PM Peak (4pm - 6pm)	374,000 (+27%)	2,024,000 (+29%)
Vehicle kilometres travelled (km)	Daily	28,070,000 (+30%)	173,015,000 (+44%)
	AM Peak (7am - 9am)	4,209,000 (+23%)	26,443,000 (+35%)
	PM Peak (4pm - 6pm)	4,467,000 (+24%)	28,271,000 (+37%)
Vehicle hours travelled (hrs)	Daily	807,000 (+46%)	4,284,000 (+57%)
	AM Peak (7am - 9am)	169,000 (+46%)	882,000 (+56%)
	PM Peak (4pm - 6pm)	169,000 (+47%)	896,000 (+59%)
Average speed (km/h)	Daily	35 (-11%)	40 (-8%)
	AM Peak (7am - 9am)	25 (-16%)	30 (-13%)
	PM Peak (4pm - 6pm)	26 (-16%)	32 (-14%)
Public transport trips	Daily	388,000 (+79%)	3,108,000 (+111%)

Source: VLC Zenith model

Figure 114 Number of public transport trips compared to all traffic trips (2016 vs 2036 'no project' scenario)

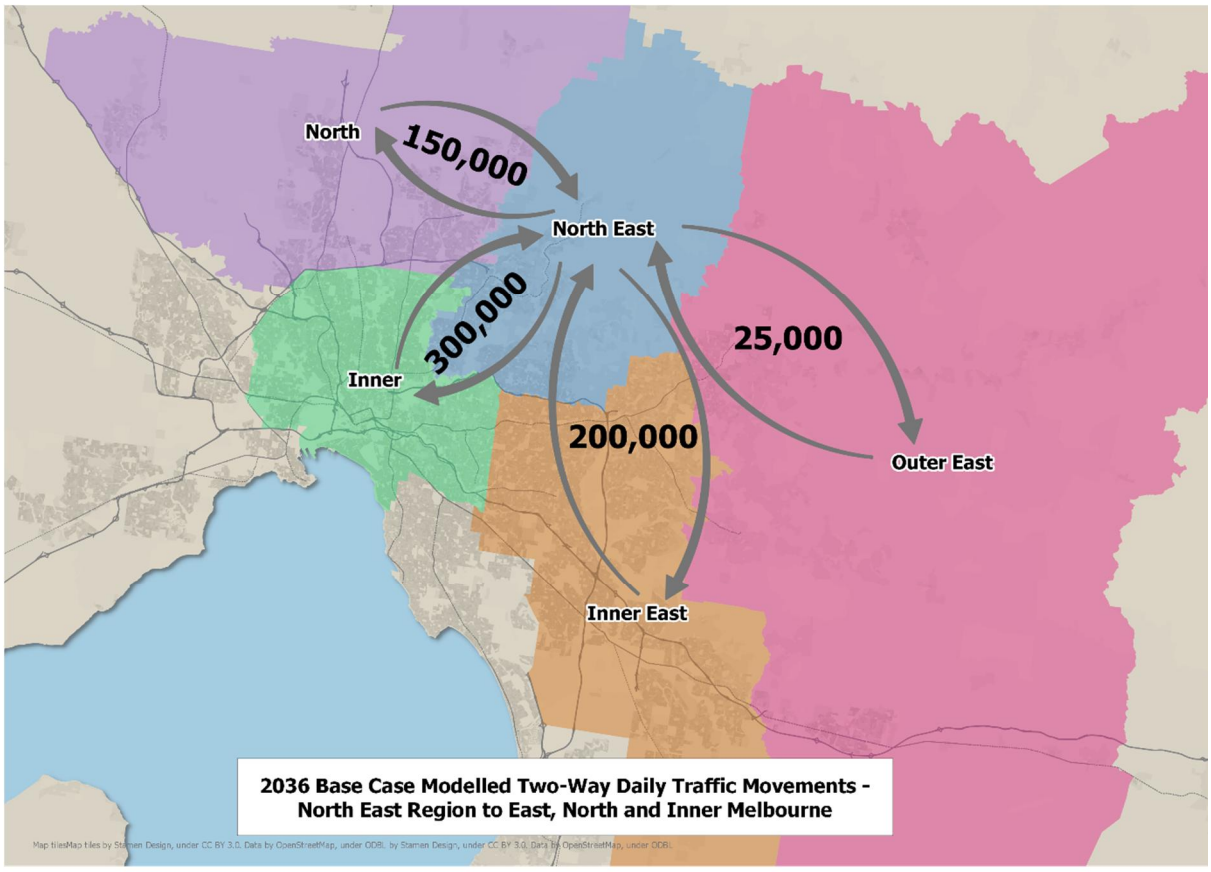


Source: VLC Zenith model

11.2 Trip patterns

Trip patterns to and from the north east are expected to remain broadly the same as today, as presented in Figure 115. Movements to and from the inner areas of Melbourne will increase by 20 percent from to 300,000 trips a day, while trips between the north and the north east will increase by 50 percent and trips between the inner east and the north east increasing by 15 percent.

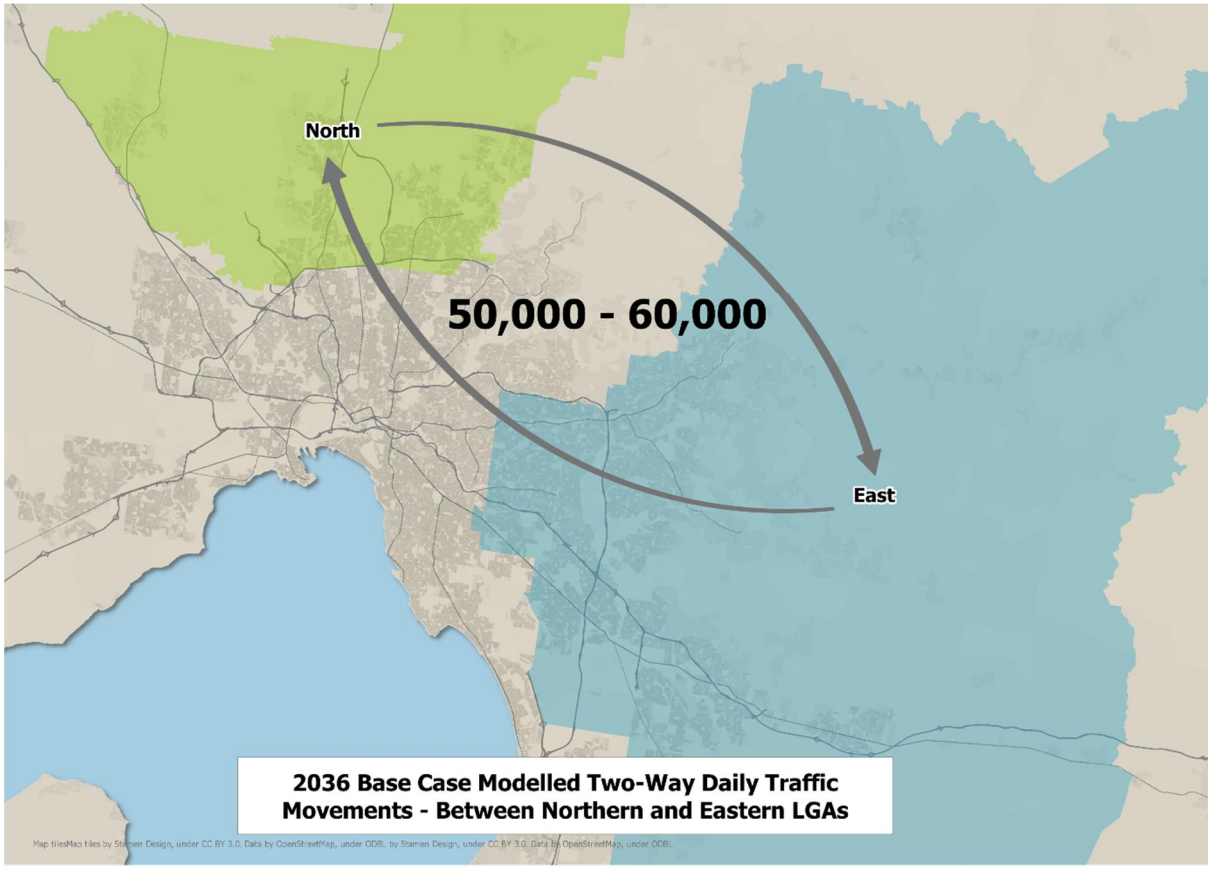
Figure 115 Daily trip movements across Melbourne to and from the north-east (2036 'no project' scenario)



Source: Veitch Lister Consulting, Zenith Model

Additionally, orbital through movements between the east and the north will increase from 40,000 trips a day to between 50,000 to 60,000 trips a day as presented in Figure 116. This means orbital journeys will continue to outweigh the number of radial trips to and from the north east.

Figure 116 Daily trip movements between the east and north (2036 'no project' scenario)



Source: Veitch Lister Consulting, Zenith Model

11.3 Traffic volumes

11.3.1 Limited network capacity for growth

As the road network in the north east is already at capacity today, and with few major infrastructure upgrades planned, there will be limited room for additional trips on the north east road network, especially during peak periods. This means that not all traffic from the outer northern suburbs will be able to travel directly to destinations further south and instead must divert to other routes with more capacity.

For example, a person travelling from South Morang to Monash will be more likely to travel further west via the Tullamarine Freeway (a longer route) rather than sit in traffic along the north east arterial road network (a more direct route) due to congestion on the north east road network.

11.3.2 Yarra River crossings

Road network capacity is the most constrained in the north east across the Yarra River, at the five bridge crossings. Across this screenline, daily traffic volumes are forecast to increase by 25 percent on average by 2036 in a 'no project' scenario, as presented in Table 18.

The largest increase is across Chandler Highway; however, this can be attributed largely to additional capacity from the duplication of Chandler Highway currently underway. This upgrade will increase the number of lanes along Chandler Highway from two to six, providing a significant increase in capacity. The Warrandyte Bridge is also assumed to be widened, which will see an increase in traffic of approximately 30 percent at this location.

Manningham Road and Fitzsimons Lane are predicted to have moderate growth of approximately 20 percent, with the bulk of this growth occurring outside of the peak periods when there is spare capacity.

Daily traffic volumes on Burke Road are expected to increase only slightly by approximately nine percent, as growth is limited by the two-lane section of Burke Road north of the Eastern Freeway, restricting the ability for this road to carry any additional traffic. This constraint is likely to place additional pressure on the crossings at Chandler Highway and Manningham Road.

Table 18 Yarra River screenline assessment 2036 'no project' scenario

River Crossing	Number of lanes (two way)	2036 'no project' scenario (Daily, two way)	Percentage change 2017 to 2036
Chandler Highway	2 (2017) 6 (2036)	63,000 – 82,000	+65%
Burke Road	4	37,000 – 49,000	+10%
Manningham Road	6	71,000 – 92,000	+20%
Fitzsimons Lane	4	63,000 – 82,000	+20%
Kangaroo Ground-Warrandyte Road	2 (2017) 3 (2036)	21,000 – 27,000	+30%
Total			+25%

While the predicted traffic growth on some of the Yarra River crossings over the next 20 years can be considered low, these roads already operate at capacity for long periods of the day. This means that there is limited spare capacity for the roads to carry any additional traffic, forcing traffic onto alternative parallel routes.

This is evident from the forecast growth on Chandler Highway, which shows that there is significant demand to cross the Yarra River but that this is restricted by the crossings currently operating at capacity. This limited capacity will mean that roads will operate near capacity longer throughout the day, with greater congestion and delays.

11.3.3 Change in traffic volumes

Overall, the increase in traffic between now and 2036 is fairly consistent throughout the arterial road network in the north east, increasing by approximately 5,000 to 10,000 vehicles per day.

The expected change in traffic volumes on the arterial and freeway network in the north east is presented in Figure 117, with the daily traffic volumes in the 2036 'no project' scenario presented in Figure 118. Notable increases include:

- Plenty Road (32,000 vehicles per day increase north of the M80 Ring Road);
- Greensborough Road (10,000 to 19,000 vehicles per day increase)
- Waiora Road (11,000 vehicles per day increase); and
- Templestowe Road (14,000 vehicles per day increase).

Figure 117 Change in daily traffic volumes between 2017 and 2036 'no project' scenario

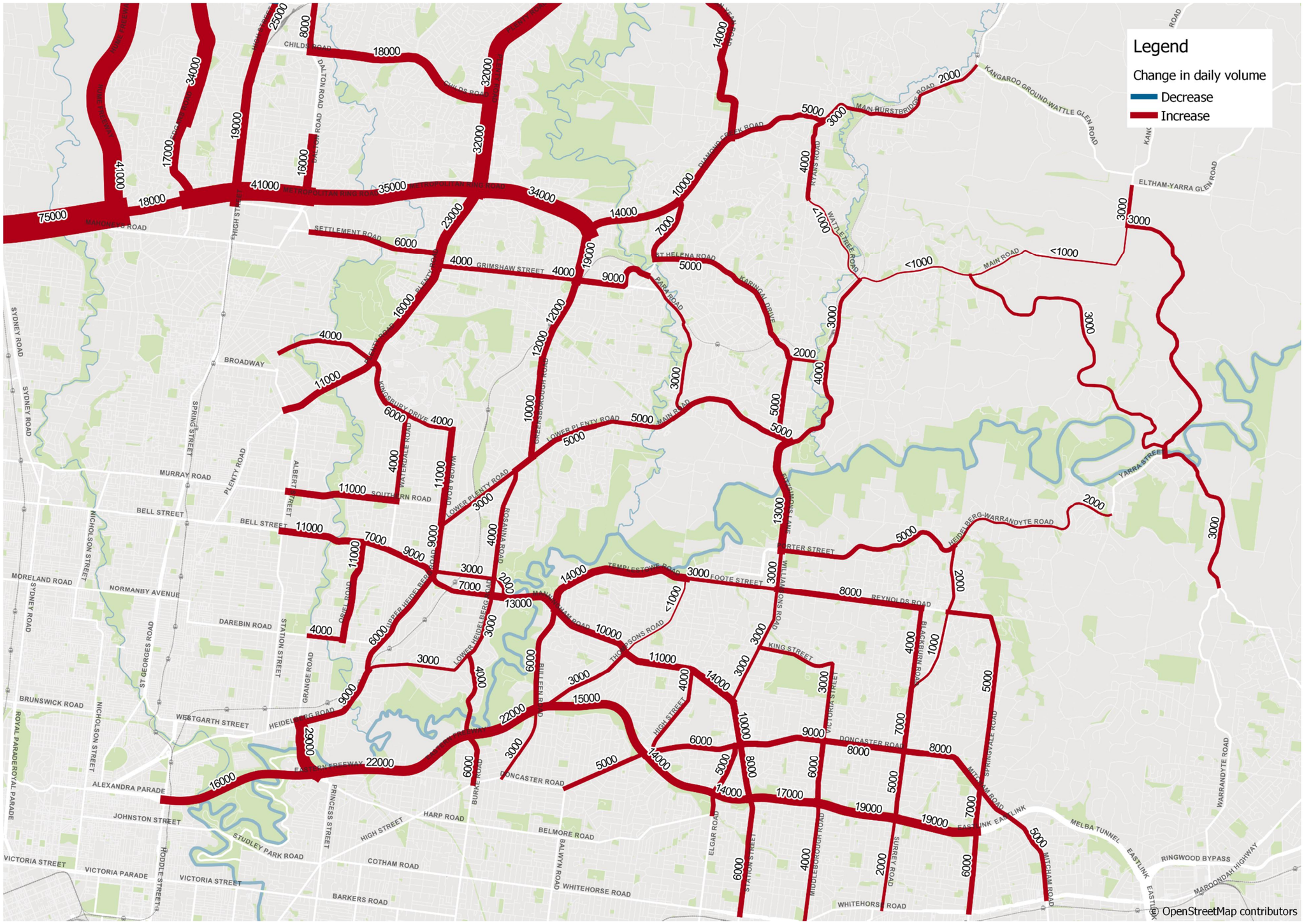
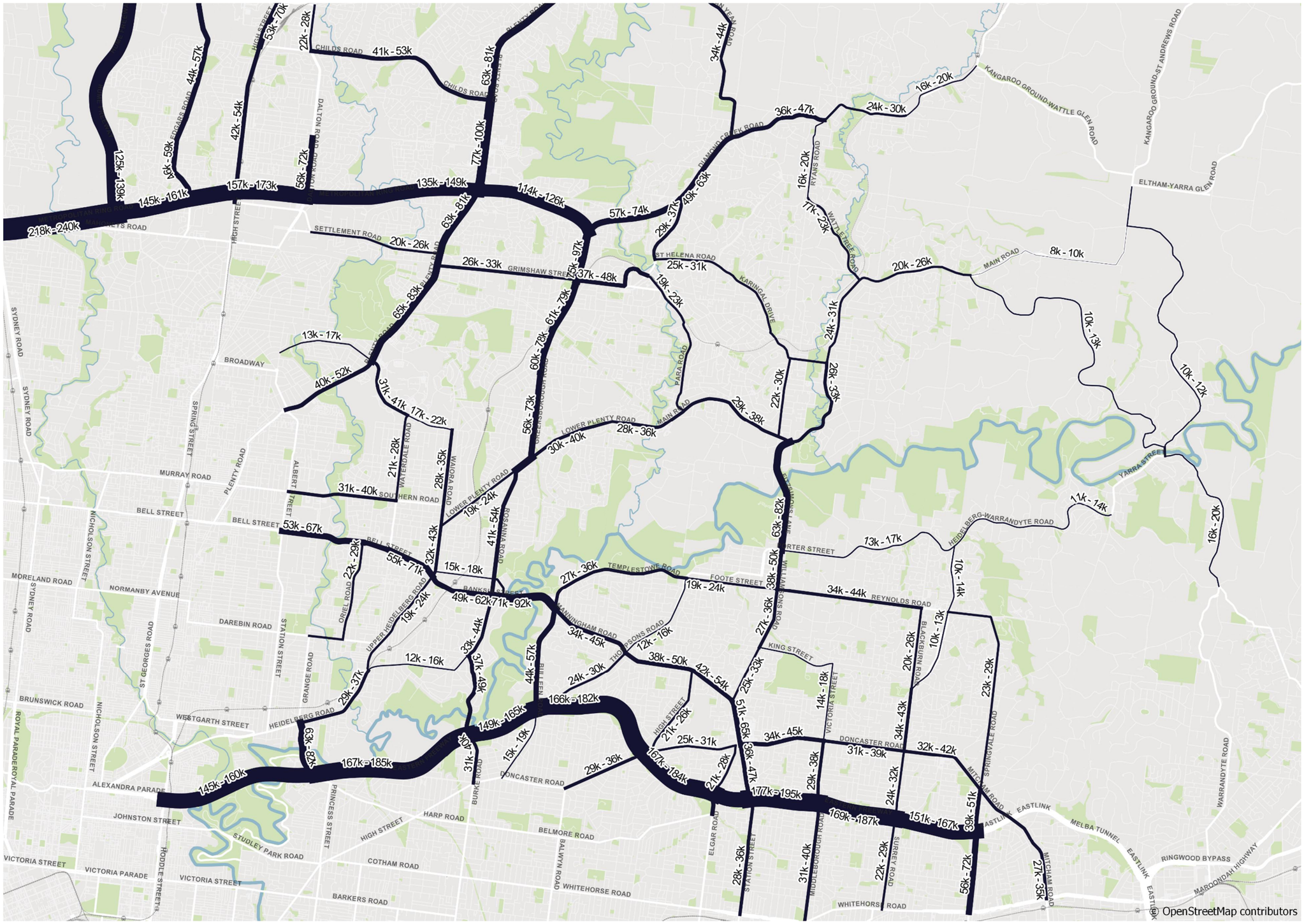


Figure 118 Daily traffic volumes 2036 'no project' scenario



11.4 Travel time changes

11.4.1 Key routes

As more people live in the outer north of Melbourne and commute into the inner and middle ring suburbs to work, roads in the north east will become more heavily congested, especially during peak periods.

With no significant new capacity or new roads planned for the north east, people will have to use already busy arterial roads such as Greensborough Road, Rosanna Road, Bulleen Road and Fitzsimons Lane to access services and jobs. All of the six travel time routes surveyed in Figure 119 will see an increase in travel times between now and 2036 as presented in Table 19. Travel times will worsen between 15 to 35 percent. This means the commute on route F between the Eastern Freeway (Doncaster Road) and M80 (Plenty Road) will be up to 10 minutes slower in the morning and evening peak periods on average.

These changes in travel times may not seem significant; however, many of these routes are already heavily congested during peak hour, resulting in people using other alternative routes instead. This is why travel times are not expected to significantly deteriorate on the Eastern Freeway during the AM and PM peaks.

Figure 119 Travel time routes

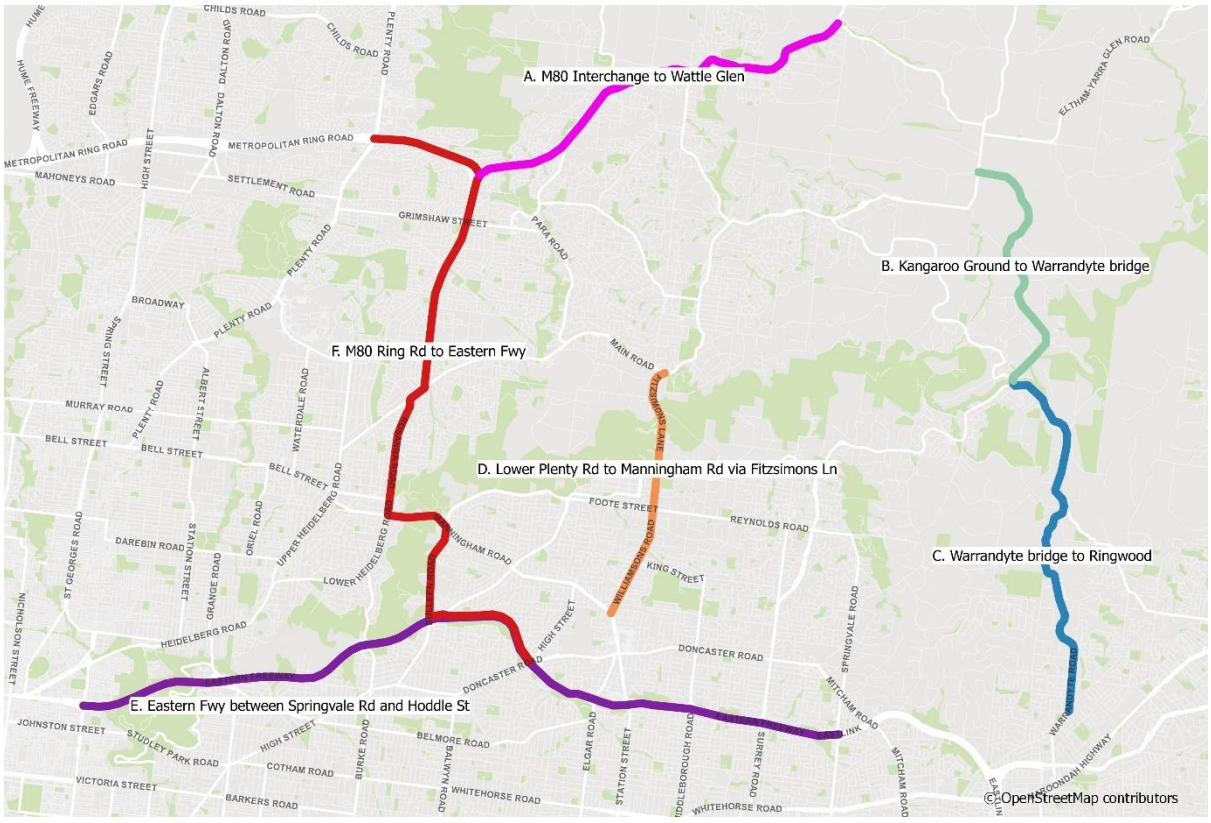


Table 19 Change in travel times between 2017 and 2036 'no project' scenario

Route	2036 'no project' scenario travel times					
	AM peak (7-9am)			PM peak (4-6pm)		
	Direction	2036 travel time (mins)	% change	Direction	2036 travel time (mins)	% change
A – Wattle Glen to M80 Interchange	WB	22 (average)	+32%	EB	19 (average)	+27%
B – Kangaroo Ground to Warrandyte Bridge	SB	10	+31%	NB	8	+36%
C – Warrandyte Bridge to Ringwood	SB	13	+21%	NB	17	+20%
D – Main Road to Manningham Road	SB	13	+21%	NB	25	+20%
E – Eastern Freeway, Springvale Road to Hoddle Street	WB	31	+17%	EB	28	+17%
F – M80 to Eastern Freeway	SB	54	+21%	NB	52	+22%

11.4.2 Travel time between key locations

Overly trafficked roads in Melbourne's north east also increase local residents' daily commutes to their workplaces. For working members of households in Melbourne's north east, a significant part of their commute time is spent moving through local and arterial roads to access higher capacity parts of the network.

Although these distances can be short in terms of overall distance travelled, they account for a significant proportion of the total journey time. For example, travel times in Table 20 for the travel time pairs in Figure 120 show that it currently takes between 10 and 35 minutes (20 to 60 km/h) to travel the 10 kilometres between Greensborough and Heidelberg in the morning peak and between 25 and 60 minutes (15 to 20 km/h) to travel the 15 kilometres between Epping and Northland – an average additional 20 minutes for a further five kilometres. By 2036, the trip time between Epping and Northland is estimated to increase by up to 50 percent. This will impact travel time and reliability not only for private vehicles but also for freight and on-road public transport.

Figure 120 Travel time locations assessed

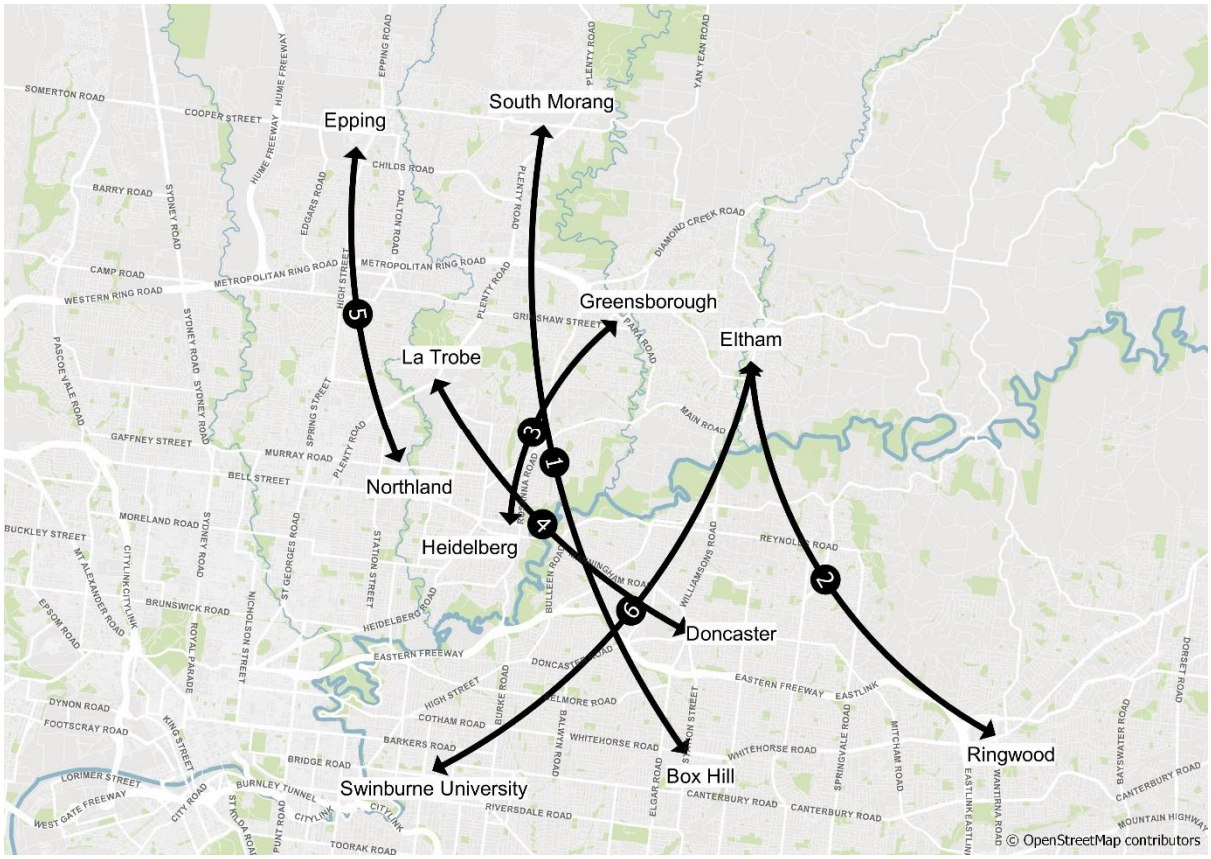


Table 20 Travel time changes between locations in the AM peak

Origin	Destination	2017 travel time (mins)	Percentage change
South Morang	Box Hill	45 to 100	20% to 25%
Eltham	Ringwood	25 to 50	20% to 25%
Greensborough	Heidelberg	10 to 35	30% to 35%
Doncaster	La Trobe	20 to 40	15% to 20%
Epping	Northland	25 to 60	45% to 50%
Eltham	Swinburne University	30 to 70	15% to 20%

Source: Google Maps and VLC Zenith Model

11.5 Freight

11.5.1 Freight task on roads within the north east

As the industrial areas in the north and south east of Melbourne continue to grow, additional pressure will be placed on the road network. This is likely to result in increased levels of congestion along the critical M1 corridor, which will result in diversion onto other roads.

The change in trucks between 2017 and 2036 is presented in Figure 121, with daily truck volumes in 2036 presented in Figure 122.

Truck volumes on roads within the north east will increase as trucks travel between the north and south east industrial precincts while avoiding the congestion on the M1 corridor. This will result in Rosanna Road remaining the main freight route through the north east due to its connectivity between the M80 and the Eastern Freeway. However, without any new transport infrastructure planned in the area, the burden of additional freight through the region will be shared fairly evenly across the entire arterial road network.

The continued reliance on Rosanna Road to carry high volumes of trucks will increase the conflict between local and 'through' traffic use of the road. Trucks volumes on Rosanna Road will increase by approximately 1,300 a day, which means that by 2036 between 3,800 to 5,000 trucks a day will use the road.

Figure 121 Change in daily truck volumes between 2017 and 2036 'no project' scenario

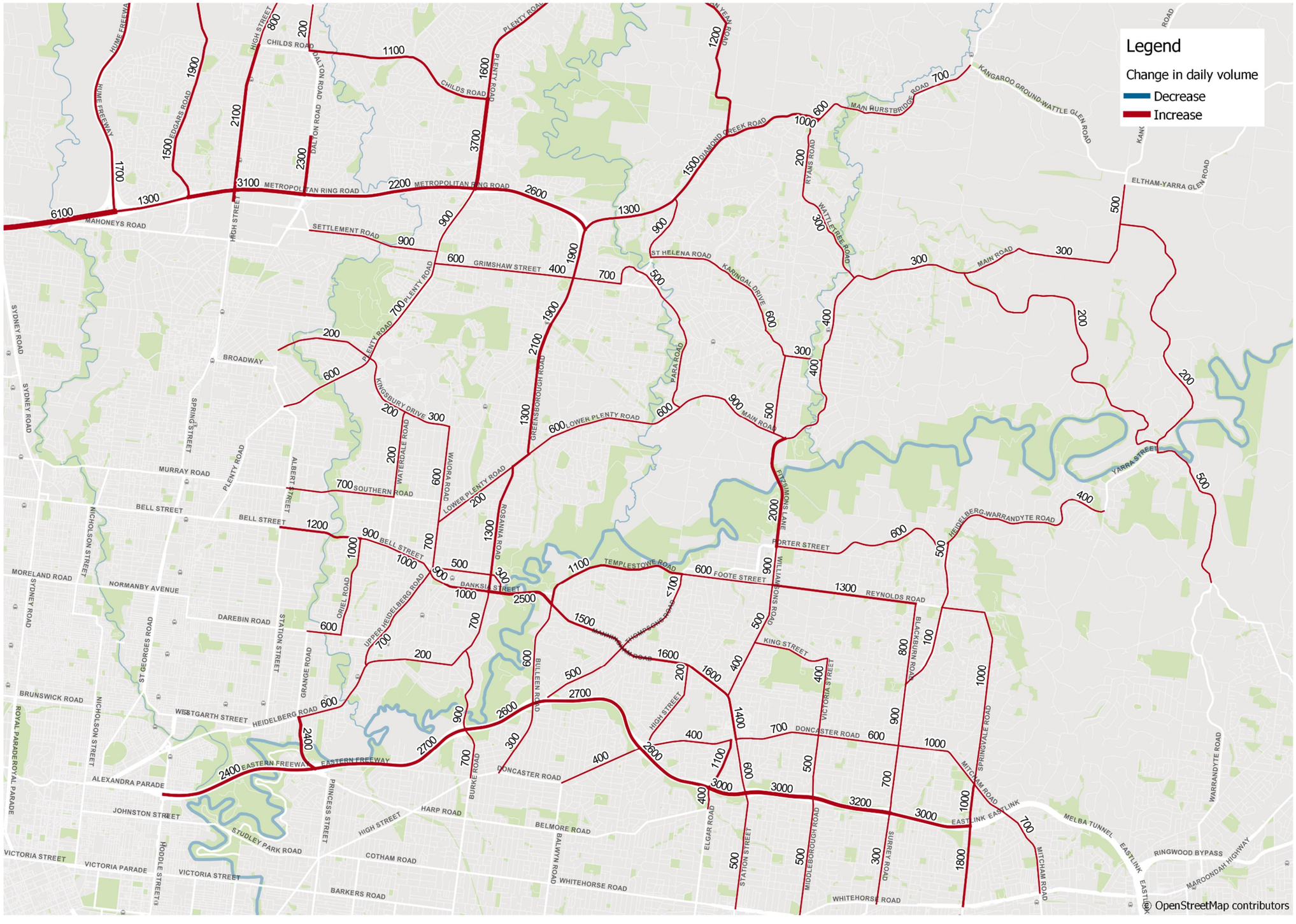


Figure 122 2036 'no project' scenario truck volumes