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Rail Futures Inc

THE MELBOURNE RAIL PLAN

Moving People in a City of 8 Million

25 May 2019

Draft for comment

This paper has been prepared by Rail Futures Incorporated in the public interest. Rail Futures Inc is an independent non-partisan group formed to advocate cost effective rail and intermodal solutions for public transport and freight problems based on sound commercial, economic and social reasoning. Rail Futures members include experienced rail professionals, engineers, planners and economists.

Foreword

Melbourne once had one of the world's best public transport systems. The forethought and planning of Victorians more than a century ago, and their capacity to value the welfare of Victorians of the future -us - as highly as their own, helped make Melbourne one of the world's economically most productive and liveable cities. For the past few generations, myopia, carelessness and excessive valuation of the present over the future have been squandering that wonderful legacy. The economic and social life of this city will be deeply impaired by barriers to movement of people around the city unless chronic underinvestment over recent generations is remedied.

The Melbourne Rail Plan 2019-50 demonstrates the way to correct the mistakes of recent generations, and that some contemporary Victorians are up to the challenge. The Report is comprehensive, creative and authoritative. It is an excellent foundation for rebuilding Melbourne to secure its position as one of the world's most successful cities.

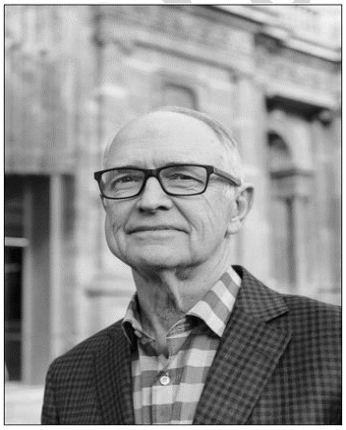
Melbourne is growing more rapidly than any other large city in the developed world.

Yet cities anywhere near Melbourne's size in Europe and east Asia now have far better metropolitan rail systems. Cities of Melbourne's size cannot function efficiently without effective rail transport.

The Report is based on integration of a range of transport technologies. Heavy and light rail is necessarily at its centre, with the strengthening of Melbourne's famed tram system an important part of the plan. While the backlog is large, catching up is supported by Melbourne's flat terrain, its railway heritage and by established grid road patterns. The Report contains carefully constructed proposals for completing rail grids in areas near the city centre and extensions to more distant suburbs where much population growth has been occurring. It discusses opportunities for lowering costs and increasing amenity by ensuring that opportunities for active transport - walking and cycling - and use of autonomous vehicles and other emerging technologies are integrated into planning for rail.

Large public investment will be required to rebuild Melbourne's public transport system. The economic case for the required investment is strong. It is stronger in the 21st century, when changes in global savings and investment patterns have greatly reduced the interest rates at which the private sector is prepared to lend to governments. Near zero real interest rates strengthen the economic case for long term investments in public infrastructure - especially on systemic changes that remedy Melbourne's rail deficit and generate benefits for the long-term life of our large city.

The Victorian Government has begun the rebuilding of Victoria's public transport infrastructure. This Report provides sound guidance for the immense task that lies ahead.



Ross Garnaut

Professor of Economics,

University of Melbourne

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PREFACE

This *Melbourne Rail Plan* (MRP) has been prepared by a transport and planning team at the Rail Futures Institute (RFI) in collaboration with members of the RMIT University School of Global Urban and Social Studies.

RFI is a self-funded, think tank and advocacy group of rail professionals, engineers, urban planners and economists working in the public interest. We undertake independent research and advocacy to promote rail-based solutions when we judge these will best meet the future needs of passenger and freight transport.

MRP is the RFI blueprint for the next thirty years of rail development in Melbourne to support a projected population of 8 million by 2050.

The challenges of population growth require fundamental shifts in strategic transport policy and comprehensive integration of transport and land use planning.

Improved rail services as part of integrated transport policy can play a very significant role in the growth and development of Melbourne, consistent with the objectives of Plan Melbourne and the State's Transport Integration Act.

The Melbourne Rail Plan presents a strategy for rail-based transport modes within the broader context of a fully integrated multi-modal transport system. It shows how such development, through phased investment, can significantly reduce Melbourne's massive car dependency and thereby benefit the city's liveability, economic performance, social fabric and environmental sustainability; and make an important contribution to meeting the Government's statutory obligations and planning objectives.

Achievement of these outcomes will require complementary transport planning for Melbourne's regions as well as policies and programs beyond rail strategy. Strong leadership is required by the State Government to ensure transport infrastructure and services are planned and delivered in alignment with settlement patterns to enable more efficient access between residences, jobs and services. Key to this is reducing travel inefficiencies related to congestion and excessive commuting times arising from the dominance of the transport task by sole occupant vehicles.

RFI's plan for the future of public transport in metropolitan Melbourne sets out staged priorities for phased implementation of its proposals to 2050, to balance ambitious and conservative initiatives with realistic funding capacity.

RFI acknowledges that the scale of investment required is unprecedented and will require new funding mechanisms, both public and private.

Planning for human settlement and movement is a dynamic process. RFI will therefore continue to review and update our plans in line with continually evolving knowledge and experience and the wider environment in which we live. This includes adaptation to the changing climate and adoption of relevant new technologies.

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EXECUTIVE SUMMARY

THE MELBOURNE RAIL PLAN is a blueprint for the next 30 years of rail development in Melbourne. It presents a strategy for rail-based transport modes within the context of a future fully integrated multi-modal transport system. Such development, through phased investment, will significantly reduce Melbourne's massive car dependency and benefit the city's liveability, economic performance, social fabric and environmental sustainability.

Melbourne's population reached 5 million in 2018 and the most recent forecasts are for a city of 6 million by 2031 and 8 million by 2050 or sooner. Melbourne's continued urban spread and population growth has not been matched with an equivalent expansion of the transport network. Symptoms of this transport malaise include worsening congestion, excessive journey to work times, restricted access to jobs, car dependent new suburbs, along with negative social, health and environmental impacts. Most new outer urban growth is occurring in areas without adequate or planned provision of public transport. Strong population and employment growth in central Melbourne and inner suburbs are placing severe strain on the radial rail and road networks with overcrowded trams being among the world's slowest, operating well below their potential. Many public transport vehicles and much rail and tram infrastructure remain non-compliant with National Disability Discrimination Act (DDA) specifications.

The challenges of population growth require fundamental shifts in strategic transport policy and serious integration of transport and land use planning. Improved rail services as part of an integrated transport policy can play a very significant role in the growth and development of Melbourne, consistent with the objectives of the State Government's *Plan Melbourne (2017-2050)* and the *Transport Integration Act.* Investment in rail infrastructure is a powerful city shaping tool and can help transport Melbourne to 2050 by:

- providing Melbournians much wider access to employment and opportunities
- delivering on the Plan Melbourne polycentric city concept
- integrating the metropolitan economy by linking activity centres and boosting the role of National Employment and Innovation Clusters (NEICs)
- promoting transit-oriented development (TOD) around key rail stations
- using the tram network to help shape rapid inner area densification; growing rail capacity to better serve Melbourne's outer growth suburbs
- delivering environmental, health and safety benefits.

The Plan has ten key elements:

- Making the existing system work better by maximizing use of the existing assets
- Creating a multi-modal grid network of high frequency services
- Completing major cross-city mass transit rail routes and a dedicated CBD to Melbourne Airport rail link
- Maximising the potential of the tram network to enhance connections for middle and inner suburbs, new CBD routes and cross-suburban journeys including route extensions and new links to rail interchanges
- Extending electrified rail coverage of metropolitan services to outer growth areas
- Developing new Medium Capacity Transit (MCT) systems (including light rail) providing high frequency orbital, cross-suburban and CBD-linked routes
- Connections to and between National Employment Clusters and Major Activity Centres
- Re-configuration of the bus network to effectively complement rail, trams and MCT
- Strongly facilitating active transport (cycling and walking) to and from public transport
- Improving accessibility of services for less able people and meeting DDA compliance.

Melbourne's existing train and tram networks are hugely valuable assets. Much can be done to enable these assets to work harder and deliver services more efficiently. While this Plan requires the provision of new large-scale infrastructure, it also aims to increase the capacity, attractiveness and efficiency of the existing network through a range of investment and operational initiatives.

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The Train Plan

The main components of the Train Plan are:

- 4 new mass transit Heavy Rail Lines
- 4 extensions of existing rail lines
- electrification of inner parts of 5 regional lines
- network reconfiguration to provide multiple major cross-city corridors
- duplication of 4 single-track sections
- 21 new stations on existing and extended lines
- level crossing removal at a further 16 locations which negatively impact rail and on-road public transport
- replacement of obsolete and inadequate infrastructure including track and structures, power supply and overhead upgrading, station rehabilitation, and new signalling and communications systems
- new trains of increased length and capacity
- new maintenance and train stabling facilities
- new and enhanced services operating to “turn up and go” frequencies.

The Tram Plan

Features of the Tram Plan are:

- 6 short route extensions
- 7 longer route extensions
- an extended Western and Northern CBD network
- expanded and reorganised route network
- upgraded stops and interchanges, meeting obligations for less able travellers
- improved connectivity between services at inner Melbourne locations
- a fleet of 640 low floor articulated trams by 2034, replacing over 300 older low capacity/high floor trams
- upgraded power supply and traction systems
- new tram maintenance and depot facilities
- new and enhanced services operating to “turn up and go” frequencies.

The Medium Capacity Transit (MCT) & Light Rail Plan

Medium Capacity Transit (MCT) is a key element of the Melbourne Rail Plan. A new concept for Melbourne, it provides an urban public transport solution ideally suited to new trunk routes not requiring the capacity of conventional heavy rail systems and deliverable at substantially lower cost. MCT infrastructure will be on the surface, elevated or underground, as determined by individual route conditions. MCT technologies are rapidly evolving, ranging from conventional light rail using upgraded trams, light metro railways to high capacity guided buses with electric and hybrid traction systems. In Melbourne, MCT will use one or more of these systems. It will fully complement other modes and interlock as one network with interchanges making it convenient to transfer between modes.

The proposed 10 initial MCT routes provide high quality cross-suburban connectivity, comprising:

- one radial corridor
  - Fitzroy to Doncaster Hill via Victoria Park and Bulleen
- 3 major orbital corridors:
  - Melbourne Airport to Derrimut via Keilor, Taylors Lakes, Delahey and Deer Park
  - Melbourne Airport to Monash University via Broadmeadows, Keon Park, Latrobe University, Heidelberg, Doncaster, Box Hill, Burwood and Mount Waverley
  - Ringwood to Mentone via Knox City, Rowville, Dandenong and Keysborough

- 6 major cross-suburban corridors:
  - Caulfield to Keysborough via Chadstone, Monash University and Springvale
  - Elsternwick to Rowville via Ormond, Huntingdale and Monash University

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- Sunshine to Altona via Braybrook, Maidstone, Footscray and Kingsville
- Newport to Brimbank Central via Brooklyn, Sunshine, Ginifer and Cairnlea
- Williams Landing to Tarneit via Point Cook, East Werribee NEIC and Hoppers Crossing
- Williams Landing to Sayers Road (future station) via Truganina

The Metropolitan Bus Network

The Plan requires a substantial re-structure of the metropolitan bus network to effectively complement the proposed train, tram and MCT networks. The revised bus network will operate at 3 levels:

- High frequency SmartBus routes on trunk corridors (including routes developed to build corridor patronage in anticipation of future MCT investment)
- High frequency feeder services to train, tram or MCT interchanges
- Local services to Major and Local Activity Centres, schools, hospitals, etc.

The bus network will be pivotal in completing the grid network of high frequency public transport on routes which cannot justify investment in major fixed infrastructure. It will be designed to provide convenient interchanges at key nodes with other modes. All principal routes would operate at "turn up and go" frequencies compatible with train, tram and MCT services. Detail of the reworked metropolitan bus network is beyond the scope of this Plan; a total review should be a Department of Transport (TfV) priority.

Active Transport

For Melbourne to have strong and healthy communities and high rates of social and economic participation, the share of trips by public transport, walking and cycling must increase. A key factor in achieving this objective is promotion of walking and cycling access to trains, trams and MCT.

Provision of dedicated safe walking and cycling paths to all principal public transport corridors and mass bicycle storage facilities at train, tram and MCT interchanges are integral components of this Plan.

A Connected City

The projects promoted in this plan are focused on improving public transport across Melbourne to ensure effective connectivity between residential areas, employment, educational, social and recreational centres without people being completely dependent on cars.

If *Plan Melbourne (2017-2050) i*s to succeed in making suburban NEICs and activity centres viable and functional places, then Melbourne will require not only much higher capacity radial rail transport, but also a quantum leap in cross-suburban public transport. The Plan proposes high-quality links to designated NEICs and some Major Activity Centres.

Estimated Cost

The Plan initiatives will require an investment of $119 billion over a 30-year period to 2050 comprising:

- Heavy Rail infrastructure $70 billion
- Tram infrastructure $9 billion
- Medium Capacity Transit infrastructure $29 billion
- Rolling stock (Trains, trams and MCT) $11 billion

The proposed capital investment program of $119 billion over 30 years to 2050 is the minimum required to meet Melbourne's public transport needs. Further expenditure to meet an even larger public transport task will be needed as Melbourne grows beyond 8 million people.

Outcomes

Based on extensive modelling undertaken with the support of RMIT University (School of Global and Social Studies), the percentage of Melbourne residents and jobs that enjoy good to excellent public transport access increases from 7% in 2016 to 31% if all proposals in this Plan are implemented.

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PART 1: MELBOURNE'S GROWTH STORY

Part 1 describes Melbourne's growth story and sets the context for developing this Plan.

- Section 1 documents Melbourne's historic and forecast population growth to 2050. It discusses the consequences and challenges of rapid and unprecedented growth.

- Section 2 contains a review of current planning policies.

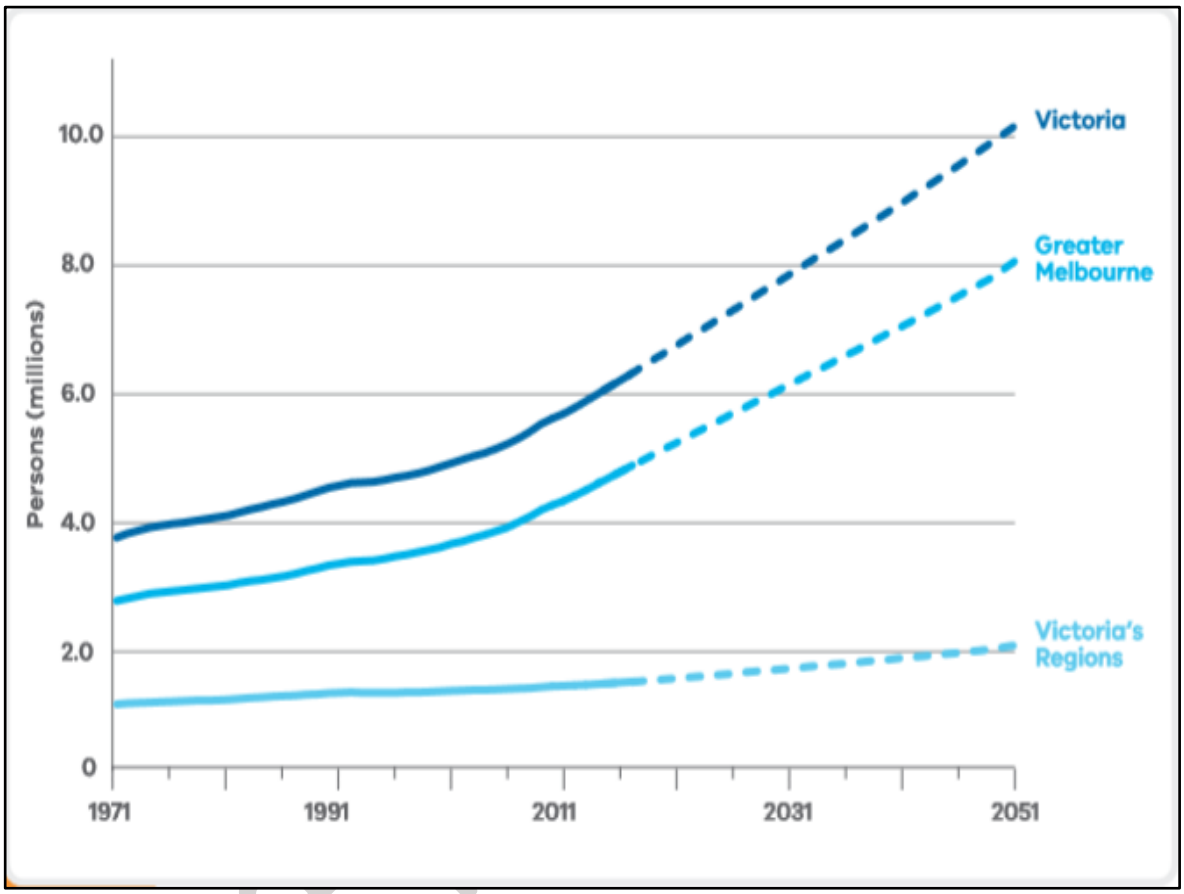
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1. Melbourne's Growth

1.1 Population Growth

Founded in 1836, Melbourne has grown to a city of more than 5 million people. Melbourne's population has increased by 50% since 1990 and is now increasing by about one million every 8 years. (Figure 1).

Figure 1: Population Growth in Victoria and Greater Melbourne



Source: *Victoria in Future 2016 (VIF 2016)*
https://www.planning.vic.gov.au/__data/assets/pdf_file/0030/97608/Victoria-in-Future-2016-FINAL-web.pdf

In 2018, the Australian Bureau of Statistics (ABS) produced forecasts of the size, structure and distribution of population in Australia under various assumptions of fertility, mortality and migration rates. These assumptions are based on long and short-term trends and scenarios dictated by research in Australia and elsewhere.

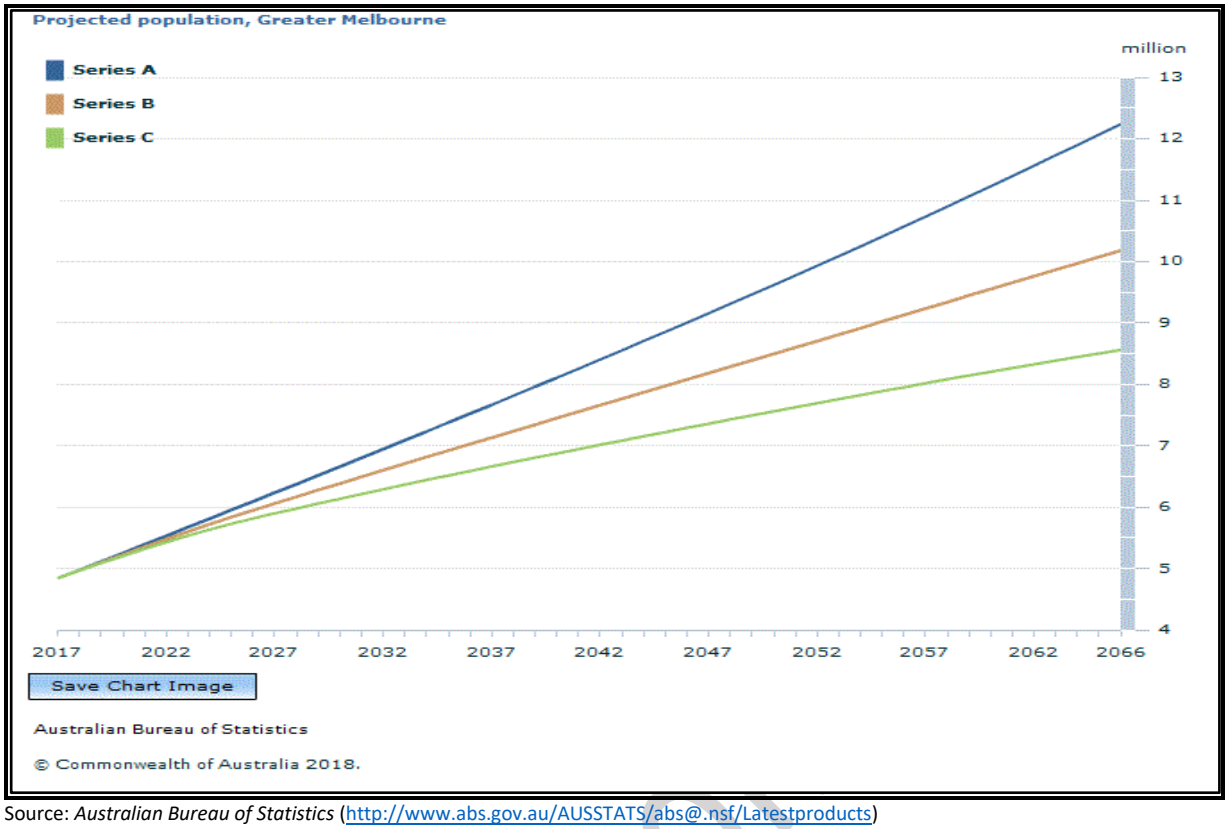
For simplicity, most analysis is limited to 3 selected series which cover 3 sets of possible population growth outcomes: higher (series A), medium (series B) and lower (series C). Projections for Greater Melbourne are shown in Figure 2.

Greater Melbourne's population is projected to increase from 4.8 million at 30 June 2017 to between 5.9 million (series C) and 6.2 million (series A) in 2027. By 2051, Victoria's population is predicted to exceed 10 million with more than 8 million in Melbourne. Most of Victoria's growth is projected to occur in Greater Melbourne.

At 30 June 2017, Greater Melbourne had 77% of Victoria's population. This proportion could increase to 79% in 2027 and reach between 84% and 85% in 2066.

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Figure 2: Projected Population, Greater Melbourne



Source: *Australian Bureau of Statistics* (http://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts)

1.2 Urban Area Growth

Historical population growth has led to progressive expansion of Melbourne's urban area. The macro-urban form of this growth has been determined largely by dominant modes of transport at various periods in Melbourne's history.

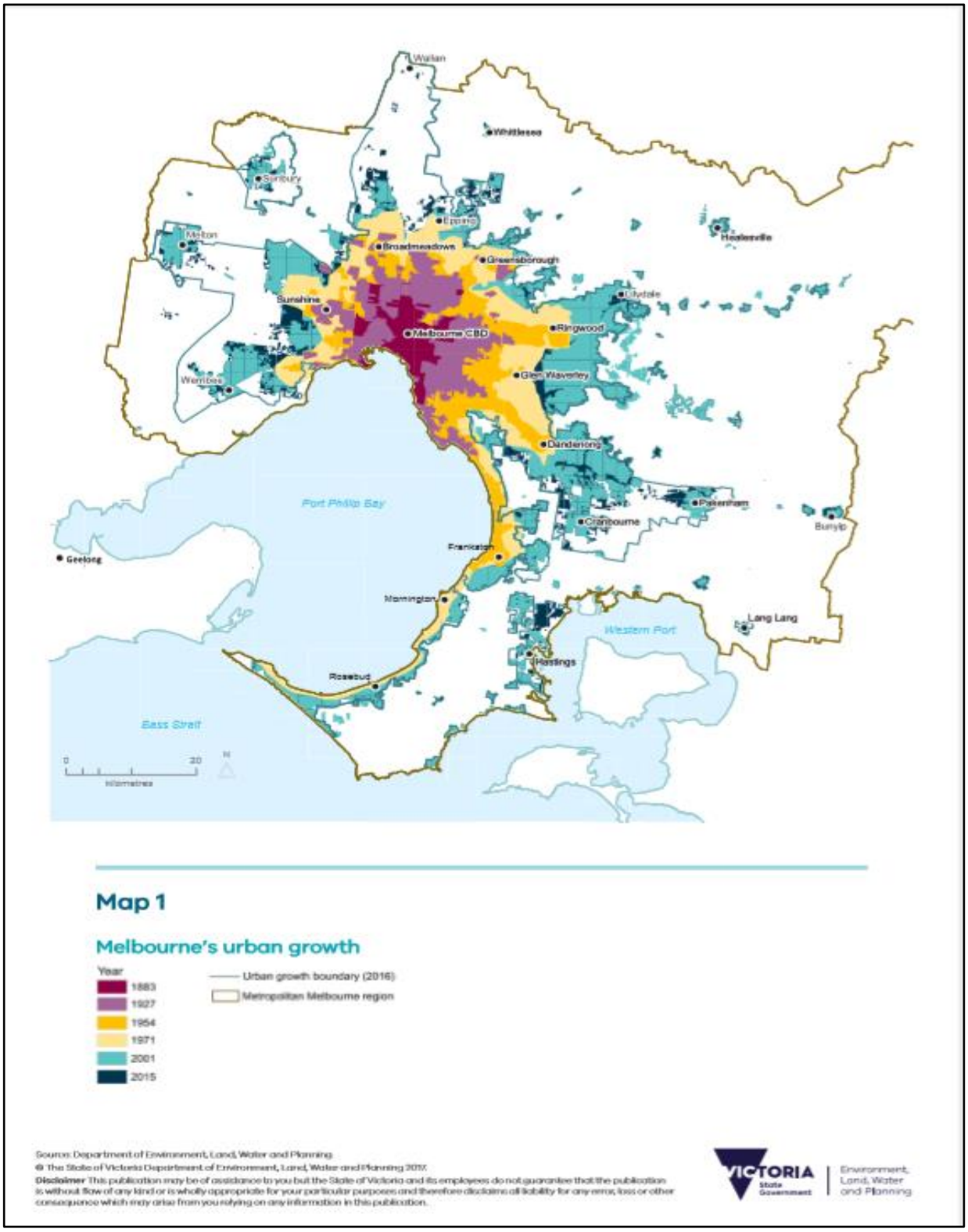
Until the1950s, Melbourne's urban expansion followed train and tram routes. Since then, land use policies favouring car-based access to housing, employment, retailing and recreation have promoted the adoption of private cars for most travel. As a result, much of the population increase has been accommodated in spaces between train and tram catchments and increasingly in outer suburban areas, generally remote from public transport. (Figure 3).

Apart from the central city, outer suburbs are still the fastest growing areas in Melbourne, especially in the west, north, and far south-east. Much of Melbourne's growth is expected to occur in communities in Melbourne's growth areas: Casey-Cardinia, Hume, Melton-Caroline Springs, Whittlesea and Wyndham. Almost one million people are expected to move into the western Local Government areas of Wyndham, Brimbank, Melton, Maribyrnong and Hobsons Bay, with Melbourne's western region alone reaching a population of 1.76 million by 2051. If trends continue, the western and northern suburbs will experience the largest population growth becoming home to 3.5 million people by 2051 *(The Age 10/03/2017).*

An increasing mismatch is evident between job availability and population growth in most municipalities. While housing is less expensive in outer Melbourne, residents there are generally impacted by inadequate access to jobs and services and thus bear significant transport costs.

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Figure 3: Melbourne's Urban Growth 1883 to 2015



Source: *Plan Melbourne 2017-2050*
http://www.planmelbourne.vic.gov.au/__data/assets/pdf_file/0003/376653/Map-1-Melbournes-urban-growth.pdf

Melbourne's population density spread has been driven by land development economics rather than by integrated transport and land use planning. Since the 1990s, a largely deregulated planning system has shifted effective decision making about the direction and type of urban growth to private land markets. Decades of deficiency in aligning spatial development with transport planning has led to car dependent low density outer urban subdivisions beyond the reach of effective public transport.

Significantly, the spread of Melbourne's population over middle, inner and outer areas as shown in Table 1 below, contrasts with the more even spread of density in European cities where public transport reach has been extended in line with settlement.

Table 1: Melbourne's Population Spread

		Inner Area	Middle Area	Outer Area	Metropolitan Melbourne
Population 2006	No (000s) % of Metro Melbourne	335.8 9.0%	1,749.1 46.7%	1,659.4 44.3%	3,744.4 100%
Population 2011	No (000s) % of Metro Melbourne	352.2 8.9%	1,804.0 45.8%	1,784.5 44.3%	3,940.8 100%
Population 2016	No (000s) % of Metro Melbourne	427.3 9.7%	1,930.7 43.7%	2,057.3 46.6%	4,415.4 100%
Total Area	Square kms	104	922	7,790	8,816
Population Density 2016	Persons per sq km	4109	2094	264	500

1.3 Melbourne's Growth Challenges

The challenge of servicing population growth is exacerbated by environmental and geographic limits to Melbourne's area. Melbourne's spread is amongst the world's most extensive. The area within its Urban Growth Boundary (UGB) is already much larger than the urbanised area of Greater London or New York City, whose current populations are comparable to the 8 million projected for Melbourne by 2050. The 2003 UGB generally continued historic planning policy confining outer urban growth to corridors based around heavy rail. However, extensions in 2004, 2010 and 2014 greatly expanded growth into green wedges between corridors. The greatest increase, in 2010, expanded the UGB by 43,000 hectares providing a 25-year outer urban land supply at some of the world's lowest densities.

Current outer suburban, low density, car-dependent growth is leading many new suburbs to dysfunction. Inadequate public transport and infrastructure have contributed to poor public health outcomes, social isolation, family violence issues, poor access to jobs, unacceptably long commuting times, traffic congestion and high infrastructure costs. If Melbourne is to successfully accommodate projected growth, a step-change from sole occupant car use to public transport is essential.

This low-density model of development located away from rail and without adequate public transport services condemns residents to car dependency for decades, or even indefinitely. Other impacts from sprawling outer urban growth include the loss of productive farmland close to the city and a range of environmental consequences. Melbourne's future growth and economic success is now best served by giving the highest priority to public transport investment. Building more roads is counterproductive, generating more traffic and worsening congestion.

Public transport and congestion are rapidly rising in importance on the political agenda, with regular and increasing calls for action by local communities, regions, business and peak organisations to remedy city dysfunctionality.

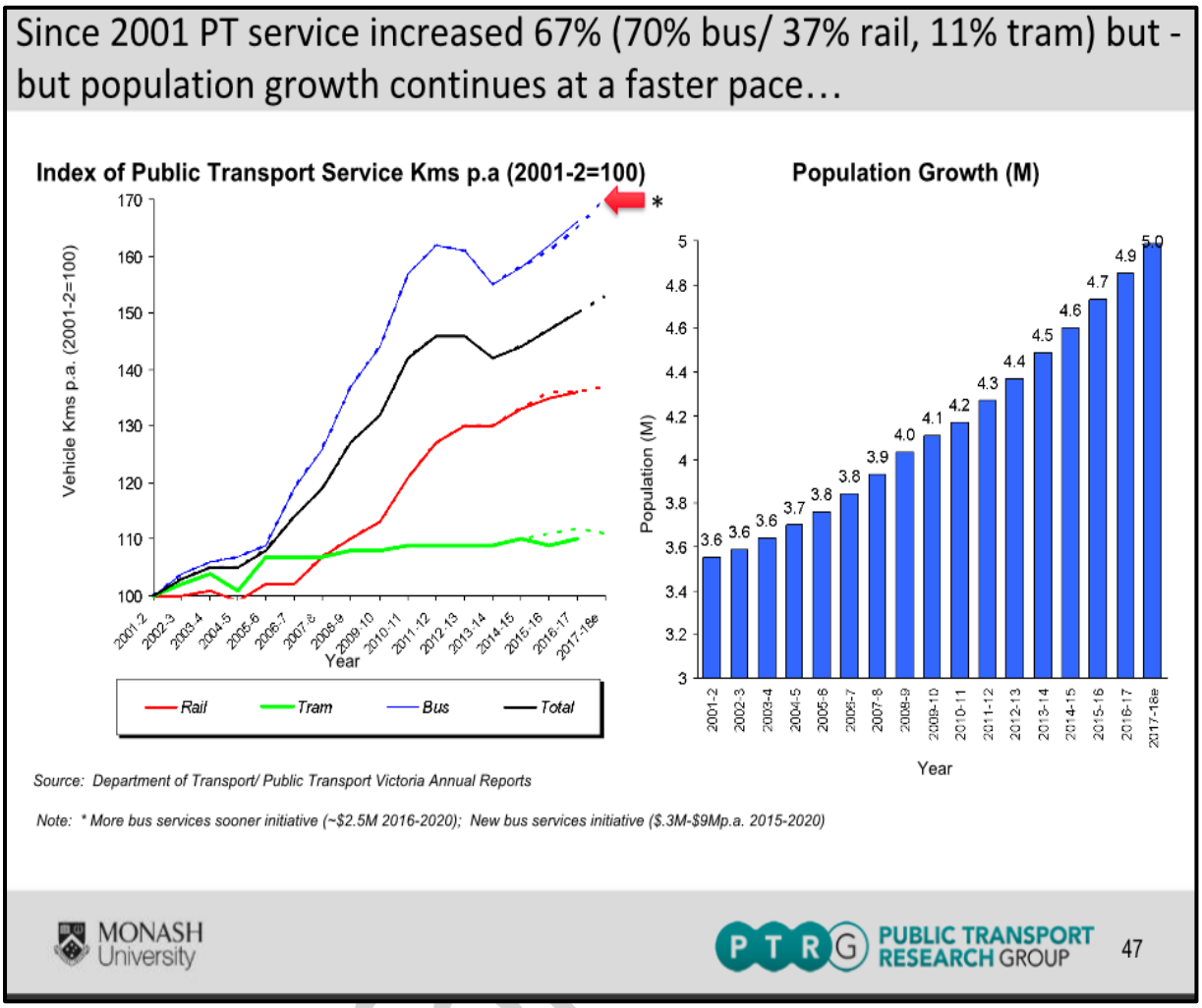
While Greater Melbourne has a land use plan, *Plan Melbourne (2017-2050)* (see Section 2.2), there is no complementary integrated long-term transport plan. This is despite such a plan being mandated under Section 63 of the Victorian Government's Transport Integration Act (2010).

Moreover, development of a comprehensive transport plan is critical to the success of Plan Melbourne, - particularly the Plan objective to achieve a polycentric city.

Credit must be given to the high level of transport investment in Melbourne by the current State Government, however, these projects are mostly "catch-up" investments and are not keeping pace with Melbourne's growth. Public Transport services have not been increased at the same rate as population growth. (Figure 4).

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Figure 4: Public Transport Service Growth compared to Population Growth



A report prepared for Infrastructure Victoria (IV) by KPMG/Arup Infrastructure for the *Managing Transport Demand Research Program* [1][i]provides an understanding of transport demand across Melbourne. This report summarises transport activity patterns now and in the future as perceived by Infrastructure Victoria.

The report provides key results for changes in demand and network performance between 2015 and the predicted future at 2031 stating:

> *"Over the next 15 years (between 2015 and 2031) the population of Greater Melbourne is estimated to grow from 4.5 million to almost six million. An additional 400,000 workers are expected by 2031 increasing the number of daily trips to work within Greater Melbourne by 25% to almost two million. However, the growth is not predicted to be evenly distributed across Melbourne, with the growth corridors in Melbourne's outer southeast, north and west as well as inner Melbourne, expected to contribute approximately two-thirds of the population increase. Over three-quarters of the projected increase in employment is forecast to occur in the inner and middle regions."*

The *Public Transport Barometer Report* [2]released in June 2018 by the Tourism and Transport Forum Australia found that:

> *"Rising congestion is estimated to be costing Australian cities $16.5 billion per year ($6b in private time costs, $8b in business time, $1.5b in extra vehicle operations and $1b in added air pollution costs).*
>
> *Melbourne bus patronage has fallen significantly due to congestion leading to slow travel times.*
>
> *Gridlock is adding an extra 34 minutes of average daily commute time in Melbourne".*

[1] Managing Transport Demand Research Program, KPMG/Arup Infrastructure for Infrastructure Victoria
[2] *Public Transport Barometer Report*

Research on *Life in the Commuter Belt* by Price Waterhouse Coopers for "The Australian" newspaper[3] found that:

> *"Melbourne had reached a critical point where a range of factors was putting upward pressure on travel time.*
>
> *Studies in other Australian cities have found that people who do not have to travel long hours to and from work are more likely to seek medical advice, eat fresh food and vegetables, spend time with their family and spend money in the local community.*
>
> *Melbourne was designed well for a city of 2 or 3 million people with a radial transport network feeding into the CBD, but the limits to that design are becoming evident with current massive growth."*

The report recommended developing a series of polycentric clusters or mini CBDs around the metropolitan area to distribute jobs and medium density living but noted these would only work with effective public transport.

A *Liveability Snapshot* released in Sept 2017 by *Interface Councils*[4] found growing pockets of inequity were developing on the outskirts of Melbourne, with unemployment, obesity, family violence, education and youth unemployment issues on the rise. It noted that:

> *"More than 40% of interface LGA residents do not live near public transport.*
> *20% spend more than two hours commuting every day.*
> *Almost 75% are completely car dependent.*
> *Unemployment in these areas at 6.9% was the highest in the State and 11% above the State average".*

The Monash University Public Transport Research Group[5] identifies that public transport service provision per capita has been declining rapidly in Melbourne since 2011-12 as city infrastructure fails to keep pace with population growth. Predicted was that:

> *"Melbourne will have an extra five hours of peak traffic by 2030 unless the current congestion crisis is fixed.*
> *Drivers would spend 20% more time sitting in traffic than they do now.*
> *The daily distances people have to travel in the outer suburbs will grow by 25%.*
> *Trains running through the new Metro tunnel will be at capacity by 2030, just five years after completion.*
>
> *Melbourne has lost its world's most liveable city status. Transport deficiencies, unprecedented road congestion and afternoon traffic peak now lasting 3.75 hours are seen as significant elements in this loss of status.*
>
> *The Melbourne tram network has speeds in the lowest 20% of the world's tram networks; and overcrowding and vehicle congestion are causing trams to spend 17% of their time stopped at traffic lights".*

The *Future of the West: Investing in Melbourne's Newest Generation* released in June 2018 by *LeadWest*[6], found that:

> *Less than 3% of the West's workers relied on trains or trams to get to work.*
> *Nearly 70% of the West's workers do not have frequent weekday services within walking distance of their house.*
> *Failure to invest in high quality public transport now will simply result in unnecessary diversion of public funds into roads, entrenching disadvantage and gridlock*."

It is evident that Rail Futures is not alone in highlighting the transport challenges facing Melbourne. There is growing consensus that Melbourne is at a critical stage of its development where substantial added investment in public transport infrastructure and services must be given priority for the city to function effectively.

Draft for comment

[3] "Life in the Commuter Belt" by Price Waterhouse Coopers for "The Australian" newspaper[3] *(Source: The Australian 12/10/2017-*

[4] *Liveable Communities – Interface Councils Liveability Snapshot Indices, September* 2017 by *Interface Councils.* Interface Councils are the 10 municipalities that form a ring around Metropolitan Melbourne, housing 1.6 million residents.

[5] Source: Government News 06/07/2018.

[6] http://www.leadwest.com.au/files/files/666_The_Future_is_West_LeadWest_Report_

2. Current Planning Policy

2.1 Overview

- The *State Planning Policy Framework* (SPPF) and *Plan Melbourne* provide the framework for land use planning in metropolitan Melbourne.
- While policies speak of rebalancing growth from Melbourne to regional Victoria, population projections are that by 2050 Melbourne will contain an even higher proportion of the State's population.
- Key elements of *Plan Melbourne* are to recognise the primacy of the central city, expand central Melbourne with major urban renewal precincts, re-shape greater Melbourne from a monocentric to a polycentric city, continue extensive outer urban corridor development and maintain urban intensification across the established metropolitan area.
- Intensification of polycentric development in national employment and innovation clusters (NEICs) and activity centres has major unaddressed transport implications; some of the largest are not served by rail and have poor accessibility.
- Apart from zoning, no mechanisms are offered to attract employment to clusters and activity centres to provide greater job accessibility.
- While planning policy encourages residential intensification near public transport, retail policy is weak resulting in proliferation of car-based centres and ever-increasing demand for car-based travel.
- Continuing large-scale outer urban growth has serious implications for the transport system. Most new outer urban growth is occurring in areas without adequate or planned provision of public transport.
- Growth corridor precinct structure plans (PSPs) perpetuate the pattern of car-based, relatively low-density detached housing separated from retail and services with little local employment, mostly in areas not easily accessible to the metropolitan rail system or on lines served only by regional (V/Line) trains.
- Without change in policy direction, the growth of car-based outer urban development will further isolate the 1.5 million new residents from employment opportunities and access to services condemning them to ongoing car dependency on increasingly congested roads.

2.2 Plan Melbourne

2.2.1 Key Features

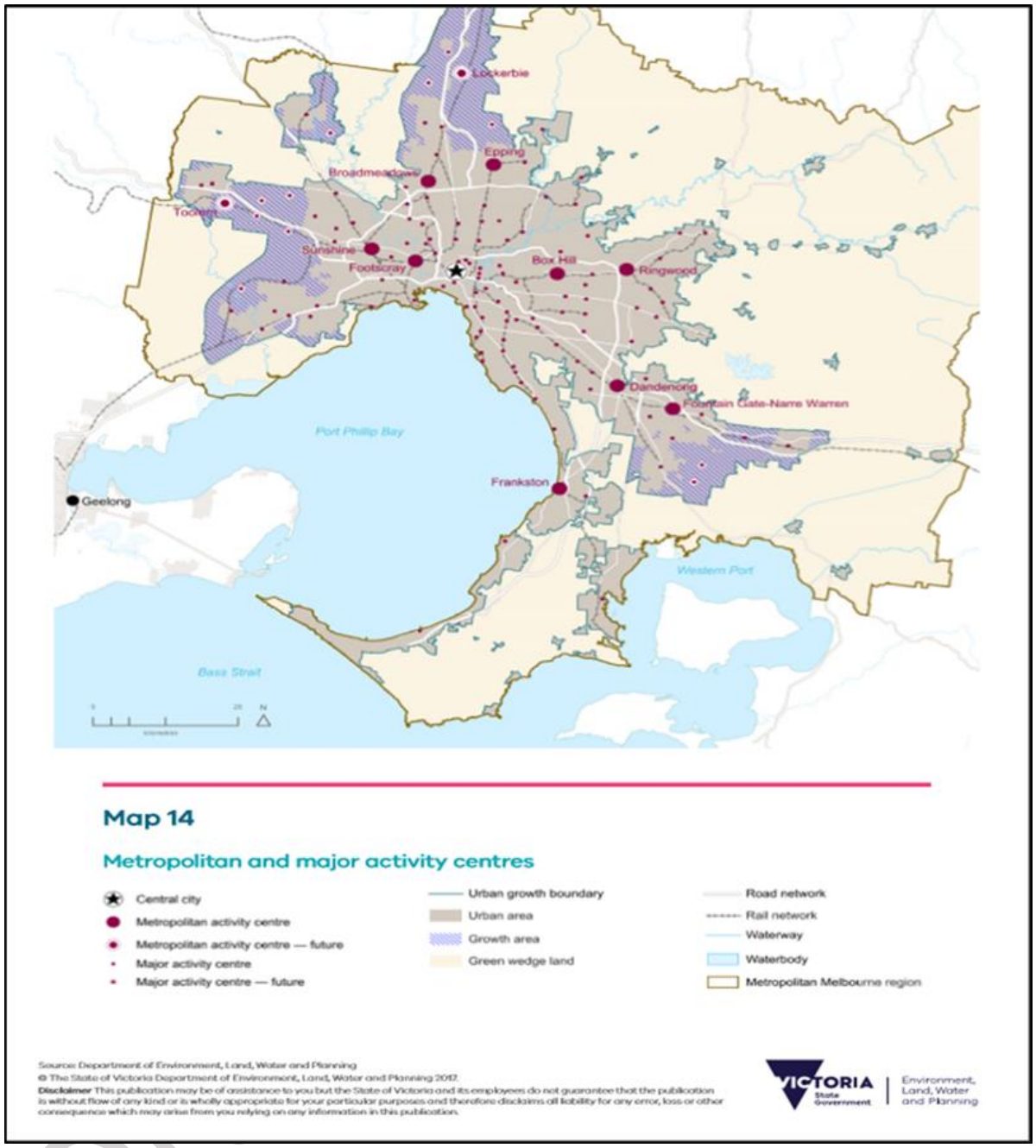
Plan Melbourne is a long-term metropolitan strategic plan to respond to the challenges and opportunities Melbourne faces between now and 2050. It is intended to provide continuity, clarity and certainty for communities, businesses and governments by guiding planners, councils, developers and the Victorian Civil and Administrative Tribunal (VCAT). It purports to be a long-term 35-year vision with a tangible implementation plan to ensure Melbourne remains sustainable, productive and liveable as its population approaches 8 million.

Key features in *Plan Melbourne* are:

- a strategy to focus investment and growth in places of State significance, including central Melbourne and metropolitan Melbourne's key centres and precincts, as well as 10 major regional cities
- support for the primacy of the central city as a commercial, retail and residential hub. This centrality will be strengthened by progressive development of major infill precincts around the central city and by market-based concentration of employment in advanced business services, new technology industries and the professions in the City of Melbourne and in the inner and middle ring suburbs
- a proposal to change Melbourne from a monocentric to a polycentric city through *"National Employment and Innovation Clusters"*, (NEICs), a network of metropolitan and major activity centres and links to regional Victoria
- adoption of a hierarchy of importance in nominating centre locations, identifying seven *NEICs*, nine *Metropolitan Activity Centres* and 112 *Major Activity Centres*. (Figure 5).

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Figure 5: Map showing Growth and Major Activity Centres



Source: Plan Melbourne 2017-2050 (http://www.planmelbourne.vic.gov.au/maps)

2.2.2 Transport Proposals in Plan Melbourne

Plan Melbourne's discussion of public transport is limited to generalised statements of intent coupled with a listing of projects already underway and due for completion in the short term. For example, it is stated[7]:

"Melbourne needs an integrated 21st-century transport system to connect people to jobs and services. Creating an integrated transport system will require:

- *the completion of the Metro Tunnel project*
- *the removal of level crossings across Melbourne's suburbs*
- *better transport infrastructure and services in newer suburbs - including new bus services for outer suburbs and, where there is sufficient demand, expansions to the rail network*

[7] *Plan Melbourne 2017-2050 Summary Outcome 3*

Under the headings of "Directions and Policies" the Plan includes the following policies:

Transform Melbourne's transport system to support a productive city

- *Create a metro-style rail system with 'turn up and go' frequency and reliability*
- *Provide high-quality public transport access to job-rich areas*
- *Improve arterial road connections across Melbourne for all road users*
- *Provide guidance and certainty for land use and transport development through the Principal Public Transport Network and the Principal Freight Network*
- *Improve the efficiency of the motorway network*
- *Improve outer-suburban public transport"*
- *Support cycling for commuting*

Improve transport in Melbourne's outer suburbs[8]

- *Improve roads in growth areas and outer suburbs*
- *Improve outer suburban public transport*

Improve local travel options to support 20-minute neighborhoods

- *Create pedestrian friendly neighborhoods*
- *Create a network of cycling links for local trips*
- *Improve local transport choices*
- *Locate schools and other regional facilities near existing public transport and provide safe working and cycling routes and drop off areas*

Plan Melbourne does not include any comprehensive public transport plan looking forward over its projected life. The principal rail project in *Plan Melbourne* (see Figure 6 below) is Melbourne Metro (MM1) which is due for completion in 2025. The others listed are "catch up" infrastructure enhancements that will add capacity to parts of the train system by 2020. They are responding to demand growth from CBD and suburban development that in most cases has already occurred.

Furthermore, except for MM1, the only current and proposed large scale transport projects are for major roads such as the West Gate Tunnel, the North-East Link, widening of the Tullamarine Freeway and upgrading of the Monash Freeway and Western Ring Road (M80). These are significant city-shaping projects that will make Melbourne a less sustainable city and further entrench car dependency.



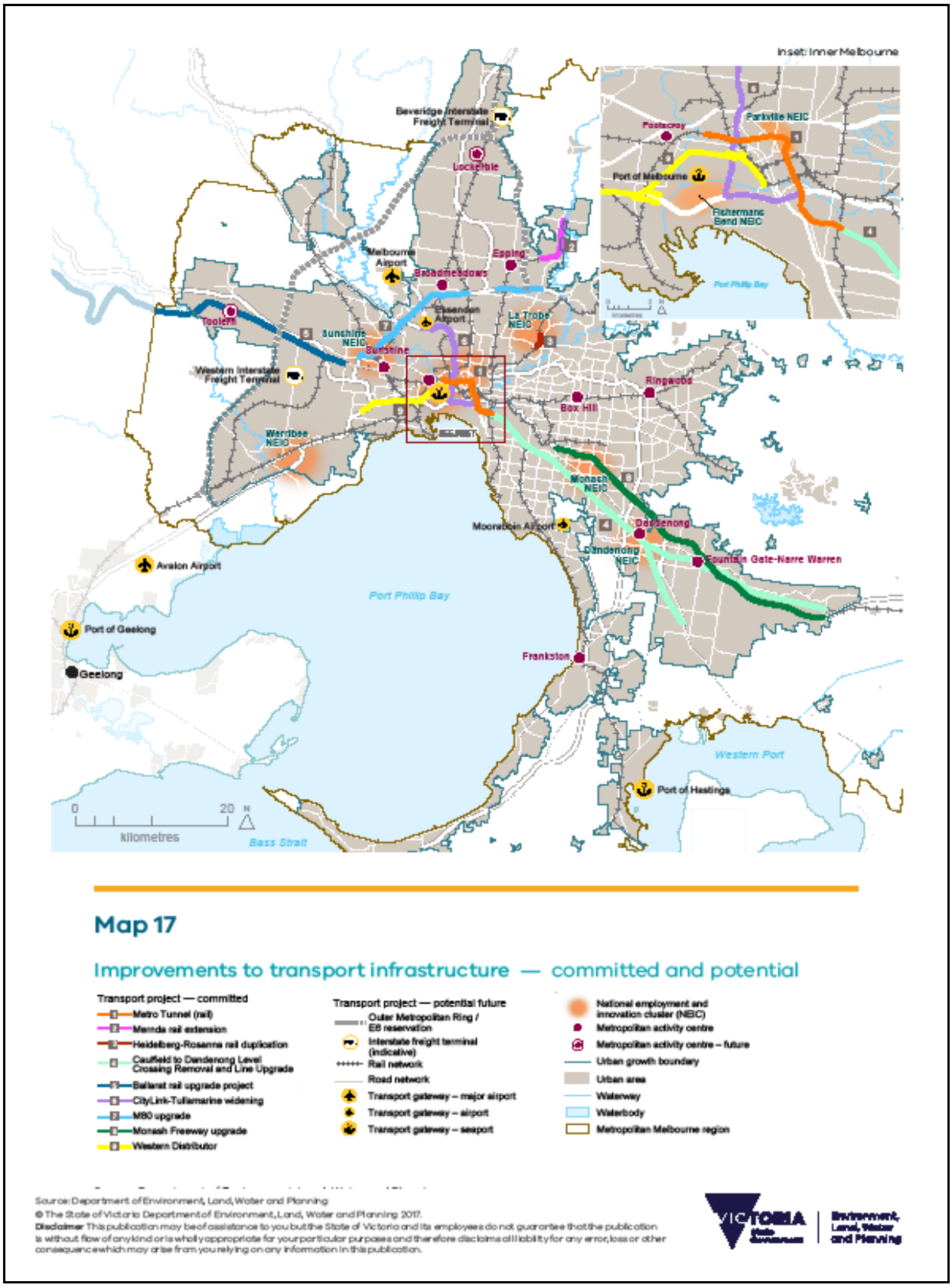
Concept image of proposed Anzac Station and tram interchange on the Melbourne Metro (MM1) project
Source*: Rail Projects Victoria*

[8] *Plan Melbourne 2017-2050 Summary Outcome 3*

For comment

Specific land use and associated transport issues associated with meeting the transport objectives in *Plan Melbourne* are shown in Figure 6 below.

Figure 6: Transport Projects in Plan Melbourne



Source: *Plan Melbourne (2017-2050) (http://www.planmelbourne.vic.gov.au/maps)*

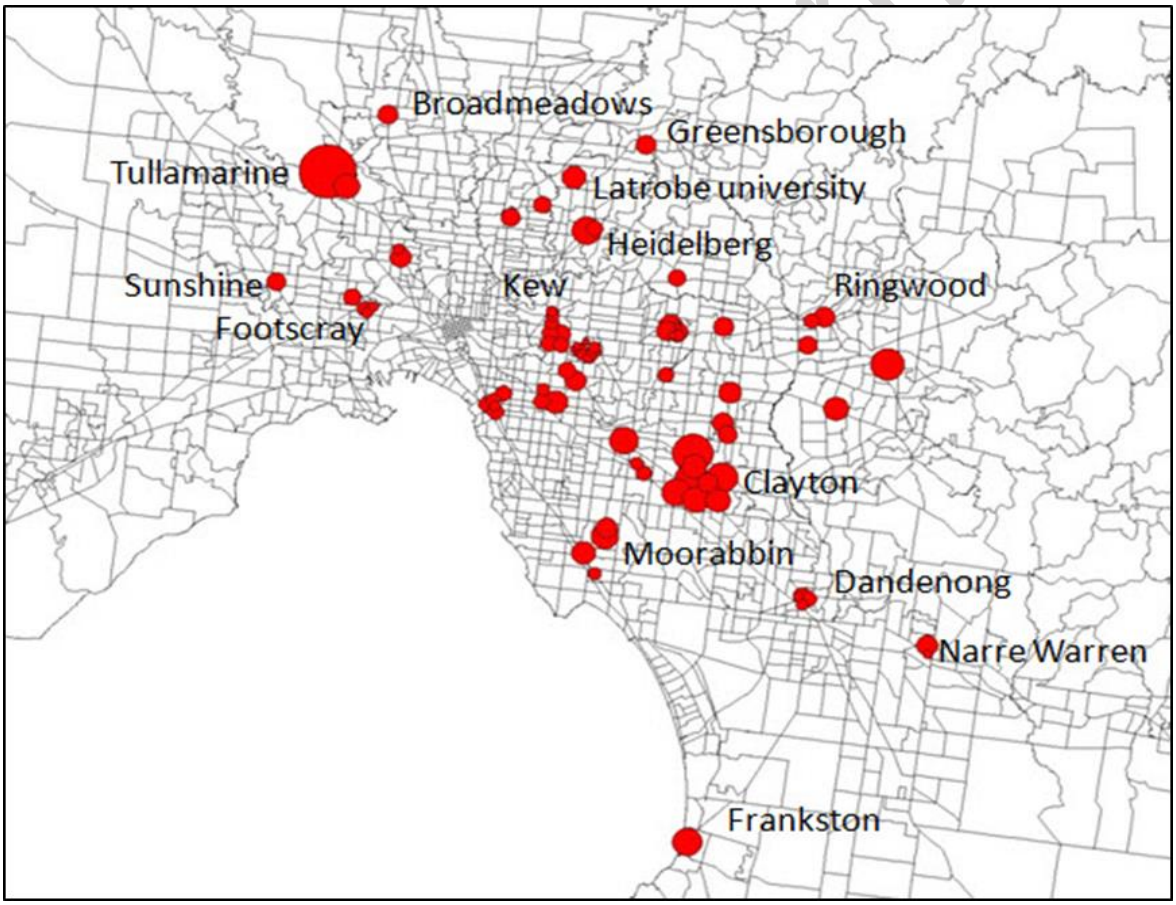
2.2.3 The Polycentric City

There is a need to serve not only the CBD but also create fast and frequent connections between bus, tram and train lines to link the most significant origins and destinations across the metropolitan area with travel times that compete with the car. The Victorian Government's announcement to commence planning for a "Suburban Rail Loop"[9] recognises the need for significant improvement in non-radial public transport in Melbourne, however this proposal, notwithstanding its massive cost, falls well short of Melbourne's overall cross suburban travel needs. These issues are addressed later in this RFI Plan (see Part 3).

Intensification of development in all Activity Centres has major implications for metropolitan transport. Some are positioned on radial rail or tram routes, but even without intensification, many are not served adequately by public transport. Three NEICs (La Trobe, Werribee East and Monash), 27 Major Activity Centres and 9 Future Major Activity Centres and Melbourne Airport - are not directly accessible from the current rail system, and most are not accessible by tram.

MM1, currently under construction, will provide the opportunity for journeys from Sunshine to Dandenong along a route connecting 4 NEICs and 3 metropolitan activity centres. However, the Monash NEIC, one of the most important, is located away from this link. While Melbourne Airport is not designated a NEIC, it has a larger workforce than any NEIC other than Monash. It is very poorly served by public transport. Public transport has a key role in serving not only NEICs but all centres with high concentrations of jobs. (Figure 7).

Figure 7: Concentration of Jobs across Suburban Melbourne (excluding CBD)



Source: *The Melbourne Urbanist / Crikey.com*

This pattern of polycentricity in Melbourne differs from many North American cities, which tend to locate mixed-use activity centres on freeway and arterial road networks with much lower provision of rail-based public transport. Melbourne's pattern also differs significantly from European polycentric cities, where activity nodes are generally served with high-capacity rail-based public transport. Even many relatively modest-sized European and British cities, with smaller populations than many of Melbourne's middle and outer suburban Local Government Areas, are well served by trams or light rail.

[9] *"Underground Suburban Rail Loop to connect Victoria"* – media release by Hon. Daniel Andrews, Premier of Victoria, 28 August 2018.

Residential and employment intensification in many of Melbourne's suburban employment and activity centres will reinforce access difficulties with continued reliance on car-based travel. Malls and "big-box" retail centres have now captured almost 50 per cent of Melbourne retailing. These centres are diversifying their activities to include entertainment, large-scale office, hotel and residential uses. Since almost all such centres depend entirely on the road network, this intensification will substantially increase road traffic movements over time unless alternative, transit-oriented modes of access are provided.

Plan Melbourne needs to provide much greater clarity on how the concept of a polycentric city will be delivered. Activity Centres and NEICs need to be linked by a network of high-capacity public transport corridors allowing both radial and orbital movement between centres. This network will attract higher development intensity and offer new residents and businesses far greater locational choices and the connectivity needed for productivity, innovation and liveability.

Plan Melbourne does not discuss whether the inner urban and central city concentrations of high value employment should be altered and to what extent and how this concentration could be varied.

Plan Melbourne largely ignores the potential of integrating metropolitan growth with regional centre growth and employment connected to Melbourne through fast rail. It assumes that over 83% of State growth will occur in an expanded metropolitan area. Population projections do not assume any policies to divert growth from Melbourne to regional Victoria.

2.2.4 Outer Urban Growth Areas

Plan Melbourne assumes that the designation of outer urban employment precincts will lead to high value employment locating there. However, it does not identify employment types to be sought more generally in outer suburban areas but assumes that zoning for business and industry will lead to job creation.

Continuing large-scale outer urban growth has serious implications for the transport system. Most new outer urban growth is occurring in areas without adequate public transport provided or planned. *Precinct Structure Plans (PSPs)* are frequently not integrated with transport planning in ways that would have land use designed for efficient public transport supply and ensure early provision of public transport consistent with the pace of development. PSPs are being approved for outer suburbs to provide a large outer urban land supply. These plans cover large areas of land usually located far from the metropolitan rail system and, where a rail service exists, this is often a V/Line service not designed to provide mass transportation for suburban passengers.



Regional V/Line trains are being overwhelmed by passengers from suburban stations on non-electrified corridors
Photo: *Bob Wilson*

for comment

PSPs generally continue an established pattern of low-density detached housing separated from retail and services and with little local employment. The retailing and services indicated on previous PSPs are often arranged in ways that are difficult to access from rail. Nor were they planned around the provision of buses at the outset, making it difficult to retrofit effective transport services once suburbs are constructed. As an example, Caroline Springs town centre is well designed with good urban amenity but the nearest rail service is over 3km away at a station of that name located in the adjoining suburb of Ravenhall.

Many new suburbs being developed are car-based, reliant on roads for both internal and external travel. Although densities in more recent developments are higher than in the past, increases are modest and still relatively low. Net residential densities are about 16 dwellings per hectare dominated by large detached residences but with minimal outside space. The more recent aim has been 18 dwellings per hectare, but only 10 dwellings per hectare gross residential density. This is one of the world's lowest.

An increased average density of a modest 20 dwellings per hectare in new growth corridors – still low by international standards – would accommodate 61 per cent more dwellings on only 45 per cent of the land required for a continuation of business-as-usual practice and make provision of public transport more economical. RFI recommends modification to the prevailing type of outer urban development, with specifications for subdivisions containing a wide range of denser, walkable, energy efficient housing types and sizes, integrated with high quality transport and other urban services.

This urban form model of intensified high-density inner areas coupled with dispersed service poor, low density outer suburbs has serious implications for Melbourne's successful future functioning and social integration. Disadvantage is spatially located, that is, the services, access and opportunity in some locations are vastly superior to those in other areas. Higher-income, tertiary-educated, professionally employed households are now concentrated in inner and middle ring suburbs, and selected outer urban areas, while lower income households without tertiary qualifications are concentrated primarily in outer urban areas. Radically different types of urban form coupled with unequal transport provision between areas are associated with increasing social differences between inner and outer urban areas. For example, transport costs are now the second highest costs for many low income outer urban households.

As Infrastructure Australia has observed,

> *"Inadequate access to public transport and poor service levels are important drivers of disadvantage for people in outer urban areas. These conditions can have a tangible impact on the quality of life and prosperity of these communities by limiting access to employment, education and other social infrastructure within reasonable travel time. As a result, people residing in these areas have become more reliant on private vehicles. Subsequently, they pay more for operating their vehicles and have less money to spend on other household expenses[10]".*

Without a change of policy direction there is every reason to suppose that the concentration on such massive car-based outer urban development will further isolate the planned 1.5 million new residents to be located there from employment opportunities and condemn them to ongoing car dependency on increasingly congested roads.

2.2.5 Urban Infill

The facilitation of urban intensification anywhere across the metropolitan area is also leading to extensive lot-by-lot redevelopment of land often distant from public transport, even in established suburbs. This policy is particularly problematic, as increasing densities in established suburbs not well served by public transport will lead to significant further road congestion. The mechanism in *Plan Melbourne* for identifying appropriate infill in established suburbs is to identify areas of minimal, incremental and high change residential development. However, this policy does not adequately integrate higher levels of residential development with access to adequate public transport, or with a plan to provide public transport to such areas.

As an example, development around the existing tram network is proof of the feasibility of transit-oriented development within a Melbourne context, however these developments are limited to inner Melbourne. Their popularity is also now resulting in stress being placed on the tram network in some places (particularly the busiest routes in the northern suburbs) and indicates the need to upgrade services to cater for rising demand.

[10] "*Outer Urban Public Transport – Improving accessibility in lower density areas*", Infrastructure Australia Reform Series, October 2018.

Draft for comment

Where once transit-oriented development was a key focus, *Plan Melbourne's* proposal for extensive urban infill would seem to be more compatible with the principles of a compact city and increased public transport use. However, the plan's failure to examine issues and propose detailed solutions leaves much unresolved.

In recent years, approximately 18,000 new dwellings have been constructed in each of three areas: Central Business District/inner urban area, middle ring and some other established suburbs, and new growth corridors. However, the model of urban form varies considerably between the high-rise apartments of the CBD and surrounds, lower rise apartments and townhouses of middle ring suburbs, and low-density housing in growth corridors. Significant infill is occurring in middle ring and some established suburbs. Townhouses and apartments 1-3 stories in these suburbs increased from 4,000 in 2005 to 11,000 in 2017, while new high-rise apartments in middle ring suburbs rose from 600 in 2005 to 9,000 in 2015 and 7,500 in 2017.

Much of the redevelopment of the inner and middle ring suburbs is occurring in the commercial and mixed-use zone, rising from 30% of new dwellings in 2005-2010 to 50% in 2011-2016. The amount of redevelopment in the Commercial 1 zone in the inner and middle ring suburbs is equivalent to the total amount of high-rise development in the Capital City and Docklands zones. The scale of this inner and middle ring suburban redevelopment has been largely ignored but has important implications for public transport use.

The lack of density and height controls in non-residential zones and the allowance of medium density development in residential zones will facilitate significant unplanned and incremental dwelling concentrations. Much new development is serviced by the tram network but is often linear, extending along arterial and tram routes, leading potentially to significant cross-town car use and increased pressure on radial routes, and now particularly evident on the tram network.

Apartment location is determined by accessibility to advanced business services, professional, research and educational employment and education centres. However, apartments are relatively expensive and reinforce Melbourne's social division. *Plan Melbourne* ignores the implications of the type, location and scale of urban infill, and does not specify preferred urban form for different areas of the city, or how to achieve desired building types matched to locations. It omits any reference to high-rise development, car-based shopping malls and "big box" retail centres. Instead it transfers such a strategic vision for infill to a deregulated planning system which is intended to facilitate industry selection of development sites and building type. The plan proposes that further urban concentration in activity centres will require greater flexibility in planning controls.

Such concentration at nominated densities in a limited number of public transport hubs may lead to increased public transport use. However, without substantial additions to cross-suburban public transport for travel between these intensifying suburban centres, cross suburban car use will also increase. Undifferentiated increased densities in 120 activity clusters and centres often poorly connected to each other and sometimes only via road-based transport is certain to lead to substantial further road use and congestion.

2.2.6 Retail Centres

Plan Melbourne transfers retail policy to a deregulated statutory system which facilitates dispersed malls and stand-alone retailing. The emphasis on creating a city of 20-minute neighborhoods close to services, jobs and public transport is laudable but lacks explanation as to how it can be achieved. Much of Melbourne is not located within 20 minutes travel by walking or public transport to centres with a broad range of retail activities.

The lack of firm policy to direct retail development into locations well serviced by public transport, coupled with the proliferation of "out of centre" retailing, undermines the policy of encouraging higher residential densities near public transport. The aim of intensifying population in traditional centres will concentrate people in mixed-use centres usually far from retail outlets, necessitating longer distance travel to car-based dispersed retail centres, and increasing reliance on car-based travel for shopping. This is a planning policy failure.

2.2.7 Transport Integration Act 2010 (TIA)

The lack of long-term integrated transport planning and the disconnect between policy and implementation are at odds with the fundamental aims of the Transport Integration Act 2010 (TIA) to reduce reliance on private cars and alleviate the need for extended commuting travel. The TIA is Victoria's principal transport statute. It aims to provide a common set of objectives and decision-making principles by which all transport and land use agencies work together towards an integrated and sustainable transport system. In practice however, the TIA provisions have been largely disregarded by successive governments.

Draft for comment

PART 2: MELBOURNE'S TRANSPORT STORY

Part Two describes Melbourne's public transport and sets the context for developing the Melbourne Rail Plan.

- Section 3 describes Melbourne's current public transport services
- Section 4 describes the challenges and opportunities

Draft for comment

3. Melbourne's Public Transport

3.1 Overview

Melbourne is blessed with extensive rail systems envied by many world cities.

Electrified heavy rail fans out from the city core connecting its urbanised area. Melbourne has one of the world's largest tram networks serving its inner and middle suburbs. The rail-based modes are complemented by a mixture of bus services, and flexible taxi and "Uber" style services. Car travel and active transport (walking and cycling) complete the total transport mix.

While rail modes are the primary focus of this plan, RFI acknowledges the essential role of both scheduled and "on-demand" bus services in a comprehensive and fully integrated system. Also recognised is the importance of active personal transport – walking and cycling, playing a far greater role in providing access to the public transport network, as an alternative to providing ever-increasing car parking spaces at metropolitan rail stations.

3.1.1 Mode Share

Victorian integrated survey of travel and activity (VISTA), 2013 found that the weekday shares of travel for all purposes in 2012-13 were as shown in Table 2

Table 2: Weekday Mode Shares

Mode	All Trips	Motorised Trips
Private Vehicle	72%	88%
Public Transport	9%	11%
Active Transport	18%	N/A
Other	1%	1%

Source: *Victorian Department of Economic Development, Jobs, Transport and Resources, Victorian integrated survey of travel and activity (VISTA), 2013*

3.1.2 Journey to Work

For journeys to work, the public transport mode share is higher. *ABS census data of 2006, 2011 and 2016* reveals a significant increase in the number of people using public transport for their commute to work.

In Greater Melbourne, public transport share for journeys to work increased from 14% to 16% between 2011 and 2016. This is equivalent to an additional 67,000 people using some form of public transport to access work. (Table 3).

Table 3: Journey to Work by Public Transport (Daily)

Census Year	Journey to work trips by public transport	% of work trips by public transport
2006	184,137	12.3
2011	250,449	14.5
2016	317,784	16.2

Source: *ABS Census Data 2006, 2011 and 2016*

Residents in Inner Melbourne have a higher public transport mode share, between 25 and 34% (2016). Areas located along the heavy rail network also have a higher proportion of public transport commuting, particularly along the Pakenham and Lilydale / Belgrave train lines.

Key public transport mode share increases between 2011 and 2016 were:

- Docklands and Melbourne experienced a 10% increase
- West Footscray and Seddon experienced a 5 to 6% increase
- Growth areas to the west and north of Melbourne including Truganina, Wyndham Vale and South Morang experienced a 5% to 6% increase.

Draft for Comment

In Melbourne more broadly, there is a correlation between access to train services and increased use of public transport. In areas without immediate access to a train line, public transport use has also increased; suggesting commuters are switching transport modes, taking a bus or driving to a rail station, for example.

3.1.3 Patronage Growth

Over the last decade, annual patronage of trains and trams in Melbourne has risen by 118 million, (an increase of 40% since 2008). This has been driven largely by strong jobs growth in central Melbourne and population growth in central Melbourne and inner suburbs as well as growth corridors to the north, west and south–east.

Over the last 5 years the total patronage on trains, trams and buses has increased by 7.8%. (Figure 8). Train patronage has increased by 6.8% and tram patronage by 13.0%. However, bus patronage has decreased by 7.7%. Figure 9 shows the patronage changes for each mode between 2012/13 and 2017/18.

Figure 8: Total Public Transport Patronage 2012/13 to 2017/18

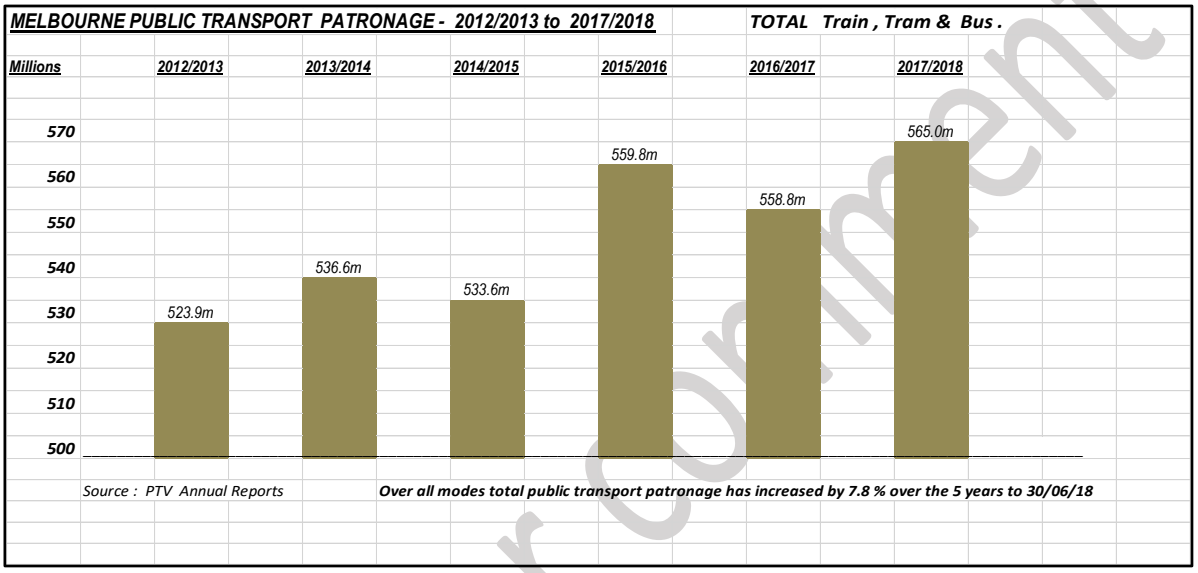
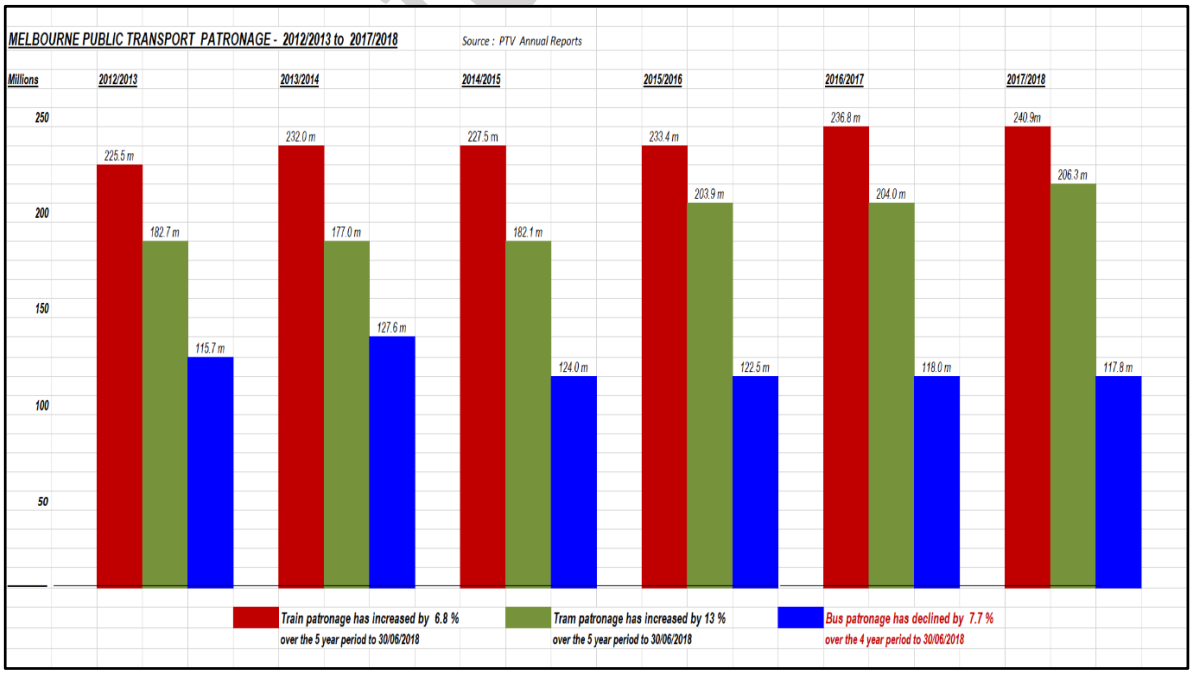


Figure 9: Public Transport Patronage by Mode in Melbourne 2012/13 to 2017/18



for comment

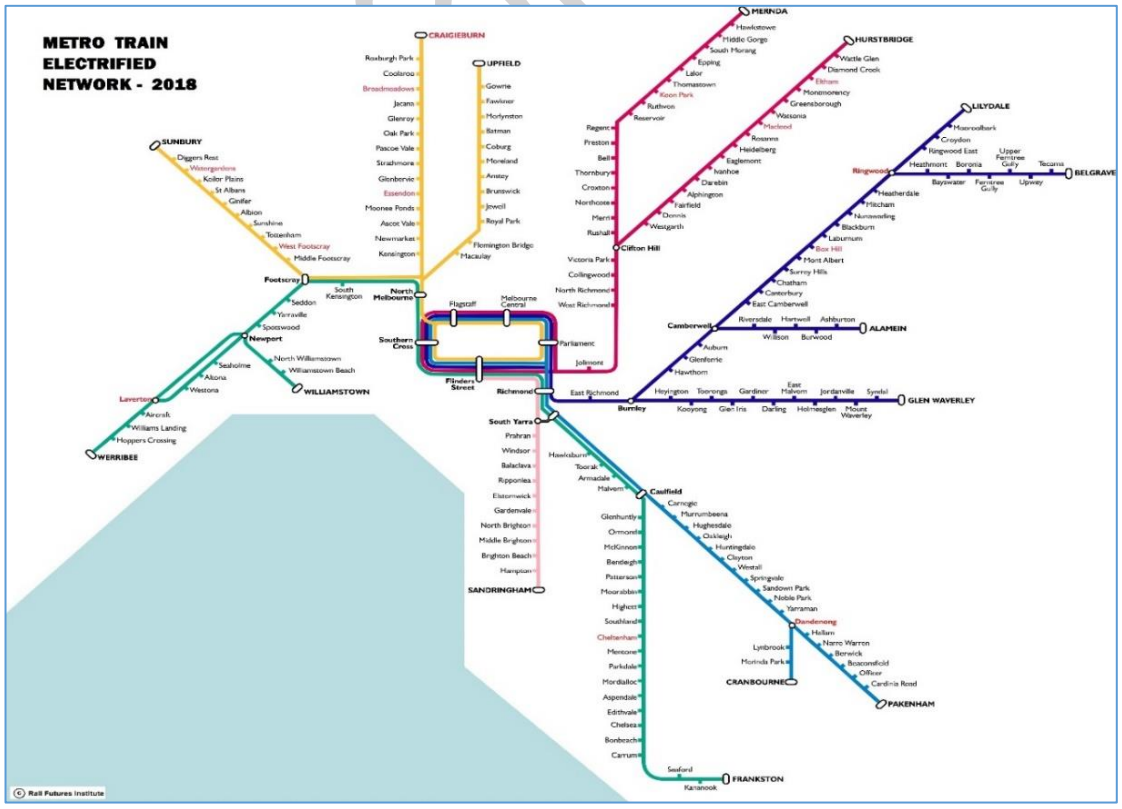
3.2 The Heavy Rail Network

Todays' train system is largely a legacy of the 19th century when Melbourne's population was less than one million. Much of the network was laid out in the 19th century with most lines electrified by the 1920s. The network has since remained relatively unaltered apart from construction of the Glen Waverley line (1931), post-war electric train extensions to Werribee, Laverton (via Altona), Upfield, Alamein and Belgrave, and relatively recent electric train extensions to Cranbourne, Mernda, Sunbury and Craigieburn. The last major upgrade to the electrified metropolitan rail system was construction of the Melbourne Underground Rail Loop (MURL) which opened progressively between 1981 to 1985.

Melbourne's train network plays a key role in the city's total transport system particularly as a radial network to the Central Business District (CBD). Key characteristics are:

- the electrified train network now extends some 372 route kilometres on 16 separate routes, with 213 stations and a fleet of around 224 trains. The longest route is to Pakenham (58 km) and the shortest are to Alamein (15 km) and Williamstown (16 km). The network serves a catchment of about 600 square kilometres (Figure 10)
- the average length of train journeys is approximately 18 km
- current trains operate in 6-carriage consists and each has nominal capacity of 900 passengers, of which around 45% have seats, the remainder being standees
- much of the network is operating at capacity or near capacity during weekday peak periods, in relation to its ability to accommodate additional train services. The inner core of the network, extending from Richmond and Jolimont to North Melbourne via the City Loop and Flinders Street is effectively full at peak periods with 18 to 22 trains per hour per direction on the main trunk corridors
- average speed over the network is 31-40 km/hr. Higher speeds are achieved in outer sections where the line speed is between 80 and 115 km/h. Closer to the CBD, trains typically run at an average speed of less than 30 km/h
- the system has a large focus on journeys to work in the CBD with pronounced peak orientation.

Figure 10: Melbourne Electrified Heavy Rail Network 2018



Beyond the electrified area, some of Melbourne's outer growth suburbs are presently served by V/Line diesel regional trains, the principal examples being Tarneit/Wyndham Vale, Caroline Springs/Melton and Donnybrook/Wallan. The metropolitan heavy rail system will be progressively extended to serve these areas, bringing the electrified route network to around 440 kilometres.

Electric Trains operating on Melbourne's Suburban Network



Xtrapolis train – over 100 train sets of this type were delivered from 2003 onwards, with more on order
Photo: courtesy *Alstom Australia*



ComEng train – 95 trains delivered between 1981 and 1990 will be progressively retired over the next 15 years
Photo: *Bob Wilson*



Siemens Nexas train – 36 trains of this type entered service between 2002 and 2005
Photo: *Bob Wilson*

3.3 The Tram Network

Melbourne's tram system is an iconic part of the city's identity and plays a key role in the city's total transport system, particularly in inner and middle suburbs. Much of the network was laid out between the 1880s and the 1920s. It has remained relatively unaltered since the mid-1950s apart from recent extensions to Box Hill, Bundoora, Vermont South and into the Docklands area. Biased towards the inner suburbs, it does not serve well the western and north-western suburbs, several newer activity centres or other growth areas. Also, major activity centres have since emerged in suburbs which are not served by tram or train such as Monash University and Melbourne Airport.

Although Melbourne is renowned for its trams, only 25% of the Melbourne Metropolitan area is served by the tram network.

Having developed independently, the tram network has relatively poor connectivity with the train network.

If it were possible to build the existing tram network in today's environment, its construction cost would exceed $55 billion.

Trams play a vital role in the city's transport system and provide access to 34% of all jobs in Metropolitan Melbourne. In 2017/18 tram patronage (by boardings) equalled 86% of the total patronage carried by Melbourne's heavy rail network.

Tram travel primarily has a focus on CBD and inner suburbs movement and plays an important role distributing people around the inner city and its surrounds – as trips in their own right or transfers from CBD train stations.

Currently, individual tram routes perform several of these tasks. One of the strengths of Melbourne's tram network is that one corridor can play several different roles across its length. For example, while the eastern portion of Route 109 to Box Hill operates parallel to a heavy rail line to and from the CBD, it plays an important local transport role (along Whitehorse Road, through Kew Junction and along Victoria Street in Richmond and Abbotsford) and a mass transit role in the designated 'light rail' section from Port Melbourne to the CBD.

Key characteristics of trams in Melbourne are:

- a network that extends some 250 route kilometres on 24 separate routes (including the City Circle tourist service), (Figure 11). The network has 1760 designated stops at typically four per kilometre. Tram route lengths are generally less than 22 kilometres with routes typically between 12 and 16 kilometres
- about 80% of the total network operates as a 'street transit' system. Only 18% of the network operates in segregated right-of-way (ROW). Over three-quarters of the tram network operates in road space shared with other vehicles (Figure 12).
- a fleet of 506 trams comprising a mixture of vehicle types with passenger carrying capacities varying from 65 to 210 (Figure 13). Of these, 180 (36%) are DDA compliant with low floors and 310 (61%) are air-conditioned. The latest trams carry up to 210 people; more than double the capacity of most trams in the current fleet
- an average speed of 16 km/h. (Figure 14). Higher speeds are achieved in the outer sections of the routes while closer to the city the average speed drops to 11km/h. Only a few sections meet modern world operating parameters with 30 km/h average speeds
- current passenger capacity on most routes is limited to between 750 and 1,300 passengers in each direction per hour, increasing to around 2,100 where the largest trams run. This is at the lower end of international best practice. Route capacity is limited by low capacity vehicles, closely spaced stops, road traffic delays, poor traffic signal priority and lack of separation from road traffic. Many routes have a potential to accommodate 16-20 trams per hour in a uni-directional flow. This equates to a potential passenger capacity of up to 7,200 per hour per single track per direction, or up to 3 times the typical capacity of a single lane of freely moving freeway with average car occupancy of 1.2 persons
- average journeys are between 3 and 4 kilometres (longer during peak times) and passenger turnover Is typically 5 to 6 times on each trip.

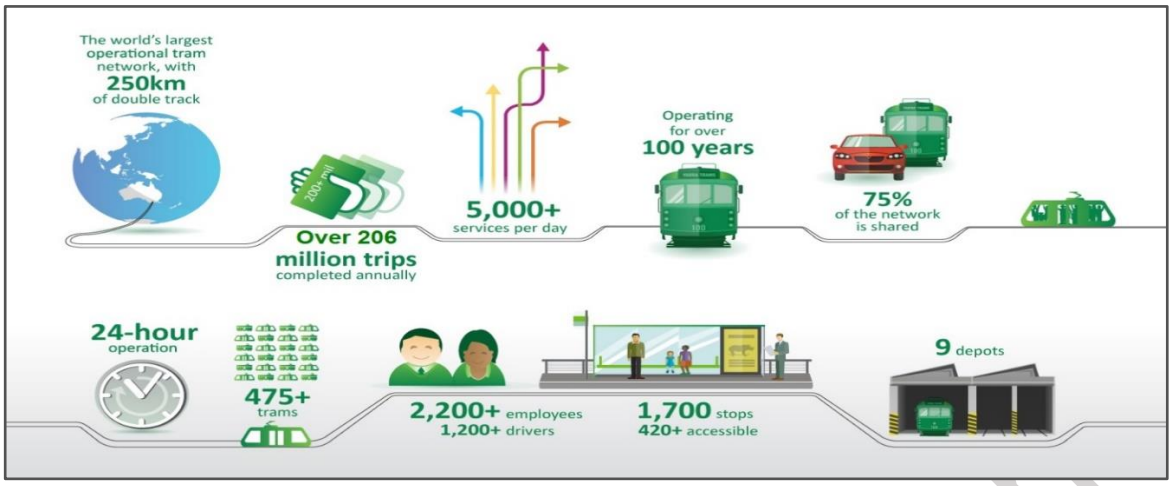
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Figure 11: Melbourne's Tram Network



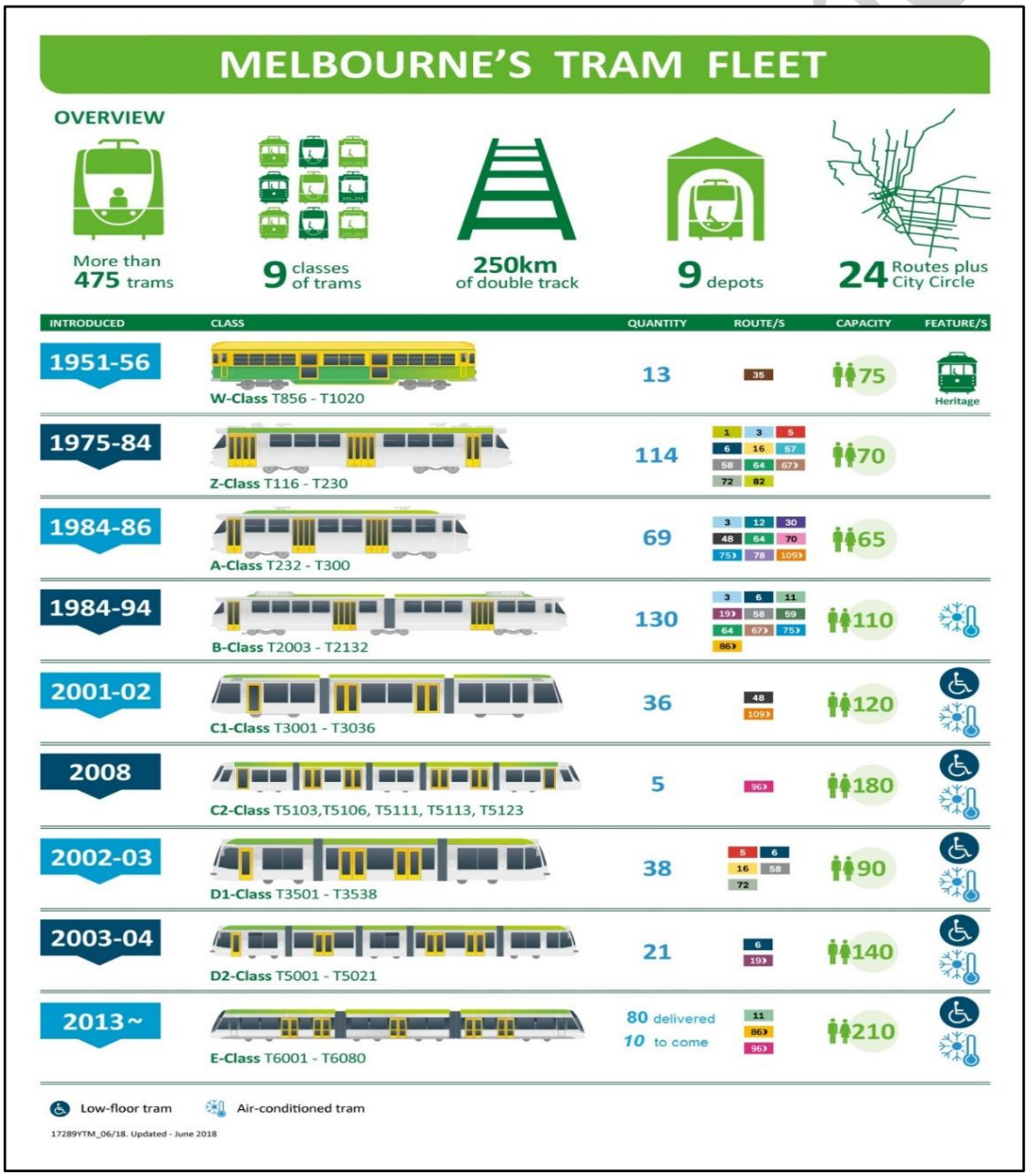
Source: Public Transport Victoria

Figure 12: Melbourne Tram Network – Key Facts



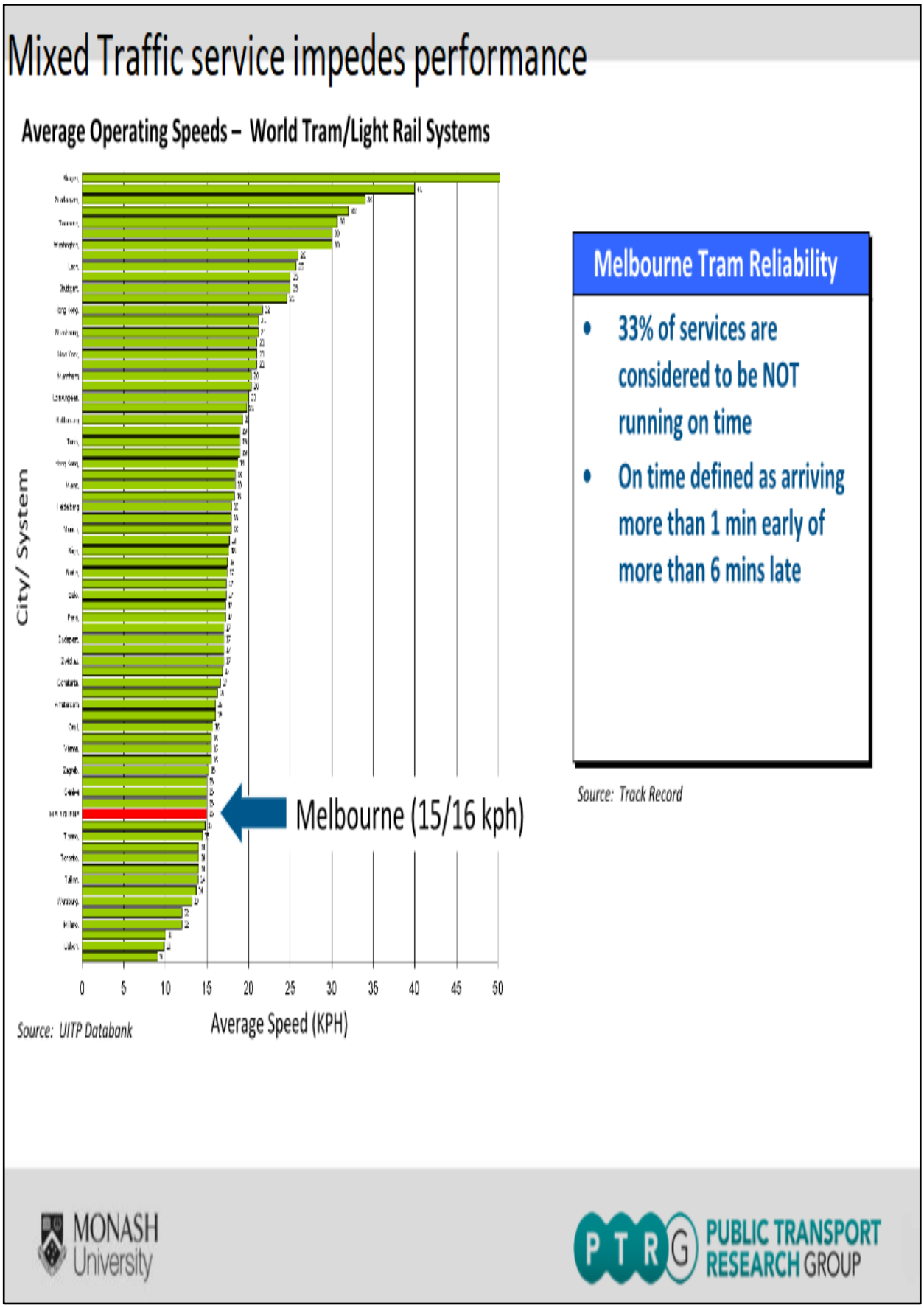
Source: Yarra Trams

Figure 13: Types of Trams in Melbourne – 2019



Source: Yarra Trams

Figure 14: Average Tram Operating Speeds in World Cities



3.4 Train and Tram Network Coverage

The heavy rail network of about 372 kilometres (830 track kilometres) covers about 600 square kilometres (within 800 metres of a route). The train network is effectively used by more than 1,000 people per square kilometre each day.

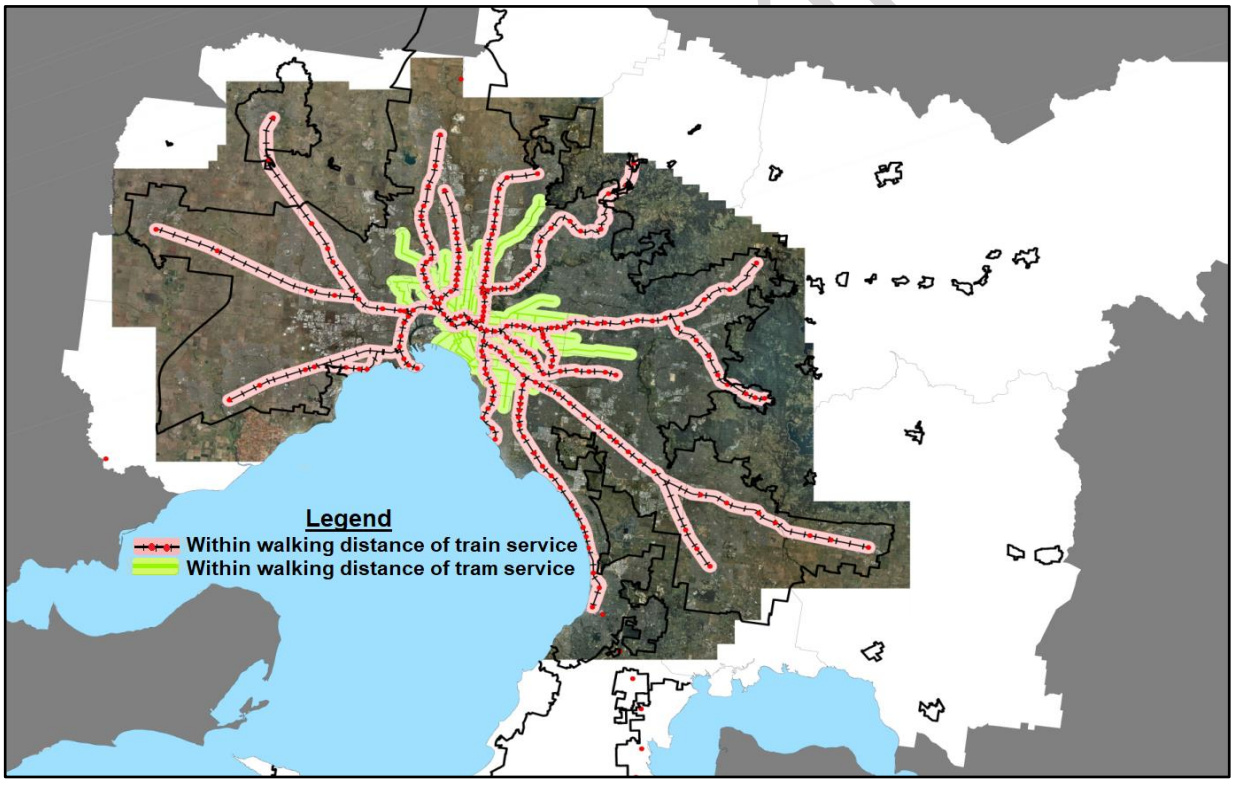
The tram network covers about 250 square kilometres and carried 206 million people in 2017/18 serving over 2,250 people per square kilometre each day.

The extent of both heavy rail and tram coverage is shown in Figure 15 below. The figure shows that while inner suburbs of Melbourne receive a comprehensive service, many outer suburbs are remote from any rail-based services.

Melbourne's inner area is almost completely served by rail services, 50% of middle suburbs are served while in outer areas less than a quarter of the population live within a rail catchment. Outer areas must rely on bus services or cars for most travel.

The radial nature of heavy rail leaves large unconnected gaps between radial lines. In outer ring suburbs, stations cater for more than their local catchments with extensive car parks, but demand often exceeds parking capacity. Some stations have bus interchanges but the current priority for extending station catchment areas is through provision of car parking spaces. In the middle suburbs, there are many stations along the radial lines, numerous bus interchange points and some car parking provision.

Figure 15: Train and Tram coverage of Melbourne Metropolitan Area



3.5 The Bus Network

Melbourne has an extensive bus network comprising 340 individual routes, currently delivered by 13 operators using a fleet of more than 1,700 buses with some 18,000 designated stops.

Unlike other public transport modes, bus patronage has been declining in recent years. Many services are characterised by near empty buses operating at infrequent intervals, often with few or no services at night or weekends, traversing indirect and meandering routes.

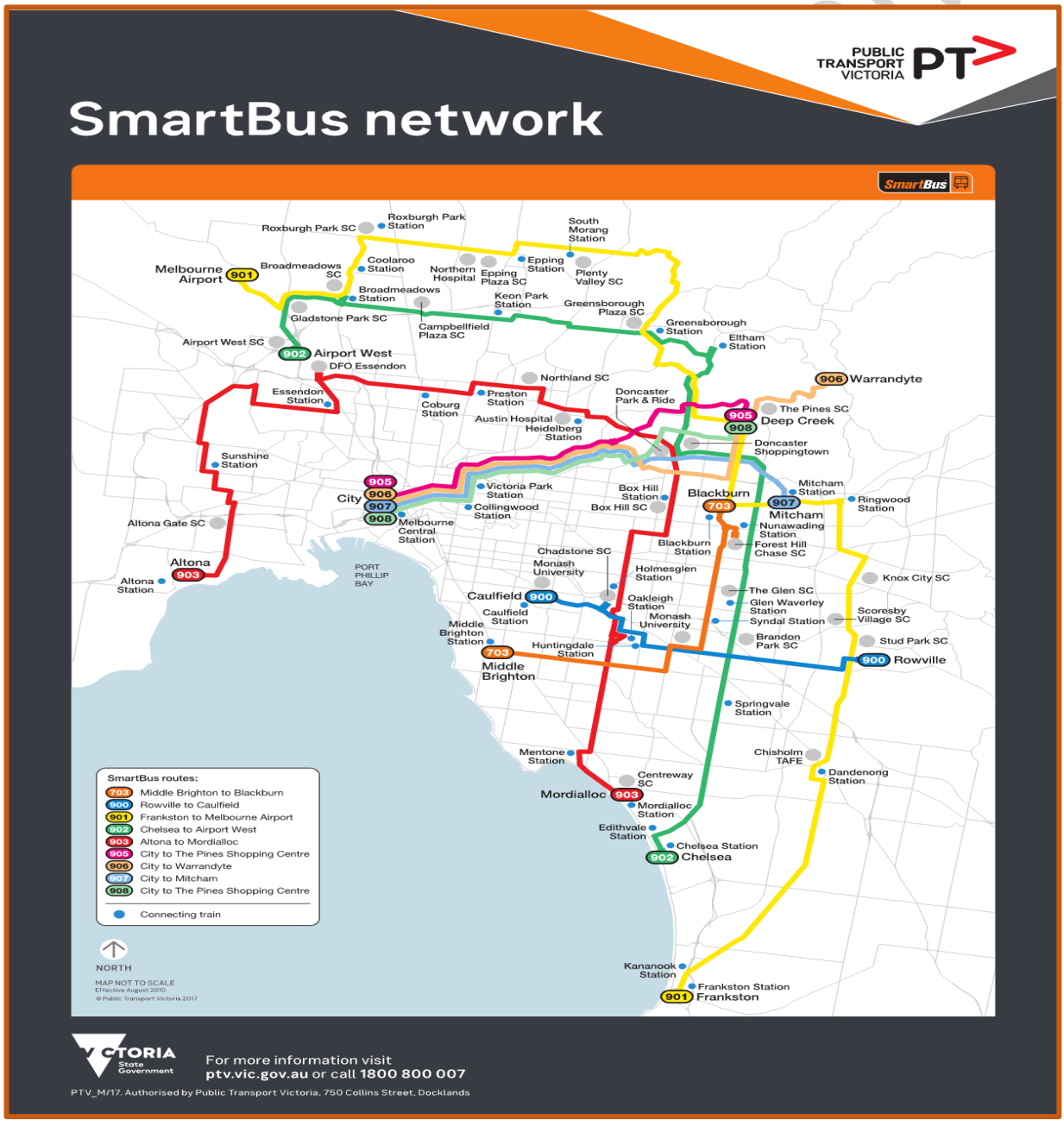
By contrast, 9 SmartBus routes (Figure 16) have provided high quality services since 2010, operating at 15-minute intervals over extended hours, 7 days per week and have experienced increased patronage.



Typical route buses in Melbourne

Photo: Wikipedia - *Marcus Wong* Photo: *Liam Davies*

Figure 16: SmartBus Routes in Melbourne



Source: *Public Transport Victoria*

4. The Challenges and Opportunities for Public Transport

4.1 Overview

The principal challenges facing Melbourne's transport system are increased demand on the existing radial rail and road networks, due primarily to rapid population growth particularly in outer growth suburbs, and the lack of quality public transport services on cross-suburban and orbital corridors leading to high levels of car dependency.

Significant parts of the road network in inner, middle and some parts of outer suburbs are already at or approaching capacity. Apart from a few very expensive freeway projects, there are few situations where road infrastructure capacity can be significantly expanded without detriment to the urban environment. Any such construction exacerbates congestion as car use inevitably expands to fill the new capacity and motorists still need to exit freeways onto already constrained arterial and local roads.

Realistic options for meeting travel demands will involve a progressive shift to public transport from private car use. In part, this can be achieved by city-shaping actions that reduce demand for personal transport, for example by generating employment opportunities closer to where people live, or by encouraging residential densification in areas closer to areas with high employment potential. Public transport provision is a powerful incentive for such densification. Unfortunately, Melbourne's low-density residential sprawl often leaves transport planners with little alternative but for best endeavours to retrofit public transport into already established built environments.

Maintaining and enhancing Melbourne's liveability will require greater reliance on mass transit systems operating on dedicated or segregated corridors, feeder buses to key transit nodes, local buses and active transport (walking and cycling). This will require a combination of more effective use of existing infrastructure with investment in new public transport infrastructure and services. The aim is a connected grid network of easily accessible high-quality services.

The bus network will play an increasingly important role in supporting the mass transit elements of the public transport network, including a significant role in completing the grid network. As with trams, the effectiveness of bus services is also dependent on being accorded appropriate road space.

4.2 Meeting Patronage Growth

Modelling for Infrastructure Victoria (IV)[11] predicts a 75.9% increase in public transport trips across Greater Melbourne between 2015 and 2031; corresponding to an additional 879,000 public transport trips each day. Annual patronage is forecast to expand to more than a billion passengers by 2031.

Given projected travel demand growth and proposed changes in network supply in the next decade, travel patterns associated with public transport are also forecast to change. Inner areas of Melbourne are forecast to experience the greatest absolute growth in daily public transport trips, but outer regions are also expected to have higher growth rates with a 16.6% increase. The IV Report predicts that public transport mode share will increase from 10.0% to 13.6 % with the most significant increase in peak periods due to a combination of population growth, improved public transport services and road congestion. For trips departing during morning peak hours (7am to 9am) the share of public transport as a proportion of motorised travel is projected to increase from 12.3% to 17.6%.

The IV Report states that public transport in 2031 will be more accessible, more interconnected and have higher service frequencies across many areas of Melbourne compared to the 2015 network. In addition, due to increased demand and resulting delays, the 2031 road network will be relatively less competitive compared to the public transport system in terms of delivering fast journey times. Despite these factors, the report concludes:

> *"Melbourne will still remain a car–dependent city, with the large majority of travellers (more than 70%) continuing to use private vehicles in 2031. This is unsurprising, given the geometry of Melbourne's public transport. The backbone of the system is the train lines, which exhibit the highest capacities, highest*

[11] Victoria's 30 Year Infrastructure Strategy – December 2015 Infrastructure Victoria

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speeds and greatest level of service across all public transport modes. These lines radiate from the CBD, leaving little opportunity for convenient radial travel using this mode. While this supports public transport use as a significant mode of travel for trips originating in inner regions growing from 39% in 2015 to 48% in 2031, for other parts of the Metropolitan areas, this is not the case. Journeys that do not involve central Melbourne areas form the majority of all travel across the city. Particularly for outer suburbs, this often leaves bus services as the only viable public transport alternative – which can struggle to compete with private vehicles in terms of journey times".

Even the relatively modest shift in mode choice predicted in the IV report will place unprecedented demand on existing public transport services and require massive increases in network capacity.

Currently, Melbourne's public transport is concentrated on providing radial transport in peak periods by train and tram. Orbital inter-suburban and cross-town travel by public transport is made difficult by a lack of major train or tram lines that serve this purpose, regardless of Melbourne having over 7,000km of bus routes. Most bus routes provide low frequency service and are inefficiently routed. The few orbital and shuttle SmartBus routes that exist generally provide good quality services and unsurprisingly have patronage that far outstrips other bus services. On a relative basis, their overall use is still low compared with the radial rail system.

The shortcomings of these arrangements are that, for all but those who travel into and out of the Melbourne CBD and some inner suburbs, public transport is usually not the best option. Travel between suburban centres located on different rail corridors often requires a journey into the city centre and out again. For most, these options do not provide a viable choice.

Census journey to work data shows that most travel in Metropolitan Melbourne is within and between suburban areas outside the central and inner city. Most of this travel is by private car. Projected population growth and the intensification of suburban NEICs and activity centres will likely double the number of people travelling overall. However, committed plans to upgrade the rail system will not cater for the great majority of inter-suburban travel demand which is not met by the radial rail network[12]. Currently it is assumed that private motoring will dominate travel to NEICs and activity centres and hence there are still calls for road widenings, more and bigger freeways and tollways. However, dramatically increased car usage is not compatible with the kinds of pedestrian-friendly, lively urban places that suburban NEICs and major activity centres will need to be if they are to attract businesses and workers.

4.3 Increasing Network Capacities

4.3.1 Optimizing the Use of each Transport Mode

To optimise the use of Melbourne's public transport assets and to expand the network's capacity and reach, each mode must be developed in ways that take advantage of its inherent advantages:

- **Heavy Rail** – for high demand corridors focussed on the CBD, cross-city and contra-flow journeys. Rail Futures envisages that heavy rail will continue to play the primary role in serving the high-volume radial corridors linking suburban areas and major activity centres with the central city area. To meet the needs of the growing metropolitan area, capacity enhancement is needed on some existing electrified corridors, together with electrification extensions along several regional corridors. Several new cross-city routes are also proposed. Projects to meet these requirements are detailed in Section 5.
- **Tram** – for frequent, quality service in the CBD, higher density inner and middle suburbs, also for local suburban access. Our proposed tram network restructure aims to create a simple and legible network with a strong customer focus. Part of this involves changing tram operations through the CBD and inner suburbs to support:
    - access to and across the expanded central city and surrounding areas
    - many more journey options facilitated by user-friendly interchange hubs
    - linking of trunk routes to provide seamless cross-network access.

[12] On 28 August 2018, the Victorian Government announced its intention to construct an underground suburban rail loop encircling Melbourne's suburb from Cheltenham to Werribee with 13 intermediate stations at an estimated cost of $50 billion and for progressive completion over a 30-year period to 2051.

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Melbourne's tram network can become more efficient through measures such as selective tram stop rationalisation and construction of level access stops. However, the greater challenge is to separate trams from general road traffic to increase their speed and reliability and maximize use of available road space. These and related issues are fully detailed in Section 6.

- **Medium Capacity Transit (MCT)**– in medium demand corridors, particularly non-radial routes linking NEICs and key activity centres. Currently only sections of the "Light Rail" routes to St Kilda and Port Melbourne could be classified as MCT Transit in Melbourne. The potential for MCT in Melbourne is very significant. Options for new MCT corridors and the prospective application of a range of emerging technologies is described in Section 7.
- **SmartBus** – to complete the principal public transport network comprising radial, cross-suburban and orbital routes where rail modes are unsuitable or unviable
- **Feeder Bus Services** – to train, MCT and tram interchanges
- **Local Bus** – providing local services to local activity centres, schools, hospitals, etc.
- **On-Demand Service –** to provide irregular or "as required" services using small buses, taxis or "ride sharing" vehicles
- **Active Transport** – Safe cycling (typically up to 5km) and walking (typically up to 500m) for personal connectivity, including between home, neighbourhoods, public transport nodes or other linkages

4.3.2 Trams versus Buses

In the Melbourne context, there has not been serious debate regarding the respective roles of trams and buses in recent years. Perhaps Melbourne's trams are so much an accepted part of the city's psyche and because electric traction is now generally viewed as cleaner, quieter and more environmentally friendly. Melbourne owes a massive debt to those who successfully argued in the 1950's and 1960's against the prevailing trend in other Australian cities and around the world to abandon tramway systems in favour of buses.

The tram network also provides other benefits to Melbourne, particularly for CBD-oriented or inner suburban travel. As population pressures intensify, a positive influence on land values derives from the perceived permanence and predictability of fixed rail transport, a trend also evident in many other cities. Added to this is the quiet efficiency with which modern trams and/or light rail vehicles (LRV's) provide capacity to move several hundred people at a time. Serving an equivalent task with buses would require many more vehicles and much more road and footpath space. Trams have been a major factor in Melbourne's identification as a liveable city.

Nevertheless, the bus network will become an increasingly critical element of Melbourne's public transport complementing the tram, MCT and heavy rail transport networks. Rail-based modes must be supplemented by SmartBus and enhanced local bus services, primarily to provide services which cannot generate sufficient patronage to justify more expensive rail-based modes. Providing SmartBus high frequency cross-town connectivity is essential to a fully integrated multi-modal network. Local feeder services to rail stations are a vital component of the network, especially in the growth areas where service frequency improvement and route development are increasingly urgent. There are also many locations where bus routes could effectively co-ordinate with the tram network. An example of good co-ordination is at the Route 75 Vermont South tram terminus where buses provide a frequent scheduled connection to the Knox City Shopping Centre.

While this Plan focuses primarily on rail transport for providing the busiest trunk routes connecting areas of Melbourne, it is recognised that Melbourne also needs a complete overhaul and mass investment in the bus system. Although taxi and ride-share options can help with this vacuum, a great deal of bus route and service level investment is urgently needed.

Further commentary regarding Melbourne's bus network in the context of our Melbourne Transport Plan Blueprint is in Section 8.

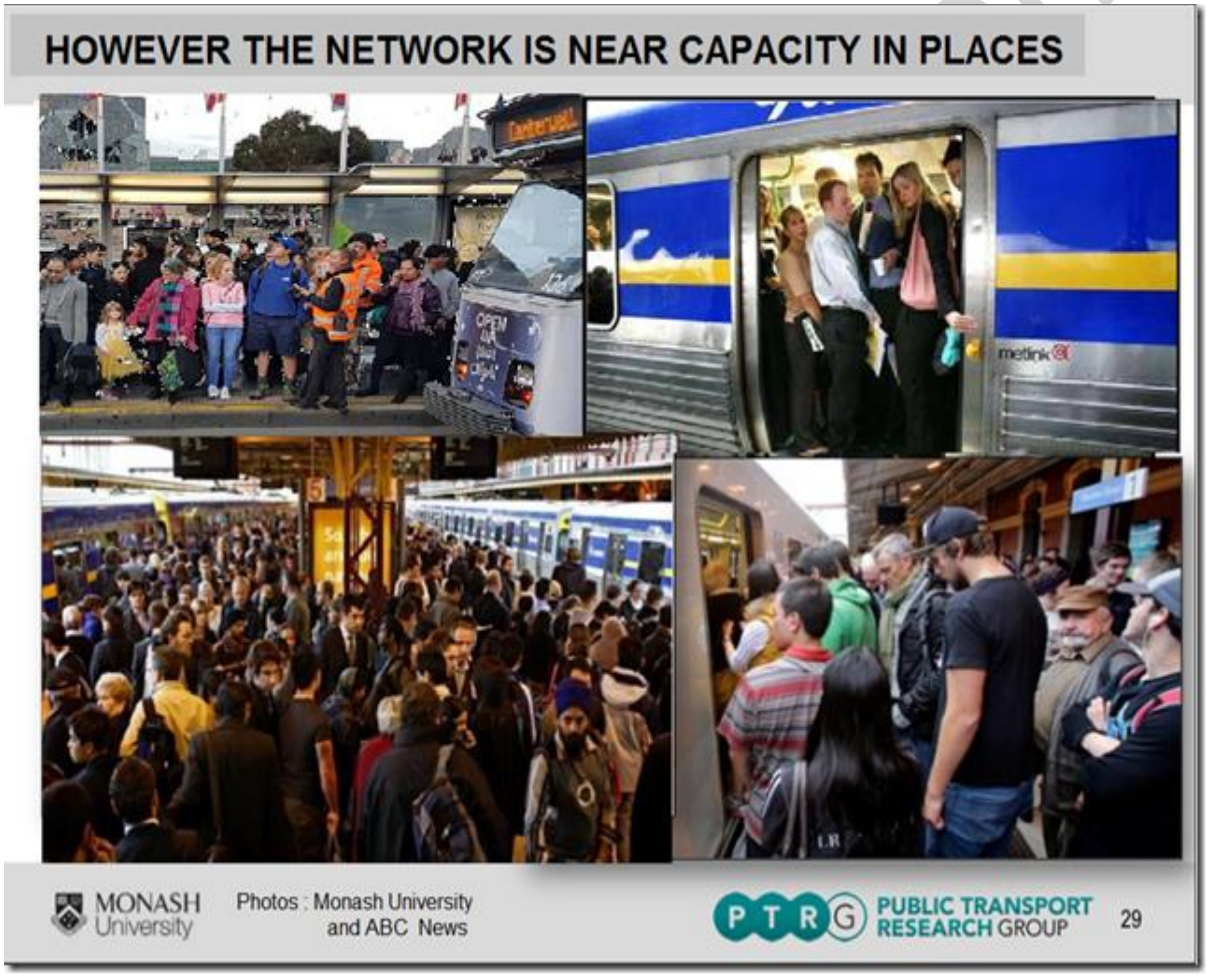
4.3.3 Increasing Heavy Rail Capacity

Melbourne's radial heavy rail services are currently constrained in the following ways:

- Peak period trains fill before reaching the inner suburbs and become overcrowded by the middle to inner suburban interface

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- Peak flow is concentrated on city-oriented weekday peak services although peak periods are expanding into mid-morning and mid-afternoon services
- Rail routes with older signalling systems result in longer headways between trains and proportionally reduced overall corridor capacity[13]
- Flat junctions and converging/diverging routes create conflicts between train movements which reduce corridor capacity by comparison with corridors not constrained in this way
- Routes with sections of single track have far lower capacity for accommodating train movements than corridors with twin tracks. Similarly, routes with three tracks (with two used in the peak direction) tend to have overall capacity constrained by the limitation imposed by the single track used for counter-peak movements
- Rail routes with trains having different performance characteristics and/or operating with inconsistent stopping conditions also suffer reduced capacity compared with those having more uniform rolling stock and operating patterns. This particularly applies where metropolitan and regional trains share the same infrastructure



To cope with the increasing demand, Melbourne's train network must be converted to a more intensive operation to maximise passenger carrying capacity, initially within the limits of existing infrastructure. Multiple options are available to increase the passenger carrying capacity of the network including:

- increasing train frequency by reducing train headways within the limitations of the signalling system
- altering train stopping patterns to provide greater consistency between successive services

[13] Each trunk rail route equipped with modern signalling systems can theoretically support trains carrying up to 1000 people operating at 2.5-minute intervals (headways) i.e. 24 trains per hour on each track carrying a total of 24,000 passengers per track/hour. On lines where high capacity trains operate, each carrying up to 1500 people, the theoretical capacity increases up to 36,000 passengers per track/hour. Trunk lines with two branches can run half of this capacity on each branch; with three branches about a third (or other proportions) not accounting for other constraints and reliability.

- ensuring train types operating on any single corridor have very similar performance characteristics
- increasing train size (by length or height) within the limits of platform lengths and other infrastructure
- accelerating procurement of higher capacity trains to make better use of the infrastructure in a transport corridor
- changing the internal train seating/standing ratio by reordering interior train layouts
- reducing station dwell times by more effective management of passenger flows on platforms, through ticket barriers and/or on vertical transport within station environs
- electrification of existing rail lines to major growth suburbs
- duplication of remaining single line sections
- re-configuration of the Melbourne Underground Rail Loop
- further segregation of regional from metropolitan train services through network re-configuration and selective track amplification
- adding turnback locations for trains to better handle shorter distance peak journeys
- providing additional tracks and/or platforms on existing corridors
- developing new corridors to directly or indirectly accommodate demand growth.

Other measures include new and more sophisticated signalling systems to allow trains to operate at closer headways, most likely involving new technologies, and introducing automated or semi-automated train operation to optimise train network performance. These options are inevitably highly complex and costly, tend to have long lead times and can introduce technology and human interface risks.

Proposed measures to increase passenger carrying capacity on Melbourne's heavy rail network are detailed further in Section 5 of this Plan.

4.3.4 Increasing Tram Capacity

Trams serve mainly central areas and run from the City's centre to the middle suburbs. Some cross-city travel is available by tram. Passenger turnover varies but can be as much as 5 – 6 times over the length of any one end-to-end service. Overcrowding is now common in peak hours on many routes with capacity being limited by factors including:

- most trams carry around 100 to 120 people with new E-Class rolling stock rated to carry 210 people. However, about 40% of the fleet consists of lower capacity vehicles carrying only between 65 and 90 people
- passenger capacity on most routes is between 750 and 1300 in each direction per hour – at the lower end of international practice – constrained by low capacity vehicles, closely spaced stops, road traffic delays, lack of traffic signal priority and few dedicated tram "right of ways"
- trams are particularly hampered by road traffic congestion, excessively low speeds and traffic management policies that still prioritise cars over people. These diminish user benefits, inflate operating costs and impede vehicle utilisation. Traffic congestion accounts for some 40% of tram running time. Other key delay factors include turning road vehicles blocking tram lines, passenger loading and unloading and car-biased traffic signal programming. Creating effective tram priority for on-road tram operations is a significant challenge that cannot be achieved in all cases due to cross-grid priorities, such as, a north-south set of flows conflicting with an east-west set of flows
- most tram stops are not easily accessible by all travellers impinging on passenger safety and slowing boarding and alighting times.

Most of these challenges are amenable to a range of solutions, as discussed in Section 6 of the Plan.

4.3.5 Providing adequate stabling, depot and power facilities for future operations

Heavy Rail Requirements

As new and more technologically advanced trains come into service and the fleet increases, the rail network will require new and extended train maintenance, servicing and stabling facilities. As the operations on each group of lines are progressively restructured to be largely independent of operations on other lines, each line group should be self-sufficient in terms of train fleet and supporting functions. This will require new servicing and stabling facilities at various locations as detailed in Section 5.13. An increased train fleet and larger trains will

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require additional traction power supplies with additional substations across an expanded electrified rail network.

Tram Requirements

The introduction of longer trams operating more frequently will require increased power supplies across the network. Larger trams also require longer platform stops and additional maintenance and stabling facilities. An emerging issue is the availability of sites for additional tram electrical supply sub-stations especially in the CBD and inner areas. This requirement needs to be considered when issuing planning approvals as often the only potential site is located within an existing re-development site. Development approval for such sites should consider sub-station requirements before approvals are issued. The space required for a modern new tram electric sub-station is not large and usually can be readily absorbed into a major new development or redevelopment at a site along a tram route.

Existing suburban tram depots are already facing difficulty in housing and maintaining the growing fleet. In addition, most depots were not designed to house or maintain the longer articulated type trams increasing in numbers on the Melbourne network. The proposed network extensions, progressive increase in overall fleet size and increasing proportion of modern, longer vehicles emphasises the need for suitably equipped new depots on reasonably large sites in the middle and outer suburbs. These developments must be dovetailed with the procurement program for new trams. Potential inner area locations for new depots are at Fishermans Bend, in the Footscray Road, West Melbourne area and at Melbourne Airport.

These issues are further discussed in Sections 6.6 and 6.7.

4.4 Extending Network Coverage

4.4.1 Heavy rail

The need to extend Melbourne's conventional heavy rail network is primarily driven by a combination of very large increases in CBD and near-CBD employment and Melbourne's continuing sprawl into outer metropolitan areas that are not currently provided with frequent electrified Metro services. Almost all the extensions proposed in this Plan are designed to extend full metropolitan network coverage to the residential growth areas in Melbourne's west, north and south-east.

Such extended coverage can be provided by electrification and/or duplication of existing lines, some of which are presently inadequately served by V/Line regional trains. Other cases involve re-opening and re-building closed lines which, fortunately, have corridors that were retained in public ownership – excellent examples of future proofing not always so evident in some more recent cases.

A total of 8 extensions of electrification on existing lines are proposed. Full details are in Section 5.4 of this Plan.

4.4.2 Trams

The tram network still serves Melbourne well, but is heavily biased towards travel to the CBD and Docklands.

If Melbourne is to take full advantage and leverage the benefits of the tram network, it requires enhancements to maximize its potential to serve Melbourne more efficiently. These enhancements include:

- Maximizing the capacity and route connectivity of the existing network, with a range of additional track connections at intersections, coupled with a restructure of existing routes and introduction of additional new routes to offer many new tram travel options
- Extensions to several tram routes from suburban termini at poorly defined destinations to new termination points at railway stations and commercial centres
- Creation of new non-CBD cross-suburban routes (mostly using existing infrastructure) to provide improved connectivity with other radial tram and rail routes, complementing the SmartBus network and forming important inner suburban elements of the new public transport grid network. Improved cross-town links are critical for Melbourne and a major feature of this Plan
- Introduction of longer trams up to 40m in length, and accelerated delivery of new larger capacity trams to replace outdated low capacity, labour intensive small tram operation, allowing fleet expansion and introduction of new and extended routes.

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These proposals are detailed in Section 6 of the Plan.

In addition, the Plan identifies new cross-suburban routes that are likely to require both higher capacity vehicles and faster operation than is practicable with conventional trams. These may operate on similar infrastructure to the tram network but substantially segregated from other traffic. In some cases, such vehicles may also operate over parts of the existing tram network. In other cases, they will employ a range of technologies which differ from conventional tramway steel wheel-on-steel rail operation. These possibilities are canvassed in Section 7 dealing with MCT.

4.5 Commuter travel times

The failure of public transport to attract a significant proportion of the total travel market is not only due to limited accessibility of many residents to services. It is also because public transport does not provide attractive door to door travel times for many common journeys, particularly if a transfer is involved. Door- to-door travel time rather than travel distance is a critical factor for most regular commuters and for many journeys, is also a primary determinant of mode choice. This includes the so-called "first and last mile" at journey origin and destination, which may involve walking or a short tram, bus or car trip.

The Marchetti Constant travel time budget of just over an hour on average has been found to universally apply across all cities[14]

> *"Some people can go beyond an hour and some much less, but the average everywhere is an hour. This has been found over and over to apply in every city ……. if people find it hard to live with so much time "wasted", they move to somewhere more within their travel time budget"*[15]

Recent research by the Federal Government on long distance commuting reiterates the Marchetti effect and finds that the direct effects of long-distance commuting are negative[16]. In general, commuters adapt by reassessing their location and commuting options. The option of using public transport is often not considered if the journey time exceeds an hour when the same journey by car is under the hour.

This underscores the obvious importance of the primary mode journey time, inclusive of waiting time at origin locations and the need for very frequent services if the notion of "turn up and go" is to be realised in practice. Where lesser service frequency is prescribed in timetables, reliability (perceived and actual) in terms of timetable adherence becomes another key consideration for regular users.

Most public transport trips in Melbourne involve at least one transfer between origin and destination and many involve two or more transfers between the same or different modes. Service frequency and reliability of the connecting modes, as well as the convenience of interchange itself are further key factors that strongly influence overall journey time and hence mode choice, often with the result that public transport is currently not a viable alternative to private car use.

Data from "Moovit Melbourne[17]" suggests the following:

- Average trip lengths of 9.8 km, but 26% of trips are over 12 km
- 60% of public transport trips involve one transfer and 19% of trips involve two or more transfers
- 14 minutes is average waiting time, with over 20% of passengers waiting over 20 minutes
- Average walk to public transport is 780 metres, but over 26% trips involve walking over 1 km
- Average one-way commuting time is 40 minutes, but 28% of public transport trips are over 60 minutes.

4.6 Providing a Grid Network in Melbourne

4.6.1 The Importance of a Grid Network

The keystone of RFI's Melbourne Rail Plan is to become significantly less car dependent by progressively transforming the current mostly radial network into an integrated connected cross-city grid network.

[14] See: http:/www.cesaremarchetti.org/archive/scan/MARCHETTI_052.pdf
[15] "Defying the one-hour rule" for city travel, traffic modelling drives policy madness, Peter Newman, The Conversation, 15January 2016
[16] BITR (2016), "Lengthy commutes in Australia", Bureau of Infrastructure, Transport and Regional Economics (BITRE) Report 144
[17] https://moovitapp.com/insights/en-gb/Moovit_Insights_Public_Transport_Index-2803 - Melbourne public transport statistics.

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Melbourne's primary public transport systems of heavy rail and tram largely evolved as radial networks focussed originally on the Hoddle Grid as the central part of Melbourne's CBD. Creation of a comprehensive grid network of public transport readily accessible to all across the breadth of Melbourne's massive suburban footprint is unlikely to ever be fully deliverable in terms of affordability or physical practicality. However, some elements of such a grid already exist, for example in Melbourne's CBD. It can be further developed in ways that will provide an extensive range of public transport options that can replace many trips currently made by car. For such trips to be an attractive alternative to a car trip, services must be part of a well-structured grid network with convenient interchanges to maximise the range of places one can reach with just one transfer and by having frequent services to ensure short waiting times at interchange points.

The effectiveness of a grid network is highlighted by the current situation, in which:

- 88% of the area and 92% of the population of Melbourne's inner area (where there is a partial grid network) is covered by high capacity (rail and tram) public transport
- 41% of the area and 54% of the population of Melbourne's middle area (which has a limited grid network) is covered by high capacity (rail and tram) public transport
- Just 4% of the area and 24% of the population of Melbourne's outer area (which has no grid network) is covered by any type of high capacity public transport

Short to medium term, the principal non-radial corridors used for journeys to work need to be identified and provided with high frequency SmartBus type services. However, as traffic congestion increases on these routes, such services will prove ineffective if buses are caught in traffic and cannot operate to reliable schedules. Dedicated bus lanes will be essential where they can be provided. Assuming proven and sufficient potential demand, these corridors are likely to become candidates for MCT solutions, as discussed in Section 7.

4.6.2 Converting a Radial Network to a Grid Network

The ideal distance between parallel routes in the grid is about 1km. This avoids the need to walk more than 500m to catch a service and, if necessary, make only one change at a suitable connecting point to arrive at any other intersection on the grid. Effective grid design maximizes the range of destinations gained with just one connection.

Because Melbourne covers such a huge area, it is not feasible to create a grid pattern across its breadth and depth or one which intersects every existing radial route. However, Melbourne's relatively flat terrain has meant that much of its suburban development has occurred on a grid form of streets and roads with few barriers to pedestrian access. This should aid the evolution of a grid-like pattern of public transport services, even though the ultimate grid network will take many years to fully develop.

Much can be achieved through better traffic management and re-allocation of road space to provide public transport priority to improve existing routes. Genuine policy change and the will to reduce car dependency will maximise the movement of people rather than vehicles. Other pre-requisites for creation of a successful grid network are passenger friendly interchanges and, above all, frequent services along the main elements of the grid. When the policy objective is to reduce car dependency, a high frequency service level is particularly important.

In many smaller cities, extensive grid networks have developed from original radial networks that served their city centres. Portland, Oregon in the US is an example of an excellent public transport (transit) network. As shown in Figure 17, many lines extending north and east from the Portland city centre form elements of a grid, but still converge in the city. Many other major routes do not proceed to the city centre, but instead complete the grid pattern. The balance between grid and radial patterns was re-constructed in 1982, replacing an old network in which almost all routes were radially oriented.

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Figure 17: Portland , Oregon, USA – Public Transport Grid Network



Source: *www.imagesofus.co/portland-oregon-public-transportation-map*

Melbourne's existing rail and tram networks provide the basic infrastructure for a future grid network. Additional elements to progressively enable the evolution of a grid network are summarised below and detailed in Sections 5, 6 and 7 of this Plan. They include:

- adding short "missing" sections to connect existing tram lines
- tram route re-structuring and selective route extensions
- other supplementary tram infrastructure
- MCT routes (including Light Rail)
- new and upgraded SmartBus routes and feeder services to stations and MCT routes
- new stations on existing rail lines
- level crossing removals to facilitate intersecting public transport corridors
- heavy rail electrification extensions
- modal interchanges

Above all, operations on the above infrastructure need to provide genuine "turn and go" service standards.

4.6.3 Tram Route Re-structuring and Extensions

The existing tram network suffers from inbuilt factors deriving from its history as a largely radial, but incomplete network. As such, re-structuring is needed to offer a partial grid network that maximizes interchange opportunities, both with other tram routes and the rail network. Extensions to logical termini at activity centres or rail stations are also proposed. Their purpose is to provide new travel opportunities and, where relevant, to encourage increased patronage at outer ends of the tram routes concerned, including for counter-peak direction travel. Bus routes will complete the ultimate grid.

It is proposed to progressively restructure the existing and extended tram network over 15 years to 2034 to achieve key elements of a new grid network that:

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- offers a greater number of cross-CBD, inner circular and cross-suburban travel options
- offers much improved connectivity between tram routes and between trams and the rail network
- offers a wide choice of tram travel options to/from and between all 15 City area rail station;
- introduces supplementary peak hour services from the CBD to selected inner suburban locations
- offers several extended tram routes to major activity centres, rail stations and other significant destinations.

Details are in Section 6 of this Plan

4.6.4 Medium Capacity Transit (MCT) for Non-radial Routes

While Melbourne has extensive rail and tram networks, a significant deficiency in the network is the lack of high-quality public transport to meet the need for:

- cross-suburban travel along relatively high usage corridors and where the installation of permanent transit infrastructure will engender market confidence resulting in land value uplift along the route and at key nodes
- connectivity with large employment clusters/activity centres
- cross-city connectivity at appropriate points with the heavy rail radial system.

MCT systems can meet this capacity/service gap. MCT systems are forms of public transport often described as 'semi-rapid transit'. MCT can take the form of rail-based technology such as Light Rail Transit (LRT), road-based systems such as Bus Rapid Transit (BRT), metro operations on the surface or underground, such as the Paris Metro and London Docklands Light Rail, or more recent developments such as very large guided buses as in China, otherwise known as "trackless trams".

According to the International Association of Public Transport (UITP) In 2018, 46 single LRT infrastructure projects were completed in 20 countries and 40 cities over a total of 309.4 km, with 66% of new lines and 22% of line extensions. The remaining 38% consisted of conversion projects.[18]



Experimental optically-guided MCT vehicle, otherwise known as a "trackless tram" in Zhuzhou, Hunan Province, China
Photo: *CRRC Zhuzhou Institute*

[18] UITP Statistics Brief – NEW URBAN INFRASTRUCTURE 2018.

Comment

Semi-rapid transit (SRT) systems can provide an intermediate step between 'street' and 'rapid' transit such as heavy rail systems. MCT can provide a range of benefits to Melbourne, offering a medium capacity urban public transport solution ideally suited to new trunk routes not requiring the capacity offered by traditional heavy rail. MCT does not require the significant infrastructure or take as much space as heavy rail but can deliver higher operating speeds, greater reliability and capacity than conventional buses at expenditure levels closer to regular tram infrastructure and much less than the very high cost of conventional heavy rail technologies. MCT capital costs are typically 25% to 35% of heavy rail and much lower if heavy rail requires tunnelling.

MCT systems are widely recognised as providing a catalyst for significant investment around stops and along routes and for improving liveability and amenity by attracting investment. This is a consequence of the long-term nature of fixed MCT infrastructure providing certainty for developers. MCT also offers the ability to closely integrate into the community and very efficiently bring people into the centre of high activity areas. To be effective, MCT combines fully or largely segregated ROWs, relevant system technologies and attractive service quality (frequency, span of hours, stopping patterns) into a package of public transport technology that is highly marketable.

As part of any plan to develop MCT corridors, a coordinated mix of land use and transport strategies must be developed. This applies where it is proposed to upgrade key routes on the existing network to MCT standards and/or construct new MCT routes and corridors. Many other land use considerations potentially affect the redevelopment of rail-based corridors, such as the existence of large numbers of historic buildings, and loss of amenity. Planning should also consider the extensive research demonstrating the benefits of concentrating increased population in mixed use activity nodes connected by high quality public transport.

With appropriate land-use planning controls in place, MCT provides opportunities to change land-use patterns and enhance land values along key corridors, around stations and in activity centres, as evidenced by experience in many other cities. MCT is often considered as the ideal foundation for maximising development along new trunk public transport corridors. Those corridors which link activity centres become vibrant and sought-after areas in which to live.

Planning for such corridors will have long lead times and involve many institutional and physical interfaces. In some cases, short term, high frequency SmartBus or similar services may be a logical transition to MCT in helping to change travel behaviour and prove up potential demand. They will also allow time to build community support, progress corridor protection measures and, above all, undertake an integrated process of transport and land use planning at a localised level.

Proposed MCT applications in the Melbourne context are described in Section 7.

4.7 Integration of Services

4.7.1 Co-ordination of routes and service

A feature of Melbourne's public transport network is that it has been multi-modal for more than 30 years, with integrated fares and ticketing. However, aside from fares co-ordination, there is no overarching network monitoring and control system to ensure that actual performance (particularly at modal interfaces) matches scheduled service.

Much of the tram network was developed in an era when rail and tram services operated as competing rather than complementary modes. This reflected a culture partly derived from a history of operation by municipal authorities followed by creation of the Melbourne and Metropolitan Tramways Board in 1923 as an independent statutory authority.

This legacy of poor co-ordination between different modes remains evident in many parts of Melbourne. Outside the CBD, the benefits of the 'network effect' are yet to be fully realised.

While parts of the bus network provide notional connectivity with rail, this is largely undermined by poor service frequency and/or restricted hours of operation. Instances of rail and tram connectivity is more by historical accident than design. Further lack of connectivity occurs in most cases where trams interface with the bus network.

Relatively low-cost additions to the tram network would enable it to take advantage of potential traffic generators, enhance overall network connectivity and better serve the changed demography of Melbourne.

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Integration of modes requires the following measures:

- high service frequency and comparable spread of operating hours of the connecting modes to provide genuine “turn up and go” service levels
- where high service frequencies are not practical or economically viable, timetable co-ordination must be planned, publicised, implemented and managed in real time
- modal co-ordination underpinned by service agreements and operational protocols that provide guidance to operators for dealing with late running and unscheduled disruptions to services
- establishment of an overarching Public Transport Coordination Control Centre alongside existing train, tram and bus operational control centres. This Centre would monitor scheduled intermodal connection arrangements providing a central facility for managing issues and ensuring accurate and fully updated information is communicated to travellers, especially at times of service disruption.

4.7.2 Modal Interchanges

Inevitably, public transport, no matter how comprehensive, cannot serve all combinations of passenger origin and destination. Hence, the effectiveness of the public transport network will depend on the willingness of travellers to transfer between routes. Car preference is unlikely to be reduced if transfers between routes involve long waiting times and/or are perceived as unattractive, unreliable or complicated.

Interchanges should offer physical facilities and information systems that support such passengers transfer.

Transfer between routes needs to be facilitated through public education and readily available information on journey options. In the field, transfer facilitation also requires excellent wayfinding signage, service information and suitable waiting areas. To minimise transfer time, high service frequencies are essential on key routes that form the principal transport grid. Real time experience needs to be supported by dynamic timetable information and infrastructure for safe boarding and alighting. This requires all stops to meet DDA standards.

Dedicated interchanges should be constructed at key transfer locations. These should be designed to ensure transfer between modes with minimal difficulty. Facilities for rapid interchange between cars and rail-based transport (“kiss and ride”) should be provided at most rail stations. However, the development of large park and ride facilities should be largely limited to outer metropolitan sites where it is impracticable to provide broad local coverage with bus feeder services. The focus should be on substantial time savings for commuters and overall reduction in travel costs to the community.

Detailed design of interchanges is not considered in the Plan as the requirements of individual interchanges will depend on local conditions at each site. However, the following are key principles for major interchanges:

- vehicle loading, unloading and transfer areas should be configured such that there are no ground level pedestrian crossings and thus no conflict between people and vehicles
- passengers should be able to see vehicles they wish to board and exits
- effective lighting, clear and extensive signage, static and dynamic service and security information are fundamental and must be available to all including less able travellers
- interchanges should be overseen by control centres with full knowledge of the operation of all services and able to make necessary day-to–day changes
- major interchanges should incorporate retail sections, the income from which can contribute to running costs as well as providing community and passenger service and amenity
- irrespective of mode used to access the interchange, the design should minimise walking distance, congested areas and queuing situations particularly at barriers and ticket validators
- transfer paths between modes should offer all-weather protection.

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Tram / Train Interchange at Den Haag Central Station, Netherlands
Source: *Courtesy Jannes Linders, Benthem Crouwel Architects, Amsterdam NL.*

4.8 Integrating Active Transport with Public Transport

While active transport as a separate important transport mode is covered in further detail in section 9 below, emphasised here is the role of active transport via walking and cycling to access public transport. Such integration helps reduce car dependency with positive health, environmental and cost impacts.

Melbourne's rail network already has some large car parks, up to 1000 spaces at some stations. There are more than 40,000 spaces across the metropolitan network and thousands more on the non-electrified V/Line network. Continued provision of commuter car parking is inefficient for attracting additional commuters to rail. This is because:

- car parks are expensive at $10,000 to $25,000 per space at ground level and over $30,000 per multi storey space, plus ongoing maintenance, lighting and security costs
- users typically drive just 1-2 kms to a rail station, leaving their vehicle there all day dictating that users own a car to access rail, and encouraging households to own 2 or more cars
- many car parks are full by 7.00-8.00am, catering for early peak commuters, thus providing poor access for the rest of the day, including off-peak times when there is ample capacity on the rail network
- car parks occupy large areas of valuable land that could be used for more appropriate urban development
- they increase traffic congestion around stations and detract from efficient access by walking and cycling[19]

"Park and Ride" may be appropriate for urban fringe areas where land is cheaper and not suited to other uses such as residential or commercial development, walking and cycling distances are too long for most people, and density does not support good bus services. However, with large volumes of passengers carried by trains, MCT and trams, it is invariably not feasible for cost and logistic reasons, to provide more than limited car and taxi parking, with drop off points for people with luggage, disabled passengers, and kiss and ride.

[19] http://economicdevelopment.vic.gov.au/transport/cycling-and-walking/active-transport-victoria; PTUA's Myth: Park-and-Ride facilities will encourage public transport use: https://www.ptua.org.au/myths/parkride/

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Ideally, access for most mass transit passengers needs to be by other modes: walking, cycling and bus.

It is critical therefore that rail station access is supported by a well-located bus interchange, and by safe walking and cycling routes, segregated from vehicle access to maximise safety and encourage active transport modes. Secure bike storage facilities with showers and repair facilities, together with bike hire through bike share provision including "e-bikes" with charging points, will also maximise scope for efficient access to rail journeys.

There is scope for substantial improvement of access to rail and MCT stations by bicycle. The case study below demonstrates excellent integration of cycling journeys with rail at Houten in the Netherlands. With a population of only 50,000, this city caters for thousands of passengers seamlessly accessing Houten rail station by bike to travel further by train. The model can also apply to key MCT stations and bus interchanges.

CASE STUDY >> BIKE/RAIL MODE

Access to rail stations is a major issue where homes and jobs are beyond station walking distance. With insufficient land for car parking to meet access demand, alternatives are essential.

Apart from bus interchanges, many cities encourage access to stations by bicycle. This necessitates safe bicycle routes and well located bike parking with direct connections to platforms or the station hall.

These facilities make access to rail stations easy and attractive. Significantly, the cycle catchment to rail stations is 15 times the size of the walking catchment.

In the Netherlands, near 50% of all train passengers cycle to their rail station. Key success factors for the bike/rail combination:

- safe bike access to reach the station
- safe, convenient, sheltered bike parking
- easy public bike rental at stations
- integrated payment of bike/rail services
- marketing that bike/rail mode is easy, fast, affordable, convenient and cool



IMAGE: Houten Station: population 50,000
SOURCE: Martin Bond / Alamy Stock Photo.

Combining the rail and bike modes is highly effective being the most energy efficient and sustainable means of mobility in cities, providing seamless door-to-door transport.

4.9 Serving the Central Business District and immediate surrounds

4.9.1 Heavy rail

Extensions and enhancements of the conventional heavy rail network are expensive but nonetheless provide the most viable mass transit solution for corridors that carry large passenger volumes. In the Melbourne context, such corridors are limited to those serving the CBD and adjacent inner suburbs which provide major concentrations of high value jobs and innovation. This job-rich area now covers a much greater area than the historic Hoddle Grid originally well served by Flinders and Spencer Street stations and, over more recent decades, by the Melbourne Underground Rail Loop.

Melbourne's job-rich centre also provides an imperative to restructure much of the existing inner network into a series of high capacity cross-city corridors that provide similar functionality to the massive *Crossrail* project in London, thereby providing efficient rapid access. The Melbourne Metro (MM1) project will provide a critically needed cross-city corridor linking lines stretching almost 100km from Melbourne's north-west to its outer south-east. An early priority is to also provide a segregated fast line to directly link Melbourne's CBD at Southern Cross station to Melbourne Airport via Sunshine and to also provide excellent connectivity with the wider rail regional network. (Section 5).

Section 5.5 of this RFI Plan explains proposed re-configuration of the City Loop to provide an essential north-south cross-city corridor. Also covered in that section is the vital Melbourne Metro 2 (MM2) project that similarly provides essential cross-city connectivity from Melbourne's outer north-east to its massively growing south-west. These cross-city connections will be complemented by two others – one that links the middle southern and western beach suburbs and another that links Melbourne's outer north with its middle and outer east. Each of these cross-city connections intersect at existing CBD stations or, in the case of MM1 and MM2, in the heart of Melbourne's university and medical precinct at nearby Carlton/Parkville, a designated NEIC under *Plan Melbourne 2017-2050*. The goal is to provide fast convenient access to Melbourne's inner core and, with a maximum of one transfer, to all its immediate surrounds.

The above major network changes will release capacity on the two remaining corridors that traverse the City Rail Loop. This will enable services to be augmented to the CBD from other parts of middle, inner eastern and north-eastern Melbourne that are growing through residential densification, albeit at a more modest rate than the outer growth areas and in some of Melbourne's inner and middle ring suburbs.

Finally, Section 5.5 of the Plan also describes an ambitious medium-term project to substantially improve rail services from Melbourne's inner, middle and outer south-east and from the Gippsland region and, in turn, provide a direct connection from these regions to the Melbourne Airport line.

4.9.2 Trams

The existing network is already under extreme pressure handling current traffic volumes particularly within the CBD. If the potential of trams to serve the CBD is to be realised enhancements are required to:

- Maximise the capacity and route connectivity of the existing network, with additional track connections at intersections, coupled with a restructure of existing routes and introduction of additional new routes to offer many new tram travel options
- Extend several tram routes to connect with existing and new stations, including the routes of MM1 and MM2, and residential, commercial and employment areas of Fishermans Bend
- Introduce longer trams up to 40m in length and accelerate delivery of new larger capacity trams to replace outdated low capacity, labour intensive small tram operation, allowing fleet expansion and introduction of new and extended routes.
- Improve tram stops
- Initiate greater tram priority measures along key routes

These proposals are detailed in Section 6 of the Plan.



D1 Class Tram in Congested Traffic – Burke Road, Camberwell

for comment

The 30 cars in front of and behind this tram carry an average 36 persons in total, whilst the latest articulated trams can carry 210 persons. This illustrates the current poor utilisation of road space in many parts of Melbourne.

4.10 Linking National Employment and Innovation Clusters (NEIC) and High Employment Areas

The tram network still serves Melbourne well, but is heavily biased towards inner northern, eastern and south-eastern suburbs in ways that largely reflect Melbourne's development between World Wars 1 and 2. Some major activity centres such as Footscray, Box Hill, Ringwood, Dandenong and Frankston are well served by the radial rail network to the extent that their access can be achieved from other locations on the same rail lines. Connecting these lines presents some of the best opportunities for public transport to provide cross-suburban access to these centres.

Some areas just beyond the Central Business District, such as Cremorne in Richmond are developing into significant commercial centres (see Case Study below).

CASE STUDY >> PUBLIC TRANSPORT LINKS UNLEASH DEVELOPMENT IN CREMORNE





City fringe locations like Cremorne are attracting significant interest from businesses who previously would have sought CBD office space. The Cremorne/Richmond area is supported by good public transport access with 3 rail stations, 2 tram lines and proximity to major activity centres of Swan/Church/Chapel Streets and the CBD. Lured by these factors, Cremorne is thriving with new businesses including creative, retail and technology companies. It is now one of Melbourne's most attractive commercial markets.

The area's amenity includes some of Melbourne's best cafés and retail strips, good public transport, Yarra River access and parks. Many businesses are avoiding a CBD location to harness the benefits of well serviced inner suburban locations like Cremorne, joining start-ups in key co-working arrangements.

Excellent public transport together with its vibrant character, are key reasons why the Rea Group moved from Victoria Gardens to Cremorne. So too for Red Energy, Seek, and David Jones,

Similar development could be expected along other well located inner areas such as Alexandra Parade if the gap in east-west rail and tram transport was remedied to link with north-south rail and tram lines; and in suburban major activity centres like Doncaster Hill, the Monash precinct, Footscray, Sunshine and others across Melbourne.

ARTICLE SOURCE: *Good public transport is key to more intense development as has occurred in Cremorne.* https://urban.melbourne/development/2018/04/24/icon-and-wood-marsh-combine-600-church-street

Other important activity centres have emerged in the middle suburbs and beyond, not served by tram or train. The most obvious are Melbourne Airport, Doncaster, Knox City, Chadstone and the Monash precinct. (See Case Study below). In most cases, these warrant a mix of high capacity radial links with the CBD, supported by cross-suburban links to provide access for centre employees, customers and visitors.

Similarly, there has been almost no extension of the tram network into middle western, north-western and south-eastern suburbs established during the decades following World War 2 when the motor car was widely perceived as the solution to mobility needs. Good quality public transport from middle suburbs has been only available via the radial rail network to the Melbourne CBD. Parts of these lines are now struggling for capacity driven by the combined effects of burgeoning growth toward their outer reaches and residential densification now occurring in many middle suburbs.

Access to middle suburb stations on these lines has largely relied on car parking availability (for which unconstrained demand greatly outstrips supply) or on feeder bus services of variable quality. Cross-suburban

trips from middle suburbs to other areas of employment concentration are almost exclusively undertaken by car in the absence of usable public transport alternatives.

New growth areas in Melbourne's north, west and south-east already have some rail access to the job-rich Melbourne CBD. This should further improve in coming years through proposed rail electrification extensions or various rail capacity enhancement projects. Some of these suburbs are also gaining feeder bus services to rail stations of reasonable quality. However, in growth areas, except for some parts of the south-east, a significant gap remains between where people live and must travel to access employment outside the Melbourne CBD. Presently very little useable public transport is available to bridge that gap.

Major employment nodes designated National Employment and Innovation Clusters (NEICs) under *Plan Melbourne 2017-2050* have developed in Werribee, Sunshine, LaTrobe, Parkville, Fishermans Bend, Monash and Dandenong. Parkville is becoming an integral part of the wider Melbourne CBD while NEICs in the East Werribee area, at Sunshine and at Fishermans Bend are in their early stages of development. The latter has planned tram extensions and prospective MM2 heavy rail line.

The Monash precinct is strong in its own right; but when combined with the Chadstone precinct and Oakleigh, the combined area is becoming a super cluster. This rapidly developing area urgently requires a combination of new heavy rail and both east-west and north-south MCT corridors to strengthen its role in education, medical research and scientific innovation. Heavy rail and MCT proposals are detailed in Sections 5 and 7 of the Plan and proposed overall public transport access to the Monash precinct is detailed in Section 10.

CASE STUDY >> POOR PUBLIC TRANSPORT STIFLING MONASH UNIVERSITY RESEARCH PRECINCT



Monash University is identified in Plan Melbourne 2017-2020 as a major employment and innovation cluster - 53,000 students and workers seek access to the precinct daily.

However, poor public transport links are stifling its growth. The bus between the University and Huntingdale Station is now Melbourne's busiest bus route; but it has limited capacity and does not provide a long term solution to accommodate the precint's growth. With increasing congestion, the Monash precinct will be unable to accommodate as many students and workers in 2025 as it does today - unless its public transport access is very substantially enhanced.

Rail Futures proposes to support the Monash precint with high capacity train and light rail services.

The LaTrobe/Austin Hospital precincts combine to form a strong relationship; but also require stronger transport linkages for employment access from the Heidelberg, Preston, Reservoir, Thornbury and Northcote residential areas. This too could become a super cluster of its own accord, supported by tram extensions and potential MCT, details of which are also set out in Section 10 of the Plan.

Dandenong is well served by existing heavy rail corridors extending from Pakenham and Cranbourne but lacks effective cross-suburban north-south or east-west connections. MCT proposals in this Plan are designed to provide these important new cross-town linkages.

Large employment nodes exist at Melbourne Airport and its surrounds, forming a super cluster of activity spread much wider than the immediate airport environs. It is possible that the Sunshine NEIC will combine with the Airport and Broadmeadows environs to create a mega cluster. There is available human capital as well as cheaper land to drive a different cluster unit here in addition to potential relationships which currently link each area with the Airport. The proposed Melbourne Airport Rail Link (MARL) from Southern Cross via Sunshine combined with proposals in the RFI Plan for a tram extension and MCT east-west corridors, will provide much of the required connectivity with the Airport.

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4.11 Meeting Disability Discrimination Act (DDA) Requirements

4.11.1 DDA Obligations and Standards

> *"Inaccessible public transport can have a profound effect on people's lives. It can frustrate and isolate people, and erode their ability to live confidently and independently"*[20]

Public transport in Victoria is gradually being made more accessible for people with disabilities and to comply with provisions of the Commonwealth Disability Discrimination Act 1992 (DDA). The DDA seeks to eliminate discrimination, 'as far as possible', against people with disabilities. Under the DDA, standards have been specified for access to public services including transport (Disability Standards for Accessible Public Transport 2002 - DSAPT). In prescribing how public transport is to be made accessible, the Standards acknowledge certain rights of passengers, operators and providers, as well as imposing some responsibilities to meet the Standards.

These Standards apply to all operators providing public transport services, and to the conveyances they use, supporting premises and infrastructure. There are specifications for manoeuvring areas, passing areas, bridges, resting places, ramps, waiting areas, boarding, handrails, lifts, etc. A target date of 31 December 2032 is stipulated for all public transport services to fully comply with the relevant Standards.

In December 2013, Public Transport Victoria (PTV) released *The Accessible Public Transport Action Plan 2013-17* for delivering accessible bus, train, tram and taxi services throughout Victoria. No update has been published to date.

"Absolutely Everyone", *Victorian State Disability Plan 2017-2020* (SDP) was released by the Victorian Government in December 2016. It observes that:

> *"Accessible public transport is critical for people with a disability. People with a disability need accessible public transport so they can easily travel to school, work and social events. Universal access to public transport services and facilities provides opportunities for people with a disability to make their contribution and lead a satisfying life. This means making public transport easy to use across all parts of the system including buses, trains, trams, taxis and other commercial passenger vehicles."*[21]

Key Priority 3 of the SDP covers public transport, but mostly in generalised statements such as to, *"prepare and maintain an accessibility implementation plan detailing how they* (public transport operators) *will make Victoria's public transport easier to use"*. Specific matters addressed in Key Priority 3 mainly relate to accessibility issues in regional Victoria. There is no reference to metropolitan train and tram services.

As detailed in the following Sections, given progress to date, it will be extremely challenging to achieve the legislated target date of 31 December 2032 for both tram and train infrastructure and the tram fleet to meet the DSAPT requirements.

4.11.2 Trains and Access

All metropolitan trains are wheelchair-accessible but require train driver assistance to deploy a portable ramp at most stations. A small number of stations have a raised section of platform alongside the front carriage that permits unassisted level boarding of wheelchairs. However, train drivers are still required to ascertain the destination of such passengers to enable them to assist if required at relevant stations. Overall, this system, whilst somewhat unique to Melbourne, works satisfactorily. It has the added benefit of bringing train drivers into direct contact with the travelling public.

Metropolitan train stations (except Heyington on the Glen Waverley line) are theoretically accessible for people using mobility aids. However, while some metropolitan stations have ramps to enter the station and platforms, many are steep and do not comply with DDA standards. Such stations require people with a mobility aid to be assisted for access, and station staff (where provided) do not usually perform this function. Lifts are available at CBD and some suburban stations[22].

[20] Public Transport Ombudsman Accessibility Report, Victorian Public Transport Ombudsman, April 2019.

[21] Victorian State Disability Plan 2017-2020, p.11, released in December 2016.

[22] Lifts are currently available at Bayswater, Bentleigh, Blackburn, Box Hill, Boronia, Carnegie, Clayton, Coolaroo, Dandenong, Elsternwick, Epping, Flinders Street, Footscray, Gardiner, Ginifer, Hawkstowe, Heatherdale, Hughesdale, Laverton, McKinnon, Mernda, Middle Gorge, Mitcham, Murrumbeena, Noble Park, North Melbourne, Nunawading, Ormond, Ringwood, South Morang, Southern Cross, Springvale, Thomastown, Watergardens, West Footscray, Westall, Williams Landing and City Loop stations.

Draft for comment

Many stations (other than those constructed or rebuilt within the past decade or so) also do not comply with the DSAPT in relation to platform curvature, height, width and gradient. Curved platforms pose design challenges in providing an acceptable gap, both horizontal and vertical, between trains and the platform edge.

4.11.3 Trams and Access

Large parts of Melbourne's tram network remain inaccessible to wheelchairs and other mobility devices. This is either because of the non-provision or limited provision of low floor trams on many routes and/or because less than one quarter of Melbourne's tram stops are DDA compliant.

Low floor trams have colour-contrasting grab handles, step edging for people and improved customer service information via automated announcements and electronic displays. All have a minimum of two allocated spaces for passengers using wheelchairs or mobility aids. This area is inside the double-door marked with a wheelchair symbol.

On low floor trams, a specially marked call button overrides the automatic door closing mechanism to allow passengers using wheelchairs or mobility aids extra time to enter or exit the tram. These trams also have an external door release (a blue button) to help passengers using wheelchairs.

High floor trams have steps, so are inaccessible for mobility aids including wheelchairs, scooters and motorised vehicles. They also present difficulty of access for those who are elderly or infirm and for those with children in pushers or prams. Over 300 high floor trams currently remain in operation.

On completion of current orders for new E class trams in 2020, there will be 190 low floor trams in use on Melbourne's tram network, representing approximately 38% of the total tram fleet. Yarra Trams aims to run all services on routes 19, 96 and 109 with low floor trams, to which routes 11 and 86 will be added when current new E class procurement has been completed. Meanwhile, routes 5, 6, 11, 16, 48, 58, 72 and 86 are partly serviced by low floor trams.

To meet DDA compliance by 2032 and to meet the projected peak traffic task by 2034 and beyond, a vastly accelerated tram fleet acquisition and replacement program is required, as detailed in Section 6. This would see the fleet grow from the current 500 trams to around 640 by 2034.





High floor tram at a DDA compliant stop ***High floor tram at a non-compliant stop in Fitzroy Street, St Kilda***

Both photos: *Max Michell*

4.11.4 Accessible tram stops

Accessible stops have ramps to improve access for passengers, including people in wheelchairs, parents with prams and elderly people. Accessible stops also feature improved lighting, granite and stainless-steel finishes, raised platforms with ramp access, real-time tram arrival information and glass shelters. Many of the newest accessible stops feature pedestrian crossings with flashing amber lights and tactile paving to assist customers to safely cross the adjacent road. Selected stops in the CBD also have audio buttons which provide real-time arrival information.

Comment

As at early 2019, 420 of the 1740 stops (24%) were DDA compliant (*source: PTV*) to complement low floor trams. However, some of these stops are on routes where low floor trams do not currently operate. Over 1300 stops still are not DDA compliant and the current platform stop construction and rationalisation program needs to be greatly accelerated. Additionally, new accessible tram stops on a route by route basis will need to be constructed to accommodate trams 33m in length. On specified routes, CBD and inner suburban platform stops will need to be extended to handle trams up to 40m in length.



Low floor trams at non-DDA compliant stops
Both photos: *Max Michell*

4.12 Encouraging Transit Oriented Developments (TOD's)

Transit Oriented Developments (TOD's) around major rail stations will be key to creating connected and lively urban areas. TODs also create job opportunities in service industries that generate counter-peak travel that the public transport network can accommodate at zero marginal cost.

Currently, most Australian rail stations have very basic and uninviting flow-through areas, but in other parts of the world they are lively recreational and retail hubs. Historically, decisions about station and over-station development have been made in isolation from urban planning decisions. However, in countries like Japan, Hong Kong and the UK, the development of recreational and retail precincts are fully integrated into station design. Railway stations in such countries also operate as the focus of wider land uses fully integrated with the public transport service, connecting employment, retail, and dense residential uses to a broader metropolis.

Managing station precinct developments is a key part of managing land assets towards better transport and community outcomes. With a focus on sustainable development, a range of benefits to precincts from upgrades and improvements to existing transport and community infrastructure, can be delivered, including,

- apartments
- shops and cafes
- landscaping and parkland
- improved station amenities
- access improvements
- bike storage and seating

The picture below shows a recent precinct upgrade in Acland Street, St Kilda at the terminus of Route 96. The tram route has been slightly shortened, two side platform stops created and cars banned from the terminus area which has been turned into an attractive pedestrian only zone. Initially strongly opposed by local shopkeepers, it has now been accepted as an improvement which benefits everyone.

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New twin track tram terminus in Acland Street, St Kilda
Courtesy: *Public Transport Victoria*

4.13 Removing Level Crossings

Operations on selected corridors will require grade separation of road and rail to improve safety and reliability, and to reduce road delays as rail services become more frequent and are intersected by other public transport routes. This particularly applies to Melbourne's remaining three rail/tram level crossings, (Kooyong, Riversdale and Glenhuntly), and those on key bus routes and other proposed tram and MCT routes.

Well-designed grade separation will facilitate improved intermodal transfer opportunities and enhance urban planning and design outcomes. Level crossing removals considered to be of high priority for removal are detailed in Section 5.9.



Heatherdale Station after removal of Heatherdale Road level crossing
Courtesy: *Level Crossing Removal Authority*\

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4.14 Determining Service Standards

Service standards for trains and trams are detailed in Sections 5.6 and 6.5 respectively

4.14.1 Service Frequency

Service frequency is the most critical element in the delivery of a grid public transport network that is sufficiently attractive to induce significant reductions in car dependency. This requires genuine "turn up and go" schedules that, for many journeys, eliminate the need to consult or understand timetables; this means intervals between services not exceeding 10-minutes. Weekday peak period services on most trunk rail and tram routes and a few bus routes already achieve this or better. This is of even greater importance where journeys involve interchange between two or more routes, irrespective of travel mode.

4.14.2 Hours of Operation

Services on all full-time routes by all modes would normally operate during a minimum spread of hours from 6am to 10pm on weekdays and 7am to 9pm at weekends. All heavy rail, tram and future MCT routes would generally provide services from 4.30am to 1.30am on weekdays and 5.30am to 12.30am on weekends. Trunk rail, tram, future MCT and SmartBus routes would also provide minimum hourly all-night services during the early hours of Saturday and Sunday mornings.

4.14.3 Reliability Standards

Existing service delivery and timetable adherence standards are generous by international standards and need to be tightened to reflect current community expectations and service reliability requirements that provide a viable alternative to private vehicle use. Proposed revised standards would require 99% monthly delivery of all scheduled services and on-time performance measured on departure, designed intermediate points and destination at 95% within 2 minutes during designated weekday peak periods and 3 minutes at other times for heavy rail services and 90% within 4 minutes for all other services. Mitigation would only be allowed in exceptional circumstances.

On the tram network, consideration should be given to monitoring service delivery relative to timetabled frequency of service, rather than adherence to timetable at specific locations en-route. To tram passengers, reliability and adherence to the advertised frequency is far more important than timetables. Already in many cases, the timetables at stops indicate the frequency of service at specific times of the day. That is what tram travellers expect.

4.14.4 Capacity and Crowding

Maximum passenger load carrying standards would continue to apply to all vehicle types. All rolling stock and buses would be equipped with load monitoring devices linked to the MYKI ticketing system which would generate continuous passenger capacity utilisation data for each route journey.

4.15 Separating Metropolitan, Regional and Freight Services

Regional passenger services need to be segregated from burgeoning metropolitan services to increase overall capacity for the rail system, enhance reliability and to segregate express from slower stopping services. Each has quite different requirements in relation to stopping conditions, speed and technology and each serves a market with different user expectations.

Where both types of service are forced to use common infrastructure, the outcome has increasingly become sub-optimal as regional trains operate on train paths squeezed between more frequent Metro trains and their differing performance characteristics consume disproportionate levels of scarce track capacity. Regional passengers are increasingly frustrated by very slow journeys through the metropolitan area following Metro trains that mostly stop at all stations.

The Regional Rail Link project, completed in mid-2015, provided separate tracks for Geelong, Ballarat and Bendigo line regional passenger services between Southern Cross and Sunshine where they had previously intermingled with Metro services. This substantially increased capacity and reliability for both regional and Metro services, while allowing regional trains to operate at much faster speeds on segregated regional tracks.

However, Metro and regional trains still compete for track capacity on the following line sections:

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- Bendigo trains – between Sunshine and Sunbury
- Seymour/Shepparton trains – between Southern Cross and Craigieburn
- Gippsland trains – between Southern Cross and Pakenham

In the absence of major additional infrastructure, the situation will considerably worsen when Metro electric train operations are extended, e.g. to Wyndham Vale/Black Forest Road, Melton/Bacchus Marsh, Clarkefield and Wallan as proposed in the following Train Plan (see Section 5.4). Hence the need to provide separate express tracks for regional trains and/or divert them on to a separate route. The proposed solutions are described in Section 5.7.

Rail freight movements that once serviced numerous sidings and terminals within the metropolitan area no longer operate wholly within the metropolitan area. Current rail freight movements are mostly for containerised and some bulk commodity exports from regional Victoria and interstate to the Port of Melbourne or for interstate domestic freight moving between Melbourne and other capital cities, particularly Brisbane and Perth. Virtually all other freight that moves within metropolitan Melbourne is handled by road transport.

The principal opportunity for changing this situation lies with the development of rail/port shuttle trains. Containerised freight comprises the largest volume of cargo handled at the Port of Melbourne, currently at almost 3 million x 20-foot equivalent units (TEU)[23] per annum. Some 60% of this volume comprises import cargo. Of this, nearly 90% has destinations within the greater Melbourne area. This volume generates thousands of truck movements per day to and from the Port precinct. Up to one-third of these movements could be handled by dedicated rail/port shuttle trains operating between the Port and metropolitan hub terminals strategically located in Melbourne's west, north and south-east. These could operate on existing rail infrastructure using available track capacity outside of weekday peak periods, including on one or more metropolitan passenger routes.

Three hub terminals have already been established for this purpose, although two are yet to be physically connected to the rail network. One or more complementary terminals would have to be established within the Port of Melbourne precinct to make the concept operate successfully. Other potential rail freight flows that could be developed to operate within or through the metropolitan rail network include building materials (sand, stone and gravel and cement) and containerised household garbage destined for recycling or reprocessing.

In 2017, the Victorian Government sought Expressions of Interest for the provision of rail/port shuttle train services between the Melbourne Port precinct and the abovementioned hub terminals. In October 2018, the Government announced partial funding to connect two metropolitan hub terminals to the proposed Port/Rail Shuttle Network[24]. The announcement also indicated a potential 'full on-dock' solution for port/rail shuttles at the Port of Melbourne.

4.16 Adapting to new transport innovations

4.16.1 New Technologies for Conventional Transport Modes

In recent years there have been rapid developments in transport technology throughout the world. The developments have been applied to existing train and tram services and to initiate proposals for radically new modes.

The conventional transport modes are continually adopting innovative technology to improve operational efficiency, reduce energy costs, improve operating performance, achieve better environmental outcomes and improve customer experience. Undoubtably Melbourne will benefit from the development and incorporation of new technology into its transport systems, particularly in areas of:

- power supply
- infrastructure upgrading including stations
- signalling system replacement
- rolling stock design
- communications and security systems upgrading
- enhancing the customer experience

[23] TEU - Twenty Foot Equivalent Unit . Conventional Measure of the number of containers transported or handled at any facility.
[24] See https://www.premier.vic.gov.au/port-rail-projects-to-take-trucks-off-local-roads/ dated 26 October 2018.

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- driverless trains and trams with automation of signalling and train control, to increase train throughput as all trains would operate without the variability associated with human control
- tram throughputs improved with vehicle activated traffic signals
- vehicle crowding problems reduced with electronic monitoring of passenger movements to enable services to be varied to distribute loads more evenly
- using power inputs from environmentally acceptable sources

Detailed review of many of the opportunities for applying new technologies are beyond the scope of this Plan but RFI recommends immediate attention be given to the following areas:

- Melbourne's power supply system was designed for a fleet of traditional trains and trams. It must transition to a future network operating much larger vehicles, operating at greater frequencies. This will require detailed study of future options in terms of vehicle technology, energy efficient traction systems and an updated power supply network that provides resilience through redundancy and leverages the latest and most suitable technologies.
- Much signalling equipment and some elements of the electric traction system are both life expired and obsolescent. Replacement provides the opportunity to progressively introduce technology which enhances both network capacity and reliability. Replacement of obsolete and inadequate infrastructure is required on a significant scale on the Melbourne metropolitan networks over at least a 15-year period.
- An ongoing program is also needed specifically directed at using the latest technologies to progressively improve passenger experience and amenity at stations and interchanges. The station improvement program needs to encompass a wide range of matters including weather protection, lighting, security systems, DDA compliance and information systems (static, dynamic, visual and audio). Public transport will be able to significantly improve customer information, security, and the entire customer experience with adoption of the latest technology. Personalised real time information can be made available about services, routes, timetables, travel conditions and parking availability. Travellers can be informed, entertained and educated while travelling.

4.16.2 Autonomous Vehicles

The introduction of autonomous driving raises many issues for transport planners and operators. Autonomous on-road driving technology has the potential to vastly alter the nature of passenger and freight travel. How and when this happens will have considerable implications for mode share and travel patterns. Some predict that by 2040 these vehicles will account for up to half of all road travel. Not only will autonomous vehicles affect travel behaviour, but they could change the development patterns of the city.

While the implications of autonomous driving are extremely difficult to anticipate there are undoubted opportunities to integrate pubic transport services with driverless cars in ways to optimise the overall effectiveness of each mode. For example, the use of driverless cars to provide local access to railway stations could provide a high quality and efficient end-to-end passenger journey.

4.17 Framework and Principles for Evaluating Projects

4.17.1 Criteria for Selecting Projects

The RFI Plan has been developed applying the following criteria for selecting projects to increase mode share for public transport by:

- improving the efficiency of the networks
- improving the accessibility and coverage provided by public transport,
- providing greater connectivity across the metropolitan area (developing a grid network),
- facilitating the development of employment clusters, transit corridors and transit-oriented centres,
- increasing capacity to match demand
- improving service quality.

Proposed projects will require rigorous economic analysis beyond the scope of this Plan. In the proposals detailed in Part 3 of this Plan the following important considerations have been recognised:

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- The estimated cost of the option, both in its cost to build and operate
- The likely economic, social and environmental impacts of the option
- Appropriate timing, including when utility of existing infrastructure will be maximised before the next stage of a planned progression will be implemented
- Extent to which public transport access to principal and major activity centres is improved
- Relationships between options including how they might enable, complement or inhibit one another
- Extent to which the project provides relevant future proofing
- The potential level of community support (or otherwise) for the option
- Resilience of the options under alternative future scenarios
- Any relevant interactions with current state planning strategies
- In the case of a heavy rail project, whether it will reduce the operational complexity of the network
- Operational feasibility and constructability.

The required economic analysis of proposals must take account of wider economic benefits, some of which are not readily quantifiable.

4.17.2 Economic Benefits from Investing in Public Transport

Increasing transport supply will invariably induce changes in transport demand, particularly with provision of fixed rail infrastructure. Availability and time involved in travel are very strong factors in housing and work location decisions. Sustained investment in transport infrastructure (and rail specifically) will materially assist in managing the challenges posed by population and economic growth and is likely to result in multiple benefits. These include:

- **Population change** - Improved rail services will expand the reach of the Melbourne commuting area and result in population growth being concentrated in areas served by upgraded rail services and in accordance with planning policies. There will be a net benefit to the State because growth can be achieved more efficiently and at lower cost
- **Business development** – Population growth in planned locations will generate multiplier effects, in turn creating further investment in a wide range of business activities, leading to new enterprises and employment. Greater connectivity reduces transport costs for businesses located in these centres and increases labour mobility. More people will be able to live in suburban areas and still access economic and social opportunities in major activity centres. The substantial increase in attractiveness and capacity of the rail network will allow Melbourne to grow by allowing concentrated employment centres to prosper while minimising road congestion that would otherwise develop.
- **Strategic Integration** – Improved rail will facilitate closer integration of the economies of urban centres and central Melbourne. Reduction in travel times will encourage more business and educational travel as people find it more convenient to attend meetings, seminars and courses in Melbourne and centres.
- **Labour market efficiencies** – Improved rail travel between central Melbourne and between urban centres will open access to a much wider labour pool for business, with skill shortages becoming less of an impediment to business and economic development throughout the entire metropolitan area.
- **Safety benefits** - Any shift from road to rail travel will reduce the potential for death and trauma from road accidents, since rail travel is vastly safer than travel by car.
- **Environmental benefits** – Rail is more efficient per passenger kilometre than car travel, therefore a shift from road to rail travel will reduce the overall energy requirements for travel and reduce motor vehicle-related pollution effects including carbon emissions.
- **Health benefits** - Major health benefits are associated with active travel, including walking and cycling to reach public transport. This will help reduce the adverse health impacts of sedentary travel patterns.

The Plan that follows is a blueprint for the implementation of a substantial program of projects. The phased program has been carefully designed to allow projects to be progressively brought on stream over a 30-year period. It is ambitious but achievable.

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PART 3: A RAIL PLAN FOR MELBOURNE 2050

Part 3 describes a plan for Melbourne's Rail-based public transport

Section 5 - The Train Plan

Section 6 - The Tram Plan

Section 7 - Medium Capacity Transit Plan

Section 8 - The Metropolitan Bus Network

Section 9 - Active Transport

Section 10 -Connections to National Employment Clusters and Activity Centres

Section 11 -Outcome of the RFI Rail Plan – improved Connectivity

Section 12 –Staging and Timing

Section 13 – Investment Profile

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5. The Train Plan

5.1 Train Plan Overview

The broad objectives of the Rail Futures' Train Plan are to:

- increase capacity of the existing metropolitan rail network to meet projected patronage growth
- simplify and streamline the rail operation to improve its overall efficiency, reliability and resilience
- provide enablers to allow metropolitan rail services to achieve consistently high levels of service quality
- extend the reach of the metropolitan rail network into high growth areas it does not presently serve
- provide direct rail access to nominated key metropolitan Employment Clusters and Major Activity Centres
- transform much of the existing radial rail network into high capacity cross-city and cross-metropolitan corridors
- segregate metropolitan and regional train operations so that each can provide high quality services
- encourage Transit Oriented Development around suitably located stations
- be an integral part of a fully integrated multi-modal Melbourne Public Transport Grid Network
- enhance the travel experience of users as part of a wider process for reducing car dependency.

The Train Plan aims to provide the essential linkage between the above objectives and their achievement by means of investment in infrastructure, rolling stock, associated facilities and systems, and through non-investment operational measures. In this Section there are recommendations for:

- projects to increase network capacity
- projects to improve operational efficiency
- extensions of electrification to outer metropolitan growth areas
- creation of major cross-city mass transit corridors
- steps in the segregation of metropolitan and regional train services
- proposals for new stations
- rail infrastructure upgrading and renewal needs
- additional level crossings that should be removed
- passenger amenity improvements at stations and interchanges
- new rolling stock requirements
- stabling and maintenance facility requirements
- operational (non-investment) measures

5.2 Projects to Increase Network Capacity

By far the most significant increment to network capacity since completion of the Melbourne Underground Rail Loop in the early 1980's will be the opening of the Melbourne Metro (MM1) project in 2024.

The MM1 project will considerably increase capacity on all corridors (other than those served by the Burnley and Clifton Hill City Loops) and enable longer trains on the MM1 corridor and more efficient operations overall. As a standalone project[25], it will achieve this by:

- creating a high capacity corridor between South Kensington and Hawksburn, initially for exclusive use by trains on the Sunbury and Cranbourne/Pakenham lines, subsequently extended to Melton/Bacchus Marsh and from Cranbourne to Clyde, and operated independently of all other Metro services
- releasing capacity in the Northern City Loop presently used by Sunbury trains allowing increased services on the Craigieburn and Upfield lines
- releasing capacity in the Caulfield City Loop presently used by Dandenong/Cranbourne/Pakenham trains allowing increased services on the Frankston line
- releasing capacity on the through suburban lines between Flinders Street and North Melbourne presently used by some peak period Sunbury trains to allow increased services on the Williamstown,

[25] Some of these outcomes will change in the event that reconfiguration of the City Underground Loop is implemented immediately after MM1 is completed (see Sections 5.5.3 and 5.5.5).

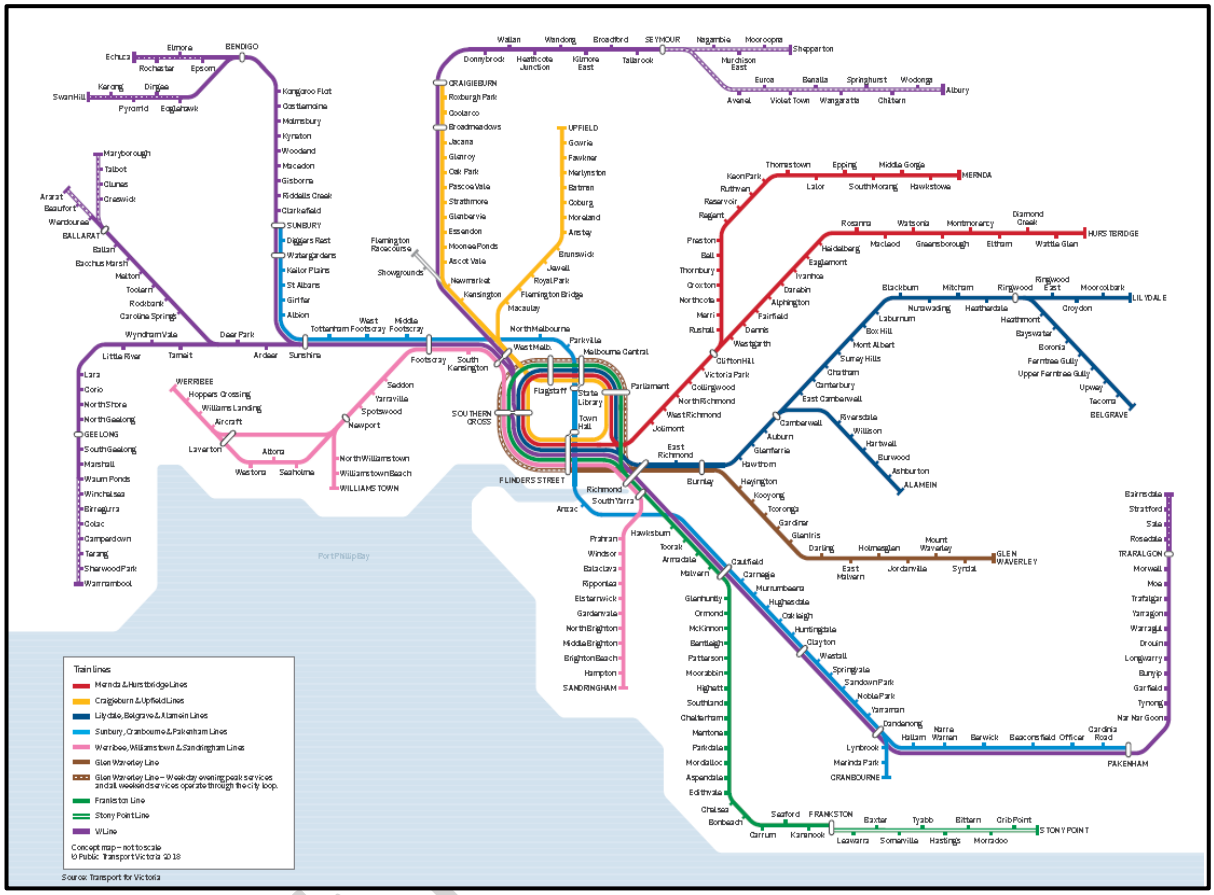
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Altona/Laverton and Werribee lines, including linking of the Werribee and Sandringham lines into a single corridor, thereby also allowing increased services on the Sandringham line

- providing updated signalling to allow trains to run at closer headways between Sunbury and Pakenham.

A diagrammatic representation of the overall metropolitan and regional network upon completion of MM1 is shown in Figure 18 and detailed in Section 5.5

Figure 18: Victorian Train Network Configuration Following Completion of MM1 Project



Source: Public Transport Victoria

The following associated works are required to ensure that the MM1 project can achieve its full functionality from commencement of operations. These works will allow more effective use of corridor capacity and contribute to a more intensive use of train sets:

- New turnbacks at West Footscray, Essendon and Cheltenham
- Signalling upgrades - Newport to Werribee, Broadmeadows to Craigieburn, South Kensington to Sunbury
- Traction power upgrades to support increased service frequencies and new trains
- Platform lengthening to accommodate longer electric trains
- Sandringham second platform

These projects are shown in Figure 19.

Further measures to increase metropolitan rail network capacity include other targeted infrastructure investments, use of higher capacity rolling stock and a range of operational measures.

Proposed targeted infrastructure investments in this Plan, also detailed below, include the following:

- Electrification extensions enabling metropolitan services to outer growth suburbs
- Duplication of single line sections that are constraints to provision of additional services
- Reconfiguration of the Melbourne Underground Rail Loop
- Developing new corridors to directly or indirectly accommodate demand growth
- Modifying station track and junction layouts to eliminate conflicting train movements

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- Providing additional tracks on selected corridors to facilitate operational segregation between metropolitan and regional trains
- Extending platforms and stabling sidings to accommodate longer trains
- Introducing new and more sophisticated signalling systems to allow trains to operate at closer headways, most likely involving new technologies
- Introducing automated or semi-automated train operation to optimise train network performance

Rolling stock measures include the following:

- Purchase of new higher capacity trains to make better use of the infrastructure, including the option of acquiring longer trains with more carriages
- Changing the internal train seating/standing ratio by reconfiguring interior train layouts

Operational (non-investment) measures include the following:

- Increasing train frequency by reducing train headways within the limitations of the signalling system
- Altering train stopping patterns to provide greater consistency between successive services
- Ensuring train types operating on any single corridor have very similar performance characteristics
- Reducing station dwell times by more effective management of passenger flows on platforms, through ticket barriers and/or on vertical transport within station environs

5.3 Projects to Improve Operational Efficiency and Resilience

Projects to improve efficiency are primarily directed at reducing the operational complexity of the network and promoting its progressive disassembly into standalone operational units. Each of these units becomes self-contained in relation to train timetabling, fleet allocation and maintenance and, to a significant extent, train crew. In this way, overall network management is simplified, and resilience increased because incidents that impact a particular line do not spread into other parts of the network.

By 2024, the Melbourne Metro (MM1) project will create a standalone corridor from Sunbury and Melton to Pakenham and Cranbourne/Clyde supported by a major depot at Pakenham East and a supplementary facility at Calder Park.

In subsequent years, further corridor segregation will occur to create six additional standalone operational units in the form of major Mass Transit Cross-City corridors (see Section 5.5). Short term, this will be facilitated by the proposed reconfiguration of the Melbourne Underground Rail Loop (MURL). Each standalone corridor will be supported by major maintenance and stabling facilities at specified locations (see Section 5.13).

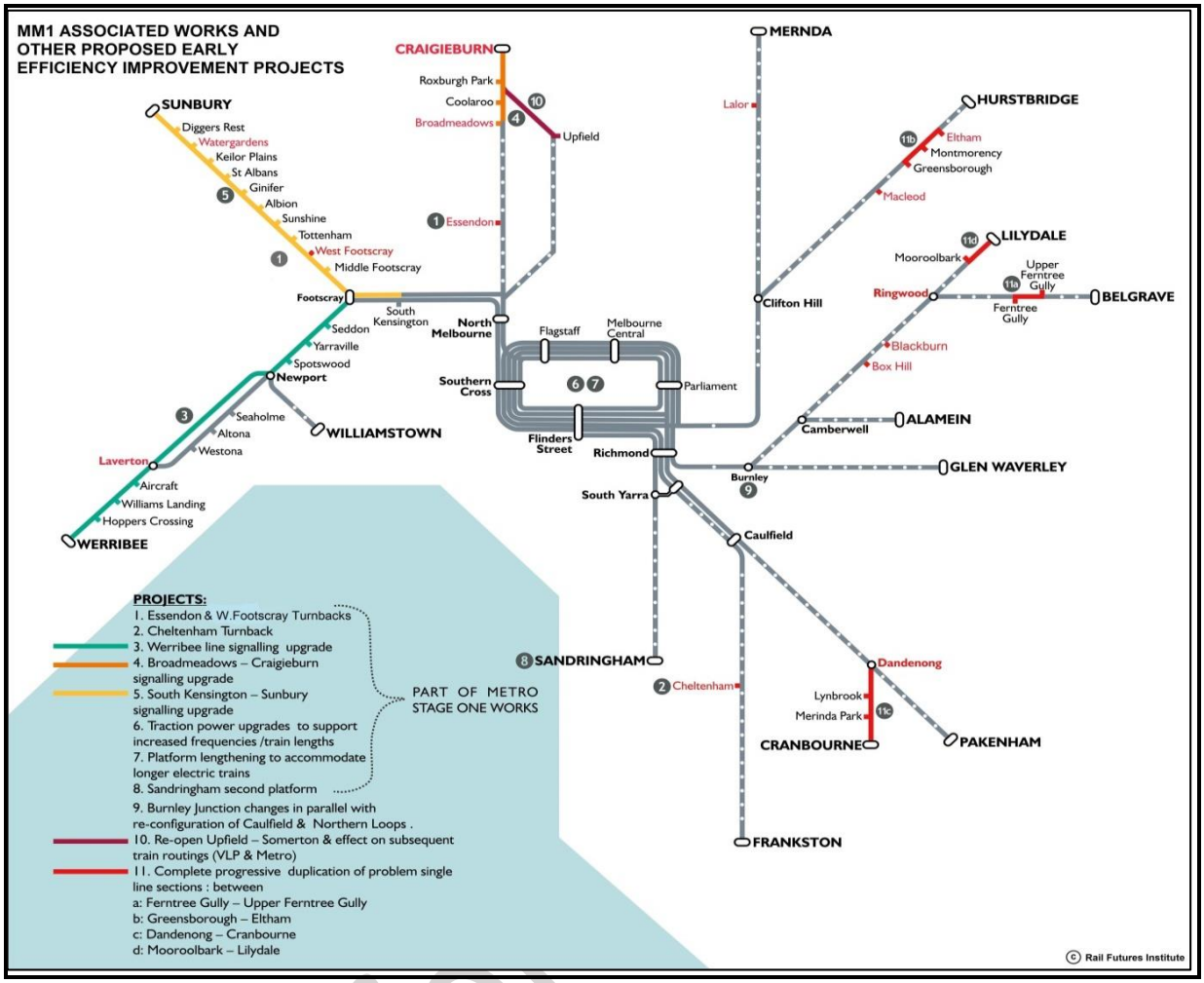
Other projects are very important for providing both additional corridor capacity and enhancing operational efficiency and reliability through the elimination of delays from conflicting train on single line sections and specified junctions. Those which are required, including in advance of, or concurrent with MM1 completion and/or proposed City Loop reconfiguration (i.e. by 2024), are:

- Progressive duplication of problematic single line sections in the following priority sequence:
  - **By 2023** - Dandenong – Cranbourne
  - **By 2025** - Greensborough – Eltham
  - **By 2025** - Mooroolbark – Lilydale
  - **By 2027** - Ferntree Gully – Upper Ferntree Gully
- **By 2024** - Burnley Junction reconfiguration
- **By 2024** - Re-opening and electrification Upfield – Roxburgh Park (including duplication Gowrie to Roxburgh Park, new stabling sidings at Upfield, grade separated junction at Roxburgh Park, an additional track pair Roxburgh Park to Craigieburn and two additional platforms at Craigieburn). This project will enable some Craigieburn trains to travel via Upfield, thus releasing capacity on the corridor via Essendon for additional regional trains to operate between Southern Cross and Wallan, pending electrification being extended from Craigieburn to Wallan by 2028 (see Section 5.4, below).

These projects are shown in Figure 19. More detail on these projects is set out in Appendices HR 3 to HR 26.

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Figure 19: Efficiency Improvement Projects



5.4 Extensions of Electrification to Outer Metropolitan Growth Areas

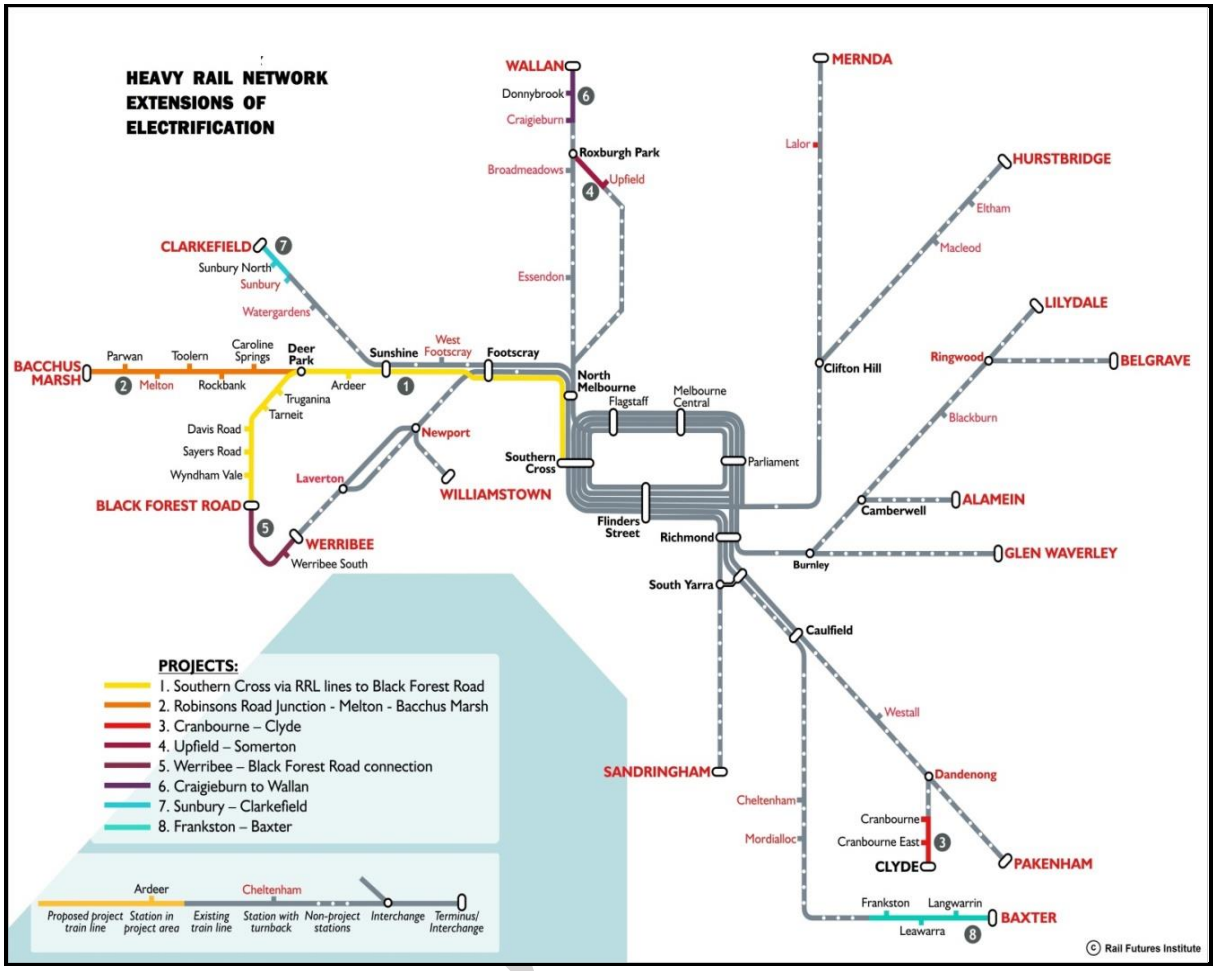
Extensions of existing metropolitan lines and/or electrification of inner parts of regional lines to service designated metropolitan growth areas are an urgent requirement. Rail extensions into outer metropolitan growth areas are directed to overcoming identified deficiencies in access to high capacity public transport. Ideally, they should be used to guide development of new growth areas and to encourage a culture of reduced car dependency in new sub-divisions from the outset although in most cases the developments will largely be in place by the time these projects can be implemented.

To address these deficiencies, the following electrification extensions are proposed, shown in indicative priority sequence (also see Figure 20):

(1) **By 2023**: Southern Cross (platforms 15/16) via RRL lines to Sunshine, Wyndham Vale and Black Forest Road *(includes initial quadruplication Sunshine to Robinsons Road Junction, later to Black Forest Road)*
(2) **By 2024**: Robinsons Road Junction to Melton *(includes quadruplication)*
(3) **By 2024**: Upfield to Roxburgh Park *(includes re-opening and duplication – precursor for electrification Craigieburn to Wallan in 2028 – see below)*
(4) **By 2025**: Cranbourne to Clyde *(includes re-opening and duplication)*
(5) **By 2026**: Extension Melton to Bacchus Marsh *(includes partial duplication)*
(6) **By 2026**: Frankston to Baxter *(includes duplication)*
(7) **By 2027**: Werribee to Black Forest Road *(includes 1.6km of twin track new connecting corridor)*
(8) **By 2028**: Craigieburn to Wallan
(9) **By 2032**: Sunbury to Clarkefield

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Figure 20: Proposed Electrification Extensions



5.5 Developing Major Cross-City Mass Transit Corridors

5.5.1 Transforming a radial network into multiple cross-city mass transit corridors

Several major projects will transform Melbourne's metropolitan rail network from its traditional radial configuration and underground City Loop circuit into a series of major intersecting cross-city mass transit corridors. All these routes will intersect at key stations within Melbourne's extended CBD (see Table 4 below), facilitating efficient interchange between the lines involved.

The combination of these major new and reconfigured corridors will provide high capacity, high frequency connectivity across Melbourne for a wide range of users, in addition to those travelling to the CBD. Journeys from one side of Melbourne to another for employment, education or health purposes will become more straightforward and faster. They will also help reduce the operational complexity of the network through its progressive disassembly into standalone rail operational units.

Viewed in combination with proposed enhancements to the tram network and proposed MCT orbital corridors detailed in Sections 6 and 7 respectively, these major cross-city corridors will form the basis of a high-quality public transport grid network.

As shown in Table 4, the new and reconfigured heavy rail routes described below provide six high capacity cross-city and cross-suburban corridors. These, in combination with the Melbourne Airport Rail Link and existing Clifton Hill and Burnley City Loop services and efficient interchange facilities, will progressively convert the traditional heavy rail radial network into a series of high capacity cross-metropolitan rail corridors that intersect at six locations within the extended Melbourne CBD, including Parkville.

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Table 4: New Cross-City Connections and Interchange Stations

Corridor	Cross-city Connection Directions	Corridor End Points	Interchange Stations	
			Extended CBD	Others
MM1	North-West <> South East	Sunbury, Melton, Cranbourne/Clyde, Pakenham	Parkville, State Library Town Hall	Sunshine Footscray Caulfield
MM2	North-East <>South-West	Mernda Werribee/Black Forest Road	Parkville, Flagstaff, Southern Cross	Laverton, Newport Croxton
Reconfigured City Loop	North <> South	Craigieburn Frankston/Baxter	Parliament, Flagstaff Melbourne Central	West Melbourne, Richmond South Yarra Caulfield
Melbourne Airport Rail Link	CBD <> North-West	Southern Cross Melbourne Airport	Southern Cross	Sunshine
Bayside Cross-City	Inner West <>Inner South	Williamstown/Laverton Sandringham	Southern Cross Flinders Street	Laverton, Newport Footscray West Melbourne Richmond South Yarra
Wallan - Knox City & Alamein	North <> East	Craigieburn/Wallan Glen Waverley/Knox City Alamein	Southern Cross Flinders Street	West Melbourne Richmond, Burnley, Camberwell
South-East Fast Line	Outer West <> South-East	Werribee/Black Forest Road/Sunshine/CBD/ Dandenong/Pakenham	Southern Cross	Caulfield Footscray Sunshine

New heavy rail corridors are very costly and are only justified if they can generate significant concentrated demand. Within this Plan's timeframe, the required concentration of demand is only likely in corridors that connect with and/or pass through the extended CBD area. The major cross-city connections proposed in this Section meet the concentrated demand criteria. Moreover, they provide a wide range of new and efficient travel options through a combination of high frequency services and efficient rail/rail interchanges.

In addition to the new North-West/South-East, North-East/South-West and North/South connections via the CBD and substantially increased corridor capacity provided by MM1, MM2 and the reconfigured City Loop, these projects enable two additional cross-city routes to be formed via West Melbourne, Southern Cross, Flinders Street and Richmond. This occurs through re-allocation of released track capacity and adjusted and enhanced services on existing corridors:

- Upfield/Wallan to Glen Waverley/Knox City (later also Alamein)
- Williamstown/Laverton via Altona to Sandringham

The Clifton Hill and Burnley groups of lines will continue to circulate through the underground City Loop, each operating continuously, but in clockwise and anti-clockwise directions respectively. This will overcome drawbacks of the present middle of the day loop reversal process. Both line groups will have added capacity to provide increased services, by virtue of the Mernda line transferring to MM2 and the Glen Waverley line, and later the Alamein line, becoming part of the Wallan-Knox City corridor.

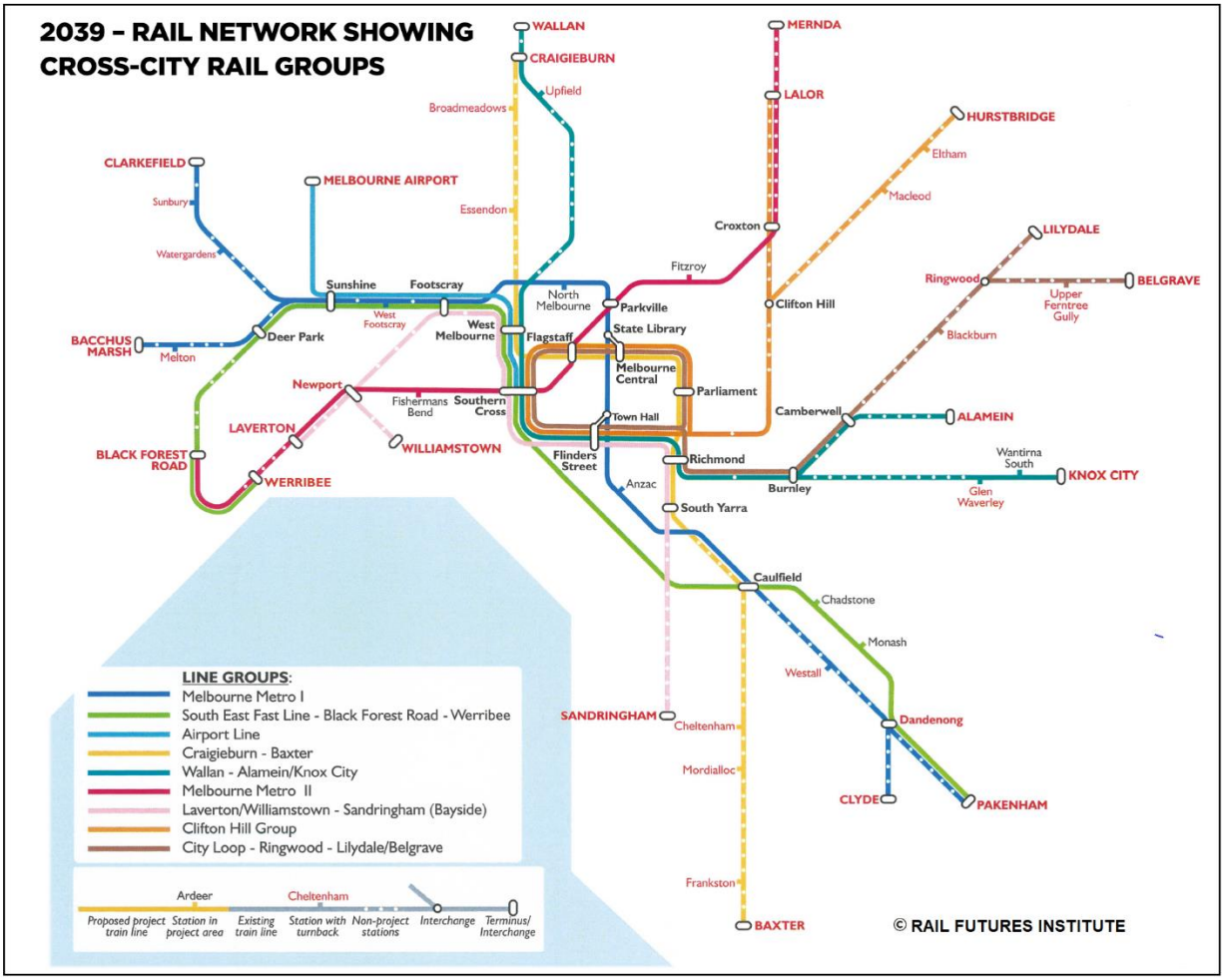
The combination of six cross-city rail routes, and the existing Clifton Hill and Burnley City Loop services will interface with a restructured CBD and inner suburbs tram network to allow efficient train/tram interchange at a total of 16 CBD and peripheral CBD stations (Southern Cross, Flinders Street, Parliament, Melbourne Central, Flagstaff, Footscray, West Melbourne, North Melbourne, State Library, Town Hall, Anzac, South Yarra, Parkville, Fitzroy, Clifton Hill and Richmond).

This will provide a wider range of new travel options and a local access service to areas surrounding those key stations, effectively creating a grid network, especially in the extended CBD area.

The proposed cross-city rail route structure is shown in Figure 21 below.

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Figure 21: Proposed New Cross-City Mass Transit Corridors



It is proposed that the major new corridor projects be sequentially implemented because of the extensive planning, approval and construction resource requirements, and cost. Proposed sequencing is generally at 4 to 5-year intervals after MM1, City Loop reconfiguration and the Melbourne Airport Rail Link are completed in 2024, 2025 and 2027 respectively. The functionality and scope of each project is described below.

5.5.2 By 2024: Melbourne Metro 1 (MM 1)

MM1 creates a unified cross-city mass transit corridor extending almost 100km from Sunbury (potentially Clarkefield) and Melton (potentially Bacchus Marsh) in Melbourne's outer north-west to Pakenham and Clyde in its outer south-east, initially serving some 52 stations, including five new stations in the inner core area between (new) North Melbourne and Anzac.

It provides new underground twin tunnels from South Kensington to Hawksburn via new underground stations at North Melbourne, Parkville, State Library, Town Hall and Anzac. Now under construction, this new cross-city corridor will physically connect the Melton/Sunbury lines to the Pakenham/Clyde lines, providing a new high capacity north-west to south-east mass transit corridor joining job rich areas across Melbourne, and interchanging with other lines at Sunshine, Footscray, State Library, Town Hall and Caulfield. Later, MM1 will also interchange with MM2 at Parkville.

A grade separated junction between South Yarra and Hawksburn will enable V/Line regional trains and freight trains to merge/split with the MM1 corridor and link with existing surface tracks between South Yarra, Flinders Street and Southern Cross.

Trains using the MM1 corridor will be based at stabling facilities at Calder Park and Pakenham East with Pakenham East being the corridor's primary maintenance facility. Some minor maintenance and servicing will also be undertaken at Calder Park. When electric trains commence running to Melton, a new stabling facility will also be provided near Melton on a site to be determined.

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Once fully commissioned, MM1 will release capacity in the Northern and Caulfield underground loops and on the existing cross-city corridor between Richmond and West Melbourne via Flinders Street, enabling additional services to operate on the Craigieburn, Upfield, Williamstown/Werribee, Frankston and Sandringham lines. It will also enable introduction of the Bayside Cross-City line between Williamstown/Altona/Laverton/Werribee and Sandringham (see below).

However, before these additional services can be introduced, reconfiguration of the existing Northern and Caulfield City Loops must be completed to create the Craigieburn-Baxter Cross-City line, as described below.

5.5.3 By 2025: Craigieburn (via Essendon)-Baxter Cross-City line

This project will create a unified north-south cross-city mass transit corridor extending some 80km from Craigieburn in Melbourne's north to Frankston and (by 2026) Baxter in the south, serving 50 stations, including five inner core stations at West Melbourne, Flagstaff, Melbourne Central, Parliament and Richmond.

To create this corridor, major reconfiguration will be required of the existing Caulfield and Northern Loop elements of the existing City Underground Loop. This involves construction of new tunnelled connections linking the Caulfield Loop to the Craigieburn line at West Melbourne and linking the Northern Loop to the Frankston line at Richmond, thus forming two opposing direction tunnels passing through Flagstaff, Melbourne Central and Parliament stations. Other works are required at West Melbourne and between South Yarra and Richmond to facilitate convenient cross-platform interchange with the Bayside Cross-City line at both West Melbourne and Richmond, necessary because the Craigieburn-Baxter Cross-City line will not pass through Southern Cross or Flinders Street.

The construction and operational logistics of this project are such that its only practical timing is for it to effectively become an addition to the MM1 project with construction underway before MM1 is completed. This will enable the necessary works to modify the existing Caulfield and Northern City Loops to be undertaken with minimal disruption prior to the full introduction of post-MM1 services. Therefore, this project needs to be closely coordinated with works to complete MM1.

The Craigieburn (via Essendon)-Baxter Cross-City line will allow Craigieburn trains to be through routed via the reconfigured City Loop to Frankston and Baxter and vice versa. In this way, it will provide a major north to south mass transit corridor across Melbourne, strongly complementing and enabling interchange with MM1 at the linked Melbourne Central/State Library station and later with MM2 at Flagstaff.

Trains using this corridor will be based at stabling facilities at Craigieburn, Kananook and Baxter with Craigieburn being the corridor's primary maintenance facility. Minor maintenance and servicing will also be undertaken at Kananook.

5.5.4 By 2025: Bayside Cross-City line

MM1 and City Loop reconfiguration enable implementation of a new cross-city connection extending 42km from Williamstown and Altona/Laverton in Melbourne's inner west to Sandringham in its inner south, serving 29 stations including 4 stations in the inner core area at West Melbourne, Southern Cross, Flinders Street and Richmond. Once MM1 and the Craigieburn-Baxter Cross-City lines are fully operational, the Bayside Cross-City line can also become operational without the need for additional track infrastructure.

It will enable interchange with MM1 at the linked Flinders Street/Town Hall station, also at Footscray. Interchange with the Craigieburn-Baxter Cross-City line will be available at West Melbourne, Richmond and South Yarra. Later, it will also interchange with MM2 at Southern Cross.

Initially, the Bayside Cross-City lines will also service stations between Laverton, Werribee and Black Forest Road, pending construction of MM2 by 2032 (see 5.5.7 below). At that time, the Newport to Werribee and Black Forest Road line will become part of the MM2 corridor. Trains using this corridor will be stabled and maintained at Newport with supplementary stabling at Sandringham.

5.5.5 By 2025: Craigieburn (via Upfield)-Glen Waverley/Alamein Cross-City line

Underground City Loop reconfiguration to create the Craigieburn-Baxter Cross-City line also enables implementation of a new cross-city connection using released capacity from the former Caulfield and Northern City Loop viaduct tracks between Southern Cross and Flinders Street. Initially extending 42km from Craigieburn via Upfield in Melbourne's mid-north to Glen Waverley in its mid-east, this unified corridor will initially serve 29

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stations including four inner core stations between West Melbourne and Richmond. It will also allow Upfield trains to operate directly via Southern Cross and Flinders Street to Glen Waverley and thereby release capacity on the Burnley City Loop for additional services to run on the Ringwood, Lilydale and Belgrave lines. It will enable interchange with the MM1 corridor at the linked Flinders Street/Town Hall station and later with MM2 at Southern Cross.

This assumes prior completion (by 2024) of the reconfiguration of Burnley Junction, duplication between Gowrie and Upfield, reopening, duplication and electrification of the former freight line between Upfield and Somerton (now Roxburgh Park), a grade-separated junction with the existing Craigieburn and ARTC interstate lines at Roxburgh Park, quadruplication from Roxburgh Park to Craigieburn and two additional platforms at Craigieburn, as described in Section 5.3.

Trains using this corridor will be based at stabling facilities at Craigieburn, Upfield, Burnley and Glen Waverley with Craigieburn also being this corridor's primary maintenance facility. Minor maintenance and servicing will also be undertaken at Macaulay.

By 2028, this corridor will be extended from Craigieburn to Wallan in Melbourne's outer north, increasing the corridor to 69km in length and initially adding a further 4 stations at Donnybrook, Cloverton, Beveridge and Wallan, with additional stabling sidings provided at Wallan.

By 2036, patronage growth from suburban residential densification will be putting further pressure on the lines served by the Burnley City Loop. To relieve this, the Camberwell to Alamein line will also become part of Craigieburn-Upfield-Glen Waverley Cross-City line. For this to occur, a fourth track will be added to the section of line between Burnley and Camberwell, with additional platforms provided at Hawthorn, Glenferrie, Auburn and Camberwell. This will create two inner express tracks for the Ringwood, Lilydale and Belgrave lines and two outer tracks for trains stopping all stations used by Alamein trains and some Box Hill trains.

By 2040, at the Glen Waverley end, this corridor will be extended to Knox City via Wantirna South.

5.5.6 By 2027: Melbourne Airport Rail Link (MARL)

This is a standalone project to provide direct fast and frequent dedicated train services extending 27km between Southern Cross and Melbourne Airport with an intermediate stop at Sunshine for interchange with the MM1 corridor, Wyndham Vale/Black Forest Road/Werribee, Geelong, Ballarat, Bendigo and Albury lines. MARL involves a new corridor, partly underground and partly on the surface, from Southern Cross via new platforms at Sunshine to an underground station at Melbourne Airport.

MARL will use specially designed dedicated electric trains based at new stabling sidings and depot at Tottenham.

By 2036, in conjunction with construction of the *South-East Fast Line* (see 5.5.8 below), an underground connection would be provided between it and MARL in the vicinity of West Melbourne, enabling direct journeys to the airport for the first time from Melbourne's south-east and Gippsland.

As a separate stage, with timing to be determined by the regional *InterCity* program[26], it is proposed to provide northern extensions beyond Melbourne Airport to link with the Bendigo line at Clarkefield and the Seymour line at Wallan, enabling through regional services to Bendigo and beyond and Seymour and beyond to operate to and from Southern Cross via the Airport. Interchange with metropolitan services would occur resulting from electrification extensions from Sunbury to Clarkefield and from Craigieburn to Wallan.

5.5.7 By 2032: Melbourne Metro 2 (MM 2)

MM2 creates a unified cross-city mass transit corridor extending approximately 72km from Black Forest Road via Werribee in Melbourne's outer south-west to Epping and Mernda in its outer north-east, initially serving some 29 stations, including two existing CBD stations (Southern Cross and Flagstaff), three new stations in the inner core area between Fishermans Bend and Fitzroy, and a major interchange with MM1 at Parkville.

MM2 will provide new underground twin tunnels from west of Newport to Northcote/Croxton via new underground stations at Fishermans Bend (most likely at Sandridge and Employment Precinct) and Fitzroy,

[26] *InterCity*: How Regional Rail can Re-balance Population Growth and create a "State of Cities" in Victoria – Rail Futures Institute, August 2016 (revised and updated version to be released in 2020).

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together with new underground platforms and passenger interchanges at Newport, Southern Cross, Flagstaff and Parkville.

This new cross-city mass transit corridor will link the Black Forest Road/Werribee line with the Mernda line, providing a major north-east to south-west corridor across Melbourne, and interchanging with other lines at Black Forest Road, Laverton, Newport, Southern Cross, Flagstaff, Parkville and Croxton.

MM2 is a critical element in providing efficient access to the 480 hectares Fishermans Bend development precinct which, based on Victorian Government projections, is expected to be home to approximately 80,000 residents and provide employment for up to 80,000 people by 2050. MM2 will also provide speedy access from Melbourne's growth suburbs to job rich areas in the CBD and inner Melbourne, including Carlton/Parkville NEIC and major activity centres in Fitzroy/Collingwood and facilitate regeneration of Alexandra Parade as a major residential and commercial boulevard.

Trains using the MM2 corridor will be based at stabling facilities at Mernda, Epping, Newport and Wyndham Vale with Wyndham Vale being the corridor's primary maintenance facility. Some minor maintenance and servicing will also be undertaken at Mernda.

Once commissioned, MM2 will release capacity in the Clifton Hill underground loop and on the Bayside Cross-City corridor between Flinders Street and Newport via Southern Cross and Footscray, enabling additional services to operate on the Hurstbridge, Williamstown, Altona/Laverton and Sandringham lines. Post-MM2, the Clifton Hill loop will continue to host some trains proceeding as far as Lalor on the Mernda line, ensuring continued connectivity between the Hurstbridge and Mernda lines and retaining services at Rushall and Merri stations, as shown in Figure 21.

MM2 would overlap the *South-East Fast Line* between Werribee and Black Forest Road allowing:

- Geelong line passengers to interchange at Black Forest Road with MM2, directly serving Fishermans Bend, Southern Cross, Flagstaff, Parkville and Fitzroy
- Passengers from Laverton, Werribee and intermediate stations to access the Geelong line with one change at Black Forest Road
- Passengers from Werribee to access Melbourne Airport with one change at Sunshine, plus additional connections at Sunshine direct to Albury, Ballarat and beyond, Bendigo, Swan Hill and Echuca.

5.5.8 By 2036: South-East Fast Line

South-East FastLine (SEFL) provides a limited stop cross-city rail corridor extending approximately 100km, linking the Werribee/Black Forest Road/Wyndham Vale line in Melbourne's outer south-west to Pakenham in its outer south-east via Sunshine, Footscray, Southern Cross, Caulfield and Dandenong. New stations would be provided at Chadstone and Monash University. Subject to detailed assessment of their viability, new underground stations could also be provided in the vicinity of St Kilda Junction and/or South Melbourne.

This new express line would carry Metro express services from beyond Dandenong and all V/Line Gippsland services, including services to/from Bendigo via Melbourne Airport, thus enabling direct journeys to the airport for the first time from Melbourne's south-east and Gippsland.

Trains stopping at all stations between Caulfield and Dandenong would continue to use the existing Dandenong Rail Corridor (DRC) and MM1 to Sunbury and Melton/Bacchus Marsh. Freight trains would continue to use the DRC between Hawksburn and Dandenong and the existing surface tracks between Southern Cross, Flinders Street and South Yarra/Hawksburn.

SEFL will provide new underground twin tunnels from north of Southern Cross to Caulfield with new underground platforms at Southern Cross and Caulfield and additional platforms at Dandenong and Pakenham. It will connect into the RRL lines north of Southern Cross with most trains operating to Wyndham Vale and Black Forest Road via Footscray and Sunshine. An underground connection would also extend from Southern Cross to the MARL corridor near West Melbourne for use by V/Line trains operating between Gippsland and the Bendigo line via Melbourne Airport.

Between Caulfield and Dandenong, SEFL will be closely associated with the Princes Highway corridor and a short section of Eastlink, and therefore be mostly on a separate alignment to the existing Dandenong Rail Corridor. The expectation is that it will be largely in tunnel between Caulfield and Chadstone, then on elevated structure

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to near Yarraman, before re-joining the existing rail corridor between Yarraman and Dandenong through a short tunnel connection.

A 7km section of third track, suitable for bi-directional operation would be provided between Beaconsfield and Cardinia Road, enabling express trains to overtake stopping all stations trains between Dandenong and Pakenham.

Metro trains using the SEFL corridor will be based at stabling facilities at Pakenham East and Wyndham Vale with Wyndham Vale being the corridor's primary maintenance facility.

SEFL overcomes a serious deficiency of the Dandenong Rail Corridor by enabling much faster travel to the CBD from Melbourne's outer south-eastern suburbs and Gippsland. It also provides long needed direct links to the Monash Precinct (with a major interchange at Monash University) and a station at Chadstone, Australia's largest non-CBD shopping centre.

SEFL would overlap MM2 between Black Forest Road and Werribee allowing:

- Passengers from stations between Sunshine and Wyndham Vale direct access to Geelong line fast trains with one change at Black Forest Road
- Passengers from stations between Sunshine and Wyndham Vale direct access to Werribee
- Passengers from stations between Sunshine and Wyndham Vale to interchange at Black Forest Road or Werribee with MM2, directly serving Fishermans Bend, Southern Cross, Flagstaff, Parkville and Fitzroy

5.5.9 By 2040: Extension Glen Waverley to Knox City

The Glen Waverley line has currently significant unused capacity. By 2040, it is proposed that the Wallan/Upfield – Glen Waverley corridor will be extended a further 6km in Melbourne's east from Glen Waverley to Knox City, resulting in a 75km overall corridor from Wallan to Knox City serving at least 36 stations.

The Knox City extension will provide two sections of underground twin tunnel totalling 5km to extend the line from Glen Waverley to Knox City. It will provide new underground platforms at Glen Waverley, a new intermediate station, major "park and ride" facility, bus interchange and train stabling sidings on the surface at Wantirna South, and a new underground terminal station at Knox City Major Activity Centre.

The new stations at Wantirna South and Knox City will serve an extensive area of Melbourne's east including the suburbs of Wheelers Hill, Scoresby, Wantirna South, Wantirna, Knoxfield and Studfield together with parts of Ferntree Gully, Mountain Gate, Rowville and Lysterfield, all of which have relatively poor access to high quality public transport. Wantirna South station would be located close to the intersection of High Street Road and Eastlink providing an ideal location for a major bus interchange and active transport links feeding from a wide arc extending over a radius of some 5km from Wantirna South.

Trains using this corridor will continue to be based at Craigieburn.

5.6 Train Service Levels

5.6.1 Service Frequency

As explained in Section 4.14.1, service frequency is the most critical element in the delivery of a grid public transport network that is sufficiently attractive to induce significant reductions in car dependency. "Turn up and go" schedules eliminate the need to consult or understand timetables. Genuine "turn up and go" schedules mean intervals between services not exceeding 10-minutes which should be the default standard on trunk rail corridors. Weekday peak period services on most trunk rail routes already achieve this or better.

At non-peak times, major improvements are needed on most routes. On the heavy rail network, currently only trunk routes to Newport, Blackburn, Dandenong and the Frankston line offer "all day" 10-minute service frequencies until about 8pm. The same applies at weekends until about 7pm to Ringwood, Dandenong and Frankston. On other trunk routes, "all day" weekday frequencies vary between 15 and 20 minutes, weekends mostly 20 minutes and evenings between 20 and 30 minutes. On some outer sections, "all day" frequencies extend to 40 minutes.

RFI proposes a minimum 10-minute service frequency from 6am to 10pm weekdays and from 7am to 9pm weekends on all trunk rail routes. Additional services would operate during peak periods and at other times as

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needed to meet demand, or to help induce demand. Outside these hours, a minimum service frequency of 20 minutes would apply. Non-trunk sections of heavy rail routes would always have a minimum frequency of 20 minutes to 10pm weekdays, 9pm at weekends and 40 minutes outside these times.

5.6.2 Hours of Operation

All heavy rail routes would generally provide services from 4.30am to 1.30am on weekdays and 5.30am to 12.30am on weekends. Trunk rail routes would also provide minimum hourly all-night services during the early hours of Saturday and Sunday mornings.

5.6.3 Reliability Standards

Proposed revised standards would require 99% monthly delivery of all scheduled services and on-time performance measured on departure, designed intermediate points and destination at 95% within 2 minutes during designated weekday peak periods and 3 minutes at other times for heavy rail services. Mitigation would only be allowed in exceptional circumstances.

5.6.4 Capacity and Crowding

Maximum passenger load carrying standards would continue to apply to all vehicle types. All trains would be equipped with load monitoring devices linked to the MYKI ticketing system which would generate continuous passenger capacity utilisation data for each route journey.

5.7 Segregating Metropolitan and Regional Train Services

In addition to capacity issues on the metropolitan rail network, expansion of regional rail passenger services has also been hampered by a legacy of under-investment in Melbourne's metropolitan rail infrastructure. Demand growth is necessitating a far more intensive Metro operation. Regional rail services still share Metro tracks on three of the five routes into Melbourne. Accordingly, ongoing increases in Metro services are slowing or crowding out regional services. This often result in delays to both regional and Metro services.

The major new projects and electrification extensions listed above, coupled with other proposed works on the regional network, as described in RFIs *InterCity* report[27] and additional works on the expanded metropolitan network will provide long term solutions to these deficiencies. The generalised scope of the required additional works is described below:

- Electrification to Black Forest Road by 2023 and Melton by 2024 will release capacity on Geelong and Ballarat line trains, enabling more comfortable travelling conditions for regional passengers. Separate pairs of express tracks will be needed for regional trains between Sunshine and Melton, Deer Park and Black Forest Road from 2024 onwards. This will allow fast regional trains on these corridors to operate without being impeded by Metro trains.
- Seymour/Shepparton line services must currently dovetail into the busy Craigieburn Metro line via Broadmeadows. This is possible because capacity constraints imposed by the Northern City Loop currently prevent the operation of additional Metro trains between Broadmeadows and North Melbourne. Following completion of MM1, removal of Sunbury trains from the City Loop will largely remove these constraints. Following the subsequent reconfiguration of the City Loop and creation of a Craigieburn-Frankston cross-city corridor (see Section 5.5.3), Craigieburn line peak period services will initially increase from 11 to 16 trains per hour (tph) and later to 18 tph. Upfield line services will at least double from 3 to 6 tph, and possibly 8 tph once the Upfield-Glen Waverley cross-city corridor becomes operational (see Section 5.5.5). This will, of necessity, require the Upfield corridor diversion (see Section 5.3) to be operational by 2024 so that some additional Metro services can be diverted via Upfield and sufficient train paths retained via Broadmeadows for regional services. However, at this stage, regional trains will continue to experience very slow journeys between Craigieburn and North Melbourne (to become West Melbourne) while following Metro trains stopping at all stations.
- When MARL opens in 2027, the option exists for fast trains between Southern Cross and Geelong, or possibly Ballarat, to also utilise the separate MARL corridor between Southern Cross and Sunshine, thus

[27] *InterCity*: How Regional Rail can Re-balance Population Growth and create a "State of Cities" in Victoria – Rail Futures Institute, August 2016 (revised and updated version to be released in 2020).

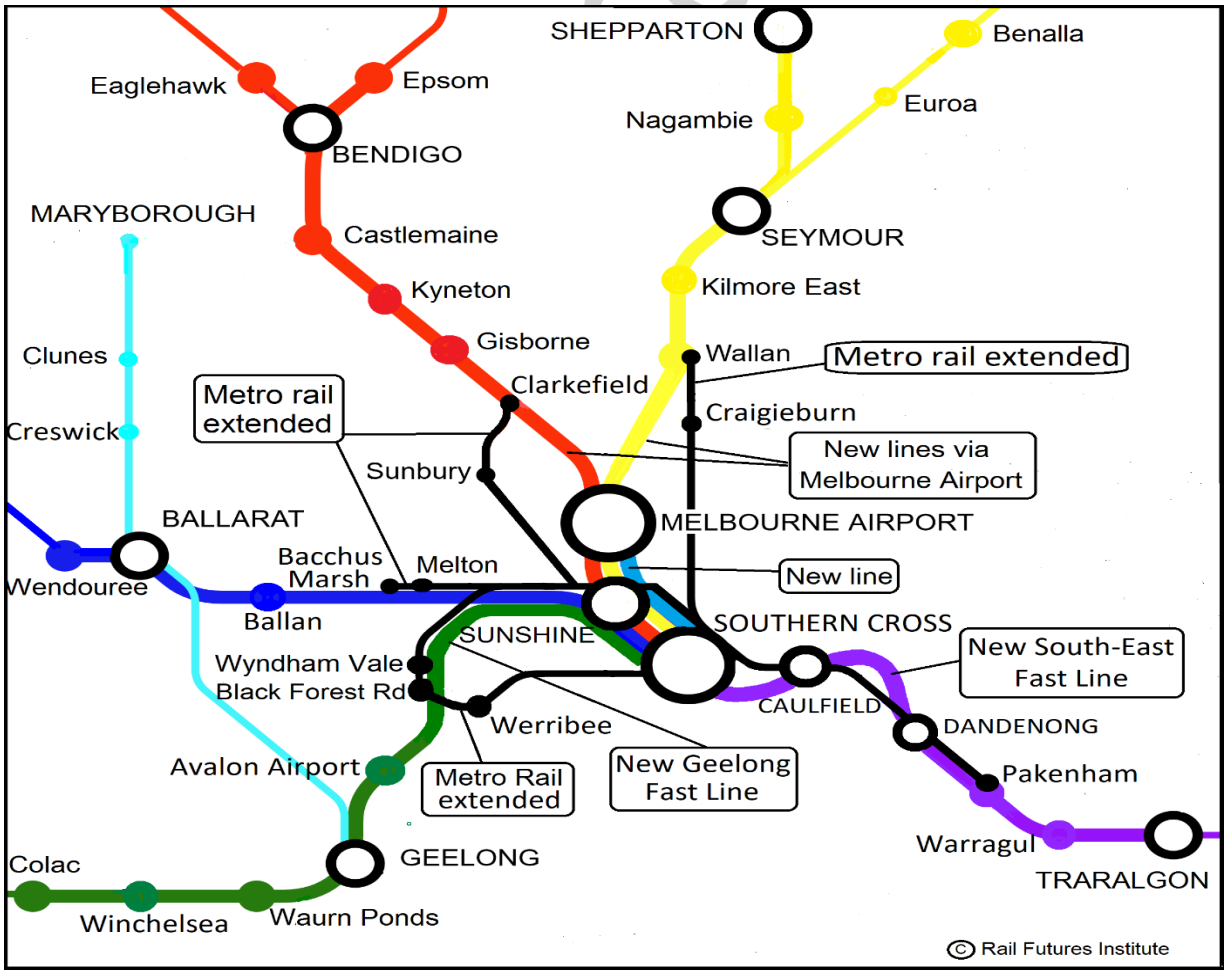
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releasing constrained capacity on the RRL lines for additional Metro services to Wyndham Vale/Black Forest Road/Werribee and/or for the Ballarat and Bendigo lines.

- By 2028 when Metro electric services are extended from Craigieburn to Wallan, Seymour/Shepparton services will be severely impeded, irrespective of whether operated via Broadmeadows or Upfield. Ideally, the proposed link between Melbourne Airport and Wallan via the Outer Metropolitan Ring (OMR) corridor will be completed by around 2030, enabling these services to divert from the existing corridor at Wallan, with provision for interchange with metropolitan services at Wallan. This will leave the existing corridor from south of Wallan to increasingly provide the level of Metro services required to adequately service this burgeoning growth corridor.
- By 2035 or sooner, the Metro lines through Sunshine will be fully utilised by suburban services from Melton/Bacchus Marsh and Watergardens/Sunbury, with additional impact on Bendigo services between Sunshine and Sunbury. The ideal solution is for Bendigo services to be diverted via Melbourne Airport by around 2032, with interchange with Metro services then occurring at Clarkefield, following the proposed extension of metropolitan electric services to Clarkefield in 2032.
- The recently upgraded Caulfield-Dandenong corridor still only comprises two tracks between South Yarra, Caulfield, Dandenong and Pakenham to accommodate all Regional, Metro and freight services. As set out in in Section 5.5.8, this Plan proposes completion of the *South-East FastLine* from Southern Cross to Dandenong by 2036, with intermediate stations only at Caulfield, Chadstone and Monash, enabling both Gippsland trains and Metro express trains to bypass the busy MM1 corridor between the CBD and Dandenong. It will also allow Gippsland trains to overtake stopping Metro trains on a section of bi-directional third track between Dandenong and Pakenham.

A conceptual view as to how the regional and metropolitan networks would ultimately interface in the manner described above is shown in Figure 22 below.

Figure 22: Conceptual Interfaces between Metropolitan and Regional Rail Networks



Comment

Both the success and growth of regional rail and the effective operation of the metropolitan rail network are dependent on major investment in new infrastructure to enable full segregation of regional express services from frequent metropolitan services which stop at all or most stations. This is necessary to increase overall capacity of the rail system, enhance reliability, meet customer expectations for faster regional journeys and ensure that each operation can maximise its effectiveness.

More detail and the estimated cost of these projects are found in Appendices HR 3 to HR 26.

5.8 New stations

New stations are proposed at several locations on existing rail lines to service existing and/or proposed development areas. Many proposed station sites are included in existing Planning Schemes or are proposed in draft or finalised Precinct Structure Plans. Existing stations need to be a minimum of 4km apart before new stations at intermediate locations should be considered. In some cases, there will be opportunities for multi-purpose developments within or close to station precincts with significant value capture potential to offset establishment costs.

Several new and additional stations will be needed on both existing metropolitan lines and on sections where electrification is to be extended to support rapid residential development in designated growth areas. In some cases, specific developments are being promoted and funded by property developers. The following new station sites have been identified based on criteria including general site suitability, distance from adjoining stations (minimum 2km, ideally 3km or greater), extent of potential residential development or workplaces within 1km radius, ease of road access, suitability for bus interchange, and land availability for commuter parking. Indicative timelines based on anticipated need are also shown.

Stations on existing electrified lines to be completed by:

- 2022: Derrimut Road *(Werribee line)*
- 2022: Toomuc Creek *(Pakenham Line)*
- 2024: Campbellfield *(Upfield Line*)
- 2025: Cave Hill *(Lilydale Line*),
- 2028: Jacksons Hill (*Sunbury Line*)
- 2028: Blue Gum Park (*Pakenham Line)*
- 2030: Delahey (*Sunbury Line*)

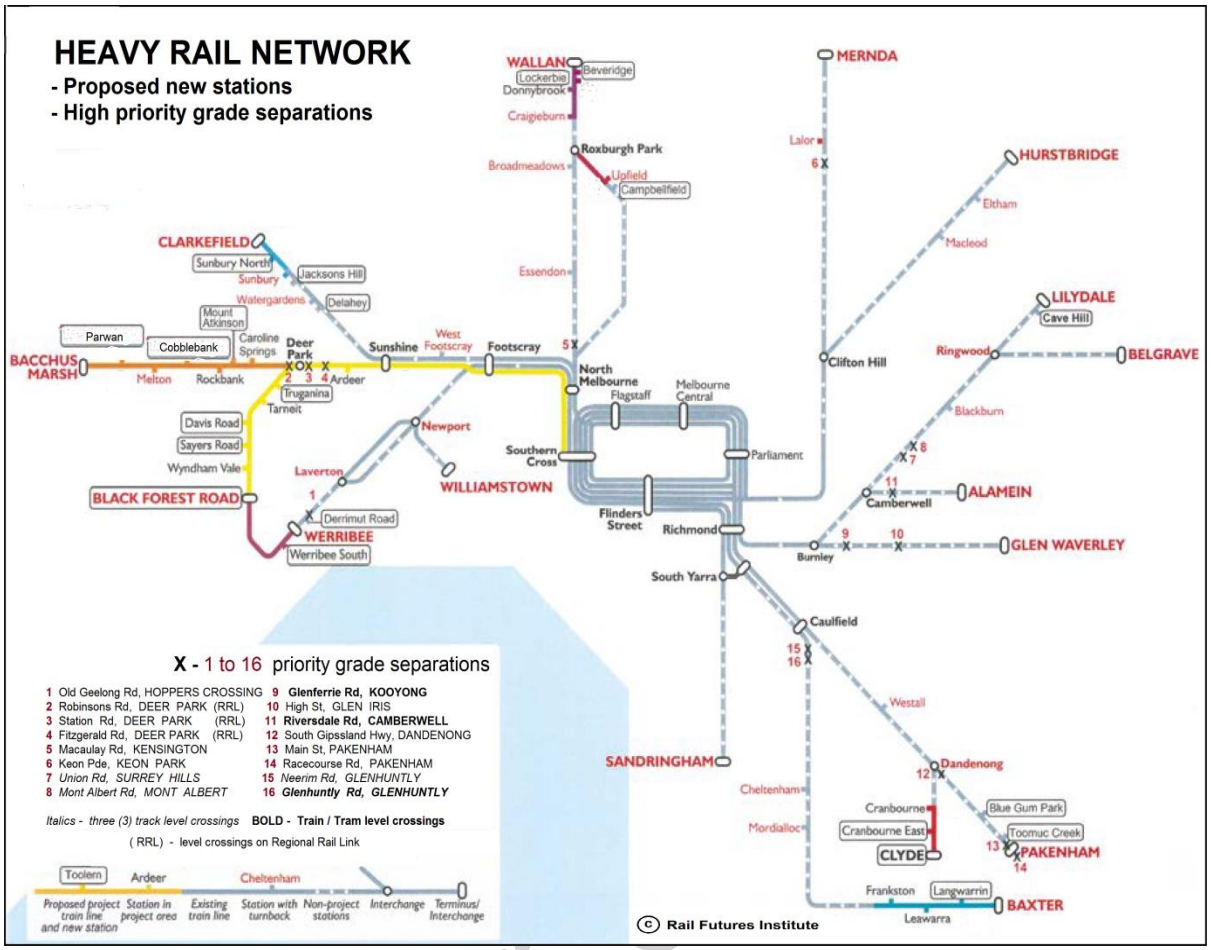
Stations on proposed extended/electrified Metro lines to be completed by:

- 2020: Cobblebank *(Melton Line*)
- 2023: Davis Road and Black Forest Road (*Black Forest Road Line)*
- 2024: Mount Atkinson (*Melton Line)*
- 2024: Sayers Road and Truganina (*Black Forest Road Line)*
- 2025: Cranbourne East and Clyde *(Clyde Line)*
- 2026: Langwarrin Parkway *(Baxter Line*)
- 2027: South Werribee (*Werribee/Black Forest Road Link)*
- 2028: Cloverton and Beveridge *(Wallan Line)*
- 2030: Parwan *(Bacchus Marsh Line)*
- 2032: North Sunbury (*Clarkefield Line*)

The location of each of the above new stations is illustrated in Figure 23 below.

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Figure 23: Proposed New Stations and High Priority Level Crossing Removals



5.9 Level Crossings

While the State Government has initiated a major level crossing removal program since 2014, more intensive services and increasing line speeds will require an expansion of the program. Operations on selected corridors need grade separation of road and rail to improve safety and reliability, and to reduce road delays (including delays to road-based public transport) as rail services become more frequent. This is a high priority component in the program and will also deliver major benefits to road users, including road-based public transport services.

Appropriately designed grade separations offer opportunities to facilitate intermodal transfers and enhance urban design and planning outcomes. Melbourne's extensive program of level crossing removals should be used to maximise revitalisation of the surrounding urban area.

The following 16 level crossings impact adversely on rail operations (and in some cases tram operations) as well as road users and are recommended as high priority additions to the existing 2019-2022 level crossing removal program[28]:

- **Werribee Line**: Old Geelong Road*, Hoppers Crossing
- **Melton Line**: Fitzgerald Road*, Station Road* and Robinsons Road*, Deer Park
- **Craigieburn Line:** Macaulay Rd, Kensington
- **Mernda Line**: Keon Parade, Keon Park
- **Ringwood/Lilydale Line**: Union Road, Surrey Hills* and Mont Albert Road, Mont Albert*
- **Glen Waverley Line:** Glenferrie Road, Kooyong (rail/tram crossing) and High Street, Glen Iris
- **Alamein Line:** Riversdale Road, Camberwell (rail/tram crossing)
- **Pakenham Line:** Webster Street*, Dandenong, Main Street* and Racecourse Road*, Pakenham
- **Frankston Line**: Neerim Road* and Glenhuntly Road*, Glenhuntly (latter is rail/tram crossing).

[28] Level crossings marked with an asterisk have since been added to the Government's level crossing program for removal by 2025.

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The location of each of the above level crossings is illustrated in Figure 23 above.

Note that the two Ringwood Line and two Frankston Line crossings proposed for removal are particularly hazardous as they are located on three track line sections, with the centre track being signalled for bi-directional use by peak period express services.



Train / Tram level crossing on the Frankston line at Glenhuntly Road, Glenhuntly
Photo: *Max Michell*

5.10 Rail Infrastructure Upgrading and Renewal

Ongoing upgrading and renewal programs will be essential to bring the general standard of the metropolitan rail network infrastructure to a level where it is considerably more robust and resilient than is presently the case in many areas. Many service failures and delays are attributable to known infrastructure deficiencies, most of which have been developing over a long period.

Progressive segregation of the network into standalone operational groups (see Section 5.3) will improve network reliability and resilience but it is equally important for the condition of both new and legacy infrastructure assets to be at a suitable standard to overcome the likely impacts of climate change and to ensure maximum benefit is obtained from the new projects detailed in this Plan.

Track condition needs lifting to a standard where it becomes sustainable with relatively low ongoing maintenance input and allows for the removal of all longstanding speed restrictions. Most of these derive from poor underlying formation, fouled ballast and inadequate drainage, leading to unsatisfactory track geometry and ride quality. These conditions, while generally not unsafe, impact timekeeping and service reliability. They can also become problematic during weather events.

Much signalling equipment and some elements of the electric traction system are both life expired and obsolescent. Replacement provides the opportunity to progressively introduce technology which enhances network capacity, reliability and resilience. Replacement of obsolete and inadequate infrastructure is required on a significant scale on the Melbourne metropolitan network over at least a 15-year period. This will involve progressive asset renewal and upgrading. The required work includes:

- rehabilitation of formation, drainage and ballast
- replacement of timber sleepers with concrete sleepers
- rail replacement and rail grinding
- turnout renewal

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- power supply upgrading and redundancy
- overhead traction system upgrading
- station platform rehabilitation and (where required) lengthening
- signalling system replacement
- communications and security systems upgrading
- corridor fencing renewal and upgrading.

These programs will necessarily go beyond that which is regarded as routine maintenance. Properly planned and executed and designed for resilience and redundancy using high quality, durable and robust materials and equipment, these programs will also produce a long-term decline in ongoing network maintenance costs.

5.11 Passenger Amenities at Stations and Interchanges

An ongoing program is needed specifically directed at progressively improving passenger experience and amenity at stations and interchanges. An audit of present conditions would identify many opportunities for improvement. The station improvement program needs to encompass a wide range of matters including weather protection, lighting, security systems, DDA compliance, placement of entrances and exits, information systems (static, dynamic, visual and audio), toilet upgrading and wayfinding.

Particularly serious deficiencies exist at the metropolitan network's two busiest stations – Flinders Street and Southern Cross, both exacerbated by very large increases in passenger throughput in recent years and not reflective of the way the CBD itself has spatially and demographically changed. Flinders Street station requires a new western elevated concourse, linked by escalators to all platforms and connected to Southbank via the Sandridge (former railway) Bridge and to a proposed Elizabeth Street pedestrian mall by a bridge passing over Flinders Street.

Southern Cross station, extensively rebuilt between 2003 and 2006, is now struggling to accommodate current passenger throughput, driven by a combination of very large patronage increases on both the Metro and V/Line regional networks and the massive redevelopment of Docklands and western parts of the CBD Hoddle Grid. The station requires a new central elevated concourse with escalators to all platforms, continuing to a covered pedestrian bridge over Spencer Street and linked to Little Collins Street. Additional escalators are also required to provide better connections between the southern end upper and lower concourses and between the northern end (Bourke Street) pedestrian bridge and regional platforms.



Southern Cross Station is now struggling to handle current passenger throughput
Photo: *Peter Don*

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5.12 New Trains

As at September 2018, the metropolitan train fleet comprises 219 train sets of the following types:

- 93 Com-Eng 6-car trains built between 1980 and 1988
- 36 Siemens 6-car trains built between 2003 and 2006
- 90 Alstom Xtrapolis 6-car trains built between 2002 and 2018, plus a further 21 trains on order for delivery to 2020.

Each of these current train types were illustrated in Section 3.2.

In addition, 65 High Capacity Metropolitan 7-car trains (HCMTs) are on order from Downer Rail and Changchun Railway Vehicles, China, for delivery between 2018 and 2023. This order provides sufficient rolling stock for operation of the MM1 corridor between Sunbury and Cranbourne/Clyde/Pakenham when it opens in 2024-25. Further orders are likely to follow, initially to support electrification to Melton and including a substantial requirement for progressive replacement of the Com-Eng fleet.



New HCMT train type for Metro Trains network
Courtesy: *PTV Victoria*

In PTV's 2012 Network Development Plan – Metropolitan Rail (NDPMR), it was estimated that the required train fleet would increase to 249 trains upon opening of MM1, then expected to occur by 2021. RFI estimates this should now be a requirement for 276 trains in 2024 as the Mernda extension and electrification to Melton, Wyndham Vale and Clyde were not included at that stage.

The NDPMR estimated a further fleet size increase to 290 trains by 2026 with the part opening of MM2, electrification to Melton and various other projects, some of which are no longer proposed for heavy rail solutions, such as to Doncaster and Rowville, but offset by several other projects being brought forward in this Plan. The NDPMR estimated fleet requirement further increased to 326 trains by 2031, including provision for the Geelong line which will continue to be a regional fleet issue.

After making approximate adjustments for these differences, we estimate that the required fleet to support this Plan, including when MM2 opens in 2032 will be 310 trains, increasing to 332 trains by 2037, including requirements for the *South-East FastLine* project. This excludes the dedicated MARL fleet which is likely to be separately owned and managed.

This also assumes that retirement of Com-Eng trains commences in 2020, with the last of the type being removed from service by around 2035.

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By 2037, the oldest of the Siemens trains will have been in operation for 35 years and a succession plan for these and the oldest of the Xtrapolis trains will need to be under active consideration. However, because of expected technological and other changes, no estimates of overall heavy rail fleet requirements have been attempted beyond 2037.

On this basis, this Plan's estimated fleet requirement over the next 20 years is likely to be as shown in Table 5.

Table 5: Estimated Overall Metropolitan Train Fleet Requirements 2018 to 2037

Train type	2018	2024	2028	2032	2037
Com-Eng	93	64	43	18	
Siemens	36	36	36	36	36
Xtrapolis	90	111	111	111	111
HCMT (7-cars)		65	75	70	110
HCMT (10-cars)			30	75	75
Fleet totals	**219**	**276**	**295**	**310**	**332**

5.13 Stabling and Maintenance Facilities

The progressive re-structuring of the metropolitan heavy rail network into a series of self-contained operating groups also requires provision of dedicated train fleets and rolling stock maintenance facilities to support each group. With the coming of non-divisible HCMTs, much larger facilities are needed that have the capacity for jacking entire train sets up to 230 metres in length and for efficient component exchange.

Such a facility is currently nearing completion at Pakenham East. This compares with existing facilities such as those at Epping and Craigieburn that were designed around 6-car trains consisting of two 3-car units, each being only approximately 72 metres long. As such, the new facilities require buildings around three times the size of those currently in use. Nonetheless, 3-car units of the Siemens and Xtrapolis fleets will doubtless remain in service for many years to come, enabling some of the existing maintenance facilities to remain functional for the foreseeable future.

The following Table 6 shows the expected requirement for maintenance facilities to support the anticipated network and fleet deployment in 2037:

Table 6: Maintenance Facilities Required by 2037

Main Depot Location	Secondary Depot Location	Corridors served	Train types	Fleet size
Craigieburn	Kananook	Wallan-Glen Waverley Craigieburn-Baxter	Siemens Xtrapolis	10 56
Epping	Bayswater	Clifton Hill/Burnley Groups	Xtrapolis	55
Newport	Macaulay	Williamstown/Laverton-Sandringham	Siemens	26
Pakenham East	Calder Park	Sunbury/Melton-Pakenham/Clyde (MM1)	HCMT	90
Tottenham	n/a	Southern Cross-Melbourne Airport (MARL)	Dedicated EMUs	10
Wyndham Vale	Mernda	Black Forest Rd-Mernda (MM2) Werribee/Black Forest Rd-Pakenham (SEFL)	HCMT	95

Additional train stabling capacity will also be required at several locations to accommodate more than 100 additional trains (including considerably longer trains) on the network. The largest stabling facilities will be at Pakenham East and Wyndham Vale, however new and/or expanded facilities will also be required at Melton and/or Bacchus Marsh, Calder Park or Clarkefield, Wallan, Upfield, Baxter, Clyde, Mernda and Lilydale. The small dedicated MARL fleet is likely to be stabled at Tottenham.

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5.14 Operational (non-investment) Measures

RFI has identified a menu of potential operational measures that can be adopted, standing alone and/or in association with investment proposals, to increase corridor capacity and resilience, improve service reliability and enhance customer service.

Examples include:

- increasing train frequency by reducing train headways within the limitations of the signalling system
- altering train stopping patterns to provide greater consistency between successive services
- adjusting timetables to minimise conflicting train movements at junctions or other pinch points
- adjusting train driver rosters to minimise turnaround times at termini
- locating driver changeover points at train termini
- ensuring train types operating on any single corridor have very similar performance characteristics
- reducing station dwell times by more effective management of passenger flows on platforms, through ticket barriers and/or on vertical transport within station environs
- enhanced staff training regimes directed at improving customer communication and incident management.

While it is not the intent of this Plan to propose detailed operational arrangements, it is emphasised that most, if not all, of these measures will need to be implemented to ensure that the recommended investments achieve their stated purpose.

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6. The Tram Plan

6.1 Tram Plan Overview

The broad objectives of the Rail Futures' Tram Plan are to:

- increase capacity of the existing tram network to meet current and projected patronage growth
- reduce journey times on routes presently suffering delays due to shared use of road space
- enhance overall tram network efficiency and asset utilisation
- provide "turn up and go" service frequency wherever feasible
- better serve the northern and western parts of the enlarged Melbourne CBD, and Fishermans Bend
- offer new cross-CBD tram routes
- provide better tram connectivity to CBD and inner area rail stations
- provide new tram links to NEICs and Major Activity Centres by extending routes ending at "nowhere in particular"
- provide new cross-suburban routes to link existing radial train and tram lines
- encourage and facilitate passenger interchange where tram routes intersect or meet bus routes and train lines
- accelerate progress toward tram fleet DDA compliance and level boarding at a majority of tram stops by 2032
- fully integrate the tram network as a key element of a Melbourne multi-modal Public Transport Grid Network
- enhance the travel experience of users as part of a wider process for reducing car dependency.

The Tram Plan aims to link the above objectives and their achievement by means of investment in infrastructure, rolling stock, associated facilities and systems, and through non-investment operational measures, including the following:

- Tram priority measures
- Proposed tram route extensions
- Proposed re-routings and additional new tram routes
- Tram route service levels
- Proposed changes to tram stops
- Proposed development of new tram/tram and tram/train interchanges
- Tram fleet requirements
- Depot, stabling and maintenance facility requirements
- Tram infrastructure enhancement, renewal and upgrading needs
- DDA compliance measures
- Other operational (non-investment) measures.

A critical requirement is to improve interchange with other modes - the best performing tram systems are tightly connected with bus and heavy rail to form an integrated grid network, multiplying the range of possible destinations and providing a credible travel alternative to the car.

The opportunity exists to progressively transform Melbourne's tramway network towards best practice, thus expanding the system's capacity to match Melbourne's growth and development; and greatly increase both efficiency and passenger attractiveness.

6.2 Tram Priority Measures

For the tram system, the prime way of improving efficiency is through traffic priority measures. The average operating speed of trams is affected by traffic congestion, delays at traffic signals, road accidents, trams braking and accelerating, dwell time at stops and distance between stops. Effective use of the tramway infrastructure and vehicles necessitates that overall transit times be reduced through more effective traffic management

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systems which prioritise trams and cars based on numbers of people travelling rather than the number of vehicles.

About 80 per cent of Melbourne's tram network operates 'on street' with ROWs located on arterial and local roads. This means average operating speeds on the network are relatively low, around 16 km/h compared to other Australian and overseas systems which feature greater separation from road traffic. On some built-up tram corridors through shopping strips, particularly Sydney Road and Chapel Street, average speeds can go as low as 6 km/h. Unfortunately, higher capacity corridors are presently constrained from achieving better operational performance (increased average speeds, higher frequencies, greater reliability) and higher passenger capacity because of a combination of closely spaced tram stops, delays caused by mixed traffic operation, lack of adequate traffic light priority and lack of dedicated tram ROWs.

Critical actions are to improve tram ROWs and tram priority to increase speed, reliability and improve tram utilisation, including measures such as re-allocation of existing road space with a focus on key locations where the impact is greatest. The current situation results in everyone losing - motorists are delayed, tram passengers are delayed - perpetuating a very inefficient system of competing modes sharing the limited available road space.

Ongoing delays to trams and current low average tram speeds make for poor utilisation of available street space, extends passenger travel times and imposes ongoing cost imposts on operation of the system. As the travel time along any route extends, more trams are required to maintain the same service frequency at extra capital cost. Additional trams also require additional drivers, consume additional energy and incur added labour and maintenance costs.

A concerted and renewed ongoing joint effort is required by Government, Councils, VicRoads and Yarra Trams to tackle tram prioritisation so that the existing and extended network can reach its optimum and full passenger carrying potential in coming years. The issue is one of moving people, NOT cars, and the most efficient use of the limited available road space.

The following package of improvements is proposed:

- Introduction of hook turns wherever feasible at intersections where cars and trams share the same road space, potentially offering an early low-cost prioritising of tram throughput on all on-street tram routes
- Improved tram priority at traffic lights, including giving trams in the CBD in Collins and Bourke Streets priority over traffic in King, Russell and Exhibition Streets which have little or no public transport
- Use of on-tram technology which allows approaching trams to trigger traffic light priority (including early application in William, Elizabeth and Swanston Streets at Flinders Lane and all "Little" cross streets within the Hoddle Grid)
- More aggressive use of Intelligent Transport Systems (ITS) including software to enhance the sophistication of traffic signal phasing
- More hard edge tram clearways as opposed to painted road line markings
- Minimising kerbside parking in narrow thoroughfares
- Selective rationalisation of closely spaced stops to accelerate services
- Provision of DDA compliant stops at all locations to facilitate access and reduce dwell times.
- Selective re location of stops away from intersections to expedite tram flow, while maintaining interchange connections
- Ongoing enforcement by Police of tram clearways and road vehicles obstructing tram flow at intersections

6.3 Tram Route Extensions

The following tram route extensions are proposed for completion by 2034 (see Section 12 for implementation program):

Short Distance Extensions of Existing Tram Routes

- Route 3: extended from East Malvern (Darling Road) terminus 0.8km to EAST MALVERN STATION
- Route 5: extended from Malvern (Burke Road) terminus 1.4km to DARLING STATION.
- Route 19: extended from North Coburg (Bakers Road) terminus 0.7km to MERLYNSTON STATION
- Route 57: extended from West Maribyrnong 1.7km to LOWER AVONDALE HEIGHTS (Clarendon St)

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- Route 67: extended from Carnegie (Koornang Road) terminus 0.9km to CARNEGIE STATION
- Route 72: extended from Camberwell northwards 1.9km to EAST KEW (Kilby Rd) meeting Route 48 North Balwyn

Longer Distance Extensions of Existing Tram Routes

- Route 11: extended from West Preston 5.2km to LATROBE UNIVERSITY via Reservoir Station
- Route 59: extended from Airport West 6.5km to MELBOURNE AIRPORT
- Route 64: extended from East Brighton 3.4km to MOORABBIN STATION

Further detail of the above proposals, including the rationale and the estimated cost for each extension are shown in Appendices T 27 to T 42.

Potential Future Network Extensions - for consideration (2035 – 2049)

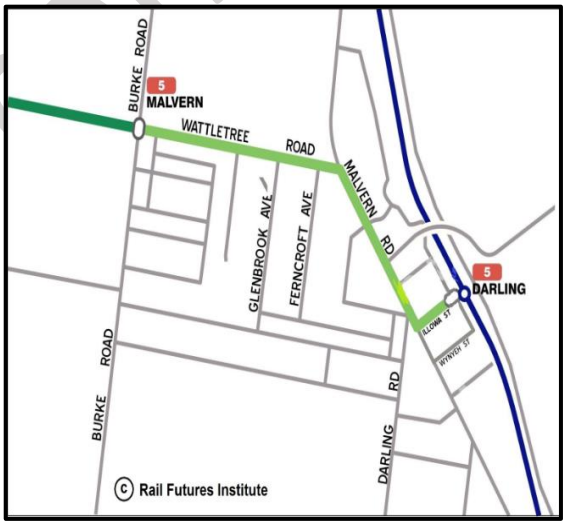
- Route 48: North Balwyn to GREYTHORN SHOPPING CENTRE and DONCASTER HILL (See also 7.2.1)
- Route 57: further extension north beyond LOWER AVONDALE HEIGHTS
- Route 72: extension from GARDINER Station via Burke Road to CAULFIELD STATION, thus creating a new North/South tram route from EAST KEW via Burke Rd and Gardiner Station to CAULFIELD STATION providing connection between eight East/West tram routes and three radial rail lines
- Route 75: Vermont South extension to KNOX CITY
- Route 86: Bundoora RMIT extension to SOUTH MORANG STATION

Examples of the above route extension concepts are illustrated in Figure 24, below.

Figure 24: Proposed Tram Route Extensions

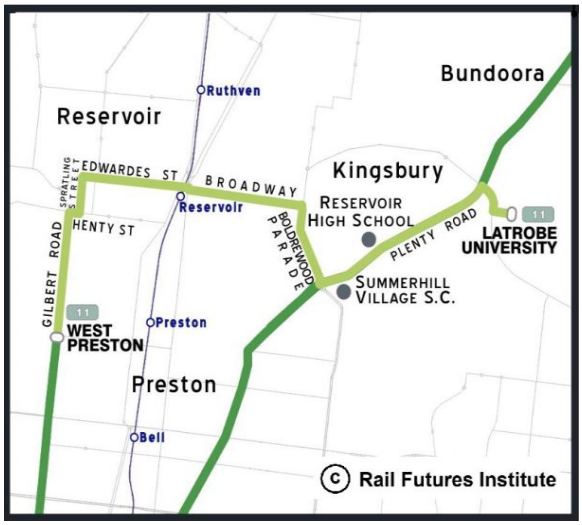


Route 3 extension to East Malvern Station

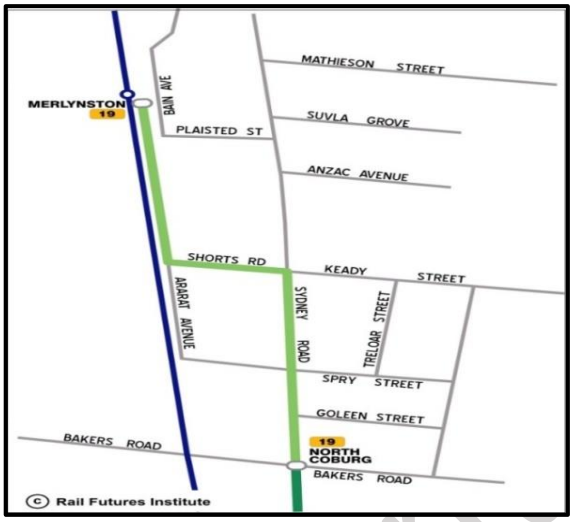


Route 5 extension to Darling Station

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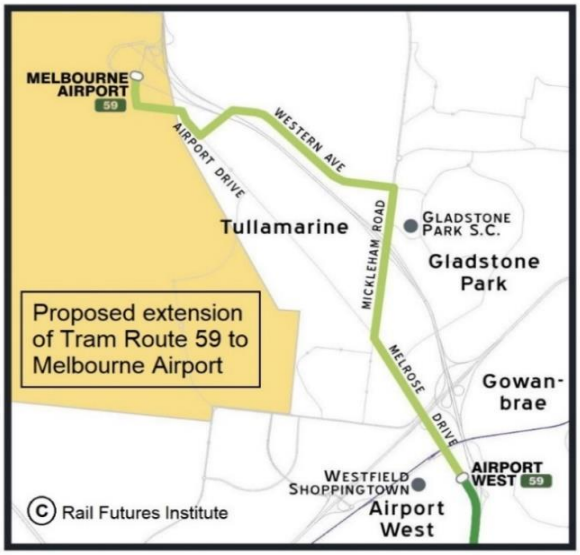
Route 11 extension to Latrobe University



Route 19 extension to Merlynston Station



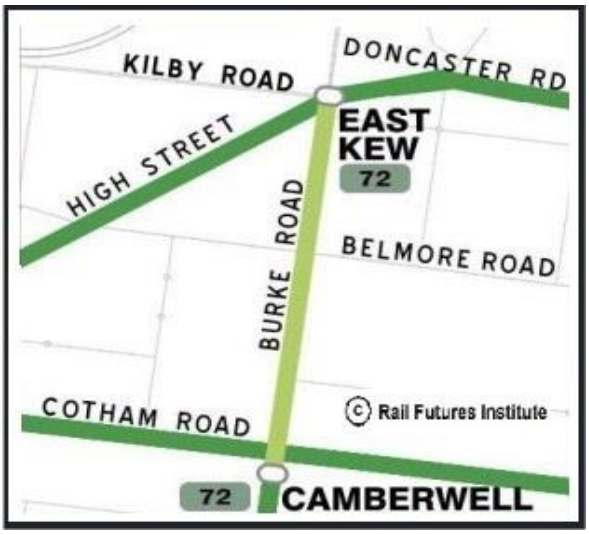
Route 57 extension to Lower Avondale Heights



Route 59 extension to Melbourne Airport



Route 68 (existing Route 64) extension to Moorabbin Station



Route 72 extension to East Kew

(Note: The route extensions shown in the above diagrams are indicative concepts illustrating the proposals at a broad level and are not intended to be definitive).

6.4 Tram Re-routings and Additional New Tram Routes

The existing largely radial network, whilst limited by historical factors, provides an excellent base to build a grid network to maximise interchange opportunities with other public transport routes and meet increasing demand for local access.

It is proposed to progressively re structure the existing and extended network over 15 years to 2034 to progress towards a grid network that:

- provides a greater number of cross-CBD tram routes, helping avoid current tram changes to complete existing trips within the CBD
- offers improved connections between tram routes and between and the rail network
- offers new cross-suburban routes including linking of Clifton Hill station to West/North Melbourne stations and to the Parkville Precinct
- offers an additional CBD access route for St Kilda Road trams via Spencer Street to Southern Cross station and the western end of the CBD
- introduces a new CBD / Inner East circular tram route and a new CBD/Inner North Circular route
- provides new and extended tram services to Sandridge/Wirraway, Westgate Park, Latrobe University via Reservoir, Melbourne Airport and to Moorabbin station
- offers a wider choice of tram travel options to/from and between 16 City/inner area rail stations including the new MM1 stations at North Melbourne, Parkville, State Library, Town Hall and Anzac and future MM2 stations at Sandridge and Employment Precinct (Fishermans Bend) and Fitzroy
- extends the existing tram network to connect with the rail network at a further 6 existing stations – Carnegie, Clifton Hill, Darling, East Malvern, Moorabbin and Reservoir
- provides a new terminal facility at Port Melbourne for an easy link to trams for Spirit of Tasmania and cruise ship passengers
- introduces new supplementary peak hour services on key routes from the CBD to inner suburban locations, relieving pressure on longer distance routes from the CBD

To achieve this, new twin track sections, connecting links and turnbacks would be constructed within the CBD and near inner suburbs linking with existing tracks to leverage best use of the existing track infrastructure and allow introduction of the new CBD and cross-CBD routes. As shown in Figures 24 and 25, this would occur in:

- Park Street, South Melbourne - 300m of new track between Kingsway and Heather Street
- Victoria Street, Melbourne – 750m of new track between Latrobe and Swanston Streets
- Elizabeth and Victoria Streets (Queen Victoria Market intersection) - new cross connection enabling continuous tram transit along Victoria Street
- Smith Street, Abbotsford – 250m of new track between Gertrude Street and Victoria Parade
- Spencer Street, Hawke Street and Adderley Streets, West Melbourne – 1.3km of new track from Remand Centre terminus to West Melbourne Station
- Hawke Street, West Melbourne – 350m of new track between Victoria Street and Spencer Street
- Laurens, Arden and Dryburgh Streets, North Melbourne – 1.8km uni-directional (single track) tram loop linking West Melbourne and new North Melbourne stations
- Harbour Esplanade, Docklands – new turnback facility at Docklands Park
- Reserved tram corridor in Royal Park – new turnback facility off Flemington Road at Royal Children's Hospital
- New tram connection to Clifton Hill – 250m of new track between Queens Parade and Hoddle Street with interchange/turnback facility linked via pedestrian bridge over Hoddle Street to Clifton Hill station
- Station Pier, Port Melbourne - 200m of new track crossing Waterfront Place and new twin track interchange/terminus at the Station Pier gate.

Additional curve pairs would also be installed at selected intersections to maximize utilisation of existing track assets.

The proposed implementation program for the principal infrastructure changes described above is shown in Section 12.

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Figure 25: Proposed Tram links to Clifton Hill Station and Station Pier, Port Melbourne

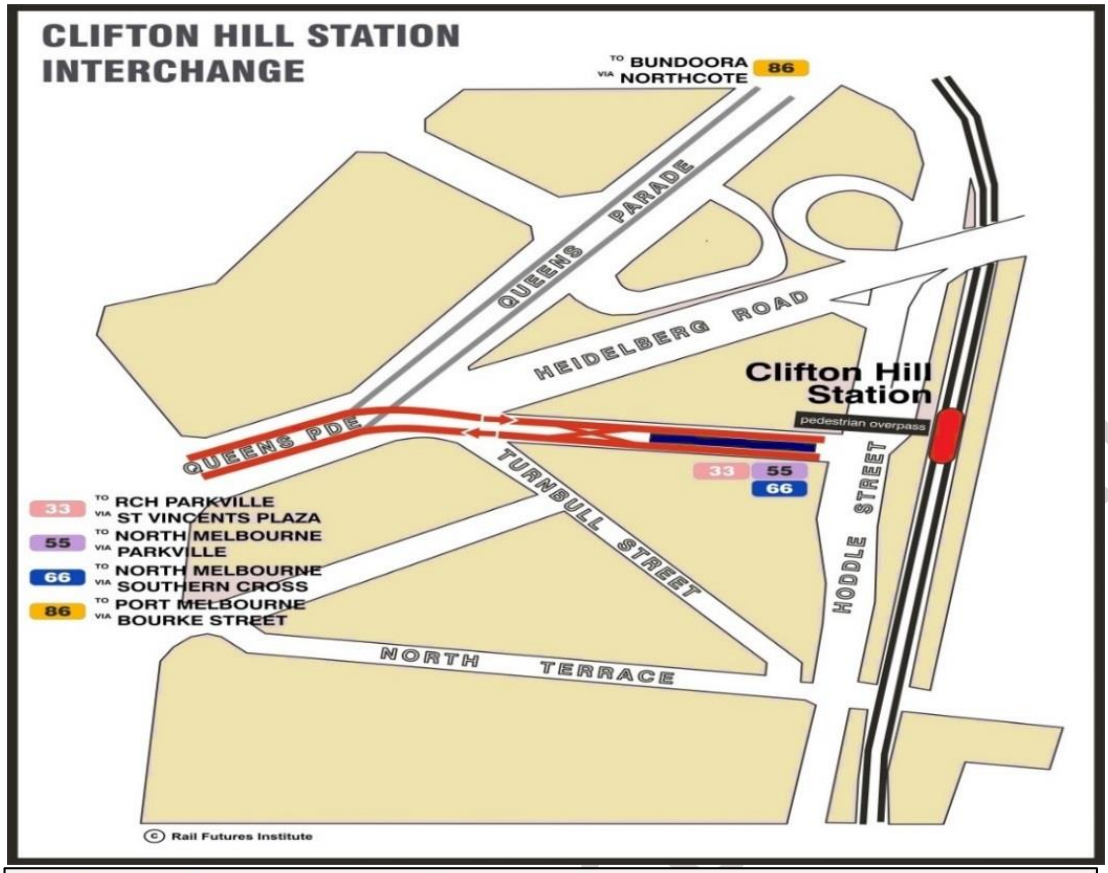
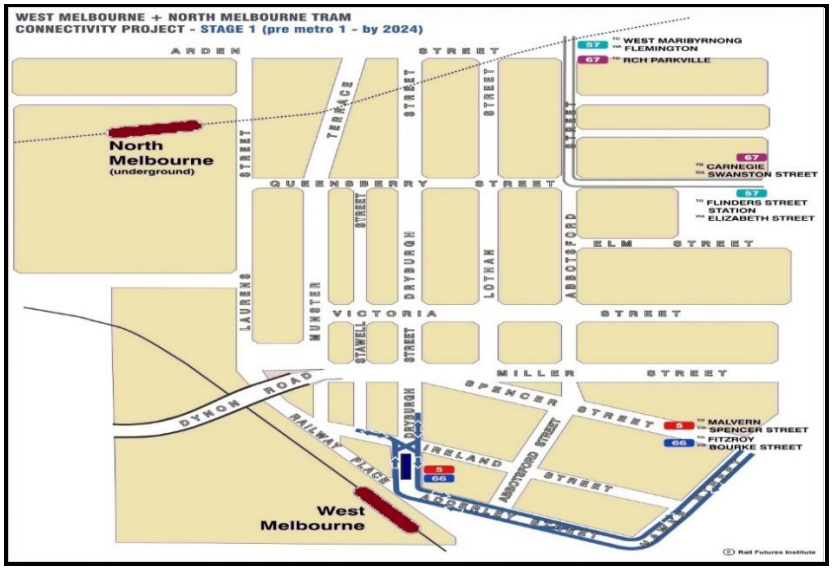
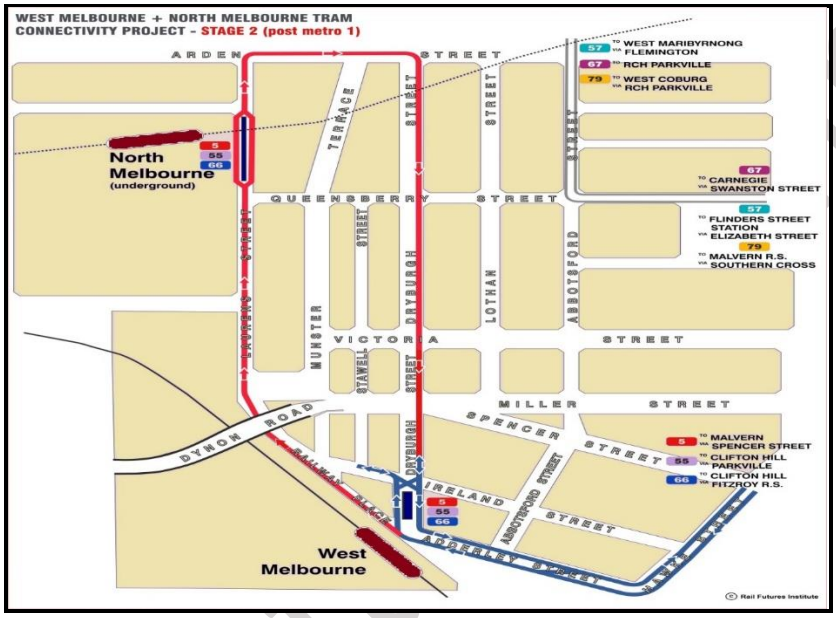
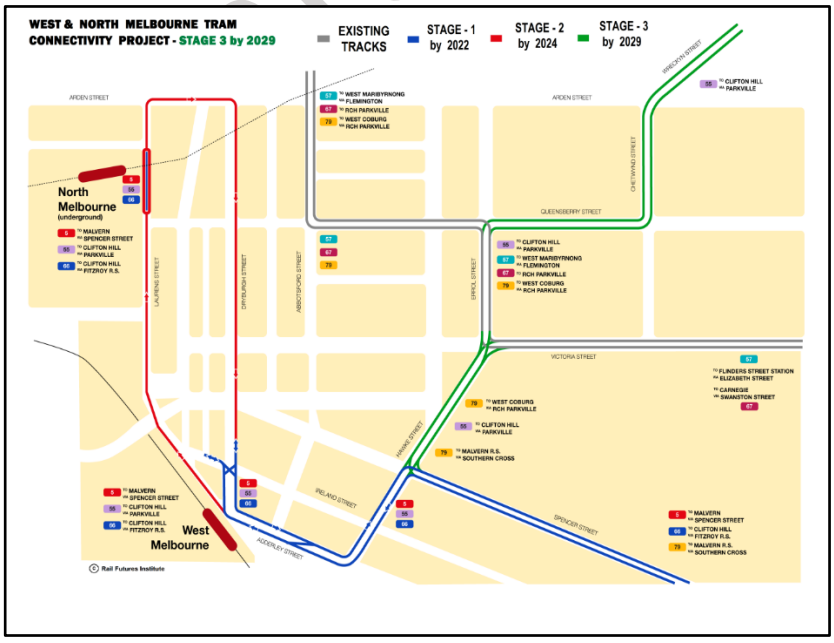




Figure 26: Proposed Tram Loop serving West Melbourne and new North Melbourne Stations







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Fishermans Bend is Australia's largest urban renewal project covering approximately 480 hectares. It is expected that by 2050, it will be home to approximately 80,000 residents and provide employment for up to 80,000 people[29]. It is proposed to construct two new tram routes into Fishermans Bend, connected via a new tram crossing of the Yarra River to the existing Collins Street West tram routes near Victoria Harbour. The two routes will service the northern and southern parts of the precinct respectively, described below and shown in Figure 27:

- Proposed Route 44 will extend approximately 4.2km to service SANDRIDGE and WIRRAWAY, generally running east-west along the Plummer Street alignment before turning south into Prohasky Street and terminating at Williamstown Road. An interchange is proposed with the Sandridge underground station on the MM2 corridor. Route 44 will run to Kew Depot via Collins Street, Victoria Parade and Victoria Street, supplementing Route 42 to Box Hill (formerly Route 109) on this corridor.
- Proposed Route 46 will extend approximately 4.9km (of which 0.6km is common with Route 44) to WESTGATE PARK, generally running east-west along the Turner Street alignment to serve the new suburb of Lorimer and the Fishermans Bend Employment Precinct. An interchange is proposed with the Employment Precinct underground station on the MM2 corridor. Route 46 will run to Camberwell Junction via Collins Street and Bridge Road, supplementing Routes 48 to North Balwyn, 70 to Wattle Park and 75 to Vermont South on parts of these corridors.

In addition, it is proposed to provide new tram tracks totalling 7km along Alexandra Parade, Barkly, Grattan, Wreckyn, Chetwynd, Queensberry and Hawke Streets. This would provide a northern CBD bypass forming a continuous east-west route between Clifton Hill and West and North Melbourne stations (see Figure 27), operated as new Route 55. This is a relatively major project to be undertaken in two stages – Stage 1 from Clifton Hill to Parkville and Stage 2 from Parkville to North Melbourne. It aims to:

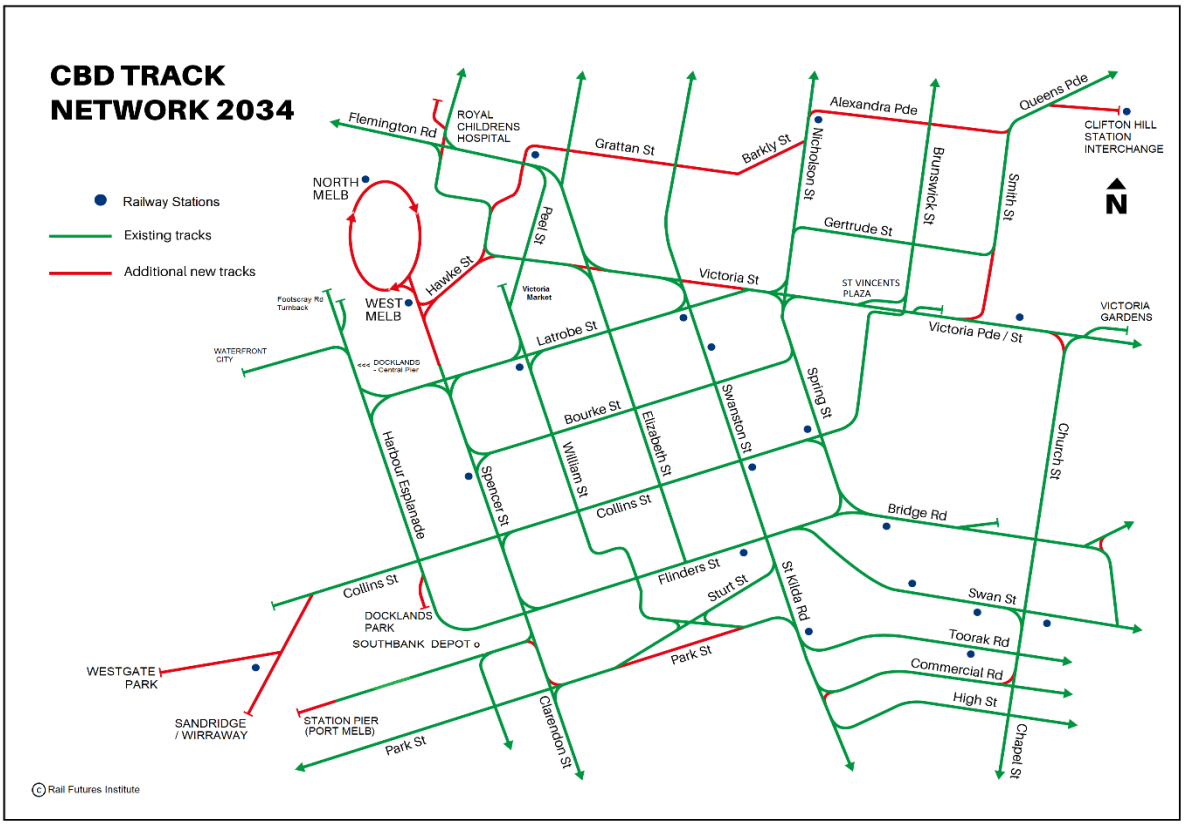
- attract concentrated redevelopment along Alexandra Parade, Fitzroy, with a vision of that thoroughfare becoming an attractive commercial and residential boulevard, similarly to Victoria Parade or St Kilda Road, served by trams in the central median between Smith and Nicholson Streets
- provide connectivity via a new tram/train interchange at Clifton Hill Station between the Hurstbridge rail line and Fitzroy, Parkville NEIC, West and North Melbourne
- provide an interchange with Fitzroy underground station, likely to be located beneath Queens Parade between Brunswick and Smith Streets on the MM2 corridor from Mernda
- provide an interchange facility with Route 96 trams in Nicholson Street at Johnston Street, Fitzroy
- install tram tracks in Barkly Street, Carlton between Nicholson and Rathdowne Streets together with dedicated bicycle paths
- convert Grattan Street into a dedicated transit corridor for trams and buses (with limited local access only for cars) between Rathdowne Street and Royal Parade, inclusive of a high capacity interchange with underground stations for MM1 and MM2 to service the critically important university and medical precincts at Parkville
- replace the Route 401 bus between North Melbourne and Parkville in an appropriate timescale as Stage 2 of the project
- provide an interchange facility with Routes 57, 67 and 79 trams in Errol Street, North Melbourne
- merge with the proposed West Melbourne extension in Hawke Street at Spencer Street and new tram loop linking tram/train interchanges at West Melbourne and the new North Melbourne station on the MM1 corridor
- provide an already established corridor for potential use by a Doncaster MCT route.

Detail of the proposed new twin track sections, connecting links and turnbacks to be constructed within the CBD and near inner suburbs is shown in Figure 27. The proposed implementation program for these works is in Section 12.

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[29] Fishermans Bend Framework, Government of Victoria, October 2018.

Figure 27: New track connections proposed within the CBD and inner suburbs by 2034



When completed in 2034, the proposed reconfigured CBD tram network is expected to provide service frequencies and route structures in the various Melbourne CBD streets as shown in Table 7, below.

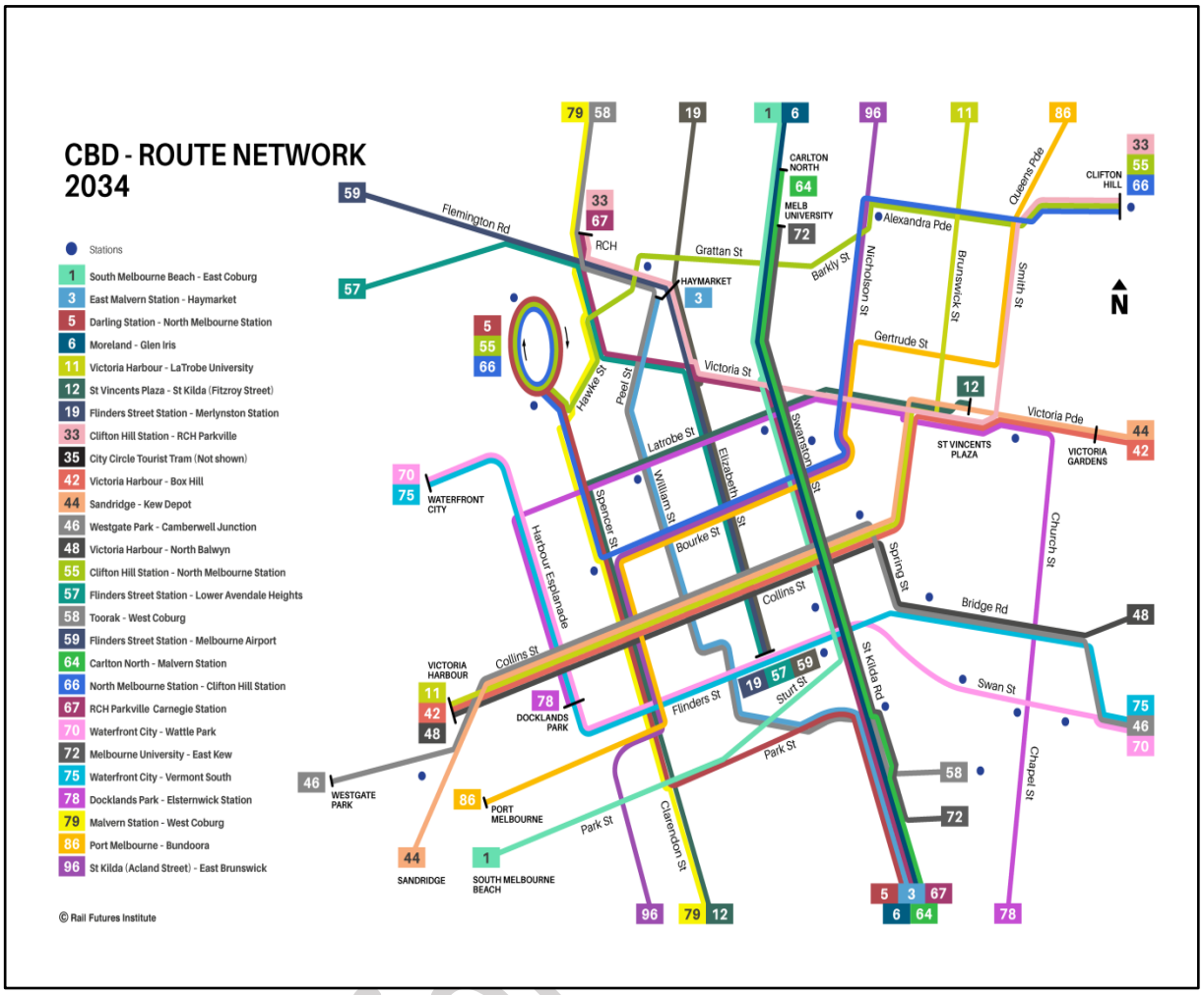
A greater diversity of route destinations will become available in all CBD streets, other than Swanston Street, reflecting the very significant shifts in commercial activity and job location within the extended Melbourne CBD and Docklands over the past 20 years or thereabouts. The reduced number of routes using Swanston Street will be offset by greater service frequency provided on Routes 1, 6, 64, 67 and 72 and introduction of MM1.

Table 7: Comparison by CBD streets of peak period frequency and routes serviced (2018 and 2034)

CBD Streets	TRAMS per hour EACH WAY		Number of Routes per CBD street		Route operation by street	
	2018 Existing	**2034 Proposed**	2018 Existing	**2034 Proposed**	2018 Existing	**2034 Proposed**
EAST / WEST ROUTES						
Harbour Esplanade	16	**34**	3	**5**	35 70 75	**35 70 71# 75 78**
Spencer Street	34	**40**	3	**5**	12 86 96 109	**5 12 79 86 96**
William Street	11	**28**	1	**4**	58	**3 56# 58 73#**
Elizabeth Street	31	**36**	3	**5**	19 57 59	**19 33 57 59 59a#**
Swanston Street	49	**34**	8	**5**	1 3 5 6 16 64 67 72	**1 6 64 67 72**
NORTH / SOUTH ROUTES						
Flinders Street	16	**23**	3	**4**	35 70 75	**35 70 71# 75**
Collins Street	35	**43**	4	**5**	11 12 48 109	**11 42 44 46 48**
Bourke Street	19	**34**	2	**4**	86 96	**66 85# 86 96**
Latrobe Street	12	**30**	2	**4**	30 35	**10# 12 35 78**
Victoria Street	8	**14**	1	**3**	57	**33 57 67**
Flemington Road	22	**37**	2	**5**	58 59	**33 56# 58 59 59a#**
See Table 9 below for key to route numbering.					***# - Weekday Peak Supplementary routes 0700-0930 and 1600-1830***	

Figure 28 below shows the complete configuration of CBD and near-CBD tram routes when the proposed changes are fully implemented in 2034.

Figure 28: Proposed CBD Tram network in 2034





E class tram on Route 96 in The Esplanade, St Kilda
Photo: *Hugh Llewelyn*

The resultant overall tram route network will be substantially different to that on offer today, as summarised in Table 8 and illustrated in Figure 29, below.

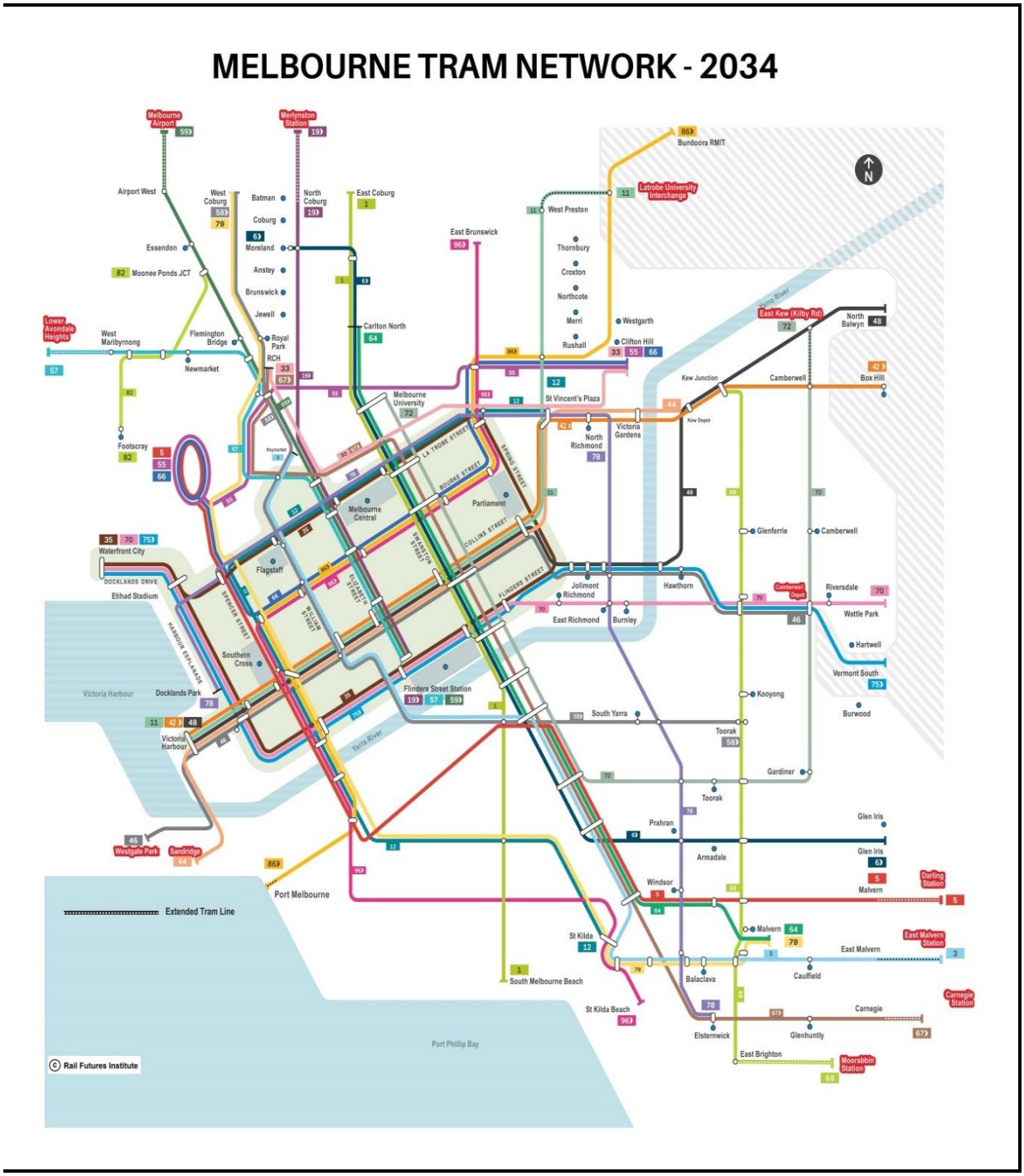
Table 8: Comparison of Tram Routes existing in 2018 and proposed in 2034

EXISTING 2018 *(24 routes)*		**PROPOSED 2034 *(36 routes)***	
Route	***From / To***	***Route***	***From / To***
1	South Melbourne Beach – East Coburg	1	South Melbourne Beach – East Coburg
3	Melbourne University – East Malvern	**3**	**Haymarket – East Malvern Station**
5	Melbourne University - Malvern	**5**	**North Melbourne Station – Darling Station**
6	Moreland – Glen Iris	6	Moreland – Glen Iris
	NEW PEAK ROUTE >>>>>	**10 #**	**Docklands (Central Pier) – Preston Depot**
11	Victoria Harbour – West Preston	**11**	**Victoria Harbour – Latrobe University**
12	Victoria Gardens - St Kilda (Park Street)	**12**	**St Vincents Plaza – St Kilda (Park Street)**
16	Melbourne University – Kew (Cotham Rd)	Incorporated into Routes 68 and 79	
19	Flinders Street Station – North Coburg	**19**	**Flinders St Station – Merlynston Station**
30	Marvel Stadium – St Vincents Plaza	Incorporated into Route 78	
	NEW ROUTE >>>>>>>>	***33***	***Clifton Hill Station – RCH Parkville***
35	City Circle – Tourist Tram	35	City Circle – Tourist Tram
	Replaces Route 109 >>>	**42**	**Victoria Harbour – Box Hill**
	NEW ROUTE >>>>>>>>	**44 #**	**Sandridge – Kew Depot**
	NEW ROUTE >>>>>>>>	**46 #**	**Westgate Park – Camberwell Junction**
48	Victoria Harbour – North Balwyn	48	Victoria Harbour - North Balwyn
	NEW ROUTE >>>>>>>>	**55**	**Clifton Hill Station – North Melbourne Stn**
	NEW PEAK ROUTE >>>>>	**56 #**	**Southbank – Ascot Vale**
57	Flinders Street Station – West Maribyrnong	**57**	**Flinders St Station – Avondale Heights**
58	Toorak – West Coburg	58	Toorak – West Coburg
59	Flinders Street Station - Airport West	**59**	**Flinders St Station - Melbourne Airport**
	NEW PEAK ROUTE >>>>>	**59a #**	**Flinders St Station – Moonee Ponds Jctn**
64	Melbourne University – East Brighton	**64**	**Carlton North - Malvern Station**
	NEW ROUTE >>>>>>>>	***66***	***North Melbourne Station – Clifton Hill Stn***
67	Melbourne University - Carnegie	**67**	**RCH Parkville - Carnegie Station**
	Replaces Routes 16 and 64 >>>	**68**	**Kew Junction – Moorabbin Station**
70	Waterfront City – Wattle Park	70	Waterfront City – Wattle Park
	NEW PEAK ROUTE >>>>>	**71 #**	**Docklands (Central Pier) – Burnley**
72	Melbourne University – Camberwell	**72**	**Melbourne University – East Kew**
	NEW PEAK ROUTE >>>>>	**73 #**	**Victoria Market – Gardiner Station**
	NEW PEAK ROUTE >>>>>	**74 #**	**Gardiner Station – East Kew**
75	Marvel Stadium – Vermont South	**75**	**Waterfront City – Vermont South**
78	North Richmond - Balaclava	**78**	**Docklands Park – Elsternwick Station**
	Incorporates Route 16 >>>>	**79**	**Malvern Station – West Coburg**
82	Footscray – Moonee Ponds	82	Footscray – Moonee Ponds
	NEW PEAK ROUTE >>>>>	**85 #**	**Docklands (Central Pier) – East Preston**
86	Waterfront City - Bundoora RMIT	**86**	**Port Melbourne – Bundoora RMIT**
96	St Kilda (Acland Street) - East Brunswick	96	St Kilda (Acland Street) - East Brunswick
109	Port Melbourne – Box Hill		Replaced by Route 42

BOLD - Indicates NEW Route, or change of route number, or origin/destination
Italics - *Denotes Supplementary day time routes 0700 - 2000 DAILY*
- Denotes Supplementary Inner Suburban Weekday PEAK Routes - 0700 to 0930 and 1600 to 1830

The transition from the existing route network of 24 routes at 2018, to that of 36 routes in 2034, takes place over 3 stages as set out in Appendix T 3.

Figure 29: Proposed Melbourne Tram Network – 2034



In addition to the basic route structure described above, it is also proposed to progressively introduce supplementary peak period services on inner parts of several tram routes to provide additional capacity in these areas and relieve pressure on full distance routes. These would be introduced progressively from 2029 to 2039, as listed in Tables 9 and 10 below and shown in Figure 30, below.

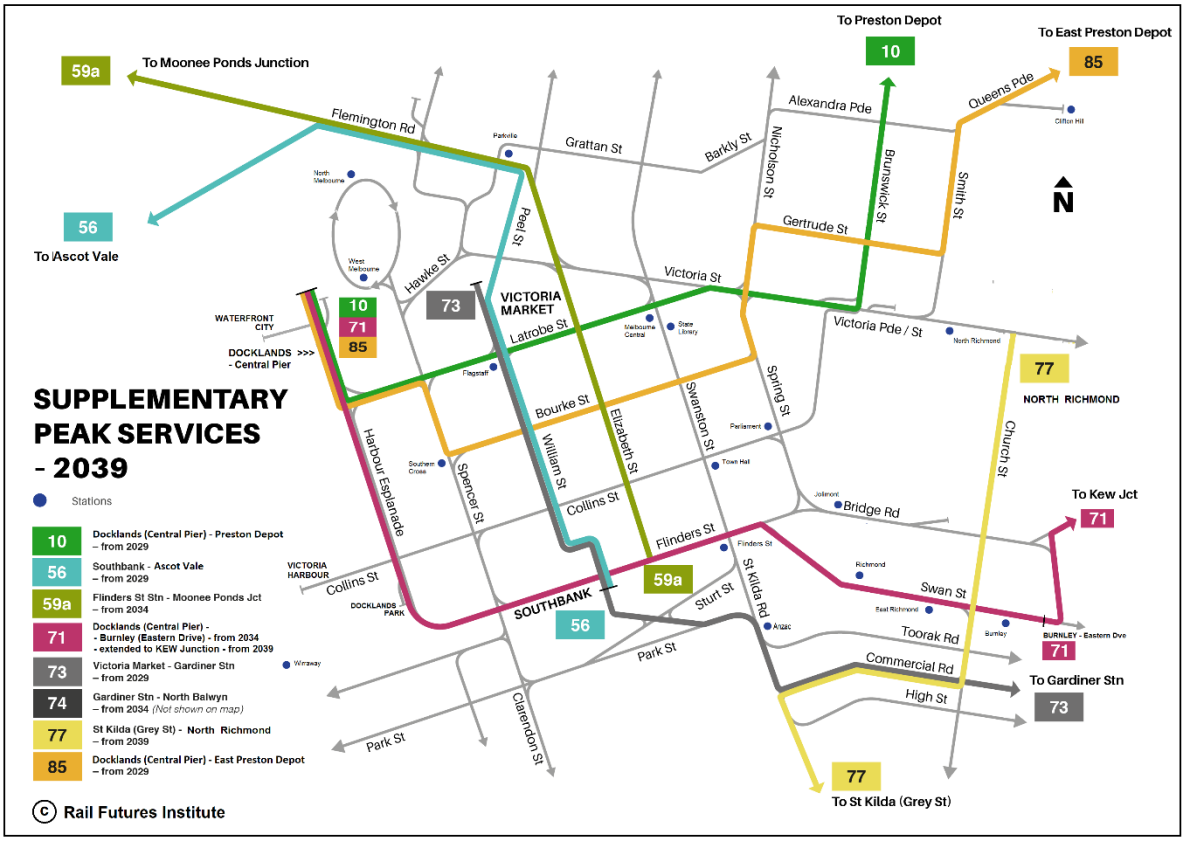
Table 9: New and altered Cross-City route choices

NEW AND ALTERED CROSS-CBD TRAM ROUTE CHOICES AT 2034		
Route	**Origin - Destination**	**Via**
3	**HAYMARKET– East Malvern Station**	Victoria, Market, & William Streets, Southbank & Domain
5	**North Melbourne Station – Darling Station**	West Melb Stn, Southern Cross Stn, South Melbourne & Domain
12	**St Vincents Plaza - St Kilda (Fitzroy St)**	Latrobe, Spencer & Clarendon Streets
33	**Clifton Hill Station – RCH Parkville**	St Vincents Plaza, Victoria Market & RMH Parkville
44 #	***Sandridge / Wirraway – KEW Depot***	*Docklands, Collins Street, St Vincents Plaza & Victoria Gardens*
46 #	***Westgate Park – Camberwell Junction***	*Docklands, Collins Street, Jolimont, MCG & Bridge Road*
55	**Clifton Hill Station – North Melbourne Stn**	Alexandra Pde, Fitzroy Station, Grattan Street & Parkville Station
64	**Carlton North - Malvern Station**	Lygon, Elgin &Swanston Streets, Domain & St Kilda
66 #	***North Melb Station – Clifton Hill Station***	*West Melb Stn, Southern Cross Stn, Bourke Street & Alexandra Pde*
67	**RCH Parkville - Carnegie Station**	Victoria Market, Swanston Street, Domain & St Kilda
75	**Waterfront City – Vermont South**	Waterfront City, Harbour Esplanade, Flinders St, Camberwell Jct
78	**Docklands Park – Elsternwick Station**	Latrobe St, St Vincents Plaza, Nth Richmond, Prahran & Balaclava
79	**Malvern Station – West Coburg**	St Kilda, South Melb, Southern Cross, West & North Melb stations
86	**Port Melbourne – Bundoora RMIT**	Exhibition Centre, Southern Cross, Bourke & Nicholson Streets
RED: - Indicates **NEW Route** or change of an existing route number. ***# - Routes 44, 46 & 66 -*** *Supplementary day time routes 0700 - 2000 DAILY* *At other times Route 44 runs as combined Through Route 42 – Sandridge/Wirraway to Box Hill* *and Route 46 operates as combined Through Route 48 - Westgate Park to North Balwyn*		

Table 10: New Supplementary Routes

NEW SUPPLEMENTARY WEEKDAY PEAK ROUTES AT 2039			
Route	**Origin / Destination**	**Inner suburban back-up to Route**	**Supplementary Service Route**
10	**Docklands – Preston**	**11**	From Docklands via Latrobe Street, St Vincents Plaza then as for Route 11 to PRESTON DEPOT.
56	**Southbank – Ascot Vale**	**57**	From Southbank, via William Street, Peel Street, Flemington Road, then as Route 57 to Maribyrnong Road
59a	**Flinders Street Station – Moonee Ponds Junction**	**59**	From Flinders Street Station as Route 59 to terminate at Moonee Ponds Junction (Connect to Route 82)
71	**Docklands – Burnley – Kew Junction**	**42, 48, 70, 75**	From Docklands via Harbour Esplanade then as Route 70 to Hawthorn Bridge, then to Kew Junction
73	**Victoria Market – Gardiner Station**	**72**	From Victoria Market via William Street, Southbank, Domain then as Route 72 to Gardiner Station.
74	**Gardiner Station – East Kew**	**NEW Mid Suburban**	From GARDINER Station (Connect from Route 73) via Burke Road to Kilby Road EAST KEW (Connect Route 48)
77	**St Kilda – North Richmond**	**NEW Cross Suburban**	From Grey St via Fitzroy Street, St Kilda Road, Commercial Road, Alfred Hospital, Chapel Street and Church Street to Victoria Street at NORTH RICHMOND.
85	**Docklands – East Preston**	**86**	From Docklands via Latrobe Street, Spencer Street then as for Route 86 to terminate at EAST PRESTON.
The above Routes operate in the AM Peak (0700 to 0930) and in the PM Peak (1600 to 1830)			

Figure 30: Proposed Supplementary Peak CBD – Inner Suburban tram routes



Full details of these routes are provided in Appendix T 2.

The reconfigured tram network effectively creates two circular corridors in inner Melbourne to form a critical component of an inner area grid network. They are a CBD and inner eastern circular route formed by the combination of Routes 78 and 79 and a CBD and inner northern circular route formed by the combination of Routes 55 and 66.

These are illustrated in Figures 31 and 32, respectively, below.

Figure 31: Proposed combined Routes 78 / 79 – CBD and Inner Eastern Circular Route

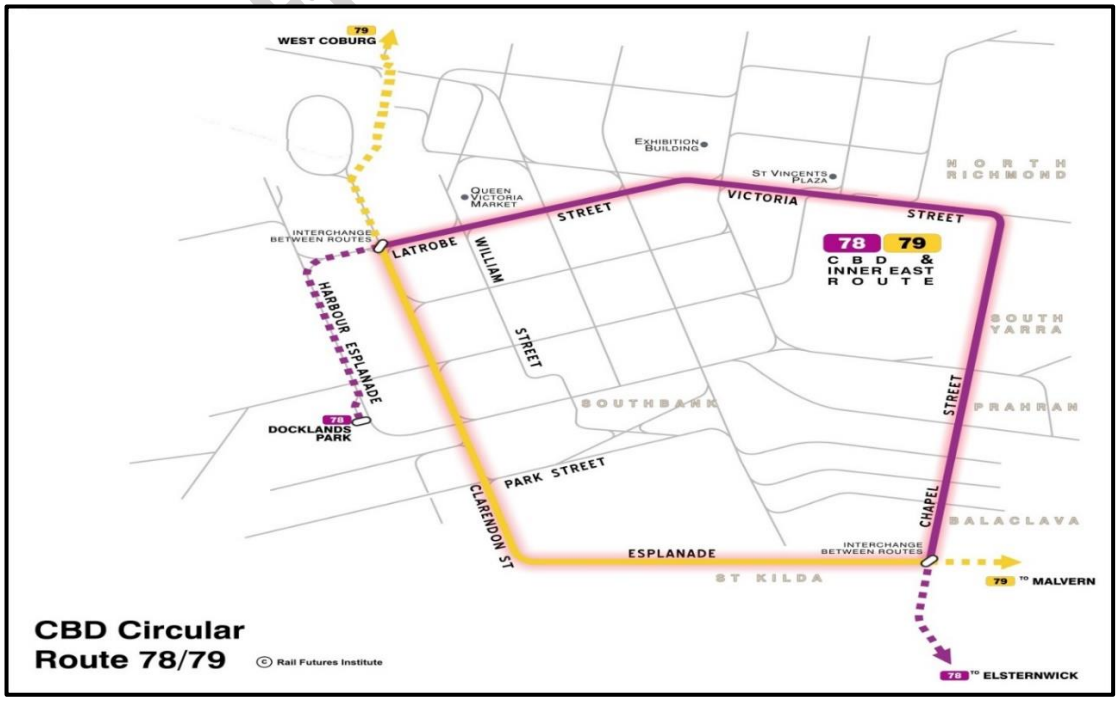
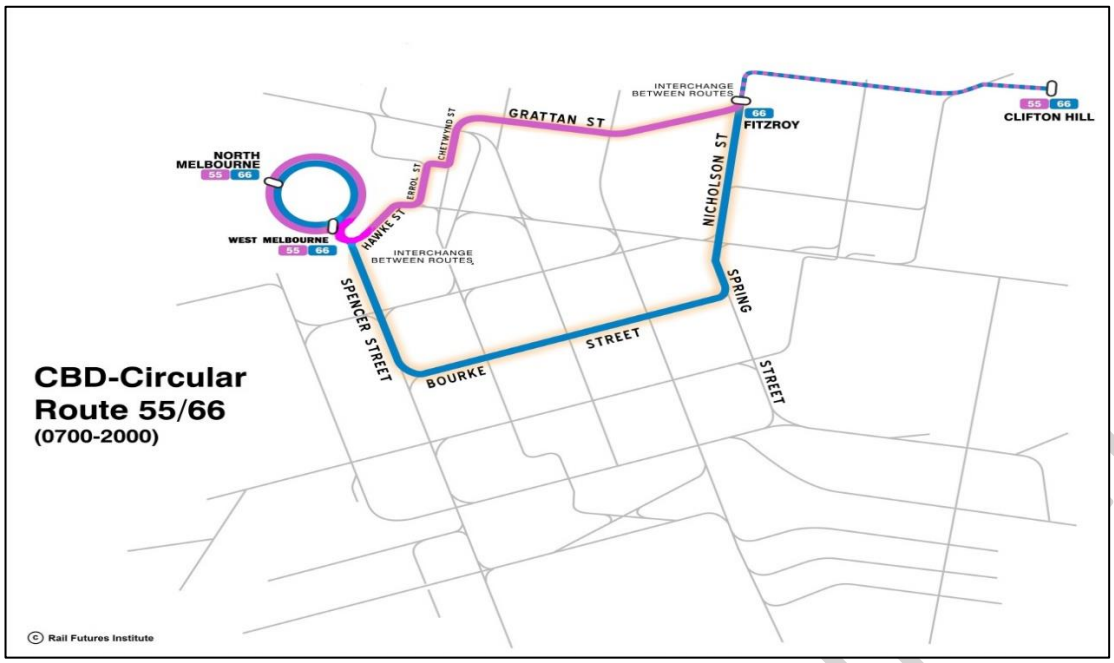


Figure 32: Proposed combined Routes 55 / 66 – CBD and Inner Northern Circular Route



6.5 Tram Service Levels

The overall principles for public transport services were outlined in Section 4.14. The RFI recommended standards for tram services are as follows:

6.5.1 Service Frequency

"Turn up and go" schedules that eliminate the need to consult or understand timetables.

RFI proposes a minimum 10-minute service frequency from 6am to 10pm weekdays and from 7am to 9pm weekends on all trunk tram routes. Additional services would operate during peak periods and at other times as needed to meet demand, or to help induce demand. Outside these hours, a minimum service frequency of 20 minutes would apply.

6.5.2 Hours of Operation

All tram routes would generally provide services from 4.30am to 1.30am on weekdays and 5.30am to 12.30am on weekends. Trunk tram routes would also provide minimum hourly all-night services during the early hours of Saturday and Sunday mornings.

6.5.3 Reliability Standards

On the tram network service reliability should in future be measured compared to the timetabled headway being maintained within a set criterion in minutes, rather than as currently to actual timetable adherence at various points along the route. To the passenger, the adherence to headway (frequency) is what is important, not adherence to timetable. Already on many routes the timetables at stops do not indicate timetabled departure times, but rather frequency of service between defined times of the day. Therefore, a monitoring regime that measures performance in terms of services delivered compared to plan; and adherence to the planned headway, is more appropriate both now and in future.

Proposed revised standards would require 99% monthly delivery of all scheduled services. Headway between services would be measured at designated locations on each route. This would require that 90% of all services operate within ±4 minutes of scheduled headways. Mitigation would only be allowed in exceptional circumstances.

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6.5.4 Capacity and Crowding

Maximum passenger load carrying standards would continue to apply to all vehicle types. All trams would be equipped with load monitoring devices linked to GPS location monitoring and the MKYI ticketing system which would generate continuous passenger capacity utilisation data for each route journey.

6.6 Tram Fleet Requirements

Current orders for new trams are limited to the acquisition of 90 E-class trams with a capacity of 210 passengers, of which the first 70 were in service at October 2018. When the current order for E class trams is fulfilled, there will be 190 low floor trams on Melbourne's network, comprising 35% of the fleet. The immediate aim is to run all services on routes 19, 96 and 109 with low floor trams. Routes 5, 6, 11, 16, 48, 58, 72 and 86 are partly serviced by low floor trams.

The Victorian Government recently announced a plan to refurbish a significant part of the existing tram fleet to improve passenger safety and undertake life extension works on the older parts of the fleet. The enhancements include new seating, replacement of glass and decals and provision of state-of-the-art passenger information systems (PIDS).

To meet DDA compliance by 2032 and to meet the projected peak traffic task over the next 15 years, a vastly accelerated tram acquisition program is required that will see the fleet grow from the current 500 trams to around 640 by 2034 and retirement of all smaller non-DDA compliant trams of the Z and A classes.

Whilst the tram fleet will increase by 28%, the peak carrying capacity will more than double through the transition to a new fleet of three articulated tram types of 24m, 33m (the present E class) and 40m in length, with carrying capacities between 150 and 275 passengers. Over the 15-year period, acquisition of an additional 175 E class, 45 x 40m F class and 250 x 24m G class is recommended. Over the same period 311 older non-DDA compliant trams would be withdrawn. The fleet projections also allow for an annual write-off of a small number of vehicles damaged in traffic accidents and thus deemed to be beyond economic repair.

Short term, to 2025, this will require an increase in new tram procurement from its current rate of around 10 trams per annum to 25 new trams per annum. Between 2025 and 2034, the procurement rate will need to further step up to 35 new trams per annum.

The projected capital cost of the recommended 15-year fleet acquisition program is $2.8 billion.

The proposed acquisition (and retirement schedule for aged low capacity high floor trams that do not meet DDA requirements) is shown in Appendix T 25.

Whilst over the 15-year period, the fleet would only grow by 149 trams (28%), peak capacity would increase by 116 % due to the fleet transitioning to a totally articulated fleet of larger capacity longer trams.

The projected tram fleet requirements are shown in Table 11, below.

Table 11: Tram Fleet Requirements 2018 to 2044

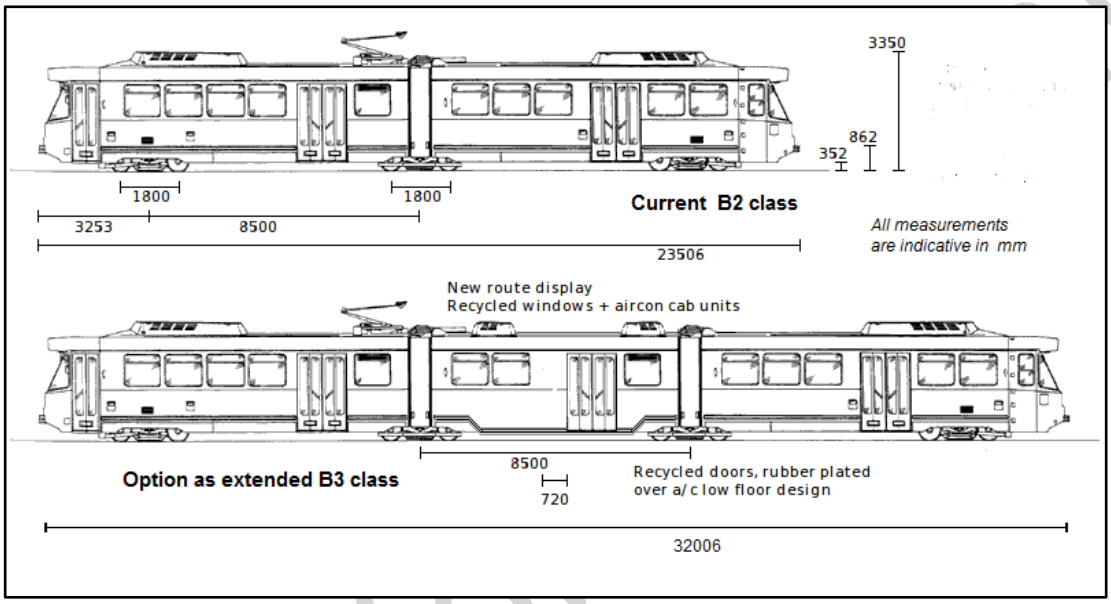
Tram Type				***Year***					
Tram Class	***Length***	***Capacity***	***DDA Compliant***	***2018***	***2024***	***2029***	***2034***	***2039***	***2044***
A	15m	65	No	69	65	0	0	0	0
B2	24m	110	No	130	128	125	0	0	0
C1	23m	120	Yes	36	35	34	33	29	25
C2	33m	180	Yes	5	5	4	3	2	0
D1	20m	90	Yes	38	37	35	33	31	30
D2	30m	140	Yes	21	20	19	18	18	18
E	34m	210	Yes	72	181	216	254	252	251
F	40m	275	Yes	0	0	32	43	93	141
G	24m	120	Yes	0	0	120	250	276	302
W	15m	75	No	13	13	13	13	13	13
Z	17m	70	No	114	0	0	0	0	0
Fleet Totals				**498**	**484**	**598**	**647**	**714**	**780**

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The above fleet proposals include the retirement by 2034 of 130 high-floor articulated B2 class trams which are also non-DDA compliant. Given the cost of new trams, a cost-effective alternative may be to insert a centre DDA compliant low-floor module to increase their capacity over a 3 to 4-year program at an estimated cost of $250 million. Some cost savings may be possible by recycling some key components from withdrawn Z and A class trams.

In the short term, this would increase the proportion of DDA compliant trams in the present overall fleet from 35% to 61%. With associated life extension works (being undertaken in any event), this would enable these 25-year old vehicles to continue in operation until the late 2030s. It would also defer the requirement for approximately 120 new G class trams by around 10 years with a net cost saving of approximately $400 million during the period to 2034. The proposed B2 to B3 class conversion concept is illustrated in Figure 33 below.

Figure 33: Potential Conversion of B2 class to B3 class DDA compliant tram



Potential Melbourne Future Tram Fleet Types



G Class 24m - 120 passengers
Photo: *Siemens*



E Class 33m - 210 passengers
Photo: *Bob Wilson*



F Class 40m - 275 passengers
Photo: *John Hearsch*

6.7 Depots, Stabling and Maintenance Facilities

The progressive increase in fleet size coupled with the transition to a total fleet of longer articulated vehicles will require the provision of expanded depot/stabling space and additional maintenance facilities. Analysis has indicated that the progressive transition to a larger fleet of exclusively articulated trams of longer length will require a near doubling of stabling capacity.

The provision of additional stabling and maintenance facilities must be programmed to dovetail with the procurement program for new trams. The existing legacy depots (especially the smaller sites) are already having difficulty in stabling the increasing number of longer articulated trams.

Initially, a suitable site exists in Footscray Road, West Melbourne and other potential sites exist or are likely to exist at Fishermans Bend and near Melbourne Airport and suitable land should be acquired. Additionally, some of the larger legacy depots (including Moreland and Essendon) may lend themselves to expansion and/or re-configuration to hold more and longer trams. The installation of a traverser at constrained sites (instead of conventional track configuration) should be considered in this context.

The need for any specific additional non-revenue track connections should be assessed to enable deployment of vehicles between depots for stabling, and to maximize fleet utilisation as the traffic task grows and changes. This allows for more efficient transfer of trams between existing depots.

6.8 DDA Compliance

The Commonwealth Disability Discrimination Act (DDA) specifies a target date of 31 December 2032 for all public transport services to fully comply with relevant standards. A vastly accelerated program of tram stop upgrades and new tram acquisitions is required if tram services are to comply with the Act. It will require a concerted commitment of Federal, State and Local Governments to create a tram system that is accessible to all Melburnians.

High floor trams have steps, so they are unsuitable for mobility aids including wheelchairs, scooters and motorised vehicles, irrespective of whether these trams are at an accessible or non-accessible stop.

Melbourne still has over 300 older high floor trams with steps. Replacing these older trams and meeting passenger growth predictions will require a tripling of the current tram procurement rate.

Currently only about one quarter of tram stops are DDA compliant and at the current upgrading rate it will be many decades before the remaining 1300 are fully accessible. A new platform stop would need to be opened every 5 days to meet the 2032 target.

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Incompatible: High floor tram and platform stop



Incompatible: Low floor tram and street level stop

Both Photos: *Max Michell*

6.9 Tram Stops and Interchanges

The combination of accessible tram stops, and low floor trams enables people of all abilities to reach jobs, educational, health and leisure facilities. Currently, only a quarter of 1700 stops currently have level boarding access. The current program for providing stops with level boarding access needs to be substantially accelerated.

In general, tram stops need significant improvement to ease overcrowding and improve access, particularly in inner city areas. This includes designs that comply with the Disability Discrimination Act (DDA). Better tram stop design and traffic treatment, particularly for some of the most important stops in the city which are interchanges between tram, train or bus, can help to create a more permeable walking environment to ease some of the current overcrowding, safety and amenity issues.

Within the CBD and inner area, the progressive provision of platform stops offers the opportunity to rationalise closely spaced stops and relocate stops away from major intersections. This improves passenger access and safety and expedites the throughput of trams and road traffic in shared and limited road space. New platform stops need to be future proofed to allow for the projected tram types planned for operation on each route/corridor longer term in 2034. New and existing platform stops at specific high passenger volume stops offer the option of off-tram MYKI touch on, potentially speeding up the boarding process and reducing stop dwell times and expediting tram throughput per hour.

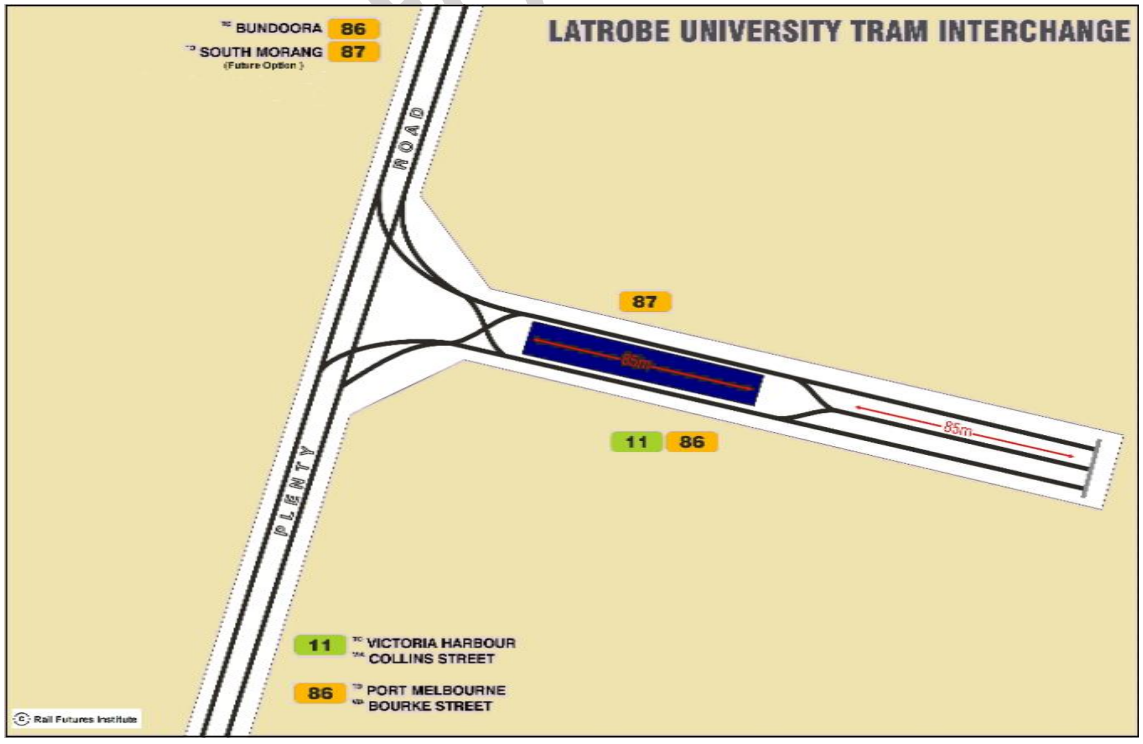
Upgraded real-time information displays should be provided at all major stops on the network and at key tram/train, tram/tram and tram/bus interchange points. These displays should list the next tram information strictly in order of departure by time, similarly to those in use across the rail network.

Several sites have been identified as opportunities to provide high quality intermodal passenger interchanges between trains, trams and buses as part of the development of a grid pattern of routes in Melbourne.

Examples are shown below (Figures 34 and 35) of proposed new Interchanges at Latrobe University and Malvern station. Others will be at Clifton Hill (see Figure 25) and Anzac stations.

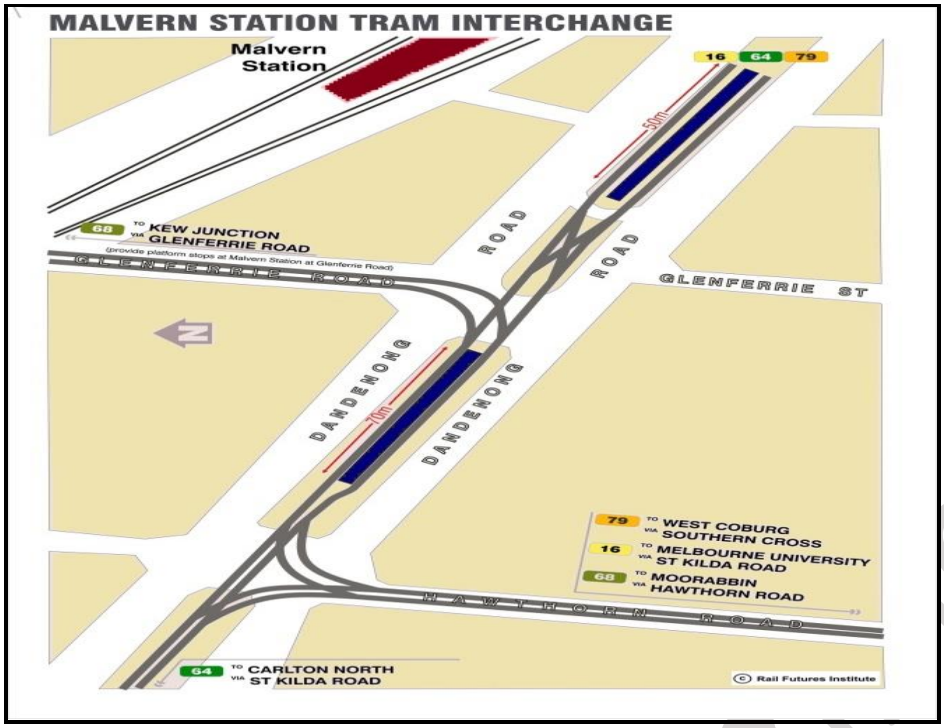
Longer trams will also progressively require selective extension of existing platform stops on a limited number of trunk routes to accept trams up to 40m in length.

Figure 34: Proposed New Tram Interchange at LaTrobe University



for comment

Figure 35: Proposed New Tram Interchange at Malvern Station



6.10 Tram / Train Interchange at Key CBD Stations

The volume of passengers transferring between trams and trains at key CBD stations especially Southern Cross and Flinders Street at street level has and will become an increasing problem as the city and public transport patronage grows. The City of Melbourne has identified these locations recently as critical pedestrian / road traffic interfaces to be addressed.

Innovative safe solutions providing improved passenger access within the stations and platforms coupled with better direct interface with the on-street tram network will need to be developed jointly by Yarra Trams, Station management, State Government and the City of Melbourne.

Such solutions potentially may include, but not be limited to:

- additional overhead station concourses at both Southern Cross and Flinders Street
- pedestrian bridges over Spencer Street at Southern Cross station
- car-free street level tram interchanges at the foot of both Elizabeth and Bourke Streets
- re-location of tram tracks along Spencer Street adjacent to the footpath at Southern Cross

6.11 Upgrading Tram Infrastructure

Melbourne's basic tramway infrastructure (primarily track and overhead wiring) has been maintained to a generally satisfactory standard over the years. During a 30-year period from the 1950s, much of the network was rehabilitated by relaying track in mass concrete, usually using short lengths of rail joined by fishplates. Half a century later, these tracks were worn out with concrete breaking up and rail joints failing. Substantial parts of the network have now been rebuilt using more appropriate track design and construction materials, but much remains to be completed before the entire network can be described as being in good overall condition. The advent of longer and heavier articulated trams places greater demands on the track structure hence tram infrastructure upgrading will be an ongoing requirement.

The transition to a totally articulated fleet will also require improved traction power supplies to support both longer trams and services operating at higher frequencies. This includes the need to acquire suitable sites for new sub-stations, often a challenge in an existing built environment. Options include inclusion of sub-stations in the basement of new apartment or commercial development sites. The requirement for additional sub-stations

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needs to be considered by planning authorities before approval of major new developments, especially in the CBD and inner areas.

In recent years there have been rapid developments in both Asia and Europe in innovative new tram traction technologies and traction power systems designed to improve operational efficiency, reduce energy costs, improve tram performance and achieve better environmental outcomes.

Melbourne's transition from a network and power supply system designed for a fleet of traditional small trams, to a future network operating much larger trams operating at greater frequencies will require detailed study of future options in terms of vehicle technology, energy efficient traction systems and an updated power supply network that leverages the latest and most suitable technologies.

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7. The Medium Capacity Transit (MCT) and Light Rail Plan

7.1 Overview

Medium Capacity Transit (MCT) is a key element of the RFI Plan and a new concept for Melbourne. This public transport solution is ideally suited to new trunk routes not requiring the capacity of traditional heavy rail systems that service Melbourne's radial corridors. MCT systems are being constructed or expanded in many cities worldwide and are increasingly favoured as a highly efficient, attractive, affordable and environmentally friendly means to facilitate sustainable urban development and reduce motor car dependency.

MCT infrastructure can be on the surface, elevated or underground, as determined by individual route conditions. MCT technologies are rapidly evolving, ranging from conventional light rail using upgraded trams to light metro railways and high capacity guided buses with electric and hybrid traction systems. In Melbourne, MCT will use one or more of these systems to provide high frequency services on segregated corridors. MCT complements other modes and, with convenient interchanges, will form a critical part of a multimodal public transport grid.

In accordance with *Plan Melbourne (2017-2050)*, the aim is to develop medium density transport corridors that connect activity centres and provide easy access to high quality public transport from adjacent suburbs. New MCT routes and corridors can provide important spines that anchor urban renewal, especially in brownfield sites in the inner and middle suburbs and provide important cross-town and infill connectivity on key routes that complement the radial heavy rail network.

There are opportunities to create new MCT routes, nodes and corridors, particularly in areas of Melbourne with strong 'knowledge job' centres such as key tertiary education and biomedical research precincts. MCT has considerable potential on several key Melbourne corridors, typically where demand is likely to exceed 5000 passengers per hour in one direction for at least 6 hours on weekdays and where conventional bus services would not provide an attractive alternative to private car use.

RFI's proposed MCT routes provide 230 km of high-quality cross-suburban connectivity at an estimated cost of approximately $32 billion, including rolling stock. Progressive implementation would occur between 2030 and 2050, but with detailed planning processes underway from 2025 onwards. They comprise:

- One radial corridor
  - Melbourne CBD to Doncaster via Fitzroy, Victoria Park and Bulleen
- 3 major orbital corridors:
  - Melbourne Airport to Derrimut via Keilor, Taylors Lakes, Delahey and Deer Park
  - Melbourne Airport to Monash University via Broadmeadows, Campbellfield, Keon Park, Latrobe University, Heidelberg, Doncaster, Box Hill, Burwood and Mount Waverley
  - Ringwood to Mentone via Knox City, Rowville, Dandenong and Keysborough
- 6 major cross-suburban corridors:
  - Caulfield to Keysborough via Chadstone, Monash University and Springvale
  - Elsternwick to Rowville via Ormond, Huntingdale and Monash University
  - Sunshine to Altona via Braybrook, Maidstone, Footscray and Kingsville
  - Newport to Brimbank Central via Brooklyn, Sunshine, Ginifer and Cairnlea
  - Williams Landing to Tarneit via Point Cook, East Werribee NEIC and Hoppers Crossing
  - Williams Landing to Sayers Road (future station) via Truganina

MCT routes are ideally installed in freeway or wide boulevard medians but can also use elevated structures in suitable thoroughfares. Many potential MCT corridors in inner and middle suburbs of Melbourne can utilise wide arterial road easements and boulevards, a legacy of previous generations of sensible road planning. Where this is not practicable, new infrastructure on high patronage corridors may need to be built to provide completely segregated ROWs for increased capacity and speeds, including on elevated structures or lowered ROWs in cut and cover trenches. Tunnelling may be unavoidable in high value areas that are fully developed and where retrofitting a new corridor into the existing built environment is not feasible.

The following section sets out proposals for multiple MCT corridors and route structures. These are preliminary proposals that illustrate how MCT concepts can be applied in various metropolitan environments. The identified routes, while considered appropriate in relation to overall network design and connectivity, will each require

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extensive investigation and assessment to determine an optimum solution, having regard to community input, environmental factors, urban form, proposed technology, cost and constructability.

7.2 Identified Corridors for MCT

7.2.1 Doncaster Radial Corridor

Rail transport for the Doncaster Corridor has been the subject of numerous proposals since 1890. Detailed planning for a railway commenced soon after the release of The Transportation Plan30 in 1969 and a route was determined in 1972. A section of the route used part of the median of the Eastern Freeway. Property acquisition along the route was completed in 1975. However, by 1982 plans to build the line were shelved by the State Government, and by 1984, land for the line was sold. Freeway expansions and the sale of properties have diminished Government enthusiasm for rail in favour of upgraded bus services.

The former Victorian Government's 2013 feasibility study for a heavy rail line to Doncaster was never completed31. The "Terms of Reference" for the study were very narrow, limiting consideration to an alignment to the Doncaster "Park and Ride" distant from the Major Activity Centre at Doncaster Hill, by conservative population and travel projections, a brief that assumed building of the East West Link road tunnel and focus exclusively on heavy rail to the exclusion of alternatives such as Light Rail.

The current Government's decision in 2017 to build a North East Link (NEL) connecting the Metropolitan Ring Road and Eastern Freeway now proposes enhanced exclusive bus lanes described as Bus Rapid Transit (BRT) along an expanded Eastern Freeway. There is no indication that the proposed bus lanes meet BRT standards or have the capacity to be converted to any other form of transit such as light or heavy rail to meet growing public transport demand.

RFI recognises the continuing need for an effective high-quality transit system between Doncaster and the CBD but also agrees with the findings of multiple studies that a heavy rail option in the Eastern Freeway corridor is unlikely to be economically viable. Other options offer better prospects of also meeting a greater diversity of user needs from the wider Doncaster area and beyond.

Several MCT solutions (apart from the original heavy rail proposal) require consideration for the Doncaster-CBD corridor, all of which potentially provide greater capacity and enhanced service quality by comparison with the currently proposed bus-only solution. These options are not mutually exclusive, and a combination of options should be considered. All options assume some level of continued Eastern Freeway bus operations.

The various MCT options for serving Doncaster are described below.

(1) City-Doncaster MCT

Assuming the State Government maintains its position that the East-West Link road project will not proceed, the case for a direct City to Doncaster MCT solution is strong. This should be the subject of an early planning and business case process in conjunction with present proposals for the NEL and an enhanced Eastern Freeway busway.

An MCT corridor to Doncaster along the Eastern Freeway is an attractive option to meet capacity and future service levels for predicted patronage. Upgraded Light Rail would be suitable for this corridor using tram/train type vehicles, as parts would overlap the existing tram network at the CBD end.

A staged development package to bring MCT to Doncaster Hill could be achieved by:

- interim improvement of Eastern Freeway bus services to grow patronage and capacity through:
  - greater bus priority on Hoddle Street/Victoria Parade, currently being implemented
  - a bus/rail interchange at Victoria Park
  - a dedicated busway along the Eastern Freeway capable of conversion to MCT/Light Rail

[30] The Transportation Plan, prepared by The Metropolitan Transportation Committee, released December 1969.
[31] Doncaster Rail Study: Phase One Recommendations Report (URS, June 2013)

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- extending the existing Route 48 (City–North Balwyn) tram along Doncaster Road for approximately 3.6 km from Balwyn Road to Westfield Shoppingtown at the Doncaster Hill Major Activity Centre, joining the Doncaster MCT corridor near the Doncaster Road freeway interchange
- constructing a 15km high-capacity MCT corridor from the Doncaster Hill Major Activity Centre to Fitzroy via Doncaster Road, the Eastern Freeway and Alexandra Parade
- integrating the Doncaster MCT corridor into the tramway network at Fitzroy (see below), and with interchanges to heavy rail at Victoria Park Station and the proposed MM2 Fitzroy Station, serving the expanding Major Activity Centres of Smith and Brunswick Streets Fitzroy/Collingwood.

Alexandra Parade is a wide boulevard with a central median extending to Nicholson Street that could readily accommodate Light Rail or other MCT infrastructure. Tramway intersections at Smith and Brunswick Streets would require suitable signalised control to ensure MCT priority and probable grade separation in the longer term. Importantly, Alexandra Parade presently lacks any form of east-west public transport. Yet it presents an opportunity for transformation into a grand commercial and residential boulevard like St Kilda Road or Royal Parade in line with the original vision for Melbourne. MCT, in conjunction with the proposed MM2 Fitzroy Station, would stimulate regeneration along Alexandra Parade on a significant scale given its proximity to the CBD.

The most appropriate corridors for entry into the CBD under a Light Rail scenario require detailed assessment. However, a merger with tram Route 96 for about 600 metres between Princes and Johnston Streets and thence via Barkly, Rathdowne and Latrobe Streets to Melbourne Central Station and Docklands, is one of several potential options. Another option is for the route to split at the corner of Barkly and Rathdowne Streets, Carlton with alternate services operating along Grattan Street interchanging with the Carlton/Parkville MM1 station, then following the same route as the proposed Route 55 tram through to West Melbourne and North Melbourne stations.

To be competitive with private car travel (by way of perception and reality) and to emulate as far as possible the performance of a heavy rail solution, very few stops would be provided on the Eastern Freeway section. Rolling stock selected for use on the corridor would be high capacity, high performance units similar to tram/train vehicles now operating in Europe, capable of operating at 100 km/h freeway speed. Significant peak mode shift is expected with such MCT far exceeding peak freeway average car speed of 20-30 km/h.

(2) Connecting Doncaster Hill to the CBD via Box Hill Heavy Rail

The Government in September 2018 announced it would construct a Suburban Rail Loop orbiting Melbourne including a section between Box Hill and Doncaster[32].

While the primary aim of an orbital corridor is to enable cross-town public transport, should the proposed rail loop eventuate in the form initially suggested by the Government, it could provide an attractive travel option between the CBD and Doncaster in both trip time and frequency in conjunction with the existing CBD - Box Hill railway, albeit requiring interchange at Box Hill. In this context, both service frequency and interchange convenience will be critical factors in user acceptance.

An implication of this option could be the additional passenger capacity demand imposed on already crowded trains between the CBD and Box Hill. This may well be a catalyst for a proposed 4th track between Camberwell and Box Hill and operation of more “short starter” services from and to Box Hill, noting that the train path capacity constraint on this corridor is that of counter-peak capacity on the single-track operating in the non-peak direction.

(3) Doncaster Bus Rapid Transit (BRT) to Fitzroy MM2 Interchange station

This RFI proposal is based on using the proposed bus transit lanes on the Eastern Freeway between Doncaster Road and Hoddle Street, but built to BRT standards[33]. The BRT lanes would continue along Alexandra Parade to interchange with the proposed MM2 Fitzroy rail station; providing fast access to Carlton/Parkville (MM1), then Flagstaff, Southern Cross, Fishermans Bend and suburbs west of the Yarra.

[32] Suburban Rail Loop Strategic Assessment, Development Victoria, released by Victorian Premier, 28 August 2018

[33] International Transport and Development Policy 2016, BRT Standard v8.75 – refer https://www.itdp.org/the-brt-standard/

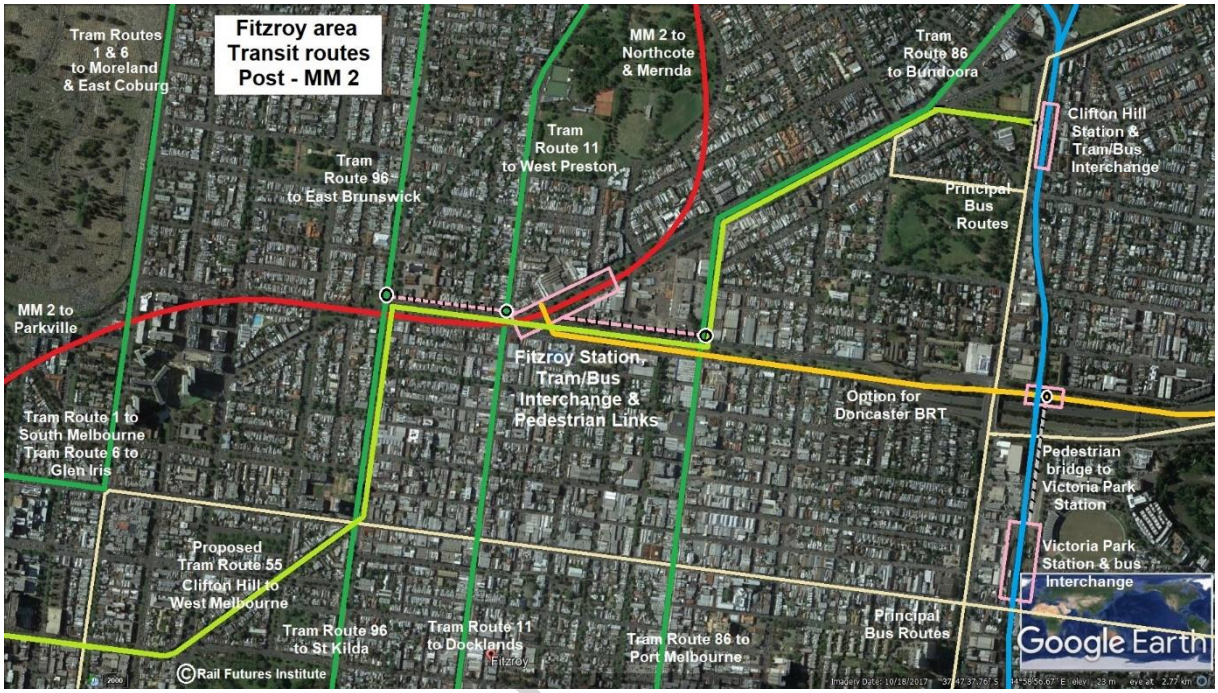
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In effect, large capacity express buses would exit exclusive BRT lanes directly into an underground interchange and bus terminal at the new Fitzroy station. With high frequency buses and Metro trains co-ordinating at Fitzroy, travel times from Doncaster to Parkville, CBD stations and stations west of the city served by MM2 would be significantly reduced.

It is envisaged that some buses would continue to operate on the existing route via Hoddle Street and Victoria Parade to a suitable CBD terminus.

This concept is illustrated in Figure 36, below.

Figure 36: Fitzroy and surrounding area Transit Routes



Under this BRT-based option, intermediate stations are proposed at:

- Victoria Park station interchange (with elevated walkway to station entrance)
- Chandler Highway
- Burke Road
- Bulleen Road
- Doncaster Road Park and Ride
- Heritage Boulevard

At the Doncaster end, the present part-time and non-continuous bus lanes would become full time and re-worked to become continuous on both sides of Doncaster Road between the Park and Ride facility and Shoppingtown.

In addition to providing a high-quality service to Doncaster, the potential combination of these east-west transit options would facilitate interchange with the north-south rail and tram networks and enhance public transport connectivity to major activity centres in Melbourne's inner north.

The MM2 station under Alexandra Parade and Queens Parade at Fitzroy would become a major hub for buses, trams and trains serving the north-eastern suburbs as a major East-West public transport connector, thereby substantially reducing pressure on the East-West road corridor.

7.2.2 Melbourne Airport to Derrimut Orbital Corridor

This is one of three proposed MCT and tram links to Melbourne Airport. In addition to the proposed fast heavy rail service from Southern Cross to the Airport, two MCT corridors will provide vastly better public transport connections to the Airport. (The other links are the extension of Tram Route 59 from Airport West – see section 6.3, and the Monash University orbital corridor described below).

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The Airport-Derrimut orbital corridor, 25 km in length, is designed to provide high quality connectivity between the Airport and Melbourne's rapidly growing north-western and western suburbs and, longer term, extended to connect through to the Wyndham/Werribee area. It will provide both east-west (Airport to Watergardens via Keilor) and north-south (Watergardens to Derrimut) links on high demand corridors which are currently devoid of quality public transport alternatives to private car use.

The corridor will interchange with the heavy rail network at Watergardens and Deer Park and the Newport to Brimbank Central MCT corridor at Cairnlea.

***Conceptual Route*:**
From the Airport Terminal precinct, the proposed corridor would run south along Airport Drive to Sharps Road, turn west into Sharps Road to Keilor Park Drive and thence on a new corridor-oriented south-west to cross the Maribyrnong River valley and Arundel Road on a major bridge spanning some 950 metres. It then continues on an elevated structure crossing the Calder Freeway and Overnewton Road to join the Old Calder Highway and Melton Highway to Watergardens Shopping Centre. From Watergardens, the corridor turns south and runs the length of Kings Road and Station Road to Deer Park Station.

Following elimination of the Station Road level crossing at Deer Park, the corridor continues south along Mount Derrimut Road to an interim terminus at Windsor Boulevard, Derrimut. Longer term, the corridor would be extended to continue south along Mount Derrimut Road, turn west into Boundary Road and south into Palmers Road and continue to Williams Landing Station.

The entire corridor is expected to be developed at grade, apart from the major bridge and elevated structure over the Maribyrnong River valley. It would be on segregated right-of-way, principally in the median of the multi-lane roads described above, with automated traffic light priority at intersections. Appropriate vehicles would operate at a maximum speed of 80 km/h. Intermediate stations are proposed at:

- Tullamarine (corner Airport drive and Sharps Road)
- Keilor (Old Calder Highway, near Overnewton Road)
- Taylors Lakes (Taylors Lakes Shopping Centre)
- Watergardens Shopping Centre
- Delahey Village
- Brimbank Central Shopping Centre/Cairnlea MCT Interchange
- Ballarat Road, Deer Park
- Deer Park Station Interchange
- Derrimut Village

7.2.3 Melbourne Airport to Monash University Orbital Corridor

The Airport to Monash University orbital corridor, 49 km in length, is designed to provide extensive east-west and north-south connectivity between the Airport and many of Melbourne's middle suburbs which are experiencing significant residential densification. It is also designed to connect the Airport with the NEICs at Latrobe and Monash Universities, Deakin University's Burwood Campus, the Austin Hospital at Heidelberg and Major Activity Centres at Broadmeadows, Doncaster and Box Hill.

The corridor will interchange with the heavy rail network at Broadmeadows, Campbellfield (future station on the Upfield line), Keon Park, Heidelberg, Box Hill and Mount Waverley, other MCT corridors at Doncaster, Notting Hill and Monash University and the tram network at Latrobe University, Box Hill and East Burwood.

As parts of this corridor pass through environmentally sensitive areas and suburbs with a long-established built environment with only a few suitable road reservations for surface treatment, the overall corridor would be a mix of infrastructure at grade, on elevated structures and underground. Potential vehicle type is a tram/train concept as operated in Europe, essentially high capacity, upgraded tram type vehicles, capable of operating at modest speeds on existing tram corridors and at up to 100km/h on dedicated right-of-way fully segregated from other vehicular traffic.

Conceptual Route:
From the Airport terminal precinct, the proposed corridor would run south along Airport Drive, turn west alongside Mercer Drive, pass over the Tullamarine Freeway, then via Western Avenue, Mickleham Road and Johnstone Street including an elevated high-level structure over Moonee Ponds Creek to Broadmeadows Station.

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Then via Camp Road, Mahoneys Road, Keon Parade, Holt Parade, then part elevated/underground beneath Bundoora Park and Plenty Road to Latrobe University proposed interchange. The corridor then continues, principally underground, via Heidelberg, Bulleen, Doncaster, Box Hill, Burwood, Mount Waverley and Notting Hill to Monash University. Intermediate stations are proposed at:

- Gladstone Park (Mickleham Road)
- Broadmeadows Station
- Campbellfield (Future Station)
- Keon Park Station
- Latrobe University Interchange
- Heidelberg Station/Austin Hospital
- Bulleen Schools complex (Bulleen Road)
- Doncaster Hill (Shoppingtown)
- Box Hill Station/Box Hill Central Shopping Centre
- Deakin University (Burwood Campus)
- Burwood East (Route 75 Tram Interchange)
- Mount Waverley Station
- Notting Hill (Monash Business Park)

7.2.4 Ringwood to Mentone Orbital Corridor

This 35 km corridor provides major north-south and east-west connectivity along high usage arterial corridors linking Ringwood with the Dandenong NEIC and Mentone via Knox City and established and growth suburbs of Wantirna, Scoresby, Rowville, Dandenong North, Keysborough and Parkdale. It will interchange with the heavy rail network at Ringwood, Knox City (future extension from Glen Waverley – see Section 5.5.9) and Mentone, and other MCT corridors at Rowville and Keysborough.

Most of this route would be on the surface using the median of major multi-lane arterial roads apart from a short-tunnelled section between Ringwood and Canterbury Road in Heathmont. This enables more opportunities for local access at modest cost than could be justified on an underground corridor. Potential vehicle types could be conventional Light Rail or guided tram/bus operating on a segregated corridor with traffic light priority at intersections and a maximum speed of 80km/h.

***Conceptual Route*:**
From Ringwood Station via Wantirna Road (partly underground), Boronia Road and Stud Road to Dandenong, then Foster Street, Cheltenham Road, Lower Dandenong Road and Balcombe Road to Mentone Station. Intermediate Stations are proposed at:

- Canterbury Road (Heathmont)
- Wantirna Hospital complex (Boronia Road)
- Studfield
- Knox City
- Swinburne University (Wantirna Campus)
- High Street Road
- Balmoral Gardens
- Scoresby (Ferntree Gully Road)
- Caribbean Gardens
- Stud Park Shopping Centre
- Rowville MCT Interchange (Wellington Road)
- Rowville South (Police Road)
- Dandenong North/M1 Interchange (Park and Ride)
- Heatherton Road
- Dandenong Hospital/Chisholm Dandenong TAFE
- Dandenong Plaza
- Dandenong Station
- Keysborough (Chandler Road)

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- Parkmore Shopping Centre
- Corrigan Road
- Keysborough MCT Interchange (Springvale Road)
- Dingley Village (Boundary Road)
- Parkdale (Warren Road)
- Nepean Highway

7.2.5 Caulfield to Keysborough Cross-Suburban Corridor

This corridor, 20 km in length, provides direct connections between Caulfield, Chadstone Shopping Centre, the Monash NEIC, Springvale and interchanges at Keysborough with the Ringwood-Dandenong-Mentone MCT corridor and with the tram network at Caulfield and Carnegie. Principally at grade, but in a segregated corridor with traffic light priority at intersections, it would partly run parallel to the underground and elevated *South-East FastLine* between Caulfield and Monash University with additional stopping places for local access.

It then provides north-south connectivity between the Monash precinct, Springvale South and Keysborough, at grade wherever practicable and otherwise on elevated structures, particularly over heavily trafficked road junctions. Conventional Light Rail or guided tram/bus vehicles operating at a maximum speed of 80km/h are likely to prove suitable for this corridor.

***Conceptual Route*:**
From Caulfield Station via John Monash Drive, Princes Highway, Ferntree Gully Road, then on a segregated route through the Monash Business Park and Monash University campus. Then via Wellington Road and Springvale Road to Keysborough Interchange at Cheltenham Road. Intermediate stations are proposed at:

- Carnegie (Koornang Road)
- Murrumbeena Road
- Chadstone Shopping Centre
- Warrigal Road
- Oakleigh East (Huntingdale Road)
- Clayton Road
- Notting Hill (Monash Business Park)
- Monash University Interchange
- Australian Synchrotron (Blackburn Road)
- Mulgrave (Springvale and Wellington Roads)
- Centre Road/Police Road
- Springvale Station
- Heatherton Road
- Springvale South

7.2.6 Elsternwick to Rowville Cross-Suburban Corridor

This 25 km corridor provides direct east-west connectivity linking the Sandringham, Frankston and Dandenong rail lines, Monash University, Clayton/Mulgrave research precinct and the Rowville area. It would also interchange with other MCT corridors at Monash University, Mulgrave and Rowville and with the tram network at Elsternwick and East Brighton.

It would be mostly at grade in segregated corridor on high usage multi-lane arterial roads and with traffic light priority at intersections. It would transition to elevated structures where road reserves are insufficiently wide and to pass over complex, very busy road junctions. Conventional Light Rail vehicles operating at a maximum speed of 80km/h are also likely to prove suitable for this corridor.

***Conceptual Route*:**
From Elsternwick Station via Horne Street, McMillan Street, Nepean Highway, North Road, Wellington Road to terminate at Napoleon Road. Intermediate Stations are proposed at:

- Gardenvale Station
- Hawthorn Road (interchange with Route 68 Tram)

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- Ormond Station
- Bentleigh East (Boundary Road)
- Oakleigh South (Warrigal Road)
- Huntingdale Station
- Monash University Interchange
- Australian Synchrotron (Blackburn Road)
- Mulgrave (Springvale Road)
- Wheelers Hill (Jells Road)
- Jacksons Road
- Eastlink Interchange (Park and Ride)
- Rowville MCT Interchange (Stud Road)
- Wellington Village

7.2.7 Sunshine to Altona Cross-Suburban Corridor

This 20.5 km corridor provides a semi-orbital route linking the Sunshine NEIC to Altona via Footscray through suburbs in transition from old industrial to commercial and residential renewal and lacking good public transport on other than direct rail corridors to the Melbourne CBD. It will interchange with the heavy rail network at Sunshine, Footscray and Altona, with the Newport to Brimbank Central MCT corridor at Sunshine and Brooklyn and with the Route 82 tram to Moonee Ponds at Footscray.

The corridor would be mostly at grade in segregated corridor in multi-lane arterial roads with traffic light priority at intersections and/or on elevated structures over high traffic volume road junctions. Again, conventional Light Rail vehicles operating at a maximum speed of 80km/h are also likely to prove suitable for this corridor and if necessary, suitable for tandem operation with Tram Route 82 for around 300 metres in Ballarat Road, Footscray.

Conceptual Route:

From Sunshine Station via Hampshire Road, Ballarat Road, then diverting into and out of Footscray Station interchange via Moore Street and Irving Street. Thence via Ballarat Road, Geelong Road, Cemetery Road, rail overpass then a new corridor paralleling Cawley Road and West Gate Freeway, then via Millers Road, Civic Parade and Pier Street to Altona Station. Intermediate Stations are proposed at:

- Sunshine Marketplace Shopping Centre
- Victoria University (Sunshine Campus)
- Braybrook College
- Braybrook Shopping Centre (Ashley Street)
- Summerhill Road
- Victoria University (Footscray Campus)
- Footscray Station Interchange (reverse direction in Irving Street)
- West Footscray Station
- Kingsville
- Brooklyn MCT Interchange
- Altona Gate Shopping Centre
- Bayside College
- Altona North (Ross Road)
- Seaholme

7.2.8 Newport to Brimbank Central Cross-Suburban corridor

This corridor, 16.5 km in length, runs generally in a north-western orientation from Newport to Sunshine. This would connect the former industrial and gentrifying suburb of Newport with the Sunshine NEIC, Sunshine Hospital and the transport-poor suburbs of Cairnlea and Albanvale, while also linking the Wyndham Vale, Melton and Sunbury lines via the proposed Sunshine Station "superhub". It will also support urban redevelopment in parts of Yarraville and Brooklyn. It would interchange with the MM2 corridor at Newport, other heavy rail lines at Newport and Ginifer and MCT corridors at Brooklyn, Sunshine and Brimbank Central in Cairnlea. Longer term, it could integrate with the heavy rail line between Newport and Williamstown.

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This corridor would be mainly at grade using available width in existing rail corridors. Some widening of existing arterial roads in Sunshine North would accommodate a segregated corridor at grade or, where necessary, on elevated structures. Conventional Light Rail vehicles operating at a maximum speed of 80km/h are also likely to prove suitable for this corridor.

Conceptual Route:

From Newport Station via the Newport-Brooklyn-Sunshine rail corridor to Sunshine Station (south side), then via Anderson Road, McIntyre Road, Furlong Road, Cairnlea Drive and Neale Road to Brimbank Central Shopping Centre. Intermediate Stations are proposed at:

- South Kingsville
- Yarraville Gardens
- Brooklyn MCT Interchange
- Somerville Road
- Sunshine Road/Wright Street
- Sunshine Station Interchange
- City West Plaza
- Sunshine North
- Ginifer Station/Sunshine Hospital
- VUSC Cairnlea Campus/Cairnlea Town Centre
- Cairnlea MCT Interchange (Station Road)

7.2.9 Wyndham area Cross-Suburban corridors

These two corridors, 15.5 and 13 km in length respectively, are designed to link the Werribee and Wyndham Vale rail corridors to the proposed Werribee NEIC and with a large part of the burgeoning residential areas of the City of Wyndham which are already suffering from serious road congestion and extreme car dependency.

The corridors would interchange with heavy rail at Williams Landing, Hoppers Crossing and Tarneit stations and the future Sayers Road station adjacent to the proposed Wyndham A-League Stadium. They would form the first stage of a more comprehensive MCT network in the Wyndham municipality and ultimately connect with the Melbourne Airport to Derrimut MCT corridor through Truganina.

Retrofitting MCT corridors into the existing road network in Wyndham will be challenging due to inadequate future proofing of most key arterial road reservation widths, reflecting poor past planning practices. However, wherever possible, the corridors would be at grade using available or widened medians with traffic light priority in existing arterial roads, or where unavoidable, on elevated structures.

Conceptual Route 1: Williams Landing Station to Tarneit Station

From Williams Landing Station via Palmers Road (South), Dunning's Road, Boardwalk Boulevard, Sneydes Road, then on a new corridor through the Werribee Employment Precinct to the Princes Highway at Hoppers Crossing Station. Then via Old Geelong Road (post completion of level crossing removal at Hoppers Crossing), Morris Road, Heaths Road and Derrimut Road to Tarneit Station. Intermediate Stations are proposed at:

- Emmanuel College
- Point Cook Town Centre
- Point Cook Senior Secondary College
- Featherbrook Shopping Centre
- Victoria University (Werribee Campus)
- Werribee Mercy Hospital
- Hoppers Crossing Station
- Mossfiel Drive
- Werribee Pacific Shopping Centre
- Hogans Corner Shopping Centre
- Sayers Road/Derrimut Road MCT Interchange
- Baden Powell Drive
- Tarneit Central Shopping Centre

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Conceptual Route 2: Williams Landing Station to Sayers Road Station

From Williams Landing Station via Palmers Road (North) and Sayers Road, extended in stages to future Sayers Road Station. Intermediate Stations are proposed at:

- Williams Landing Town Centre
- Palmers/Sayers Road corner
- Westbourne Grammar School/Werribee Islamic College
- Wyndham Village Shopping Centre
- Sayers Road/Derrimut Road MCT Interchange
- Tarneit Road
- Davis Road
- Sewells Road
- Wyndham A-League Stadium

Examples of Medium Capacity Transit Vehicles



Sheffield UK - Vossloh Citylink Tram/Train
Photo: *By Buttons0603 - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=69754031*

These tram/train vehicles can operate at up to 100km/h. They can use 750v DC or 25kv AC traction systems.



A Utah Transit Authority Trax light rail vehicle in downtown Salt Lake City, USA
Photo: *Garrett - Flickr: Green line Trax at Gallivan Plaza*



Docklands Light Railway, London
Photo: *By Hippoattack at English Wikipedia*

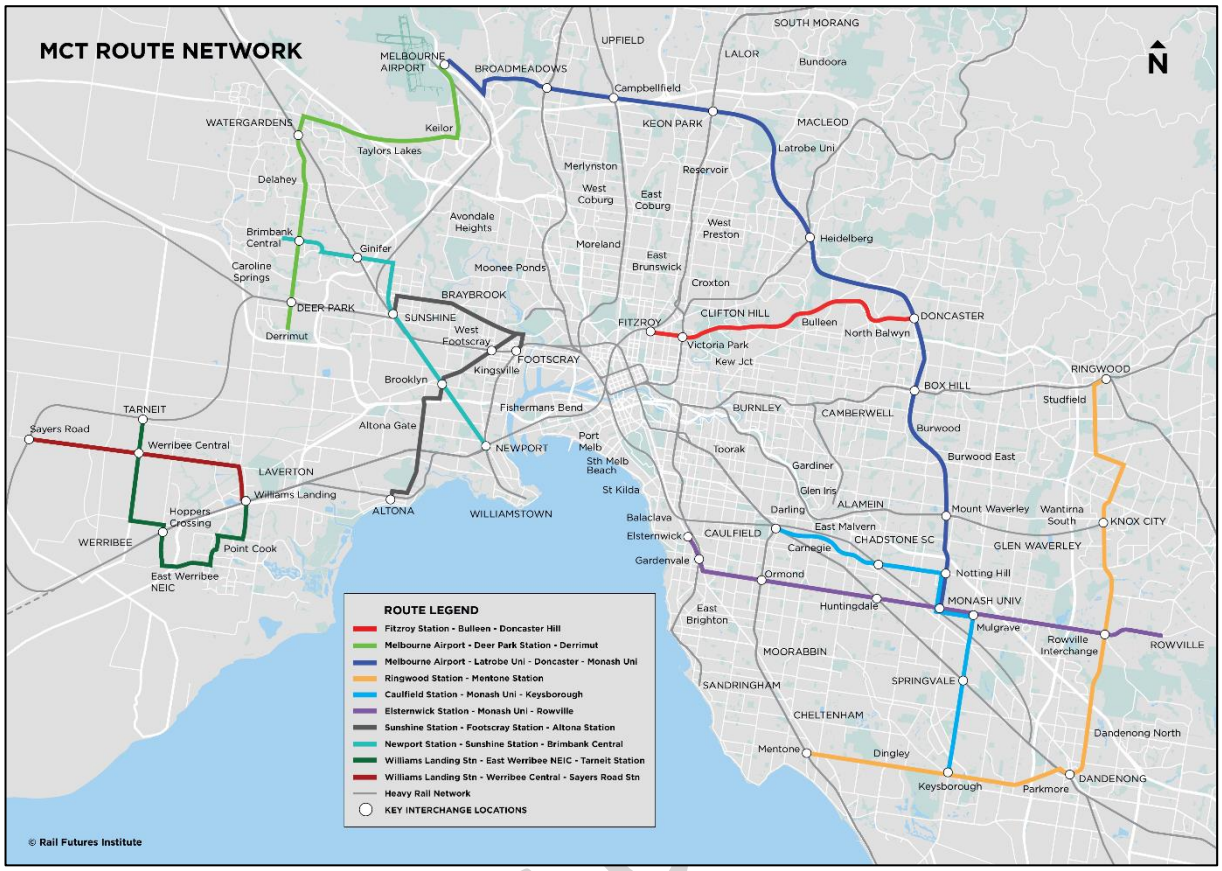


Rubber-tyred tram in Padua, Italy
Photo: *By Ivan Furlanis. Source - https://commons.wikimedia.org/wiki/File:APS_03_Eremitani_070329*

The central rail is used for guidance and return traction current.

The overall proposed initial MCT route network for Melbourne is shown in Figure 37.

Figure 37: Proposed Initial MCT Route Network



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8. The Metropolitan Bus Network

8.1 Overview

This Plan proposes a substantial re-structure and mass investment in the metropolitan bus network so that it more effectively complements the train, tram and MCT networks. Buses then become an increasingly critical element of Melbourne's public transport providing high frequency public transport on routes which cannot justify investment in major fixed infrastructure. The bus network will be designed to provide convenient interchange at key nodes with other modes and with all principal routes operated at "turn up and go" frequencies compatible with train, tram and MCT services. Detail of the reworked metropolitan bus network is beyond the scope of this Plan, but it is envisaged that the revised bus network will operate at four levels:

- High frequency SmartBus routes on trunk corridors (including routes developed to build corridor patronage in anticipation of future MCT investment)
- Feeder services to train, tram or MCT interchanges
- Local services to Major and Local Activity Centres, schools, hospitals, etc.
- On-Demand services to provide irregular or "as required" services

8.2 SmartBus services for high use, high frequency routes

High frequency bus services, using the already well recognised *SmartBus* branding, should be further developed and/or implemented to provide services that match the frequency and span of hours of the rail, tram or MCT services with which they interconnect. Ideally, they would operate on dedicated lanes and at 10-minute or better "turn up and go" frequency, other than early morning and late at night. Such services should be provided to:

- complete the principal network where rail modes are unsuitable or unviable
- generate sufficient patronage to justify the more expensive rail-based modes
- to enhance cross-town connectivity necessary to properly integrate the overall multi-modal network
- service routes likely to become candidates for MCT solutions

The last point is particularly important as high frequency SmartBus or similar services may be a logical transition to MCT in helping to change travel behaviour and prove up potential demand. They will also allow time to build community support, progress corridor protection measures and, above all, to progress an integrated process of transport and land use planning at a localised level. Several of the existing SmartBus routes are effectively precursors, at least in part, to some of the MCT corridors proposed earlier in this Plan.
However, as traffic congestion increases on these routes, such services will prove ineffective if buses are caught in traffic and cannot operate to reliable schedules. Dedicated transit lanes will be essential where these can be provided.



Doncaster SmartBus
Photo: *Liam Davies*



Urban Route Bus
Photo: Marcus Wong - Wikipedia

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8.3 Feeder Bus Services to Train, Tram or MCT Interchanges

Feeder routes to train, tram or MCT stations and interchanges form a critical part of the grid public transport network. This applies especially in growth areas where service frequency improvement and route development are increasingly urgent. Wherever possible, these services should match the frequency and span of hours of the rail, tram or MCT services with which they interconnect, again ideally operating at 10-minute or better frequency, other than early morning and late at night.

Users of these services are generally "time poor" hence route directness is important. As with the SmartBus routes, such services will prove ineffective if buses are caught in traffic and cannot operate to reliable schedules. Dedicated transit lanes, most likely applicable for peak direction traffic flows, will be needed in congested areas.

For bus routes serving areas of lower population density, it is unlikely that service frequencies can be justified that match those provided by trains or MCT routes.at connecting stations. In these cases, scheduled connections will become essential, monitored centrally and with dynamic information displays for both bus operators and passengers. Such connections would be managed in accordance with prescribed protocols stipulating the processes to be adopted when services run late or are impacted by unplanned events.

There are also many locations where bus routes could effectively co-ordinate with the tram network. An example is the Route 75 Vermont South tram terminus where buses provide a frequent scheduled connection to the Knox Shopping Centre. Put simply, buses have a significant role in complementing the tram, MCT and heavy rail transport tasks.

8.4 Local Bus Services

Local bus services are also needed to link residential neighbourhoods to major and local activity centres. Users of these routes are usually less time-sensitive than regular commuters so that area coverage is probably more important than travel time or route directness for these services. Many of these routes will not support "turn up and go" service frequency but regularity and spread of hours are still important factors for achieving adequate patronage support.

8.5 On-Demand Service

Where demand is insufficient to support regularly scheduled local bus services, provision of irregular or "as required" services using small buses, taxis or "ride sharing" vehicles will have many applications, especially in areas of low residential density or where street layouts are not suitable for accommodating conventional buses. On-demand services may also be appropriate for serving community needs which cannot be satisfactorily met by normal bus routes. Such a service has successfully operated in Woodend since 2016 and would be appropriate in some outer metropolitan areas.



On-demand FlexiRide bus serving Woodend township
Photo: *Craig Halsall*

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9. Active Transport

9.1 Role in the Transport Mix

The importance of encouraging active transport via walking and cycling is well recognised in a range of State policies. Both forms of active transport play a vital role in the transport mix as independent modes in themselves as well as supporting public transport services.

The State's Transport Integration Act 2010 articulates important integrated transport and land use objectives relevant to active transport. These include:

- promoting forms of transport that have the least impact on the natural environment and have the greatest benefit for, and least negative impact on health and well-being
- reducing the need for private motor vehicle transport and the extent of travel in terms of number of trips and distances travelled
- increasing the mode share of public transport, walking and cycling trips as a proportion of all transport trips.[34]

Active Transport Victoria (ATV), within Department of Transport, is focused on increasing walking and cycling. It developed an updated Victoria's Cycling Strategy 2018-2028 to encourage cycle transport to work, school, and around neighbourhoods and to support local Councils in their crucial role in providing and managing much of the cycle network. ATV is also working with VicRoads and the TAC to target investment in enhancing cyclist and pedestrian safety.

Cycling is also supported in Plan Melbourne 2017-2050, the Victoria Public Health and Wellbeing Plan 2015-2019 and in Infrastructure Victoria's 30-year Infrastructure Strategy.

At the national level, Infrastructure Australia in its reform series,[35] highlights:

> *"Walking and cycling are environmentally friendly and healthy ways to access the public transport network, and also amongst the cheapest to accommodate and should therefore be embraced."*

9.2 Active Transport to access Rail Stations

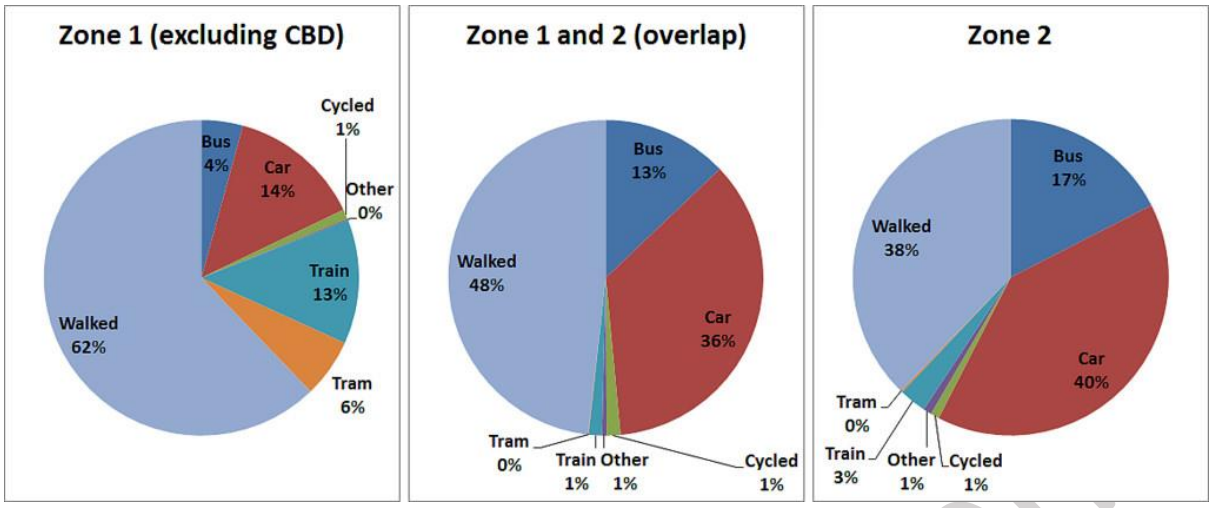
As discussed earlier in section 4.8 above, building big car parks around stations is not efficient to get more people onto public transport and, in many cases, not the best use of valuable land around stations.

Despite lobbying to build more car parks to expand park and ride at rail stations, there is demand for more sustainable access. Figure 36 below shows that a majority of train travellers use active transport to reach rail stations, in the main by walking. An increasing proportion arrive by bus or tram. People walking to trains increased by 63% between 2001-2011, those using feeder buses or trams increased by 89%, while driving or being driven to stations increased by just 8%.[36] Cycling to rail stations is also on the increase.

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[34] Transport Integration Act Sections 11(2)(c),12(2), 13(2)(c), 86(2)(b);
[35] Infrastructure Australia's Reform Series: **Outer Urban Public Transport: Improving accessibility in lower-density areas, Recommendations 3,4; see also National Cycling Strategy 2011-2016**
[36] Myth: Park-and-Ride facilities will encourage public transport use: https://www.ptua.org.au/myths/parkride/

Figure 38: Access modes to railway stations



Source: *Daniel Bowen …….*

A combination of walking, cycling and train travel is an effective and sustainable alternative in metropolitan areas to journeys by car or a combination of car and train and should be supported over building more park and ride facilities.

9.3 Integrating cycling and public transport

Cycling to stations is handicapped because cycle networks are not continuous and do not adequately protect cyclists. Required are continuous, low-stress routes that connect directly and conveniently to stations and major interchanges. Cycling can also be encouraged through facilities such as lockers, bicycle parking and an expanded Parkiteer cage network. On-demand bike services such as bike share including e-bikes available at rail stations enable passengers to extend how far they can travel once they end their public transport trip.

PTV's policy is for bicycles to be carried for free on Melbourne metropolitan trains. Carriage of bicycles is allowed on V/Line trains subject to space availability, and space is often limited. At peak time on commuter services (both Metro and V/Line), emphasis should be [37]on maximising train space for passengers so bikes are not permitted then other than folding bicycles, or for counter-peak travel. Alternatives to carriage of bicycles on peak period trains are:

- riding from home to the station, then leaving the bike in secure storage at the "home" rail station
- readily available bike hire options at major Melbourne CBD stations. These should be expanded to busy suburban rail stations
- promotion of improved CBD tram network connectivity options, frequency and routes at all 15 key CBD and inner area stations
- at stations such as Flinders Street, Southern Cross, West Melbourne, Richmond and Clifton Hill, Parkiteer cages enable passengers to leave their prime bike at home stations, commute by train and complete their journey using a second bicycle housed in other Parkiteer cages at key CBD and inner area stations

Parkiteer cages provide free, secure bike parking at Victorian train stations and transport hubs like Doncaster Park and Ride.

[37] Myth: Park-and-Ride facilities will encourage public transport use: https://www.ptua.org.au/myths/parkride/

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Bicycle Storage at South Morang railway station

Source: https://www.bicyclenetwork.com.au/newsroom/2019/02/12/how-do-you-ride-to-the-station/

There are currently hundreds of Parkiteer cages on the metropolitan and regional rail network, and over 100 metropolitan stations with one or more cages. Some stations currently enjoy substantial levels of bicycle access, often outstripping capacity of bike cages. Given one cage storing 26 bikes takes the space of about 2 cars and is something like an eighth of the cost, clearly provision of additional secure cycle space is far more cost-effective than continued provision of car spaces.

Bicycle hoops in weather-protected locations at shops and stations are an inexpensive alternative to Parkiteer cages. Bike hoops can be found at almost every station across Victoria, with the number of hoops increasing regularly. End-of-trip facilities include showers, changing rooms, lockers and bicycle maintenance at major rail stations.

Many people who ride bikes to stations leave them at railings and lamp posts where bikes are vulnerable to damage and theft. Increased facilities are needed to meet demand and it is time to commence installing more substantial secure parking stations.

9.4 Improving the Walking Catchment for Public transport

As well as health benefits, walking is easy and convenient for local trips, or to connect other forms of transport. As evidenced above, more people walk to most stations than drive, despite often adverse walking conditions.

A market intelligence review by Public Transport Victoria (PTV) for April to June 2012, found that 44% of people using train services walked to the station from their homes and 77% walked from their destination train station to their final destination. Over half of the respondents walked 1.2 kilometres to a station and many walked much further.

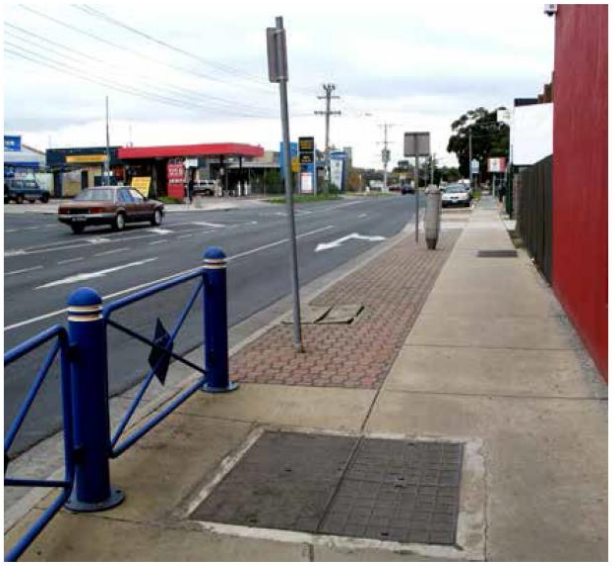
Development of high-quality walking routes to stations covering a catchment area of walkable distances from a station is needed. The identification and delineation of Principal Pedestrian Networks (PPNs)[38] enables effective, scale appropriate strategic network planning for pedestrians in the broader context of transport and land use planning.

PPNs aim to identify routes within the built environment that can carry more pedestrians walking to key destinations including transport nodes. A PPN is an important planning and policy tool for the development and promotion of walking as a mode of transport, recognising that walking has a valuable role to play in creating a more effective and resilient transport system. PPNs can reinforce the strengths of existing land use and transport patterns by encouraging pedestrian movement in desired areas.

In 2013 the Victorian and Federal Government jointly funded PPN demonstration projects in four local government areas. The funding covered the planning and construction of several PPN Routes.[39]

[38] http://www.victoriawalks.org.au/Assets/Files/5.%20Kristie%20Howes%20Principal%20Pedestrian%20Networks%20.pdf
[39] http://www.federalfinancialrelations.gov.au/content/npa/infrastructure/project-agreement/Principal-Pedestrian-Network-PA.pdf

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An uninviting existing pedestrian route



An attractive Principal Pedestrian Network Route

Encouraging walking as a transport mode requires attention to several elements that contribute to attractive walking environments. These elements include smooth surfaces, creating high quality public spaces and streetscapes, street lighting and seating, pedestrian crossings and signage and of course, appropriate repair and maintenance of all of these. Improved walking environments, as in Figure 50, can be achieved through a variety of measures including:

- adjustments to signalised intersections
- installation of increased priority crossing opportunities such as zebra or wombat crossings
- increases to pavement width or quality
- installation of trees, vegetation or other landscaping
- the provision of seating, other street furniture, street art, shade and drinking fountains

9.5 Increasing Active Transport Mode Share

As set out above, an objective set out in the Transport Integration Act is "to increase the mode share of public transport, walking and cycling trips as a proportion of all transport trips"[40]

The United Nations recommends that to increase mode share, governments dedicate 20% of transport funding to active transport. However, the Federal and Victorian Governments spend less than 1% of their transport funding on active transport infrastructure.[41]

The bulk of funding for walking and cycling initiatives falls to local governments. Cycling has increased substantially with investments in bicycle paths and bicycle parking, particularly in parts of inner Melbourne where the cycle mode reaches 15-20% of journey to work trips. For the most part cycling's share across Melbourne remains under 2%.

Yet much of Melbourne is ideal for cycling and walking for most of the year. Increasing the mode shares of public transport, walking and cycling trips requires far enhanced investment by all tiers of government, Councils, State and Federal governments.

[40] Section 86(2)(b)(i)

[41] https://theconversation.com/cycling-and-walking-are-short-changed-when-it-comes-to-transport-funding-in-australia-92574

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10. Connections to National Employment Clusters and Major Activity Centres

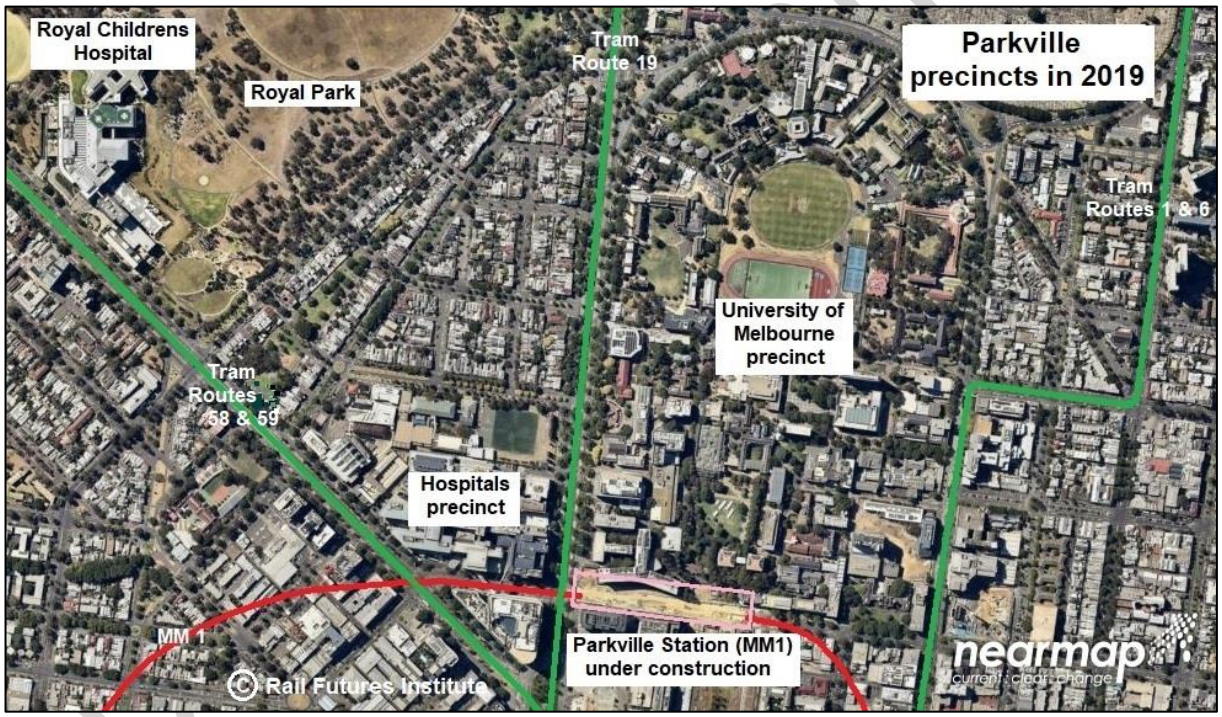
The listing below provides a snapshot of the rail lines and multiplicity of origins and destinations that will provide direct high-quality links to the designated National Employment and Innovation Clusters (NEIC) and some of the Major Activity Centres when this Plan is fully implemented.

10.1 Parkville NEIC

The Parkville NEIC covers most of the compact suburb of Parkville (postcode 3052) on the northern outskirts of the Melbourne CBD. It includes most of the campus of the University of Melbourne, Royal Melbourne Hospital, Royal Womens Hospital, Royal Childrens Hospital and the Peter McCallum Cancer Centre. World leading medical research facilities are embedded within these centres. Extensive sporting facilities and Melbourne Zoo are in Royal Park which comprises Parkville's western precinct, bisected by the Route 58 tram to West Coburg and the Upfield railway including Royal Park station.

The general location of these facilities and the existing radial tram routes in Parkville are shown in Figure 39. Also shown is the approximate underground route of MM1 and construction works at Parkville station.

Figure 39: Parkville NEIC overview in 2019



From the principal university and medical precincts, the following network would develop:

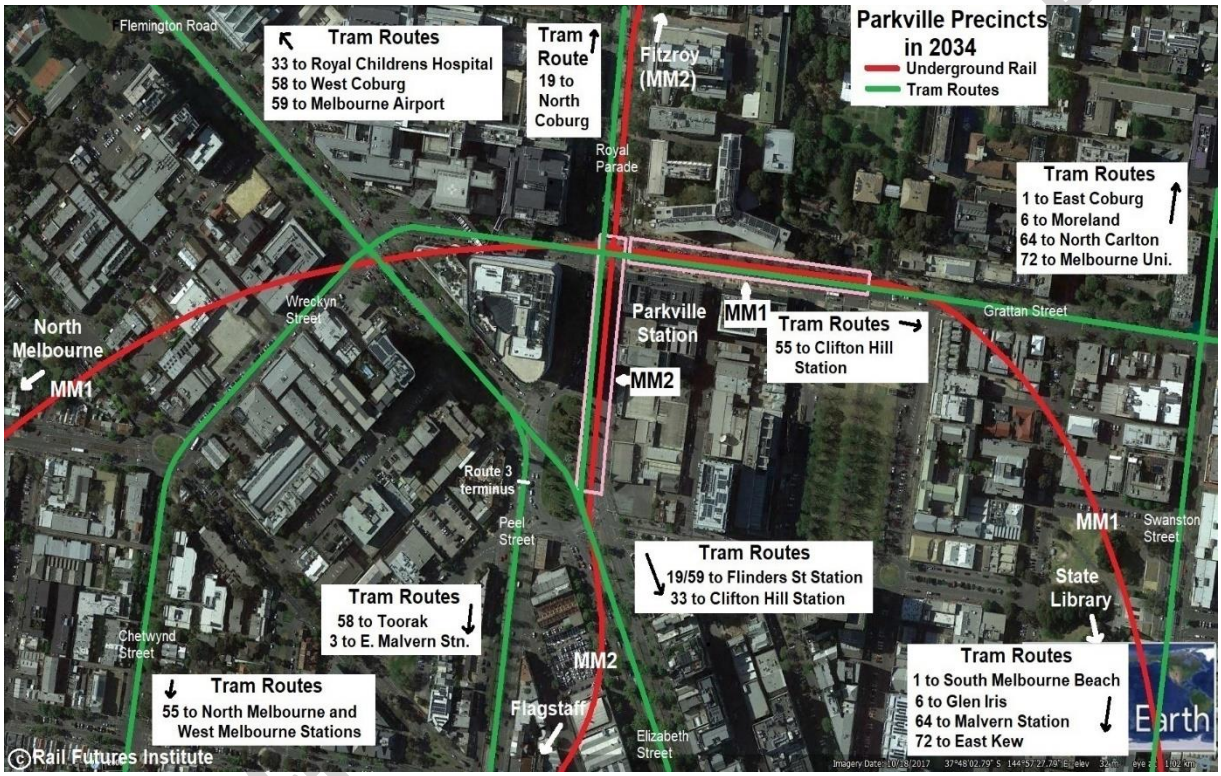
- MM1 providing direct services to the Sunbury, Melton, Pakenham and Clyde lines via new City stations, Anzac, Caulfield, Dandenong, North Melbourne, Footscray and Sunshine, served by a new Parkville underground station beneath Grattan Street
- MM2 providing direct services to the Mernda and Werribee/Black Forest Road lines via Flagstaff, Southern Cross, Fishermans Bend, Newport, Fitzroy, Preston, Reservoir and Epping, served by additional underground platforms beneath Royal Parade
- Tram Route 1 in Swanston Street to East Coburg and South Melbourne Beach
- Tram Route 3 in Peel Street to East Malvern and Caulfield
- Tram Route 6 in Swanston Street to Moreland and Glen Iris
- Tram Route 19 in Royal Parade to North Coburg
- New Tram Route 33 in Flemington Road to St Vincents Plaza, Fitzroy and Clifton Hill station

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- New Tram Route 55 in Grattan Street to North Melbourne & West Melbourne Stations, Fitzroy and Clifton Hill station
- Tram Route 58 in Flemington Road to Toorak and South Yarra
- Tram Routes 58 and 79 in Flemington Road to West Coburg
- Tram Route 59 in Flemington Road to Airport West and Melbourne Airport
- Tram Route 64 in Swanston Street to North Carlton and Malvern Station
- Tram Route 72 in Swanston Street to Camberwell and East Kew
- Future MCT route in Grattan Street to Doncaster

The proposed configuration of underground rail corridors for MM1 and MM2 and tram routes inherent in this Plan are shown in Figure 40, below.

Figure 40: Parkville NEIC showing Proposed Rail and Tram access



10.2 Fishermans Bend NEIC

The 480 hectares Fishermans Bend development precinct is expected to be home to approximately 80,000 residents and provide employment for up to 80,000 people by 2050. The overall development area has been sub-divided into five precincts: Lorimer, Sandridge and Montague with a mix of residential and commercial development and the Employment Precinct and Wirraway which are earmarked for light industrial, research and commercial development.

The area includes the former General Motors Holden car production plant and significant aviation industry manufacturing and research establishments, including Boeing. The precinct directly abuts the Yarra River on its northern boundary, including the South Wharf facilities of the Port of Melbourne, whilst immediately to its west is Webb Dock, also part of the Port of Melbourne. The former rail freight line to Webb Dock (opened 1986, closed 1996) will be replaced by a new rail reservation, mainly on elevated structures, and most likely along the Turner Street alignment as shown in Figure 39

Current public transport in the precinct is provided by tram route 96 (one stop only at City Road), route 109 which serves the Montague area and several bus routes. Upon full implementation of this Plan, the Fishermans Bend NEIC would be served by:

- MM2 providing direct services from new underground stations at Sandridge and Wirraway to

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Mernda and Werribee/Black Forest Road lines via Parkville, Flagstaff, Southern Cross, Newport, Fitzroy, Preston, Reservoir and Epping. (Note: Final route of MM2 through Fishermans Bend to be determined – alternative route could be via Employment Precinct)

- New Tram Route 44 from Sandridge and Wirraway via Collins Street to Victoria Gardens
- New Tram Route 46 from Employment Precinct and Montague via Collins Street to Camberwell Junction
- Tram Route 86 from Montague to Port Melbourne and Bundoora
- Tram Route 96 from Montague (City Road) to St Kilda and East Brunswick

Potential options for heavy rail, rail freight and tram routes within the Fishermans Bend Development Precinct are shown in Figure 41. Alternative alignments for some or all of these routes may be adopted as the development process proceeds.

Figure 41: Fishermans Bend Development Precinct showing proposed MM2, Tram and Rail Freight access



10.3 Monash NEIC

Monash NEIC, located in Clayton, some 20km south-east of central Melbourne, has the highest concentration of jobs outside of the Melbourne CBD. It currently supports approximately 85,000 jobs across a diverse range of industries with the potential for employment numbers to double by 2050. It contains nationally significant facilities centred upon Monash University, Australian Synchrotron, CSIRO, Monash Business and Technology Precincts, Monash Children's Hospital and Monash Medical Centre.

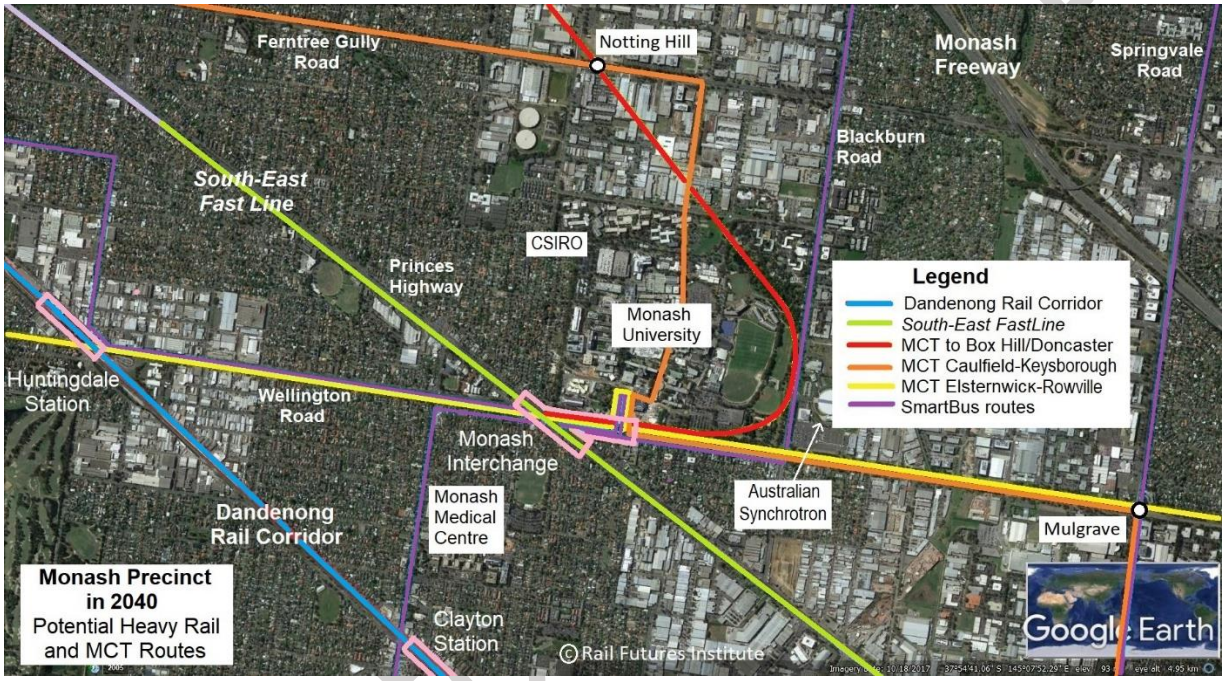
The principal elements of the NEIC are in an area bounded to the north by the Monash Freeway, by the Dandenong rail corridor to the south, Clayton Road to the west and Springvale Road to the east. Current public transport is provided by Clayton, Westall and Springvale stations on the Dandenong line and a significant number of bus routes including three SmartBus routes. Upon full implementation of this Plan, the Monash NEIC will be served by:

- *South-East Fast Line* from a new station at Monash University providing rapid direct services to the Melbourne CBD at Southern Cross station, Sunshine and Dandenong NEICs, Caulfield and Chadstone, and all stations on heavy rail lines to Wyndham Vale and Pakenham, together with regional services to Gippsland

- Dandenong line at Clayton, Westall and Springvale stations providing direct services via MM1 to the Melbourne CBD, Parkville and Sunshine NEICs, also Dandenong NEIC and all stations on heavy rail lines to Sunbury, Melton, Pakenham and Cranbourne/Clyde
- Proposed MCT route from Caulfield to Keysborough via Chadstone, Notting Hill, Monash University, Mulgrave and Springvale
- Proposed MCT route from Elsternwick to Rowville via Monash University, Ormond and Mulgrave
- Proposed MCT route from Melbourne Airport to Monash University via Broadmeadows, Keon Park, Latrobe University, Doncaster, Box Hill, Deakin University (Burwood) and Mount Waverley
- SmartBus and local bus services on multiple routes

The conceptual arrangement of the routes described above is shown in Figure 42.

Figure 42: Monash NEIC showing Proposed Rail and MCT access



10.4 Dandenong NEIC

Dandenong NEIC incorporates the Southern State Significant Industrial Precinct (SSIP) in Dandenong South and the Dandenong Metropolitan Activity Centre (MAC) as illustrated in Figure 43 below. The cluster area is bounded by the Monash Freeway and Heatherton Road to the north, EastLink to the west, Hallam Road to the east and Glasscocks Road to the south.

The cluster currently supports approximately 66,000 jobs and is one of Australia's largest manufacturing areas. Increasingly, it is also supporting knowledge-based manufacturing activity, typified by development of the Logis Eco-Industrial Park which is expected to generate around 5,000 jobs, one of several industrial precincts which reflect the transition away from traditional manufacturing. Other key sectors include health, education, retail, wholesale trade and transport and warehousing activities.

The Dandenong MAC includes Dandenong Hospital and Chisholm TAFE. Dandenong's central area is the focus of the Government's Revitalising Central Dandenong initiative. It also includes the Dandenong Plaza and Dandenong Market, the second largest retail market in Melbourne.

Current public transport is provided by the Dandenong rail corridor at Dandenong and Hallam stations and a multiplicity of bus routes including the Route 901 SmartBus which is a lengthy orbital route extending from Melbourne Airport to Frankston. Upon full implementation of this Plan, the Dandenong NEIC will be served by:

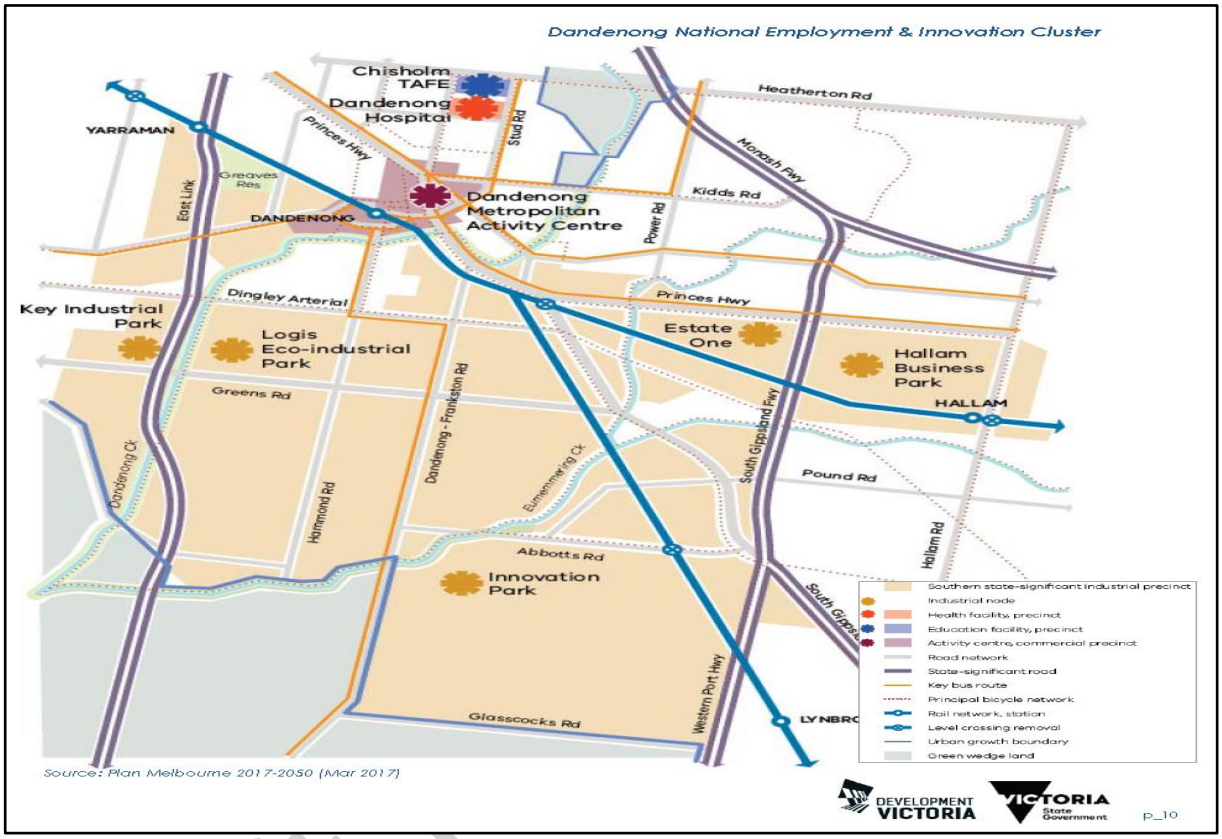
- Dandenong line at Dandenong and Hallam stations providing direct services via MM1 to the Melbourne CBD, Parkville and Sunshine NEICs, and all stations on heavy rail lines to Sunbury, Melton, Pakenham and Cranbourne/Clyde

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- *South-East Fast Line* providing rapid direct services to the Melbourne CBD at Southern Cross station, Monash and Sunshine NEICs, Caulfield and Chadstone, and all stations on heavy rail lines to Wyndham Vale and Pakenham, together with regional services to Gippsland
- Proposed MCT route to Ringwood via Wantirna, Knox, Scoresby and Rowville
- Proposed MCT route to Mentone via Keysborough
- SmartBus and local bus services on multiple routes

The proposed rail and MCT access within the Dandenong NEIC area is shown in Figure 43.

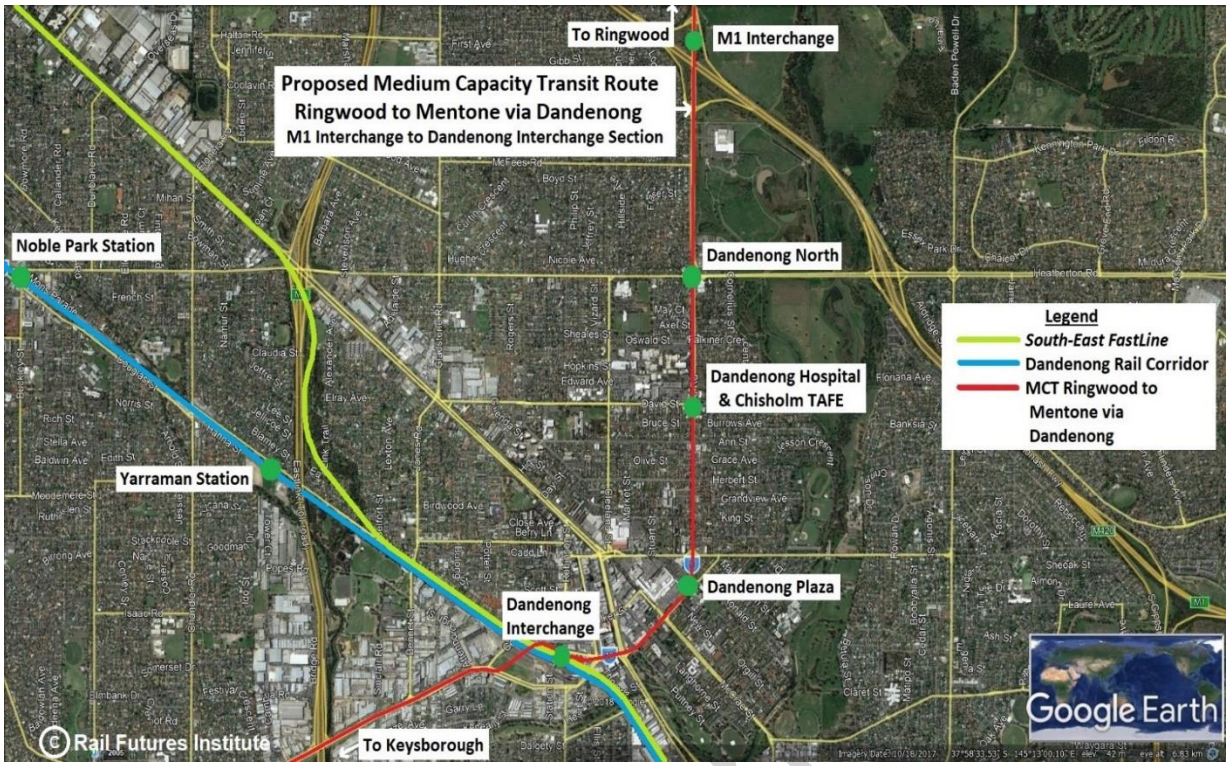
Figure 43: Dandenong NEIC area



Source: *Development Victoria*

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Figure 44: Dandenong NEIC showing Proposed Rail and MCT access



10.5 LaTrobe NEIC

The La Trobe National Employment and Innovation Cluster (La Trobe Cluster) sits within the northern sub-region of Melbourne in the suburb of Bundoora, 14km north-east of the Melbourne CBD.

With the highest concentration of jobs in Melbourne's north-east, the LaTrobe NEIC is seen as the key location for the growth of business and employment in Melbourne's north, leveraging the established specialized facilities at LaTrobe University and Austin Hospital. There are currently almost 28,000 jobs within the cluster with a critical mass of leading education, health and research facilities including Rio Tinto and the agricultural and bio-science research centre at LaTrobe University.

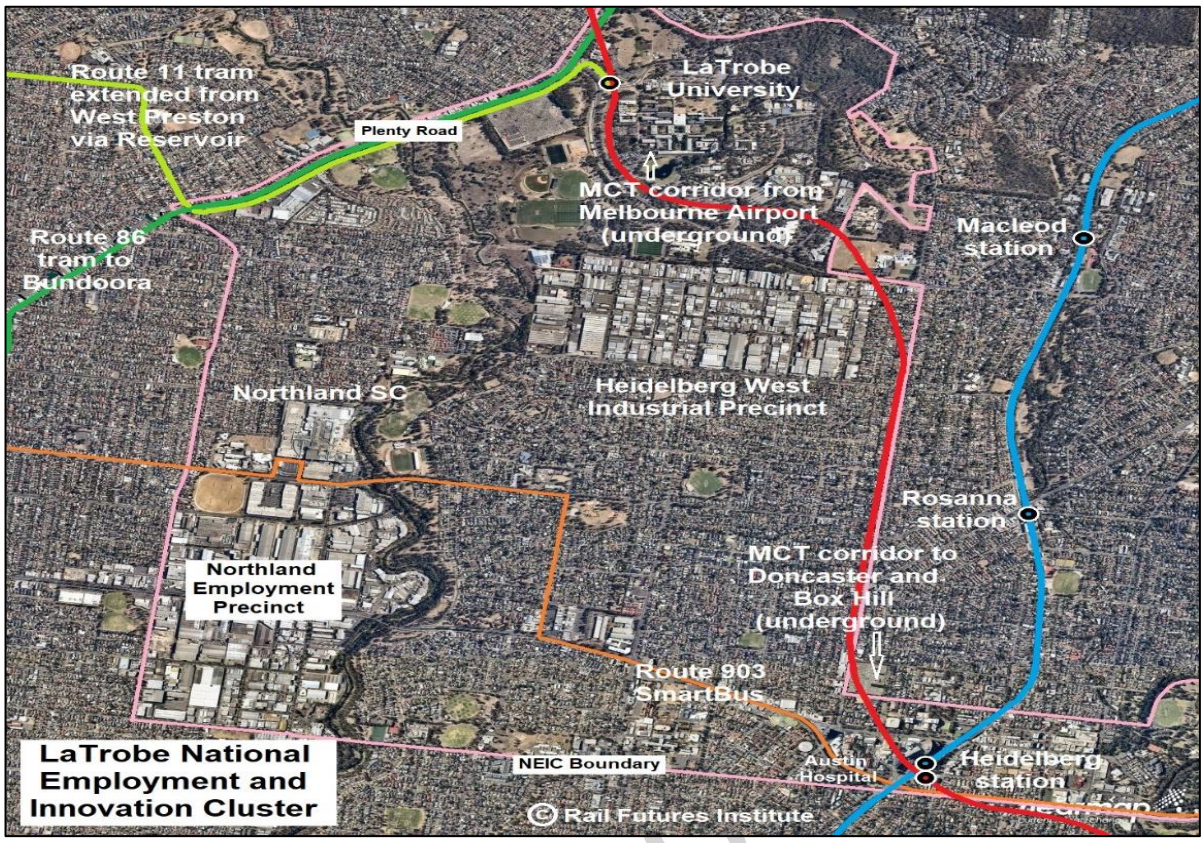
The cluster also includes other significant employment locations including the Heidelberg Major Activity Centre and medical precinct, Northland Major Activity centre and industrial area to its south and the Heidelberg West industrial estate.

Current public transport is provided by the Hurstbridge rail line at Heidelberg station (also at Rosanna and Macleod stations which are outside of the NEIC boundary), Route 86 Bundoora tram on Plenty Road and several bus routes including SmartBus Route 903 from Mordialloc to Altona via Heidelberg and Northland Shopping Centre. When this Plan is fully implemented, as shown in Figure 45, LaTrobe NEIC will be served by:

- Hurstbridge line from Heidelberg station and all stations to Greensborough, Eltham and Hurstbridge, also all stations to Melbourne CBD (City Loop) via Clifton Hill
- Proposed MCT route from LaTrobe University to Melbourne Airport via Keon Park, Campbellfield and Broadmeadows
- Proposed MCT route from LaTrobe University to Monash University via Heidelberg, Doncaster, Box Hill, Deakin University (Burwood) and Mount Waverley
- Extended Tram Route 11 from LaTrobe University to Victoria Harbour (Docklands) via Reservoir, West Preston, Fitzroy and Melbourne CBD via Collins Street
- Tram Route 86 from LaTrobe University to Melbourne CBD (via Bourke Street) and Port Melbourne, also to RMIT University at Bundoora
- SmartBus and local bus services on multiple routes

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Figure 45: LaTrobe NEIC showing Proposed Rail, Tram and MCT access



10.6 Sunshine NEIC

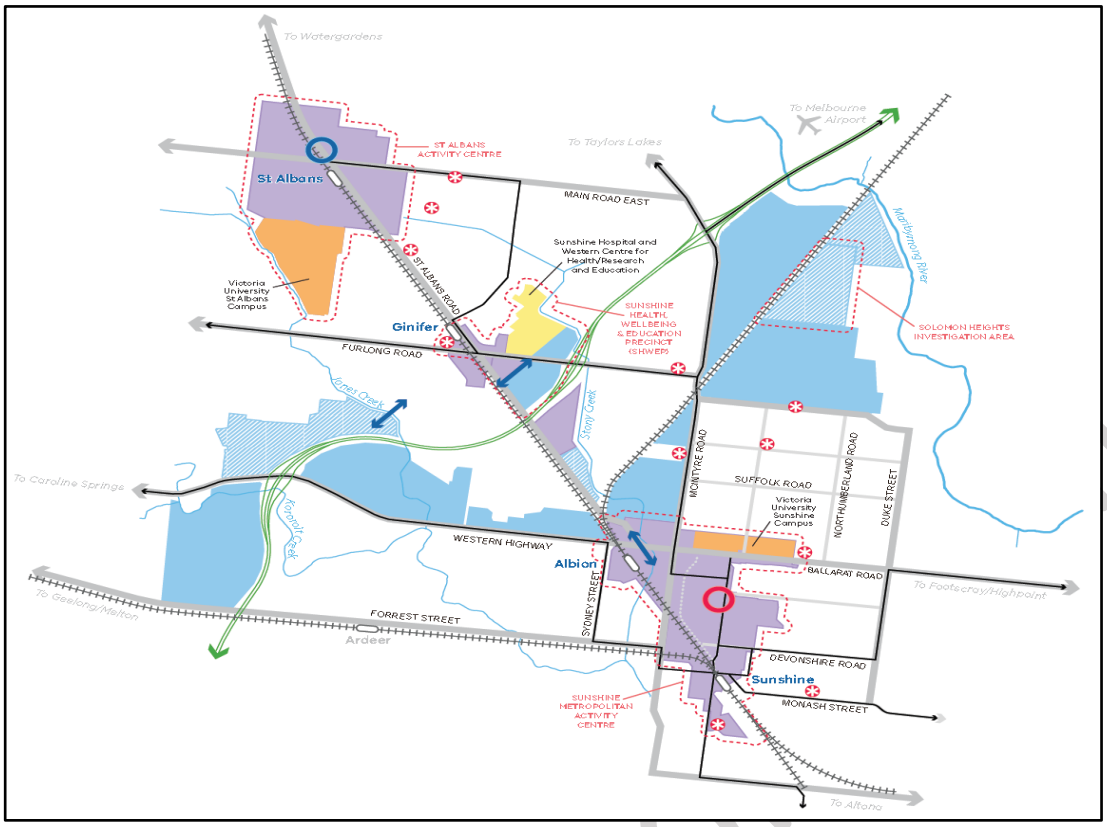
The Sunshine Cluster is located within Brimbank City Council, 12-14 km west of Melbourne's CBD. The cluster is developing as an economic hub that provides a central service function for Melbourne's west. The cluster supports approximately 14,600 jobs across a diverse range of industries stretching between the established Activity Centres of Sunshine and St Albans. The cluster also includes the suburbs of Albion, Ardeer, Sunshine North, Cairnlea and part of Deer Park, as shown in Figure 46, below.

In recent decades, Sunshine's fortunes have declined with the loss of manufacturing enterprises. The area is ripe for renewal, the next phase of investment and re-emergence as a major job centre and focal point for health and education services. Current major facilities include Sunshine Hospital and Victoria University Campuses at Sunshine and St Albans.

Current public transport is provided by the Sunbury rail line stations at Sunshine, Albion, Ginifer and St Albans and Ardeer station on the Melton line. There are no tram services in the Brimbank municipality. The cluster has a multiplicity of local and cross-suburban bus services including SmartBus Route 903 from Mordialloc to Altona which stops at Sunshine station and the main Sunshine shopping precinct.

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Figure 46: Sunshine NEIC area



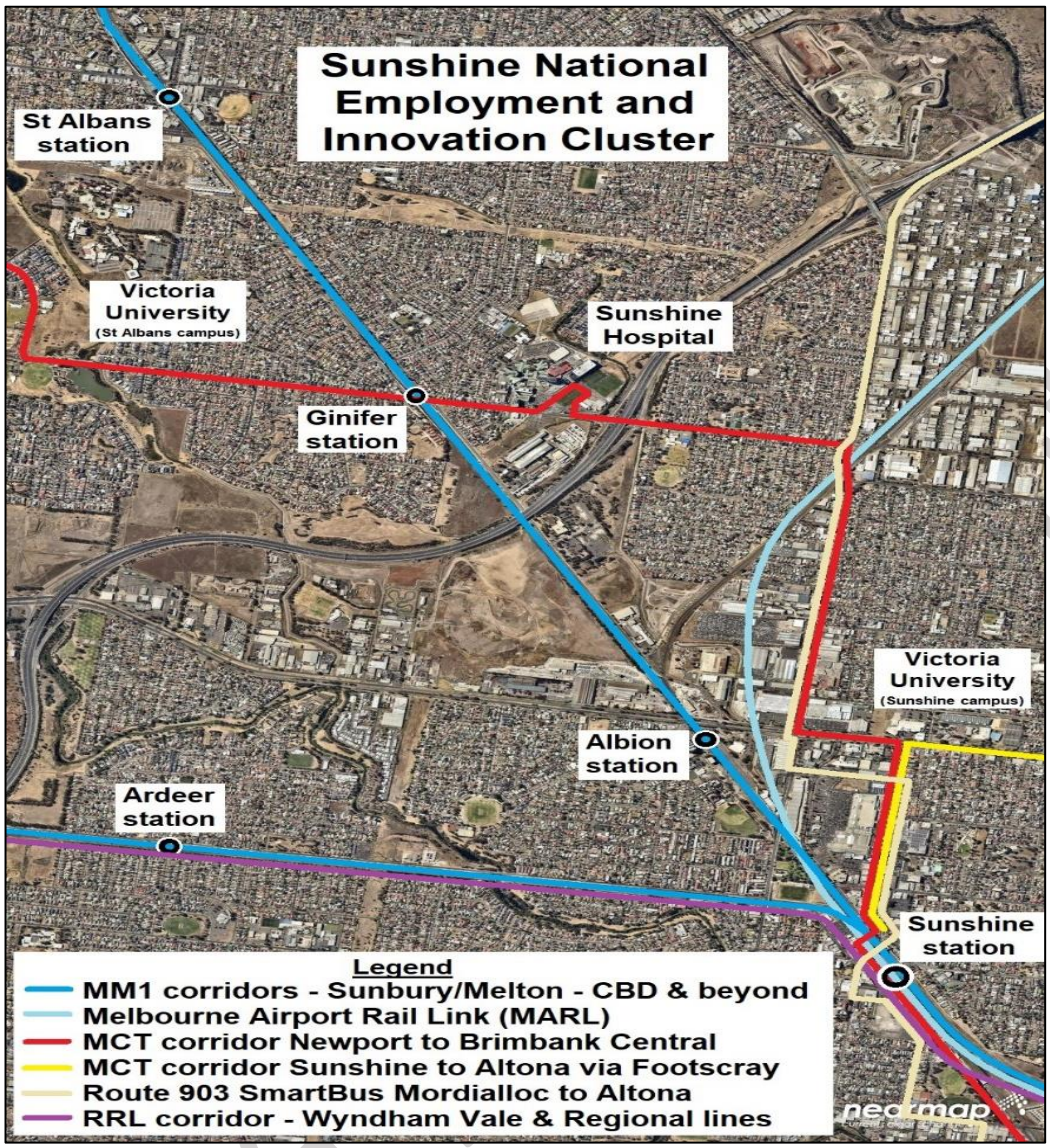
Source: *Victorian Planning Authority*

When this Plan is fully implemented, as shown in Figure 47, Sunshine NEIC will be served by:

- MM1 providing direct services from Sunshine, Albion, Ginifer, St Albans and Ardeer stations to all stations on the Sunbury, Melton, Pakenham and Clyde lines via new City stations, Anzac, Caulfield, Dandenong, Footscray and North Melbourne.
- MARL providing fast direct services to Melbourne Airport and Southern Cross.
- Black Forest Road line from Sunshine station to Wyndham Vale and Tarneit
- Direct regional services from Sunshine station to the Geelong, Ballarat, Bendigo and North-Eastern lines.
- Proposed MCT route from Sunshine station to Altona via Braybrook, Footscray, Kingsville and Brooklyn
- Proposed MCT route from Sunshine station to Brimbank Central via Sunshine Hospital, Ginifer and Cairnlea
- Proposed MCT route from Sunshine station to Newport via Brooklyn
- SmartBus and local bus services on multiple routes

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Figure 47: Sunshine NEIC showing Proposed Rail and MCT access



10.7 Werribee NEIC

The Werribee cluster is situated within the City of Wyndham approximately 32km from the Melbourne CBD, one of the fastest growing municipalities in Australia. It currently supports around 8,400 jobs and could ultimately support more than 50,000 predominantly white-collar jobs in health, education and high-tech research. Its major potential lies in 775 hectares of predominantly greenfield land south of the Princes Highway which comprises the East Werribee Employment Precinct and Werribee Agriculture and Food Technology Precinct.

The cluster includes the University of Melbourne Veterinary Hospital, University of Notre Dame, Victoria University, Werribee Mercy Hospital, Wyndham Private Medical Centre, CSIRO, Suzanne Cory High School and a range of research companies in the food and agricultural industries, as shown in Figure 48. Many of these white-collar job providers have significant expansion plans for the next 20 years. A site for a new hospital has also been purchased within the cluster by St Vincent's Private Hospital.

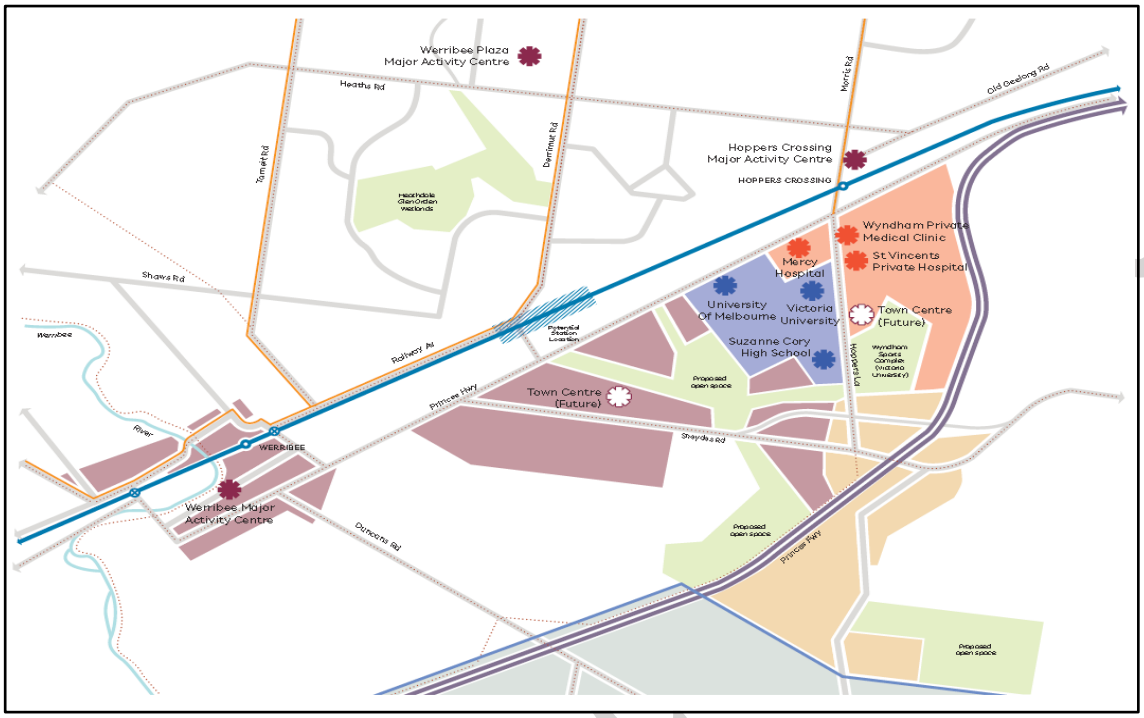
Public transport is currently provided by the Werribee rail corridor with stations at Hoppers Crossing and Werribee and multiple bus routes which connect to these stations. No SmartBus routes currently operate in the City of Wyndham. When this Plan is fully implemented, as shown in Figure 49, Werribee NEIC will be served by:

- MM2 providing direct services from Hoppers Crossing and Werribee (and a proposed new station at Derrimut Road) to the Mernda line via Newport, Fishermans Bend, Southern Cross, Flagstaff, Parkville, Fitzroy, Preston, Reservoir and Epping, also to Black Forest Road

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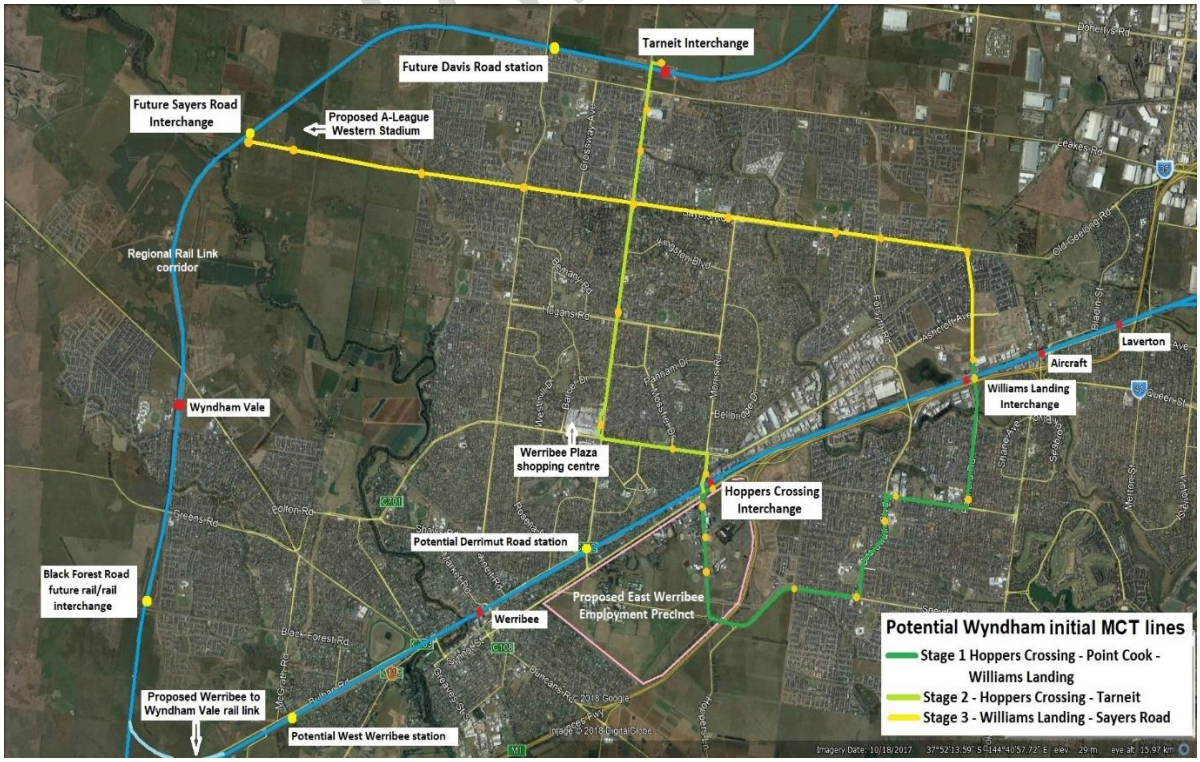
- Proposed MCT route from Hoppers Crossing and Derrimut Road to Williams Landing via East Werribee and Point Cook (also see Section 7.2.9)
- Proposed MCT route from Hoppers Crossing to Tarneit station via Werribee Plaza MAC
- Proposed MCT route from Williams Landing to Sayers Road (future station) via Truganina
- Local bus services on multiple routes

Figure 48: Werribee NEIC area



Source: *Plan Melbourne 2017-2050 (Map 11)*

Figure 49: Wyndham Municipality including Werribee NEIC showing Proposed Rail and MCT access



10.8 Melbourne Airport

Melbourne Airport covers an area of 2,600 hectares in the suburb of Tullamarine, some 22km north-west of the Melbourne CBD. Being in proximity to major industrial areas and Melbourne's residential growth corridors, apart from its primary role as Australia's second busiest domestic and international airport for passengers, it serves as a hub for the freight and logistics industry. Although it is does not have NEIC designation, Melbourne Airport is a major employment generator with around 20,000 jobs currently located within the wider airport precinct. This is expected to increase to around 35,000 jobs by 2050.

Apart from premium fare Skybus services to the Melbourne CBD, Docklands and some suburbs including St Kilda, Frankston and Werribee, Melbourne Airport is poorly served by public transport by way of destinations, service frequency, accessibility from some terminals and visibility for arriving passengers. A partial exception is the Route 901 SmartBus which runs at 15 minutes frequency to Frankston via an outer orbital route through Broadmeadows, Epping, Greensborough, Ringwood and Dandenong.

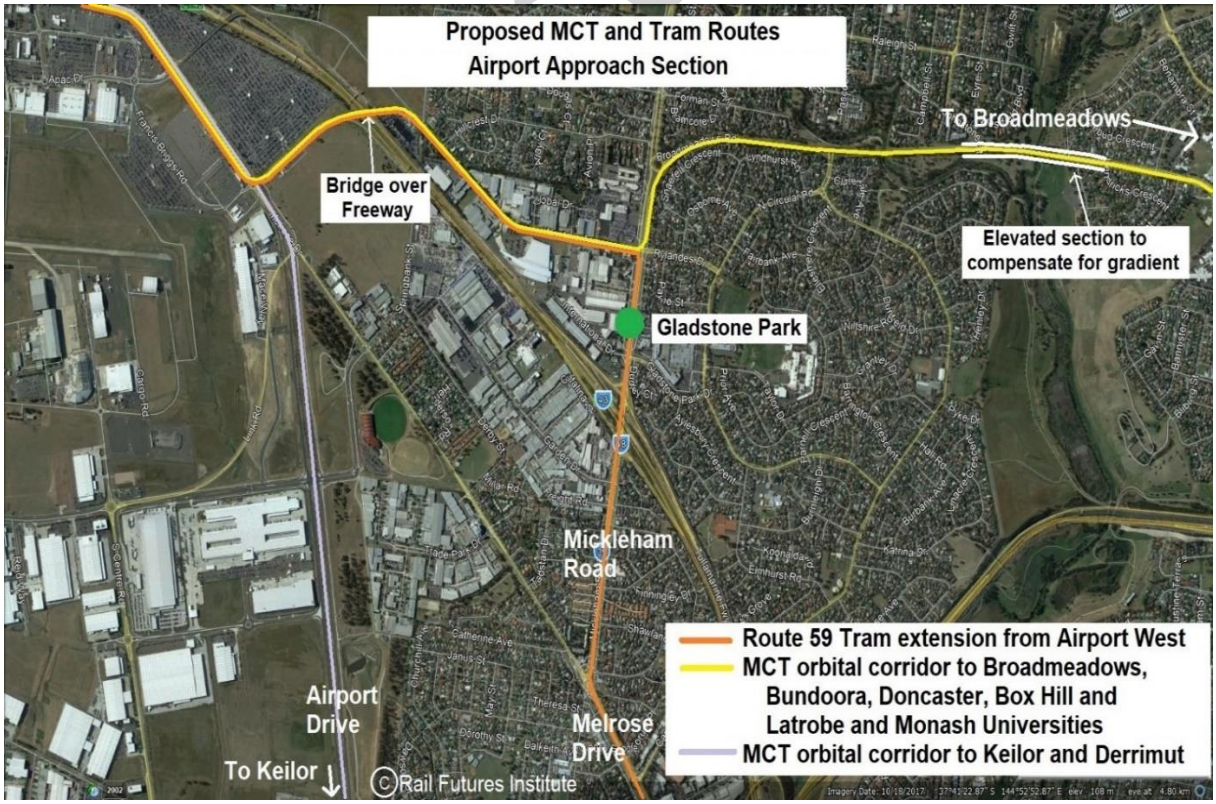
When this Plan is fully implemented, Melbourne Airport will be served by:

- MARL fast direct services to Sunshine and Southern Cross
- Extended Tram Route 59 to Melbourne CBD via Gladstone Park, Airport West, Essendon and Moonee Ponds
- Proposed MCT route to Monash University via Broadmeadows, Campbellfield, Keon Park, LaTrobe University, Heidelberg, Doncaster, Box Hill, Burwood (Deakin University) and Mount Waverley
- Proposed MCT route to Derrimut via Keilor, Taylors Lakes, Watergardens, Delahey and Deer Park
- Other local bus routes

Longer term, potential exists for direct regional services from Melbourne Airport to the Bendigo and North-Eastern lines.

The approximate location of proposed MCT and tram routes as they approach Melbourne Airport is shown in Figure 50, below.

Figure 50: Proposed MCT and Tram Routes approach to Melbourne Airport



Comment

10.9 Chadstone Major Activity Centre

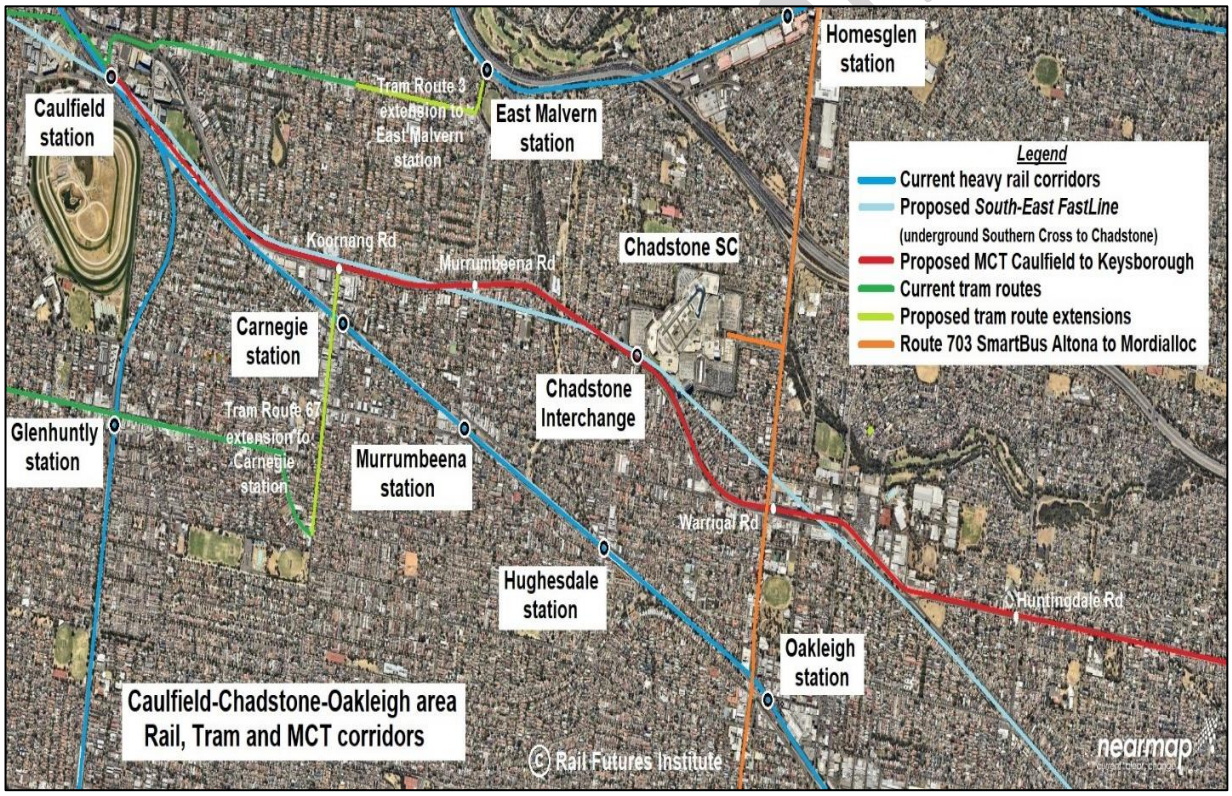
Chadstone MAC, located approximately 15km south-east of Melbourne's CBD, is Australia's largest shopping mall with some 550 shops and some 23 million visits annually. The site is being developed into a major retail, entertainment and commercial precinct with a 250-room hotel currently under construction. The Centre currently provides approximately 10,000 free car parking spaces.

Reflective of there being no rail-based transport in the immediate vicinity, Chadstone Shopping Centre operates its own regularly scheduled shuttle bus to and from the Melbourne CBD. Local public transport access is provided by several bus routes, including two SmartBus routes (700 Caulfield to Rowville and 703 Altona to Mordialloc. Chadstone's continuing development therefore inevitably reinforces very high levels of car dependency.

Under this Plan, as shown in Figure 51, below, Chadstone MAC will become a major train/MCT/bus interchange served by:

- *South-East Fast Line* providing direct services to Black Forest Road via Caulfield, Southern Cross and Sunshine and to the Pakenham and Gippsland lines via Monash University and Dandenong
- Proposed MCT route from Caulfield to Keysborough via Notting Hill, Monash University, Mulgrave and Springvale
- Other SmartBus and local bus routes

Figure 51: Chadstone MAC and surrounding suburbs showing Proposed Rail and MCT access



10.10 Doncaster Major Activity Centre

Doncaster MAC is located approximately 15km east of the Melbourne CBD. It is dominated by the Westfield Doncaster Shopping Centre located on an elevated site on Doncaster Hill. The Centre has 400 shops and approximately 5,000 car park spaces.

As described in Section 7.2.1, several prior studies have examined options for a heavy rail corridor to Doncaster, but each have been rejected by successive governments. The Centre is therefore only serviced by bus, although it also promotes travel by train to Box Hill and the use of connecting bus routes to Doncaster as a viable public transport option. Current bus routes servicing Doncaster MAC include SmartBus routes 902 (Airport West to

Chelsea), 903 (Altona to Mordialloc) and 907 (City to Mitcham) although the latter stops outside the main centre in Doncaster Road.

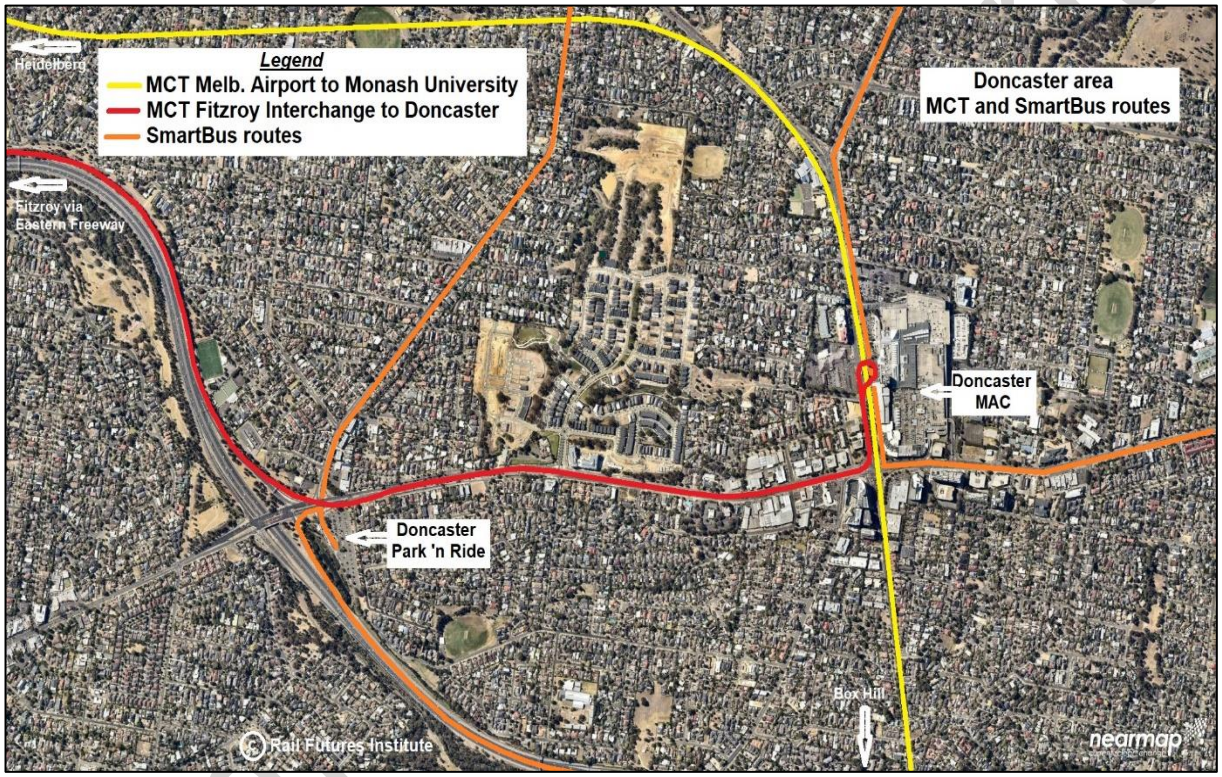
Other bus routes operate through the Doncaster Park and Ride facility, about 2km west of the MAC on the corner of Doncaster Road and the Eastern Freeway. This provides approximately 350 commuter car park spaces representing a very small proportion of bus users from that location.

When this Plan is fully implemented, as shown in Figure 52, Doncaster MAC will be served by:

- Proposed MCT (most likely Bus Rapid Transit) to Fitzroy interchange via Eastern Freeway
- Other bus routes including to Collingwood and CBD via Eastern Freeway
- Proposed MCT to Melbourne Airport via Heidelberg, Latrobe University, Keon Park and Broadmeadows
- Proposed MCT to Monash University and Clayton via Box Hill, Burwood and Mount Waverley.

For more details of Doncaster MCT options refer to Section 7.2.1.

Figure 52: Doncaster MAC and surrounding area showing Proposed MCT and Bus access



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11. Access and Connectivity Benefits

The projects proposed in this Plan are focused on improving public transport across Melbourne so that they can ensure a high degree of connectivity between residential areas, employment, educational, social and recreational centres without people being completely dependent on cars. A high level of accessibility will allow the city to continue to provide opportunities for an increasing population to enjoy a high quality of life in an environmentally sustainable city.

The effects of the Melbourne Rail Plan 2019-2050 on network performance and accessibility (land use and transport integration) have been assessed using the Spatial Network Analysis for Multimodal Urban Transport Systems (SNAMUTS) tool. SNAMUTS is an interactive decision tool designed to assist in examining the performance of a city region's current public transport network framed around the accessibility of the transport network and accessibility of place. The SNAMUTS tool enables the quantification of the effect of transport infrastructure improvements and modifications, and of land use intensification, on the accessibility of activity centres and corridors by different modes of transport to all centres across the metropolitan area.

Figures 53 and 54 provide an overview of the levels of public transport accessibility achieved across Metropolitan Melbourne in the base case (2016) and after completion of the measures proposed in this Plan. Traffic light colours identify spatial accessibility levels from green (excellent to good), yellow and orange (average) to red and maroon (poor or minimal). Grey shading indicates urbanised areas where current (bus-based) public transport services do not meet the minimum standard of 20-minute daytime frequencies on weekdays and 30-minute frequencies on weekends. However, it is likely and highly desirable (though beyond the scope of this Plan to assess in detail) that bus services across the metropolitan region will also be improved to support the enhanced rail mode network measures.

The maps show the synergy effects on accessibility that emerge from the provision of a high and medium-capacity rapid transit network extending into Melbourne's middle suburbs and beyond. The boost to the rail system proposed in this report ensures that adequate locational choices exist for both residents and businesses.

The MCT route from Melbourne Airport to Monash University provides an orbital corridor through Broadmeadows, Bundoora, Heidelberg, Doncaster and Box Hill which connects a string of 'super-hubs' that become as easy, if not easier, to get to and from by public transport than by car. The MCT semi-orbital corridor from Ringwood to Mentone via Knox City, Rowville, Dandenong and Keysborough connects major activity centres with the Dandenong NIEC to provide similar benefits.

The percentage of Melbourne residents and jobs that enjoy 'good to excellent public transport access' (the green colour brackets on the map) increases from 7% in 2016 to 31% if all proposals in this Plan are implemented.

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Figure 53: Map showing Public Transport Accessibilty Index for Melbourne 2016

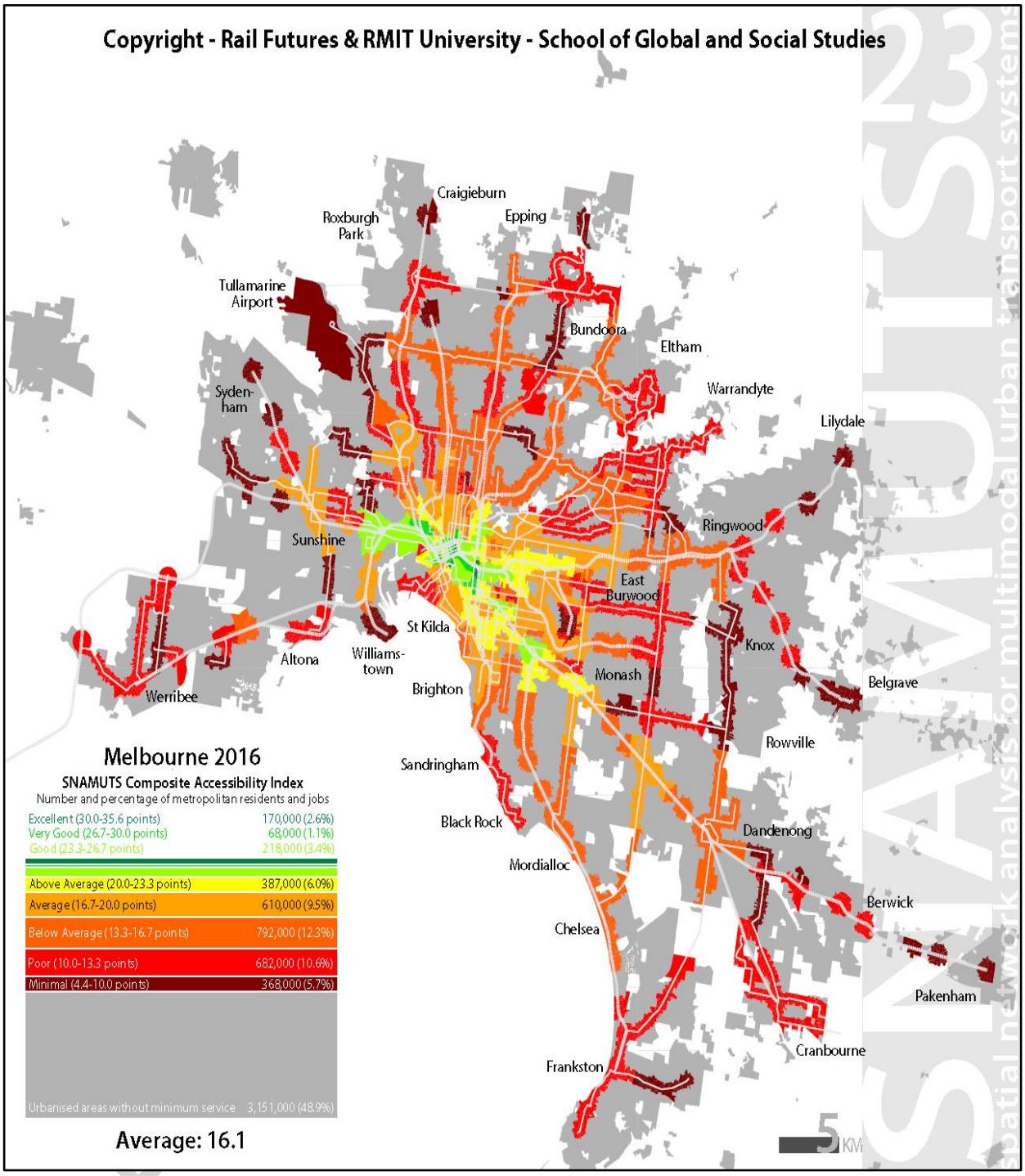
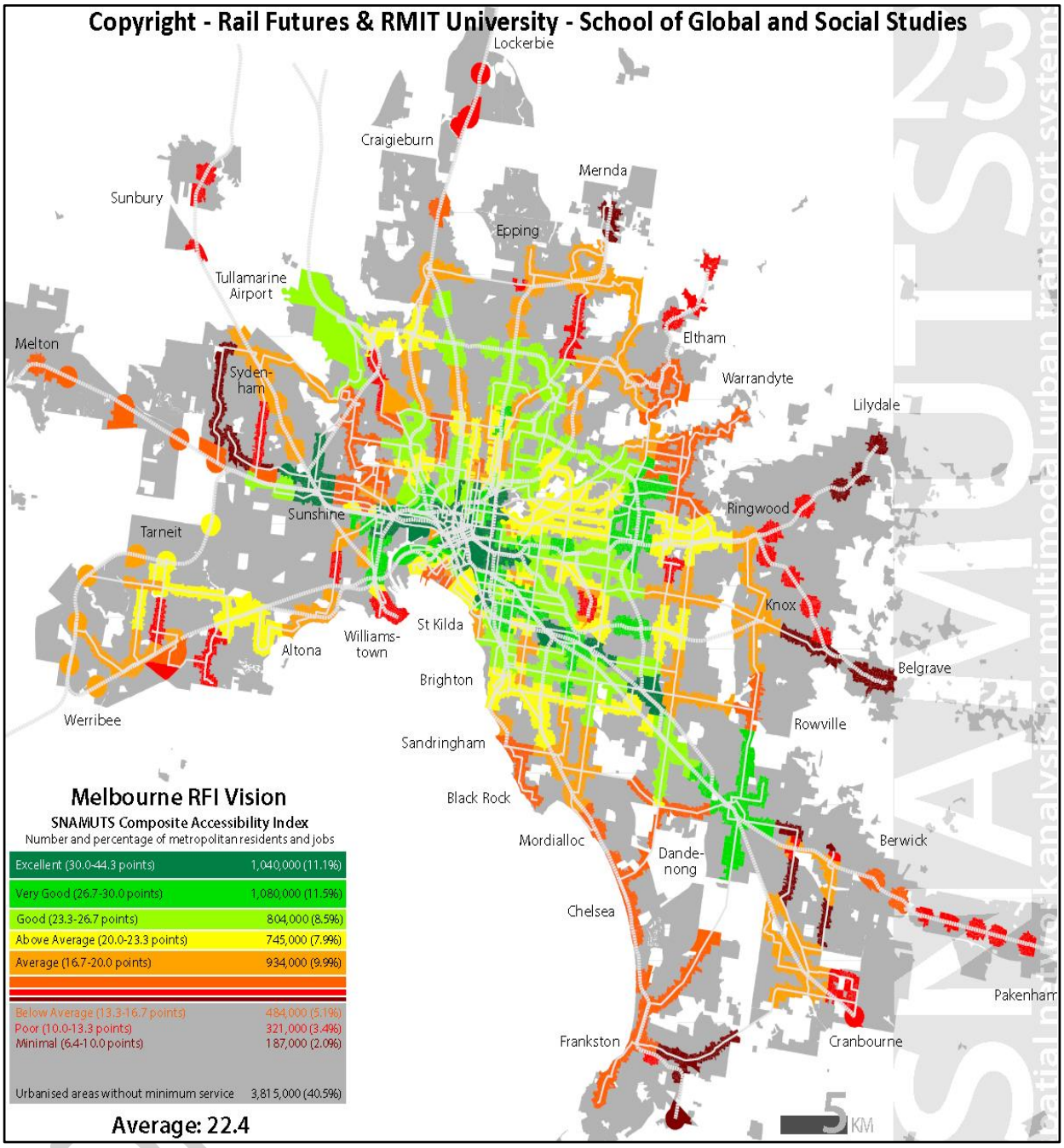


Figure 54: Map showing Public Transport Accessibilty Index with inclusion of RFI Projects



About SNAMUTS

Spatial Network Analysis for Multi-modal Urban Transport Systems or SNAMUTS is a collaborative international research project headed by Professor Carey Curtis and Doctor Jan Scherer.

The primary objective of the research project was to develop an interactive decision tool (SNAMUTS) to assist in examining scenarios for the future growth of metropolitan areas.

Rail Futures gratefully acknowledges the SNAMUTS assessment of the Melbourne Rail Plan – 2050 done by RMIT University School of Global Urban and Social Studies

(For more detail on the methodology see www.snamuts.com)

12. Staging and Timing

Development and delivery of the public transport projects proposed in this Plan will be a significant challenge for the Victorian Government in terms of expertise needed to integrate the program and then obtain the resources and skills to successfully plan, design, procure and deliver the projects. This section of the Plan addresses the issue of physical program integration and reflects our expectations of the capacity of the State to undertake these processes in parallel for multiple projects.

Each project must pass through at least three major phases from conception to completion:

- Phase 1 – initial conception, high level scoping, detailed project planning, business case preparation, funding approval
- Phase 2 – detailed or reference design[42], statutory planning approvals, project procurement
- Phase 3 – construction, testing and commissioning

While some projects may be developed, managed and completed through all three phases with the same project team, this is unusual as each phase generally requires different skills and resources. Sometimes it is not a continuous process from one phase to the next. For example, completion of detailed project planning and a satisfactory business case does not necessarily imply that the project will immediately flow to the next phase.

Some projects, particularly large and costly ones, can be developed and constructed in discrete stages, if each stage can be brought into operation and achieve benefits independently of any subsequent stages. In such cases, the phasing of each stage can be separately considered. For example, the proposed *South-East FastLine* can be considered as three separate but related projects:

- Stage 1 – Caulfield to Dandenong – combination of underground and elevated construction
- Stage 2 – Southern Cross to Caulfield – entirely underground construction
- Stage 3 – Dandenong to Pakenham – almost all at ground level

The following tables showing the recommended staging and implementation programs for programs in the Plan have been developed on the understanding of the above considerations. The proposed programs reflect relative priorities based on our assessment of need and the timing of pre-requisite precursor projects (where applicable). In each phase, the projects are also prioritised having regard to lead times from inception to delivery. In turn, this reflects the relative difficulty, complexity and scale of each project.

For each project, the expected degree of difficulty and complexity and its relative scale is graded at 1 (least demanding and smallest scale) to 10 (most demanding and largest scale). These values are subjective and do not have a linear relationship. In making these assessments, Rail Futures acknowledges that all proposals in the Plan should be the subject of formal analysis, at least to the level of Phase 1, as described above.

Heavy rail, tram and Medium Capacity Transit (MCT) projects are separately colour coded in the following tables to assist identification.

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[42] Detailed design is usually undertaken at this stage if subsequent procurement is for construction only. More commonly, a reference design is undertaken which is sufficiently detailed to fully specify the project deliverables and provide reasonably robust cost estimates. Put simply, a reference design tends to specify "what" the client requires but is not definitive about "how" the project is to be undertaken. Under these conditions, the procurement phase usually provides for the successful contractor to undertake both detailed design and construction.

Table 12: Phase 1 – Proposed Project Planning, Business Case, Funding Approval Processes

Proposed Phase 1 – Project Planning, Business Case and Funding Approval Processes				
Year	**Projects**	**DOD ***	**Project Scale**	**Notes**
2018/19	Cheltenham Turnback	3	2	Part of LXRA level crossing project
	West Footscray Turnback	3	2	MM1 support project
	Werribee line signalling upgrade	3	2	MM1 support project
	Platform lengthening for HCMT trains	2	3	MM1 support project
	Traction power upgrading	5	5	MM1 support project
	Essendon turnback	2	2	MM1 support project
	Sandringham second platform	2	2	MM1 support project
	Park Street, South Melbourne tram connection	1	1	MM1 support project
	East Dandenong-Cranbourne duplication	4	4	
	Melbourne Airport Rail Link	9	9	Includes new Airport station
2019/20	Cranbourne-Clyde re-opening	5	5	Duplication, electrification & two new stations
	Southern Cross-Wyndham Vale electrification	6	6	Includes track amplification beyond Sunshine
	Deer Park-Melton electrification	7	7	Includes track amplification
	Craigieburn line signalling upgrade	2	2	MM1 support project
	Station Pier, Port Melbourne tram extension	2	1	
2020/21	Caulfield/Northern Loops reconfiguration	8	8	
	Gowrie-Upfield duplication	3	3	Includes new Campbellfield station
	Upfield-Roxburgh Park re-opening	6	5	Duplication, electrification & quad to Craigieburn
	Greensborough-Eltham duplication	4	4	
	Spencer St to West Melbourne tram extension	3	2	
2021/22	Frankston-Baxter electrification	5	4	Includes duplication & two new stations
	Mooroolbark-Lilydale duplication	4	3	Includes new Cave Hill station
	Burnley Junction upgrade	3	3	
	Melton-Bacchus Marsh electrification	5	4	Includes part duplication
	West Melbourne-Nth Melbourne stations tram loop	3	2	
2022/23	Werribee-Black Forest Road link	4	4	Includes electrification & one new station
	Fishermans Bend tram extensions	5	5	Includes Yarra River bridge
	Clifton Hill-Fitzroy-Parkville tram extension	4	3	
2023/24	MM2 tunnel Newport-Croxton	10	10	3-year process starting 2021
	Stony Point line crossing loop	2	1	
	Craigieburn-Wallan electrification	4	4	Includes two new stations
	West Preston-Latrobe Uni tram extension	5	4	
	North Coburg-Merlynston tram extension	2	2	
2024/25	Burnley-Camberwell 4th track	5	4	
	Ferntree Gully-Upper Ferntree Gully duplication	3	2	
	East Brighton-Moorabbin tram extension	4	3	
2025/26	SEFL Stage 1 - Caulfield-Dandenong	9	8	2-year process starting 2024
	Carnegie-Carnegie Station tram extension	2	2	
	Darling Rd-East Malvern Station tram extension	2	2	
	Airport West-Melbourne Airport tram extension	4	5	
	Parkville-West Melbne-N Melbne tram extension	4	3	
2026/27	SEFL Stage 2 – Southern Cross-Caulfield	10	9	3-year process starting 2024
	Caulfield-Monash-Keysborough MCT	7	6	2-year process starting 2025
2027/28	SEFL Stage 3 – Dandenong-Pakenham	5	4	
	W Maribyrnong-Avondale Heights tram extension	4	3	
	Elsternwick-Monash-Rowville MCT	7	6	2-year process starting 2026
2028/29	Sunbury-Clarkefield electrification	4	4	
	Malvern-Darling Station tram extension	2	2	
	Camberwell-East Kew tram extension	3	3	
	Ringwood-Dandenong-Mentone MCT	7	7	3-year process starting 2026
2029/30	Glen Waverley-Knox City extension	8	7	3-year process. Includes two new stations
2030/31	Camberwell-Box	5	4	
	Melbourne Airport-Latrobe-Box Hill-Monash MCT	9	8	3-year process starting 2028
2031/32 onwards	Melbourne Airport-Keilor-Deer Park-Derrimut MCT	7	7	2-year process starting 2033
	CBD-Vic Park-Bulleen-Doncaster Hill MCT	7	6	3-year process starting 2033
	Williams Landing-Point Cook-Tarneit MCT	6	6	2-year process starting 2036
	Williams Landing-Truganina-Sayers Rd MCT	6	6	2-year process starting 2037
	Sunshine-Footscray-Kingsville-Altona MCT	6	6	2-year process starting 2038
	Newport-Sunshine-Ginifer-Brimbank C MCT	6	6	2-year process starting 2039
DOD * - Relative Degree of Project Difficulty and/or Complexity				
Second year of each timeline infers State Budget funding approval in that year, e.g. 2019/20 infers funding in May 2020 State Budget				

Table 13: Phase 2 – Proposed Detailed/Reference Design, Planning Approvals, Procurement Program

Proposed Phase 2 - Design, Approvals and Procurement Program													
Projects	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
Cheltenham Turnback													
West Footscray Turnback													
Werribee line signalling upgrade													
Platform lengthening for HCMT trains													
Traction power upgrading													
Park Street, South Melbourne. tram connection													
Melbourne Airport Rail Link													
Dandenong-Cranbourne duplication													
Cranbourne-Clyde re-opening													
S. Cross-Wyndham Vale electrification													
Deer Park-Melton electrification													
Station Pier, Port Melbourne. tram extension													
Caulfield/Northern Loops reconfiguration													
Gowrie-Upfield duplication													
Upfield-Roxburgh Park re-opening													
Essendon turnback													
Craigieburn line signalling upgrade													
Sandringham second platform													
Greensborough-Eltham duplication													
Spencer St to West Melbourne tram extension													
Frankston-Baxter electrification													
Mooroolbark-Lilydale duplication													
Burnley Junction upgrade													
Melton-Bacchus Marsh electrification													
West Melbourne-North Melbne stations tram loop													
rribee-Black Forest Road link													
Fishermans Bend tram extensions													
Clifton Hill-Fitzroy-Parkville tram extension													
MM2 tunnel Newport-Croxton													
Stony Point line crossing loop													
Craigieburn-Wallan electrification													
West Preston-Latrobe Uni tram extension													
North Coburg-Merlynston tram extension													
Burnley-Camberwell 4th track													
Ferntree Gully-Upper Ferntree Gully duplication													
East Brighton-Moorabbin tram extension													
SEFL Stage 1 - Caulfield-Dandenong													
Carnegie-Carnegie Station tram extension													
Darling Rd-East Malvern Station tram extension													
Airport West-Melbourne Airport tram extension													
Parkville-West Melbne-North Melbne tram extension													
SEFL Stage 2 – Southern Cross-Caulfield													
SEFL Stage 3 – Dandenong-Pakenham													
W Maribyrnong-Avondale Heights tram extension													
Sunbury-Clarkefield electrification													
Caulfield-Monash-Keysborough MCT													
Elsternwick-Monash-Rowville MCT													
Malvern-Darling Station tram extension													
Camberwell-East Kew tram extension													
Ringwood-Dandenong-Mentone MCT													

Proposed Phase 2 - Design, Approvals and Procurement Program (continued)													
Projects	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**
Ringwood-Dandenong-Mentone MCT													
Melbourne Airport-Latrobe-Box Hill-Monash MCT													
Melbourne Airport-Keilor-Deer Park-Derrimut MCT													
CBD-Vic Park-Bulleen-Doncaster Hill MCT													
Glen Waverley-Knox City extension													
Camberwell-Box													
Williams Landing-Point Cook-Tarneit MCT													
Williams Landing-Truganina-Sayers Rd MCT													
Sunshine-Footscray-Kingsville-Altona MCT													
Newport-Sunshine-Ginifer-Brimbank C MCT													

for comment

Table 14: Phase 3 -Proposed Construction, Testing and Commissioning Program

Proposed Phase 3 - Construction, Testing and Commissioning Program													
Projects	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
MM1 tunnel South Kensington-Town Hall-Hawksburn													
Cheltenham Turnback													
West Footscray Turnback													
Werribee line signalling upgrade													
Platform lengthening for HCMT trains													
Traction power upgrading													
Park Street, South Melbourne. tram connection													
Melbourne Airport Rail Link													
Dandenong-Cranbourne duplication													
Cranbourne-Clyde re-opening													
S. Cross-Wyndham Vale electrification													
Deer Park-Melton electrification													
Station Pier, Port Melbourne. tram extension													
Caulfield/Northern Loops reconfiguration													
Gowrie-Upfield duplication													
Upfield-Roxburgh Park re-opening													
Essendon turnback													
Craigieburn line signalling upgrade													
Sandringham second platform													
Greensborough-Eltham duplication													
Spencer St to West Melbourne tram extension													
Frankston-Baxter electrification													
Mooroolbark-Lilydale duplication													
Burnley Junction upgrade													
Melton-Bacchus Marsh electrification													
West Melbourne-North Melbne stations tram loop													
Werribee-Black Forest Road link													
Fishermans Bend tram extensions													
Clifton Hill-Fitzroy-Parkville tram extension													
MM2 tunnel Newport-Fishermans Bend-Croxton													
Stony Point line crossing loop													
Craigieburn-Wallan electrification													
West Preston-Latrobe Uni tram extension													
North Coburg-Merlynston tram extension													
Burnley-Camberwell 4th track													
Ferntree Gully-Upper Ferntree Gully duplication													
East Brighton-Moorabbin tram extension													
SEFL Stage 1 - Caulfield-Dandenong													
Carnegie-Carnegie Station tram extension													
Darling Rd-East Malvern Station tram extension													
Airport West-Melbourne Airport tram extension													
Parkville-West Melbne-North Melbne tram extension													
Caulfield-Monash-Keysborough MCT													
W Maribyrnong-Avondale Heights tram extension													
Sunbury-Clarkefield electrification													
Malvern-Darling Station tram extension													

Proposed Phase 3 - Construction, Testing and Commissioning Program (continued)													
Projects	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**
Caulfield-Monash-Keysborough MCT													
Elsternwick-Monash-Rowville MCT													
Ringwood-Dandenong-Mentone MCT													
Melbourne Airport-Latrobe-Box Hill-Monash MCT													
Melbourne Airport-Keilor-Deer Park-Derrimut MCT													
MM2 tunnel Newport-Croxton													
SEFL Stage 2 – Southern Cross-Caulfield													
SEFL Stage 3 – Dandenong-Pakenham													
W Maribyrnong-Avondale Heights tram extension													
Sunbury-Clarkefield electrification													
Malvern-Darling Station tram extension													
Camberwell-East Kew tram extension													
CBD-Vic Park-Bulleen-Doncaster Hill MCT													
Glen Waverley-Knox City extension													
Camberwell-Box													
Williams Landing-Point Cook-Tarneit MCT													
Williams Landing-Truganina-Sayers Road MCT													

for comment

Proposed Phase 3 - Construction, Testing and Commissioning Program (continued)													
Projects	**2045**	**2046**	**2047**	**2048**	**2049**	**2050**							
Williams Landing-Truganina-Sayers Road MCT													
Sunshine-Footscray-Kingsville-Altona MCT													
Newport-Sunshine-Ginifer-Brimbank Central MCT													

Further details of each project are in Appendices HR 3 to HR 26, T 17 to T 42 and M 4 to M 15 including project description, purpose, infrastructure requirements, operational and fleet implications and a high-level cost estimate.

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13. Investment Profile

In this Plan, a detailed cash flow profile has not been developed for the proposed investments as this would require robust cost estimates based on full project scoping, risk assessment, good knowledge of constructability issues and assumptions regarding procurement strategies. These are matters that would normally be addressed in the Business Case for each project. Instead, based on high level capital cost estimates for each project, aggregate cash flows by mode have been prepared in 5-year blocks, commencing from the 2019/20 financial year, as shown in the following table.

Table 15: Estimated Cash Flows over 30 years for Proposed Projects

Melbourne Rail Plan Estimated Project Cash Flows 2019/20 to 2048/49								
Project Group	**2019/20 to 2023/24 $m**	**2024/25 to 2028/29 $m**	**2029/30 to 2033/34 $m**	**2034/35 to 2038/39 $m**	**2039/40 to 2043/44 $m**	**2044/45 to 2048/49 $m**	**30-year Program $m**	**Notes**
Heavy rail infrastructure	20,465	19,085	19,850	9,200	1,000		69,600	(1)(4)(5)
Heavy rail rolling stock	1,500	1,500	1,155	900	200		5,255	(3)(5)
Tram infrastructure	3,260	4,080	1,180	40			8,560	(1)(5)
Tram rolling stock	715	1,100	1,015	540			3,370	(3)(5)
MCT infrastructure		250	6,200	9,150	8,450	5,445	29,495	(1)
MCT rolling stock		150	600	600	600	450	2,400	(2)(3)
Totals	**25,940**	**26,165**	**30,000**	**20,430**	**10,250**	**5,895**	**118,680**	
Average Annual Outlay	**5,188**	**5,233**	**6,000**	**4,086**	**2,050**	**1,179**	**3,956**	

Notes to the above table:

(1) Includes associated systems for operational control, passenger information, power supply management, etc.
(2) Excludes cost of depots and rolling stock maintenance facilities – these items are included in MCT infrastructure
(3) Rolling stock capital costs assume compliance with Government policy of minimum 60% local content
(4) First 5 years to 2023/24 includes the estimated cost of MM1, less expenditure incurred prior to 2019/20
(5) Additional heavy rail and tram projects are likely to be added to the program from 2034/35 onwards. These will be identified in subsequent updated versions of this Plan.

Individual estimated capital costs of each project included in the aggregate figures above are shown in Appendices. HR 2-H 26 (Heavy Rail), T 16-T 43 (Tram) and M 3-15 (MCT)

Initial investments to 2024 should largely be within the funding capacity of the State Government, supported by Federal Government contributions, within normal budgetary and electoral cycles. This part of the program is dominated by the Melbourne Metro (MM1) project, associated works and western suburbs electrification extensions.

The following 10 years to 2034 is more ambitious with a program that will also entail Federal Government contributions, new and innovative funding sources, including significant private sector involvement and greater use of value capture. The 10 years to 2034 will be dominated by the delivery of several very large projects including reconfiguration of the City Loop, Melbourne Airport Rail Link (MARL), MM2 and the first stage of the *South-Eastern FastLine*. It will also include the first two of several cross-suburban Medium Capacity Transit (MCT) projects, significant re-investment in the tram network and tram fleet and numerous smaller but important projects.

With the majority of proposed heavy rail projects completed or nearing completion, the primary focus for the 10 years to 2044 will be development of the MCT second tier network, providing intermediate level capacity, mainly over key orbital and cross-suburban corridors, as a critical alternative to private car dependency and creating much of the base public transport network grid that will require further infill in subsequent years.

The potential for value capture as a source of project funding is the subject of on-going debate. Value capture refers to the potential uplift in economic values, such as property, to contribute a proportion of infrastructure investment costs. Experience from other jurisdictions indicates that there is potential for this in Victoria, and while its capacity to be a source of upfront funding should not be overstated, it should still be pursued and utilised more aggressively in future by Victorian Governments.

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Appendices

Category	*Appendix*	*Title*
Heavy Rail	HR 1	Metro Train Service Specification
		Heavy Rail Capex Project Details
Heavy Rail	HR 2	Heavy Rail Capex Summary
	HR 3	Metro 1 Tunnel – Ancillary Works Package
	HR 4	Duplication Single Line Sections
	HR 5	RRL Electrification Southern Cross – Black Forest Road
	HR 6	Melton Electrification – Stage 1 Robinsons Rd Junction – Melton
	HR 7	Melton Electrification – Stage 2 Quadruplication – B Marsh
	HR 8	Extension electrification and Reopening - Cranbourne – Clyde
	HR 9	Extension electrification and Reopening – Upfield – Somerton
	HR 10	Link – Black Forest Rd – Werribee and Electrification
	HR 11	Extension electrification – Craigieburn to Wallan
	HR 12	Extension electrification – Sunbury to Clarkefield
	HR 13	Extension electrification – Frankston to Baxter
	HR 14	Metro 1 Rail Tunnel
	HR 15	City Loop Re-configuration and Burnley Junction Changes
	HR 16	Airtrain – Southern Cross – Sunshine – Melbourne Airport
	HR 17	Metro 2 - Newport – CBD – Parkville – Fitzroy - Croxton
	HR 18	South East FastLine – Stage 1 Caulfield - Dandenong
	HR 19	South East FastLine – Stage 2 Southern Cross - Caulfield
	HR 20	Extension electrification and line – Glen Waverley – Knox City
	HR 21	Metro Train Fleet Acquisitions
	HR 22	Metro Train Power supplies, Signalling
	HR 23	Train stabling and Maintenance
	HR 24	New stations on existing electrified lines
	HR 25	Quadruplication – Burnley Junction to Camberwell
	HR 26	Quadruplication - Camberwell to Box Hill
		Tram Capex Project Details
Category	***Appendix***	***Title***
Tram	T 1	Tram Service Specification
	T 2	Proposed Tram Route Alterations and Extensions
	T 3	Comparison and Evolution Existing to Route Network – 2034
	T 4	Comparison of Existing and Proposed Peak Route Frequencies
	T 5	Comparison of Existing and Proposed Peak Route Capacities
	T 6	Existing and Proposed CBD Route Capacity by CBD Street
	T 7	Existing and proposed CBD Points of Route Termination
	T 8	Summary of CBD Key Tram Interchanges - Connectivity
	T 9	Projected Tram Fleet Profile and Fleet Acquisitions
	T 10	Stage 1 2024 Proposed Peak Fleet Disposition by Route
	T 11	Stage 2 2029 Proposed Peak Fleet Disposition by Route
	T 12	Stage 3 2034 Proposed Peak Fleet Disposition by Route
	T 13	Stage 5 2044 Proposed Peak Fleet Disposition by Route
	T 14	Proposed Routes – Progressive Introduction of 40m Trams
	T 15	Tram Infrastructure Program - Staged Improvements

Tram Capex Project Details (continued)		
Category	***Appendix***	***Title***
Tram	T 16	Tram Capex Summary
	T 17	Additional Curve Pairs
	T 18	CBD – Additional Twin Trackage
	T 19	CBD – Additional Track Connections
	T 20	NEW Twin Track Network Turnbacks
	T 21	Port Melbourne – Extension to Station Pier and Turnback
	T 22	Conversion Single to Twin Track Termini
	T 23	Depots and Maintenance Facilities
	T 24	Accessible Platform Stops, Power Supplies, Tram Priority
	T 25	Tram Fleet Acquisitions
	T 26	Tram Supervisory, Monitoring and PIDS Systems
	T 27	Additional twin trackage Park Street – South Melbourne
	T 28	Extension Remand Centre to West Melbourne Station
	T 29	One Way Loop West Melbourne – North Melbourne Stations
	T 30	NEW Cross-Northern Connection – North Melbne to Clifton Hill
	T 31	Extension Route – 3 to East Malvern Station
	T 32	Extension Route – 5 to Darling Station
	T 33	Extension Route - 11 to Latrobe University
	T 34	Extension Route – 19 to Merlynston Station
	T 35	Extension Route – 48 Victoria Harbour to Westgate Park
	T 36	Extension Route – 57 to Lower Avondale Heights
	T 37	Extension Route – 59 to Melbourne Airport
	T 38	Extension Route – 67 (Stage 1) to Carnegie Station
	T 39	Extension Route – 67 (Stage 2) to Dandenong Road
	T 40	Extension Route – 68 to Moorabbin Station
	T 41	Extension Route – 72 to East Kew (Kilby Road)
	T 42	Extension Route – 109 Victoria Harbour to Sandridge/Wirraway
MCT Capex Project Details		
Category	***Appendix***	***Title***
MCT	M 1	MCT Service Specification
	M 2	MCT Characteristics
	M 3	MCT Capex Summary
	M 4	Doncaster BRT - Fitzroy and Doncaster End Components
	M 5	Derrimut – Deer Park Station - Melbourne Airport
	M 6	Melbourne Airport – Latrobe University – Monash NEIC
	M 7	Ringwood Station to Mentone Station
	M 8	Caulfield Station to Keysborough
	M 9	Elsternwick Station to Rowville
	M 10	Sunshine Station – Footscray Station – Altona Station
	M 11	Newport Station – Sunshine Station – Brimbank Central
	M 12	Williams Landing Station to Tarneit Station
	M 13	Williams Landing Station to Sayers Road Station
	M 14	MCT Fleet Acquisitions
	M 15	MCT Depots and Maintenance Facilities

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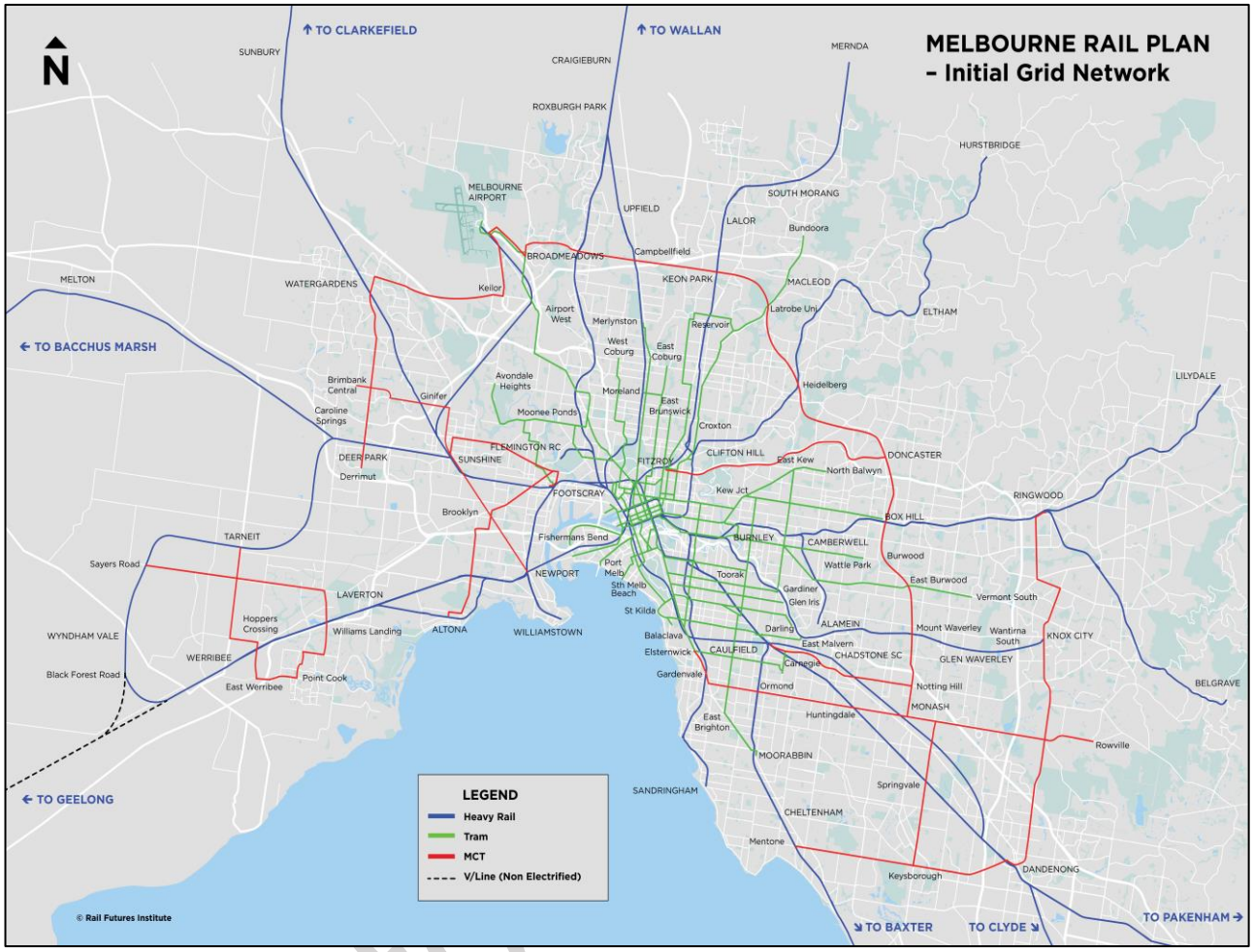
Australian Bureau of Statistics, 2017. *Australian Demographic Statistics, Jun 2017 – Estimated Resident Population, States and Territories* & Australian Bureau of Statistics, 2017: *Population Projections, Australia, 2012 (base) to 2101.*

http://infrastructureaustralia.gov.au/policy-publications/publications/future-cities-melbourne-maps.aspx

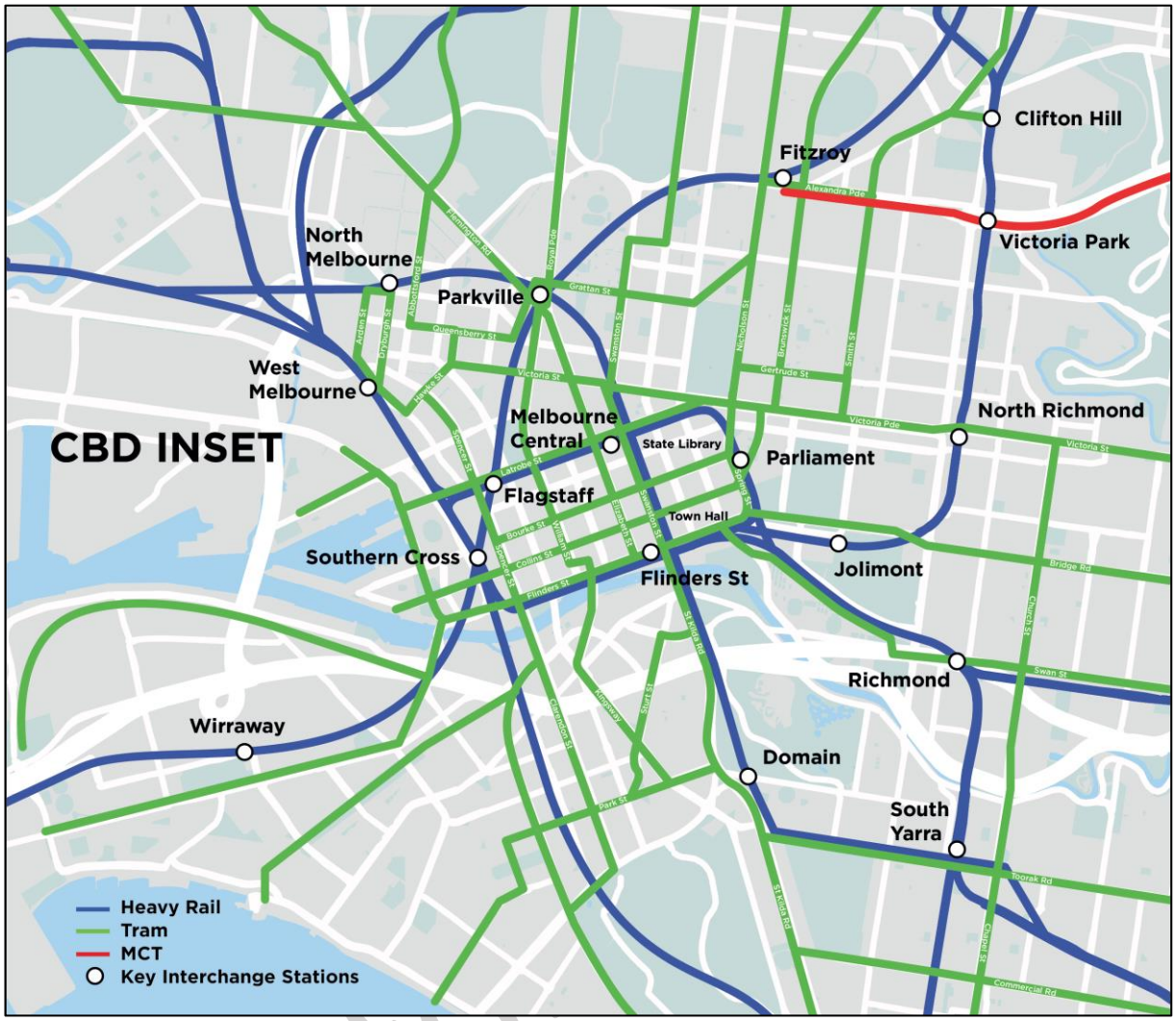
NEED TO EXPAND

Draft for comment

Figure 55: Melbourne Rail Plan – Network Map 2050



Draft for


CBD INSET
Clifton Hill
Fitzroy
Victoria Park
North Melbourne
Parkville
West Melbourne
Melbourne Central
State Library
Parliament
North Richmond
Flagstaff
Town Hall
Southern Cross
Flinders St
Jolimont
Richmond
Wirraway
Domain
South Yarra
Heavy Rail
Tram
MCT
Key Interchange Stations

Draft for