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Strategic Modelling Outcomes

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Strategic Transport Modelling Outcomes

Prepared for Infrastructure Victoria by Arup and AECOM.

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[1] https://ctan.org/pkg/memoir

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Glossary

Term	Description
AV	Autonomous vehicle
CBD	Central business district
CCM	Cross city motorway
CLR	City loop reconfiguration and northern rail corridor project
DoT	Department of Transport
EAV	Electric and autonomous vehicles
FER	Functional economic region
FUA	Functional urban area
IV	Infrastructure Victoria
MM2G	Melbourne Metro 2 and direct Geelong rail services project
NDS	Network development scenario
OMR	Outer Metropolitan Ring Road
PHT	Passenger hours travelled
PKT	Passenger kilometres travelled
PT	Public transport
PV	Private vehicle
RMS	Road management systems
SALUP	Small area land use projection
TBC	Transport base case
VHT	Vehicle hours travelled
VITM	Victorian Integrated Transport Model
VKT	Vehicle kilometres travelled
VLUTI	Victorian land use and transport integration model
VU	Victoria University
WFH	Working from home
WRU	Western rail upgrade project

Executive Summary

PROJECT SCOPE

To support the development of *Victoria's infrastructure strategy 2021-2051* (*Victoria's infrastructure strategy*) Arup and AECOM were engaged to provide high level preliminary cost estimation, demand modelling and economic analysis of several transport projects and scenarios as selected and specified by Infrastructure Victoria (IV).

IV has identified the selected projects taking into consideration their potential benefits to address future key challenges. This includes future population growth in areas expected to come under pressure; improving access to jobs and services between the city, key precincts, and outer suburban and growth areas; and to support Plan Melbourne's *direction 1.1* to create a city structure that strengthens Melbourne's competitiveness for jobs and investment. The selected projects also have the potential to encourage better use of existing assets through improved road network operation systems and to complement other major transport projects already under construction. The projects are described below:

City Loop Reconfiguration and Northern Rail Corridor Upgrade (CLR) A broad group of interrelated changes to the rail network facilitating increased service provision along the Craigieburn, Frankston and Glen Waverley corridors. This also includes new stations and the extension of the metropolitan rail services towards Wallan.

Cross City Motorway (CCM) Widening of the Eastern Freeway from Chandler Highway inbound and a new road tunnel that forms an east-west connection connecting the Eastern Freeway and CityLink to West Gate Tunnel.

Melbourne Metro Two and Direct Geelong Rail Line (MM2G) The construction of a new rail tunnel connecting Newport to Clifton Hill, to support additional train services on Hurstbridge, Mernda, and Werribee / Williamstown services and support direct electrified train services to Geelong.

Outer Metropolitan Ring Road (OMR) A new tolled ring road across Melbourne's outer western and northern suburbs, facilitating 100 km/h travel for private vehicles and freight. While the corridor will ultimately be used for rail freight also, no rail freight has been considered as part of this scope.

Road Management Systems (RMS) A combination of network-wide operational improvements, such as improved traffic signal timings, for arterial roads in metropolitan Melbourne as well as lane configuration changes on select corridors to assist with traffic flows and public transport reliability and punctuality, assumed to drive an increase in efficiency across the network.

Western Rail Corridor Upgrade (WRU) Upgrades to the Melton rail corridor to support extension of the metropolitan rail services from Sunshine to a new station at Mount Atkinson. This would also enable increased capacity to the Pakenham/Cranbourne corridors in Melbourne's south-east.

Demand modelling and economic analysis was also undertaken for two additional sensitivity tests to help explore the resilience of projects to disruption caused by a range of factors (including the COVID-19 pandemic and technology disruption):

Working From Home (WFH) Testing the impact of ongoing working from home with assumptions regarding affected industries, commuter trip rates, and changes to non-home based travel. This scenario explored the impact of employees in suitable industries choosing to work from home 2 days per week, and the impact that will have on network capacity and land use projections for population and employment.

Automated and Electric Vehicles (EAV) Testing the impact of increased automated and electric vehicle use, with assumptions regarding lower emissions, reduced value of time, and reduced vehicle operating costs. This scenario explores the outcomes of a network with automated vehicle technology resulting in increased trip making, and the impact that will have on network performance, and land use projections for population and employment.

This report contains a description of the approach undertaken for the demand modelling portion of this assessment, as well as the resultant outcomes.

APPROACH

Arup and AECOM have supported IV to develop cost estimation, demand modelling and economic analysis to support an overarching project appraisal presented in the IV Major Transport Program Strategic Assessment Report. This material has been used to inform recommendations in Victoria's infrastructure strategy as shown in Figure 1.

For the demand modelling specifically, the Victorian Land Use and Transport Integration (VLUTI) model was used to model a set of base case scenarios and six projects corresponding to the described major projects considered for the IV Major Transport Program Strategic Assessment Report. Several additional scenarios were also modelled in the VLUTI for the aforementioned sensitivity tests regarding working from home and automated/electric vehicles. All scenarios were modelled for 2036 and 2051.

The VLUTI model is an integrated land use and transport model combining a spatial economic model developed by Victoria University's Centre of Policy Studies (CoPS) and the Department of Transport's (DoT) Victorian Integrated Transport Model (VITM). These two models operate together to incorporate land use outcomes in a feedback loop with

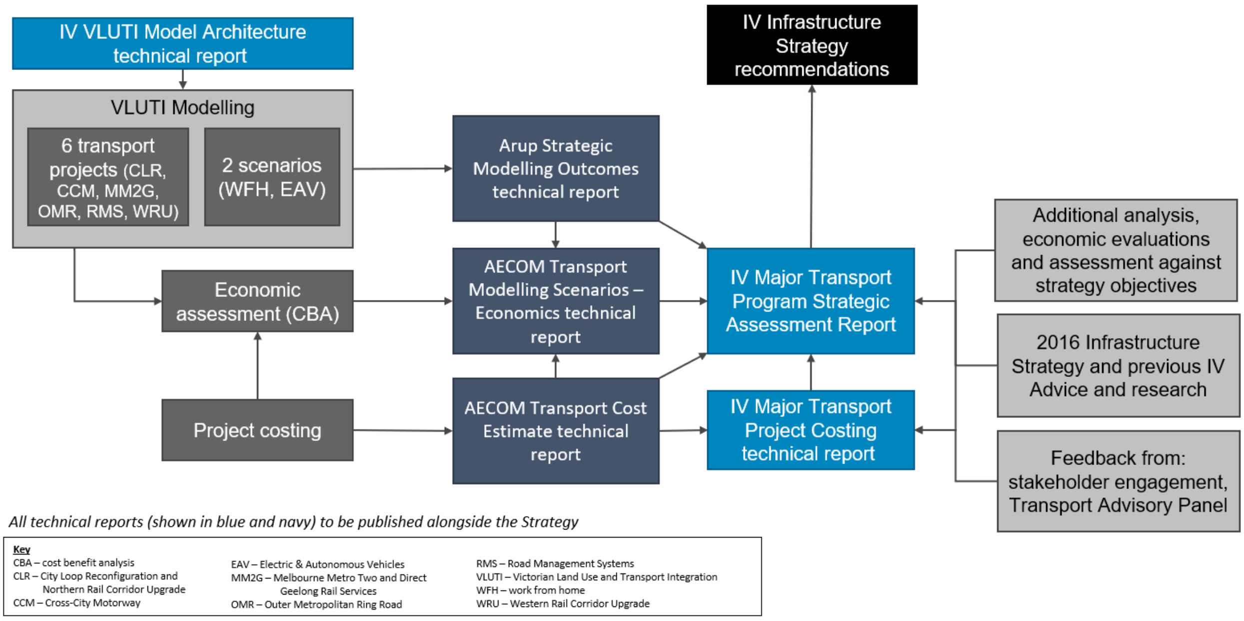

Figure 1: Role of Arup and AECOM's work in informing recommendations

the traffic distribution and assignment process. This allows for land use and network performance to directly influence each other during testing, rather than land use remaining as a static input. Whilst these interactions can be complex to interpret, generally interventions that increase accessibility will attract more residents or jobs towards those locations in varying ways[3]. VLUTI forecasts were also compared with the conventional modelling approach of using the VITM only.

[3] A full description of the VLUTI model is provided in the supporting technical report: *VLUTI Model Architecture Report* [Vic21].

PRESENTATION OF RESULTS

Demand modelling outcomes are split across two sections – one covering the results of the six transport infrastructure projects and one covering the additional sensitivity tests undertaken. For each set of scenarios the following aspects are discussed:

Demographic Changes
: The manner in which the tested scenarios affected demographic distributions of population and employment relative to the appropriate base case.

Travel Demand
: How the tested scenarios affected the amount of travel occurring, the mode choice of trip makers and where such changes were seen.

Network Impacts
: The effects of the tested scenario on network performance metrics such as congestion across the road network and public transport crowding relative to the base case.

Accessibility
: Aggregate changes to journey times experienced across the tested scenarios relative to the base case.

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Part I

CONTEXT

1 Introduction

▸ INFRASTRUCTURE VICTORIA (IV) plans to release *Victoria's infrastructure strategy 2021-2051* reflecting Victoria's evolving infrastructure needs and priorities. On behalf of IV, Arup and AECOM conducted strategic transport modelling assessments that contribute toward the strategy's evidence base. This report summarises the outcomes of these assessments.

1.1 BACKGROUND

In 2016, IV released the first iteration of Victoria's 30-year Infrastructure Strategy[1]. This was an evidence-based view of what future infrastructure and planning policy would be required to provide for the state's growth. As the future outlook for Victoria changes through means as varied as the global economy, national politics, emerging technologies or changing values, the assumptions made in previous planning exercises become less certain. The forthcoming 2021 strategy is intended to address these changing conditions.

[1] *Victoria's 2016 30-Year Infrastructure Strategy* [Vic16]

Contributing to this update, Arup and AECOM were engaged by IV to forecast how Victoria's transport network and land use patterns may evolve over time. The focus of this work was the assessment of several specific city-shaping infrastructure projects using the *Victorian Land Use Transport Integration* model (VLUTI). These assessments build upon several other reports, including:

- *VLUTI Model Architecture Report*[2]. An overview of the VLUTI model development process and motivations.
- *Problem Definition Modelling Outcomes*[3]. A general assessment of the Victorian transport network's capability to meet the population's future mobility needs given a broad set of infrastructure staging assumptions.

[2] See [Vic21].

[3] See [AA20].

As was the case with the previous problem definition report, impacts to future land use were explored in addition to the traditional strategic transport assessment through the VLUTI. Decisions people make about where they live and work are linked to the structure of our transport network in a feedback loop. As such, both land use and transport factors shape how cities grow over time.

1.2 THIS REPORT

This report summarises the strategic transport modelling undertaken by Arup and AECOM in order to assess several large infrastructure projects (as well as several accompanying sensitivity tests) using the VLUTI. It is structured as follows:

- §1 *Introduction* provides an overview of the assessment undertaken and how to navigate this report.
- §2 *Approach* covers the high-level mechanics of the VLUTI and scenario tests undertaken.
- §3 *Assumptions* outlines the land use and network assumption inputs adopted across each scenario test conducted.
- §4 *Infrastructure Tests* discusses the outcomes of the infrastructure scenario tests from a network performance perspective.
- §5 *Sensitivity Tests* discusses the outcomes of the accompanying sensitivity scenario tests from a network performance perspective.

Separate infrastructure costing and economic analysis reports have also been prepared covering this assessment through a different lens.

1.3 TERMINOLOGY

In contextualising assessment outcomes, this report uses specific terminology related to scenarios, regions, time periods and performance metrics to illustrate impacts across different parts of Victoria and to elements of the transport system. For clarity, these are outlined in the subsequent sections.

1.3.1 *Scenario Nomenclature*

This report will use the terms *project* and *scenario* when referring to the testing undertaken depending on context. For clarity, these two terms are defined as follows:

Project A specific group of infrastructure and/or policy assumptions that has been adopted across the set of modelled years. For example, due to staging the Outer Metropolitan Ring Road (OMR) project has a different assumed configuration in 2036 and 2051. The OMR *project* generically refers to both of these configurations regardless of modelled year unless otherwise stated.

Scenario The combination of a specific project (i.e. set of assumptions) and modelled year. For example, the OMR in 2036 represents a specific scenario that was tested.

1.3.2 *Region Systems*

When referring to specific parts of the state, unless otherwise stated, this report uses two region systems – *Functional Urban Areas* (FUA) and *Functional Economic Regions* (FER):

- The FUA system splits Victoria into six regions, defined by their level of centrality to Melbourne's CBD (Figure 1.1). This also accounts for potential growth opportunities in the future.

- The FER system defines distinct parts of Melbourne's geography that correspond to interconnected, regional economics within the city (Figure 1.2). In brief, trade, commerce, commuting and other activities occur more frequently between firms and residents within these regions than those outside of them[4].

[4] More information on the FER system can be found in *Melbourne Functional Economic Region Report*, prepared by *SGS Economics and Planning* for IV [EP19].

1.3.3 *Time Periods*

The VLUTI aims to represent travel demand and network performance for the average non-school holiday weekday. This representative day is split into four distinct periods (Table 1.1) to account for varying travel behaviours during these times. Assessment outcomes will often correspond to one of these specific time periods.

Table 1.1: VLUTI time periods

Time Period	From	To
Morning peak (AM)	7AM	9AM
Inter-peak (IP)	9AM	3PM
Evening peak (PM)	3PM	6PM
Off-peak (OP)	6PM	7AM

1.3.4 *Metrics*

The outcomes of each scenario are represented through metrics that have precise definitions. Travel will often be characterised in terms of *kilometres travelled* or *hours travelled*. This is the number of people or vehicles travelling multiplied by the distance or time spent travelling for a particular time period.

Both congested and crowded conditions also have precise definitions within the context of this report:

Congestion
: Measures of congestion represent the degradation of road performance that accompanies sources of delay. Within the VLUTI, road performance is a function of volumes relative to a road's *capacity*[5]. As the volumes on a road rise, congestion is said to have worsened and is represented by a higher volume/capacity ratio.

[5] Estimated based on a number of characteristics like number of lanes, purpose, impedance from parked cars and public transport etc.

Crowding
: Each type of public transport vehicle has a defined load standard capacity[6]. The level of crowding on a particular public transport service can be characterised as a percentage of this load standard value.

[6] A passenger density limit defined by DoT. Beyond this density limit the vehicle is considered *crowded*.

For the purposes of this report, *congested travel* is said to occur on roads that are experiencing volumes above 80% of their capacity. 80% capacity corresponds approximately with 'Level of Service D' conditions[7]. Similarly, *crowded travel* is said to occur when passenger volumes on public transport exceed 80% of the load standard value.

[7] *Level of Service* refers to a standardised scale of quantitative and qualitative measures for determining road conditions used throughout transport assessments.

Figure 1.1: Functional Urban Areas

Figure 1.2: Functional Economic Regions

1.4 LIMITATIONS

It is important to note that model outputs are always an approximation of what can be expected in the real/built environment. They are subject to technical limitations and the general uncertainty associated with projections. As such, it is important that results from the VLUTI are treated with caution and interpreted with an understanding of the strengths and weaknesses of these modelling tools[8], as well as the basis of inputs adopted.

[8] See §A and §B.

2

Approach

Six transport infrastructure projects were assessed for this report. An additional two sensitivity tests were also conducted, exploring the potential impacts of other behavioural, technological and policy-based changes that may manifest in the future. Furthermore, since its initial development, several updates were implemented within the VLUTI to improve the methodology and support this work.

2.1 VLUTI updates

The VLUTI was developed by the consultant team for IV from a modified version of the Department of Transport's (DoT) *Victorian Integrated Transport Model* (VITM). It incorporates a land use model developed by Victoria University (VU) in a feedback loop with the VITM's traffic distribution and assignment processes. This allows for land use and network performance to directly influence each other during testing, rather than the land use remaining as a static input. Whilst these interactions can be complex to interpret, interventions that increase accessibility will generally attract more residents or jobs towards those locations in varying ways[1].

Between the finalisation of the problem definition assessment[2] and the commencement of this work, VU implemented significant structural changes to the underlying land use model component of the VLUTI. This necessitated several internal changes to the VLUTI beyond those described in the architecture report[3]. Whilst that document still represents the most authoritative description of the model's structure, the following updates are worth noting:

- In the previous version of the VLUTI, freight demand remained unaffected by broader population and employment changes. The new version adopted for this assessment harnesses more granular industry and occupation data produced by the land use model. This means that freight demand within the land use model now reacts to changes in transport costs in the same way that the population does.
- Several additions were implemented for the Department of Transport's (DoT) economic evaluation module to help capture wider economic benefits that result from land use changes[4].

§B provides further background for the VLUTI model, including references that detail the underlying land use model's mechanisms. §A provides similar background context for the VITM.

[1] Whilst the land use model uses transport costs from the VITM as an important set of inputs to redistribute population and employment, it also considers many other factors across the broader economy simultaneously.

[2] See [AA20].

[3] See [Vic21].

[4] The accompanying economic evaluation report for this assessment will expand on these additions on more detail.

2.2 SCENARIO TESTING

Two groups of scenario tests were conducted – one covering the assessment of several transport infrastructure projects (Table 2.1) and the other covering non-infrastructure-based sensitivity tests (Table 2.2).

Table 2.1: Infrastructure scenario tests

Abbreviation	Full Name	2036	2051
TBC	Transport Base Case	•	•
CCM[a]	Cross-City Motorway	•	•
OMR	Outer Metropolitan Ring Road	•	•
CLR[b]	City Loop Reconfiguration	•	•
MM2G	Melbourne Metro 2 and Direct Geelong Rail Line	•	•
WRU	Western Rail Corridor Upgrade	•	•
RMS	Road Management Systems	•	•

[a] A version of this project was tested with conventional land use assumptions, see §D.1.
[b] A version of this project was tested with conventional land use assumptions, see §D.2.

Table 2.2: Sensitivity tests

Abbreviation	Full Name	2036	2051
NDS	Network Development Scenario	•	•
WFH	Increased Working from Home	•	•
EAV	Electric and Autonomous Vehicles	•	•

All scenario tests were conducted for 2036 and 2051, representing periods 15 and 30 years into the future respectively. In contrast to the VITM, the VLUTI produces its own distribution of population and employment but still relies upon state-wide totals from the *Small Area Land Use Projections*[5] (SALUP) for each of these years[6].

The assumptions underlying all these scenarios are detailed in §3. It is worth noting that the base case scenarios differ between the infrastructure and sensitivity tests[7]. This is because the sensitivity tests served a secondary purpose informing some of IV's other internal research surrounding future trends and travel patterns.

[5] Sourced from *SGS Economics and Planning* in 2018.

[6] See §3.1.

[7] At a Victoria-wide level, the base case used for the sensitivity tests incorporates a greater level of road and public transport supply than the equivalent infrastructure test base case. §3.2 contains further details.

3

Assumptions

▸ EACH SCENARIO IS DEFINED through its road network, public transport and behavioural parameters. 22 scenario tests were conducted as part of this assessment across two groups: *infrastructure testing* and *sensitivity testing*[1].

[1] See §2.2.

A consistent set of state-wide demographic totals were adopted across all scenarios as described in §3.1. As mentioned in §2.2, the base case network assumptions adopted across both groups of scenario tests differed slightly – §3.2 describes the commonalities and differences. Subsequently, §3.3 and §3.4 describe the specific assumptions implemented for each of the scenarios across the infrastructure and sensitivity tests respectively[2].

[2] §C contains a more granular description of each scenario's implementation from a transport modelling perspective.

3.1 DEMOGRAPHIC ASSUMPTIONS

State-wide totals of population, employment, households and enrolments were taken from the SALUP demographic projections – a standard dataset used to inform strategic transport modelling assessments in Victoria. Table 3.1 summarises these totals.

Table 3.1: Victorian demographic totals

Metric	2018	2036	2051
Population	6,464,000	8,863,000	10,838,000
Employment	3,219,000	4,553,000	5,549,000
Households	2,513,000	3,486,000	4,312,000
Enrolments[a]	1,629,000	2,368,000	2,827,000

[a] Including primary, secondary and tertiary students.

For each scenario, the VLUTI model generates its own spatial distribution of population, employment and households throughout the state whilst matching the SALUP total values[3]. The specific spatial distribution of enrolments is taken from SALUP and remains fixed throughout the scenario testing process.

[3] It is worth noting that the VLUTI's land use behaviour is itself calibrated based on SALUP distributions for the 2018 year. See [Vic21].

3.2 BASE CASE NETWORK

The underlying basis of the adopted base case network assumptions is known as the *Network Development Scenario* (NDS)[4]. This includes all funded and committed projects as of the time of testing, as well as non-committed projects that have not been fully planned or assessed but may play an important role in meeting future demand. The NDS is meant to represent reasonable assumptions about the development of

[4] These assumptions align with those used for the previous problem definition modelling assessment [AA20].

a future transport network that align with existing transport planning approaches.

§3.2.1 and §3.2.2 outline the major future road and public transport asssumptions underpinning the base case networks. §3.2.3 explains how the NDS assumptions were modified for the infrastructure scenario tests compared to the sensitivity tests.

3.2.1 *Road Network*

Table 3.2 and Table 3.3 summarise the difference in lane kilometres across the 2018, 2036 and 2051 years under the NDS assumptions by FUAs and FERs respectively.

Compared to today, a large portion of future road investment is located in Melbourne's growth areas. This additional network is intended to support basic connectivity within these development areas to the broader city – hence carrying a proportionally higher level of growth. This is most pronounced north and west of the city.

Table 3.2: NDS lane kilometres by FUA

FUA	2018	2036	vs. 2018	2051	vs. 2018
Inner Melbourne	2,460	2,520	+2.4%	2,530	+2.8%
Middle Melbourne	5,450	5,790	+6.2%	5,860	+7.5%
Outer Melbourne	7,790	8,420	+8.1%	8,920	+14.5%
Growth Areas	1,580	2,690	+70.3%	3,300	+108.9%
Regional Cities	5,620	5,840	+3.9%	5,920	+5.3%
Regional Centres/Rural	79,590	79,910	+0.4%	80,290	+0.9%
Total	102,490	105,170	+2.6%	106,820	+4.2%

Table 3.3: NDS lane kilometres by FER

FER	2018	2036	vs. 2018	2051	vs. 2018
Eastern	3,000	3,060	+2.0%	3,320	+10.7%
Inner	3,990	4,110	+3.0%	4,120	+3.3%
Northern	3,200	4,160	+30.0%	4,410	+37.8%
Peninsula	1,790	1,830	+2.2%	1,890	+5.6%
Southern	4,710	5,180	+10.0%	5,580	+18.5%
Western	4,910	5,650	+15.1%	6,170	+25.7%
Other	80,900	81,190	+0.4%	81,320	+0.5%
Total	102,490	105,170	+2.6%	106,820	+4.2%

Driving these increases in lane kilometres are several significant road projects. These are aimed at providing broad capacity uplifts across key corridors throughout Melbourne and its surrounding regions. Table 3.4 summarises the sequencing of these major projects for 2036 and 2051[5]. Figure 3.1 shows the evolution of these changes spatially.

[5] The fact that a project is present in a particular year does not imply its opening date. For example, the West Gate Tunnel is assumed to come online earlier than 2036. However, that year is the first time it is seen across the modelled scenarios in the context of this assessment.

Table 3.4: NDS major road project sequencing

Projects	2036	2051
Calder Freeway Upgrade	•	•
M80 Upgrades	•	•
Monash Freeway Upgrades	•	•
North East Link	•	•
Tullamarine Freeway Upgrade	•	•
West Gate Tunnel	•	•
Bayswater Bypass	•	•
Bellarine Link - Stage 1	•	•
Bulla Bypass	•	•
Dandenong Bypass Extension	•	•
E6 Corridor	•	•
Tullamarine Freeway Extension	•	•
Westall Road Extension	•	•
Bellarine Link - Stage 2		•
Deer Park Bypass Connection		•
Outer Metropolitan Ring Road[a]		•
Stud Road Extension		•
Western Port Highway Conversion		•

[a] This project is modified in the TBC and the OMR scenario (see §3.3.4).

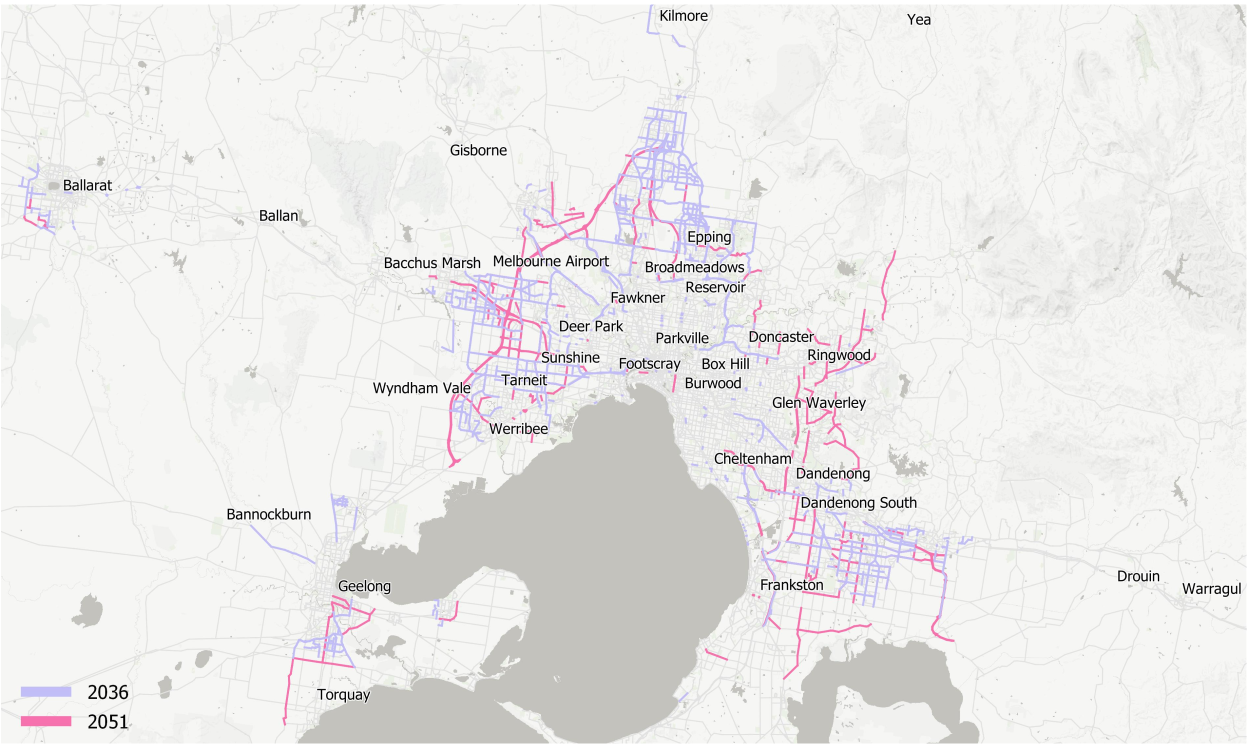

Figure 3.1: NDS road network changes vs. 2018

3.2.2 *Public Transport*

Table 3.5 summarises the differences in daily service kilometres across each public transport mode under the NDS assumptions[6]. Substantial growth in public transport provision is included, achieved through the construction of new infrastructure and increases in frequency throughout the network. There is also the use of higher capacity vehicles that can carry more passengers, contributing to less crowding.

[6]Decreases in V/Line service kilometres between 2036 and 2051 reflect the impact of electrification projects, essentially expanding the size of the metropolitan train network.

Table 3.5: NDS public transport service kilometres

Mode	2018	2036	vs. 2018	2051	vs. 2018
Train	72,220	125,250	+73.4%	195,880	+171.2%
Tram	72,400	77,650	+7.3%	77,650	+7.3%
Bus	388,850	656,880	+68.9%	703,080	+80.8%
V/Line	38,620	69,000	+78.7%	52,990	+37.2%

Table 3.6 and Table 3.7 show the assumed sequencing of major train and tram projects respectively. Bus connectivity also receives improvements through the Suburban Rail Loop (SRL) project, the Doncaster Bus Rapid Transit (BRT) system and increased provision in growth areas.

Table 3.6: NDS major rail project sequencing

Projects	2036	2051
Cranbourne Duplication	•	•
Hurstbridge Line Upgrades	•	•
Melbourne Airport Rail Link	•	•
Melbourne Metro	•	•
Suburban Rail Loop (Southland to Box Hill)	•	•
Burnley Junction Segregation	•	•
Cranbourne East/Clyde Rail Extension	•	•
Cross City Line (Sandringham to Werribee)	•	•
Mount Atkinson Electrification[a]	•	•
Geelong Rail Corridor Improvements	•	•
Mooroolbark-Lilydale Duplication	•	•
Upfield Link	•	•
Wallan Electrification[b]	•	•
Wallan Extension from Upfield[c]	•	•
Suburban Rail Loop (Southland to Melbourne Airport)		•
Geelong Electrification[d]		•
Melbourne Metro 2[e]		•
Baxter Electrification		•

[a]This project is modified in the TBC and the WRU scenario (see §3.3.6).
[b]This project is modified in the TBC and the CLR scenario (see §3.3.1).
[c]This project is modified in the TBC and the CLR scenario (see §3.3.1).
[d]This project is modified in the TBC and the MM2G scenario (see §3.3.3).
[e]This project is modified in the TBC and the MM2G scenario (see §3.3.3).

Figure 3.2 and Figure 3.3 shows the uplift in public transport passenger capacity for the AM period spatially across metropolitan Melbourne.

Figure 3.2: NDS public transport capacity uplifts, 2036 vs. 2018 (AM period)

Figure 3.3: NDS public transport capacity uplifts, 2051 vs. 2036 (AM period)

Table 3.7: NDS major tram project sequencing

Projects	2036	2051
Melbourne Metro Configuration Changes	•	•
Park Street Link	•	•
Caulfield to Monash Route	•	•
Fishermans Bend North and South Routes	•	•
Spencer Street to Arden Route	•	•
Trunk Corridor Service Improvements	•	•

3.2.3 *Transport Infrastructure and Sensitivity Test Differences*

The sensitivity test base case matches the NDS specification as described in §3.2.1 and §3.2.2 (and is referred to as such throughout this report). However, the infrastructure testing requires a base case that does not contain any form of the considered projects whilst still retaining enough transport supply to model sensible future forecasts. Thus, the infrastructure testing base case can be characterised as the same as the one adopted for the sensitivity tests with the following projects excluded:

- Outer Metropolitan Ring Road
- Projects associated with the City Loop Reconfiguration, including the Wallan Electrification and Wallan Extension to Upfield.
- Melbourne Metro 2 and associated Geelong rail corridor improvements.
- Western Rail Corridor Upgrade

The Cross-City Motorway is not mentioned because the NDS specifications do not include this project.

Given the absence of these projects, the sensitivity testing base case provides a higher supply of both road and public transport infrastructure when compared to the infrastructure testing base case. Table 3.8 summarises these differences across different modes of travel. Rail services differ the most between the base case versions, owing in part to the large amount of electrification work assumed within the considered infrastructure projects which transforms V/Line services into metropolitan services.

Table 3.8: Base case supply comparison, infrastructure vs. sensitivity testing

Mode	2036	2051
Private Vehicle (*lane km*)	-0.2%	-0.6%
Train (*service km*)	-14.7%	-40.6%
Tram (*service km*)	+0.0%	+0.0%
Bus (*service km*)	+0.2%	+0.2%
V/Line (*service km*)	+4.6%	+36.2%

§C provides a more detailed view of the implemented specifications for each of the infrastructure projects and the base case.

3.3 INFRASTRUCTURE TESTS

3.3.1 *City Loop Reconfiguration*

The City Loop Reconfiguration (CLR) is comprised of changes to the metropolitan and regional rail networks to support for growth in the north of Melbourne. Overall, the full CLR package would enable an uplift in services across the Craigieburn, Frankston, Glen Waverley and Upfield (Wallan) lines by reorganising how services interact with the city loop as well as a number of capacity and signalling upgrades. It is assumed to connect the Craigieburn line with the Frankston line and connect the Upfield line with the Glen Waverley line. Furthermore, it would include the electrification of the line from Upfield to Wallan. The Upfield to Glen Waverley services extend to Wallan by 2036, with Wallan services using the Upfield line via Craigieburn.

The CLR project provides options to improve the reliability of Shepparton and Seymour services. This includes aligning it along the Upfield line or along the Albion and Jacana corridor[7], which will free up rail paths on the Craigieburn line. This would facilitate more frequent V/Line services to and from Seymour and Shepparton. The primary reason for the shift is to allow for a greater uplift of services on the metropolitan lines, but it would also enable a future uplift in regional services not currently considered in this project.

[7]Use of the Albion and Jacana corridor for regional rail is included in both the project and TBC scenarios as part of an assumed change related to the Inland Rail Project. This will support re-alignment of V/Line services from Seymour to Shepparton onto this corridor.

However, whilst regional services are assumed to operate through the Albion to Jacana sections in both cases, boarding and alighting at Beveridge can only occur in the project on the metropolitan network, with Donnybrook also becoming a metropolitan station.

Table 3.9 shows the difference in daily service kilometres provided by the CLR project compared to the TBC in 2051. The outer north experiences the largest proportional uplift in service levels, with the new metropolitan services able to act as an alternative to existing metropolitan and V/Line routes. Figure 3.4 shows the resultant capacity uplift.

Table 3.9: CLR daily metropolitan rail service kilometres by FUA

FUA	2051 TBC	2051 CLR	% Difference
Inner Melbourne	40,000	39,900	-0.2%
Middle Melbourne	45,200	47,500	+5.1%
Outer Melbourne	25,900	28,900	+11.6%
Growth Areas	2,600	5,500	+111.5%
Total	113,700	121,800	+7.1%

An important consideration when evaluating the effectiveness of this project is that the reconfiguration would result in a very minor increase in travel time for city loop users that currently use rail to travel east and west across the CBD. The re-routing of Upfield and Craigieburn services would mean that a trip is more likely to require a transfer.

Conversely, trip-makers travelling north or south along the corridor would no longer need to transfer and would experience a more frequent service.

3.3.2 *Cross-City Motorway*

The Cross-City Motorway (CCM) would facilitate east-west private vehicle travel for people and freight across Melbourne's inner North by

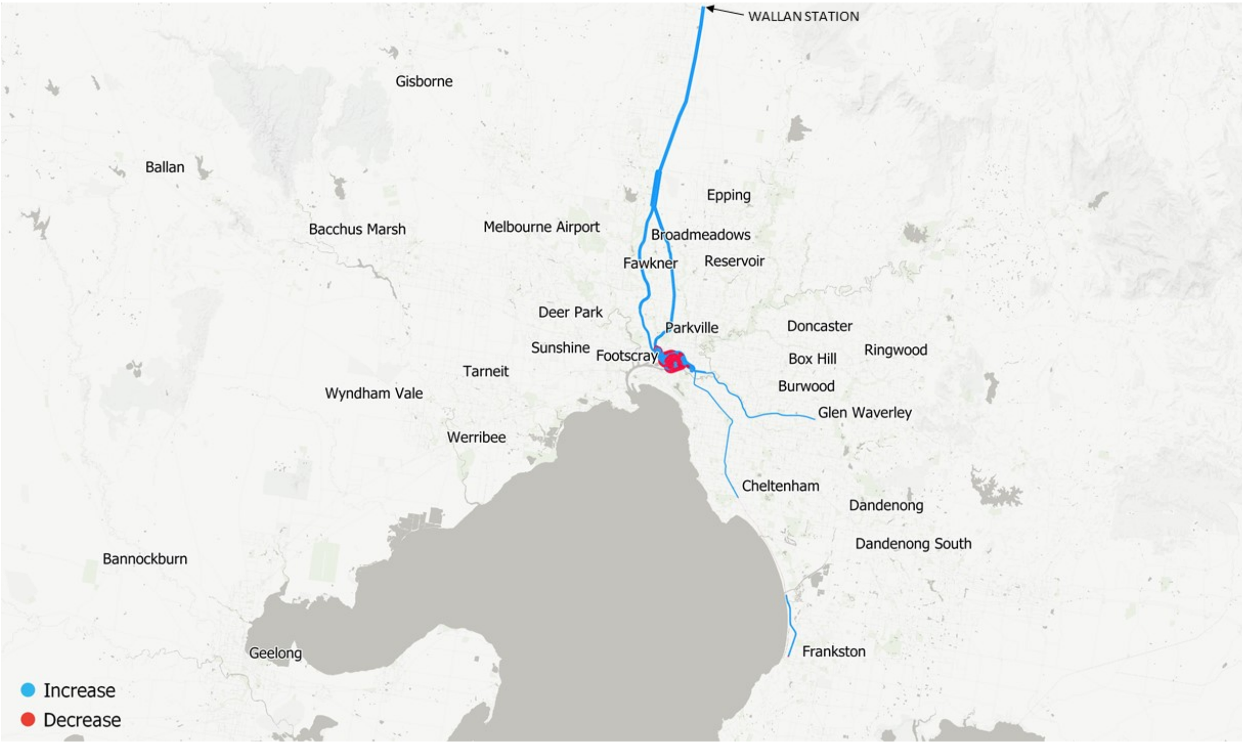

Figure 3.4: CLR capacity uplifts vs. TBC, 2051 (AM period)

providing a connection between the West Gate Tunnel and Eastern Freeway.

Figure 3.5 shows the scope of the CCM project implemented for both 2036 and 2051[8]. It includes the widening of the Eastern Freeway from Chandler Highway to Hoddle Street, after which the CCM transitions into a three-lane tunnel that emerges past Royal Park[9]. Traffic at this point can then access CityLink or continue towards a two-lane connection to Footscray Road and the West Gate Tunnel[10].

[8]Totalling 60 additional lane kilometres. The project does not differ between 2036 and 2051.

[9]Referred to as 'Sector A'.

[10]Referred to as 'Sector B'.

Figure 3.5: CCM project scope

It has been assumed that two toll gantries will be implemented - one for each of Sector A and B. The implemented gantry prices are shown in Table 3.10.

Gantry	Car	Light Commercial	Heavy Commercial
Sector A	$5.95	$9.52	$17.85
Sector B	$0.85	$1.36	$2.55

Table 3.10: CCM toll gantry prices (cents, 2016 dollars)

3.3.3 *Melbourne Metro 2 and Direct Geelong Rail Line*

The Melbourne Metro 2 project involves the construction of a new metropolitan rail tunnel connecting Newport to Clifton Hill, accompanied by the Geelong electrification by 2051.

The project is implemented using a staged approach, with the first stage involving the construction of a new tunnel between Newport and Southern Cross Stations by 2036. This would relieve existing capacity constraints through Footscray by re-routing Werribee services through the new infrastructure. This would also deliver reduced travel times for Geelong services through this more direct route, in addition to facilitating capacity uplifts for Sandringham-Williamstown cross-city services from Wyndham Vale and along the Grampians regional lines.

By 2051, the second stage of the project involves the extension of the tunnel from Southern Cross Station through to Clifton Hill. Coinciding with this is the implementation of the Geelong electrification. In total, this provides an additional cross-city corridor that connects the Werribee line with the Mernda line, allowing a more significant reconfiguration of metropolitan train service patterns. Capacity increases are realised on the South West corridor and each of the Mernda, Hurstbridge, Laverton and Sandringham lines.

Figure 3.6 shows the modelled alignment of the new tunnel and the location of two new stations in Fishermans Bend and one in Fitzroy.

Figure 3.6: Melbourne Metro 2 alignment and stations

Table 3.11 shows the change in daily rail service kilometres provided by FUA[11]. Figure 3.7 and Figure 3.8 shows the resultant capacity uplifts spatially.

[11] Both metropolitan and V/Line services combined.

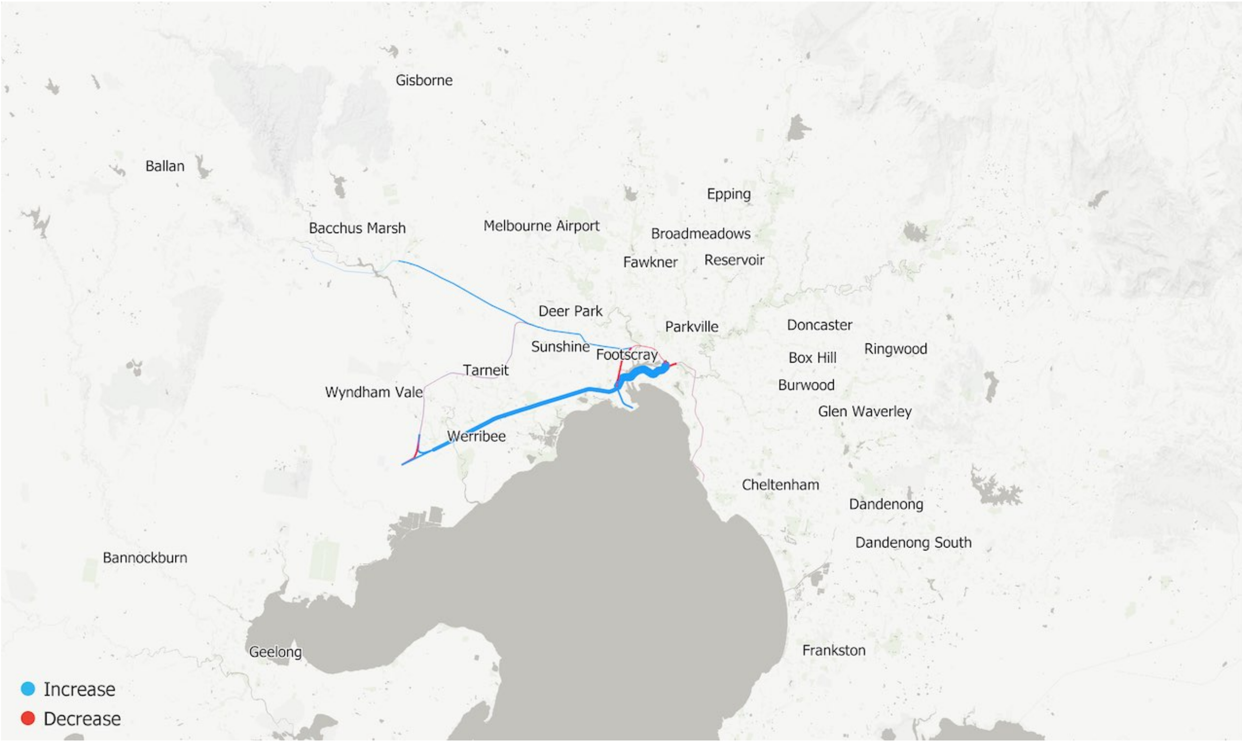

Figure 3.7: MM2G capacity uplifts vs. TBC, 2036 (AM period)

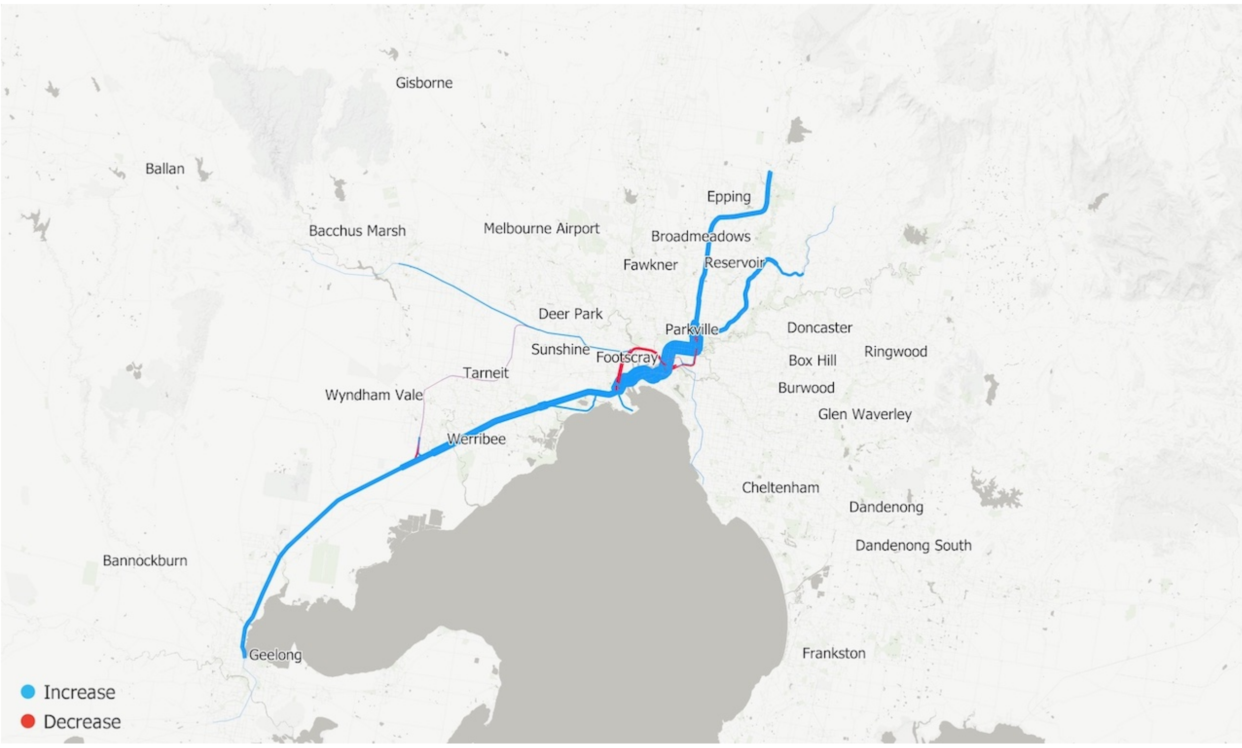

Figure 3.8: MM2G capacity uplifts vs. TBC, 2051 (AM period)

FUA	2036 TBC	2036 MM2G	% Difference	2051 TBC	2051 MM2G	% Difference
Inner Melbourne	45,900	46,700	+1.7%	45,900	49,900	+8.7%
Middle Melbourne	44,800	46,200	+3.1%	50,900	55,100	+8.3%
Outer Melbourne	31,800	33,500	+5.3%	35,000	39,000	+11.4%
Growth Areas	13,800	13,900	+0.7%	13,800	15,000	+8.7%
Regional Cities	9,600	9,600	0.0%	9,600	12,200	+27.1%
Regional Centres/Rural	33,000	33,100	+0.3%	33,300	34,800	+4.5%

Table 3.11: MM2G daily rail service kilometres by FUA

Whilst not included in the considered project, the described implementation would also potentially allow for further upgrades to the Wyndham Vale corridor that caters less to the regional rail network and more to the expansion of the metropolitan network – conceivably consisting of electrified track and new stations between Wyndham Vale and Deer Park. However, in this assessment it remains a regional service. Another benefit of this project is that it would allow for an increase in service frequency on the Mernda line without sacrificing the service requirements of other lines sharing the track between Clifton Hill and Parliament stations.

It is worth noting that a new Melbourne University campus, intended for the General Motors Holden site, would capitalise on the direct link between Fishermans Bend and the main campus serviced by Parkville Station. The demographic change associated with this possibility has not been modelled explicitly in this assessment.

3.3.4 *Outer Metropolitan Ring Road*

The OMR and E6 transport corridor would help facilitate high-speed travel (100 km/h) for people and freight across Melbourne's north and west[12]. It would connect key hubs including Melbourne Airport, Avalon Airport and the Port of Geelong, whilst improving access to a growing residential population in the city's outer suburbs.

[12] Whilst broader planning studies for the OMR corridor make reference to both road and freight rail connections, this strategic assessment focuses on the road component only.

Figure 3.9 shows the scope of the OMR project across the 2036 and 2051 years. The E6 corridor and a portion of the OMR is introduced in 2036, linking the M80 Ring Road, Hume Freeway, Calder Freeway and Melton Highway. The remainder of the OMR is introduced in 2051, adding connections to the Western Freeway and Princes Freeway. The corridor is assumed to be two lanes in each direction for its entire length. Several associated projects such as the Deer Park Bypass Connection and a new link between the OMR corridor and Melbourne Airport are included.

The entire length of the primary OMR and E6 corridors are assumed to be tolled with gantries at every major interchange. The implemented prices were 50 cents, 80 cents and 150 cents for private vehicles, light commercial vehicles and heavy vehicles respectively for each gantry[13].

[13] 2016 dollars.

3.3.5 *Road Management Systems*

The Road Management Systems project seeks to capture the potential impacts of improving road operations management – primarily that of

Figure 3.9: OMR project scope

arterial roads. Three sets of interventions were implemented for the purpose of modelling, described at a high level as follows:

Arterial Operations Improvements
: Network-wide improvements to signal timings and linking across arterial roads within metropolitan Melbourne. This was represented in the VLUTI by increasing the percentage free-flow speed[14] and lane capacity of relevant road types by 6.25% – mostly affecting inner city and arterial routes within the urban growth boundary[15].

New Clearways
: Several new peak-period clearways were implemented across metropolitan Melbourne with the aim of adding a lane of traffic during times of congestion.

Select On-Road Public Transport Improvements
: Specific tram and bus routes were given dedicated right-of-way and/or intersection priority. Intersection priority was represented as a 5 km/h increase in the travel speed of the public transport vehicle in question.

§C.1.6 provides further clarity surrounding the exact interventions implemented for the RMS project, including the location and nature of the clearway and public transport improvements mentioned.

3.3.6 *Western Rail Corridor Upgrade*

The Western Rail Corridor Upgrade incorporates upgrades to the Melton corridor associated with electrification from Sunshine to a new station

[14] The speed at which drivers would be able to travel if there was no congestion or other adverse conditions.

[15] See §C.1.6 for the precise road types modified.

at Mount Atkinson by 2036. Replacing the existing V/Line services with High Capacity Metro Trains (HCMT) allows an increase to the capacity of the services. There is also an increase in the number of services departing from Mount Atkinson, Pakenham and Westall. Table 3.12 shows the change in daily metropolitan rail service kilometres provided by FUA in 2051. Figure 3.10 shows the resultant capacity uplifts.

FUA	2051 TBC	2051 CLR	% Difference
Inner Melbourne	40,000	42,800	+7.0%
Middle Melbourne	45,200	47,900	+6.0%
Outer Melbourne	25,900	28,600	+10.4%
Growth Areas	2,600	3,500	+34.6%
Total	113,700	122,800	+8.0%

Table 3.12: WRU daily metropolitan rail service kilometres by FUA

Figure 3.10: WRU capacity uplifts vs. TBC, 2051 (AM period)

Whilst not modelled as a part of this project, it is worth noting that it would also allow for some improvement to the capacity and reliability of regional Geelong and Ballarat V/Line services.

3.4 SENSITIVITY TESTS

3.4.1 *Increased Working from Home*

The COVID-19 pandemic has shown that rapid and significant changes in commuting behaviour can manifest under specific regulatory conditions and industry practice. It is conceivable that these experiences may lead to a larger proportion of the population electing to work from home, even after the threat of coronavirus has subsided. This sensitivity test considers the potential network performance impacts of such a change.

To construct this test, IV provided the consultant team with a specific set of *'working from home'* factors, representing an assumed propensity for people of a specific industry and location to work from home in the future. This input was then used to recalibrate the VLUTI's land use parameters, as well as the number of commuting (and associated non-home-based trips) generated by the VITM. The result of these changes is a model that produces fewer trips than the what would be found in the NDS scenarios.

To provide an indication of how these assumptions impact demand, Table 3.13 compares the total daily home-based work trips between the WFH tests and the NDS. It can be seen that the implemented changes result in approximately 12-13% fewer commuting trips across the network for private vehicle and public transport travel combined.

Year	NDS	WFH	
2036	4,851,000	-605,000	-12.5%
2051	5,799,000	-729,000	-12.6%

Table 3.13: Difference in total daily statewide trips, NDS vs. WFH

§C.2.1 provides further details surrounding how these tests were constructed.

3.4.2 *Electric and Autonomous Vehicles*

An increased adoption of electric vehicles, and eventually, autonomous vehicles (AVs) could have profound impacts on the cost of travel, broader network efficiency and the availability of private vehicle journeys. This sensitivity test combines a number of assumption changes compared to the NDS that seek to capture the potential implications of this transition, including:

- Changes to private vehicle operating cost to reflect a transition towards a fleet with a higher proportion of electric vehicles in use. Electric vehicle travel was assumed to be accompanied by a 2.5 cent surcharge per kilometre of travel.
- Changes to the average perceived value of time to reflect a transition towards a fleet with a higher proportion of AVs in use. It was assumed that those in AVs have a lower perceived in-vehicle cost of travel compared to a conventially driven vehicle (CDV), reflecting that travel time could be used on activities other than driving.

- The introduction of the concept of an AV vehicle fleet, representing a shared pool of vehicles that could be used by the broader population analogous to today's ride-sharing services. It is assumed that the services would be priced competitively, leading to widespread use. With this, assumptions surrounding car availability within the VITM were relaxed such that essentially everyone had access to private vehicle travel.

Table 3.14 shows the adopted fleet mix for the EAV tests across 2036 and 2051, devised by IV for the purpose of this scenario.

Table 3.14: EAV assumed fleet mix

Year	Region[a]	CDVs	Electric CDVs	Private AVs	Fleet AVs
2036	Inner	48%	32%	10%	10%
	Middle	55%	30%	8%	8%
	Outer	65%	25%	5%	5%
	Regional	68%	25%	4%	3%
2051	Inner	0%	20%	30%	50%
	Middle	5%	35%	35%	25%
	Outer	10%	50%	25%	15%
	Regional	20%	50%	20%	10%

[a]Regions correspond with the FUA system. *Outer* includes both Outer Melbourne and Growth Areas. *Regional* contains the remainder of the state.

In addition to the defined changes, a small proportion of *dead running*[16] was also assumed across the network. §C.2.2 contains further details surrounding the implemented assumptions, including the specific cost adjustments made.

[16] A trip made by an AV with no occupants, for example as it is returning from its drop-off point.

It is noted that the assumptions made regarding electric and autonomous vehicle uptake, their operating costs and efficiencies are based on the best available information informing a *'central'* or *'medium'* level of uptake and performance. There is likely to be a range of government, commercial and private incentives, policies and charges over the coming decades that could result in lower or higher levels of impact than tested. The sensitivity tests devised here are intended to explore this central or medium position and do not constitute a judgement of whether a particular set of policies will achieve or hinder targeted adoption rates.

Part II

OUTCOMES

4

Infrastructure Tests

▸ THIS SECTION SUMMARISES the outcomes of the infrastructure project testing compared to the base case scenarios. The underlying assumptions of these tests are described in §3.3 and §C.1.

4.1 CITY LOOP RECONFIGURATION

4.1.1 *Demographic Changes*

Table 4.1 shows the change in population distribution at 2036 and 2051 respectively for the CLR compared to the TBC. In both 2036 and 2051, the Growth Areas FUA is expected to grow more heavily in terms of residents in the CLR scenario. Figure 4.1 offers further insight into these outcomes, showing these population changes spatially for 2051. Population redistribution is focused along areas of service uplift, most noticeably along the Upfield and Craigieburn lines and south to Frankston.

FUA	2036 TBC	2036 CLR		2051 TBC	2051 CLR	
Inner Melbourne	1,344,000	-3,000	-0.2%	1,709,000	-12,000	-0.7%
Middle Melbourne	2,078,000	+2,000	+0.1%	2,542,000	+2,000	+0.1%
Outer Melbourne	2,310,000	-1,000	≈0%	2,612,000	≈0	≈0%
Growth Areas	1,010,000	+7,000	+0.7%	1,466,000	17,000	+1.2%
Regional Cities	828,000	-3,000	-0.4%	974,000	-3,000	-0.3%
Regional Centres/Rural	1,292,000	-3,000	-0.2%	1,536,000	-4,000	-0.3%

Table 4.1: CLR population changes

Table 4.2 shows the change in employment distribution at 2036 and 2051 respectively for the CLR project relative to the TBC. The spatial distribution of these changes is also shown in Figure 4.2. No significant employment uplift occurs in any business district. Instead, job redistribution moves toward areas with population uplift, driven by the increased household activity and the need for additional retail and service industries.

FUA	2036 TBC	2036 CLR		2051 TBC	2051 CLR	
Inner Melbourne	1,359,000	+2,000	+0.1%	1,592,000	-1,000	-0.1%
Middle Melbourne	991,000	+1,000	+0.1%	1,209,000	+3,000	+0.2%
Outer Melbourne	1,086,000	-1,000	-0.1%	1,376,000	+1,000	+0.1%
Growth Areas	94,000	+1,000	+1.1%	136,000	+1,000	+0.7%
Regional Cities	444,000	-2,000	-0.5%	549,000	-2,000	-0.4%
Regional Centres/Rural	580,000	-1,000	-0.2%	686,000	-2,000	-0.3%

Table 4.2: CLR employment changes

Each dot represents a difference in population of one person. This is the case for all maps of this nature throughout the report.

Figure 4.1: Change in population, 2051 CLR vs. TBC

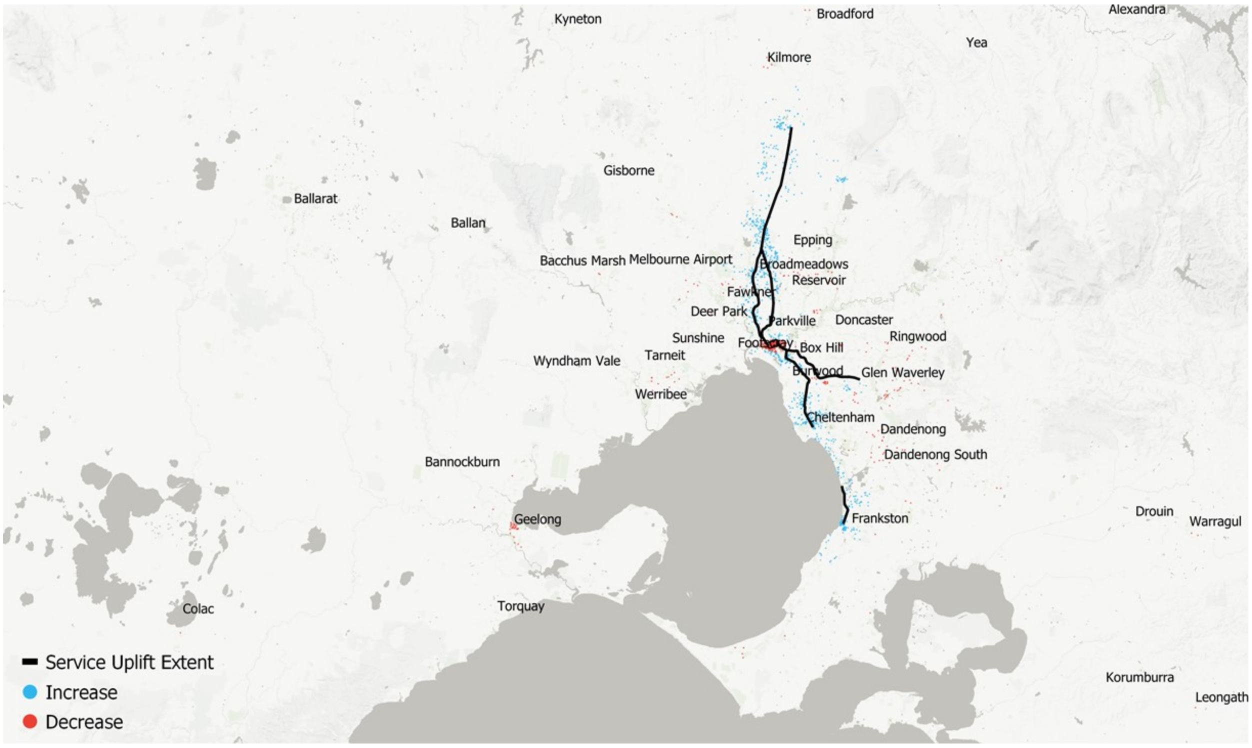

Figure 4.2: Change in employment, 2051 CLR vs. TBC

Compared to the other public transport projects tested, there is limited or no uplift in activity across Melbourne's CBD due to either population or employment redistribution. Instead, the nature of the service reconfiguration leads to the VLUTI moving activity away from the CBD. This is due to the reduction in the number of city loop stations that each train line stops at and a corresponding increase in average public transport travel times for trip makers within the CBD[1]. Although the increase in average travel cost is less than one minute, this still has an impact on the resultant distribution of job and resident locations. It is also worth noting that trips between the northern and southern regions of Melbourne experience improved connectivity due to this change.

[1] See §3.3.1.

As with all project testing in this study, no complementary projects are included which might compensate for the expected disbenefits described. For example, it is conceivable that the additional cost for trip makers in the CBD due to the CLR project might be offset by a network upgrade not currently captured in the assessed project that takes further advantage of the new capacity within the loop. Should this be included it is likely demographic activity in the city would remain stable or grow.

4.1.2 *Travel Demand*

Table 4.3 shows the change in total morning peak trips by mode for the CLR project relative to the TBC. The CLR project increases public transport mode share, most noticeably in the Growth Areas and Middle Melbourne FUAs[2]. When considered by FER, the Northern region is most noticeably impacted.

[2] See Table 4.4 for the change in public transport trips by FUA.

Metric	2036 TBC	2036 CLR			2051 TBC	2051 CLR
Private Vehicle Trips	3,240,000	-2,000	-0.1%	3,789,000	-5,000	-0.1%
Public Transport Trips	529,000	+6,000	+1.1%	663,000	+6,000	+0.9%
Mode Share	14.0%	14.2%	+0.1%	14.9%	15.0%	+0.1%

Table 4.3: CLR changes in morning peak trips

FUA	2036 TBC	2036 CLR			2051 TBC	2051 CLR
Inner Melbourne	191,000	+1,000	+0.5%	231,000	≈0	≈0%
Middle Melbourne	171,000	+3,000	+1.8%	213,000	+2,000	+0.9%
Outer Melbourne	99,000	+1,000	+1.0%	119,000	+1,000	+0.8%
Growth Areas	41,000	+2,000	+4.9%	64,000	+3,000	+4.7%
Regional Cities	11,000	≈0	≈0%	13,000	≈0	≈0%
Regional Centres/Rural	17,000	≈0	≈0%	24,000	≈0	≈0%

Table 4.4: CLR public transport trips by FUA (AM period, originating)

Figure 4.3 and Figure 4.4 show growth in rail patronage across the north at 2036 and 2051 respectively. The growth is due to an uplift in service provision and improved accessibility along the existing Craigieburn and Upfield lines. There is also a corresponding growth in rail patronage on the southern Frankston and Glen Waverley lines. Because this project includes the extension of the Upfield line to Wallan, residents in the north can board metropolitan services to access the CBD and have direct access to the Upfield corridor stations. The resulting shift from regional V/Line services to the metropolitan network in the project is represented in Figure 4.3 and Figure 4.4 as a decrease in patronage on the V/Line Albion-Jacana corridor[3].

The road network displays only a slight decrease in volumes at both 2036 and 2051. Although the impact on the amount of private vehicle travel is negligible, the population migration out of the CBD invokes a corresponding drop of private vehicles departing the Inner Melbourne FUA of 0.4% and 0.8% in 2036 and 2051 respectively[4].

[3] As mentioned in §3.3.1, V/Line services have been modelled utilising the Albion and Jacana corridor, with the assumption that rail freight is able to access new infrastructure as part of the Inland Rail Project.

[4] See Table 4.5.

FUA	2036 TBC	2036 CLR		2051 TBC	2051 CLR	
Inner Melbourne	325,000	-1,000	-0.3%	386,000	-3,000	-0.8%
Middle Melbourne	727,000	+1,000	+0.1%	841,000	-2,000	-0.2%
Outer Melbourne	932,000	-1,000	-0.1%	1,018,000	-1,000	-0.1%
Growth Areas	406,000	+1,000	+0.2%	551,000	+4,000	+0.7%
Regional Cities	360,000	-1,000	-0.3%	422,000	-1,000	-0.2%
Regional Centres/Rural	489,000	-1,000	-0.2%	571,000	-1,000	-0.2%

Table 4.5: CLR private vehicle trips by FUA (AM period, originating)

Figure 4.3: Change in public transport volumes, 2036 CLR vs. TBC (AM period)

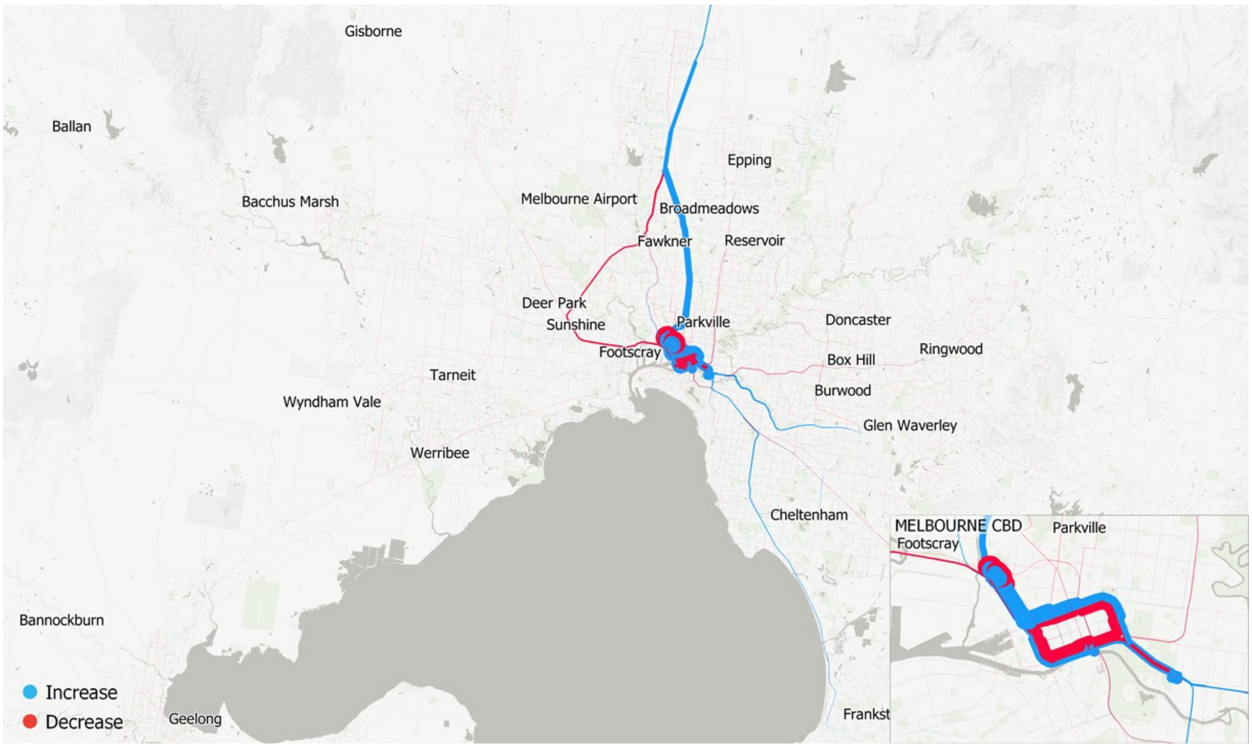

Figure 4.4: Change in public transport volumes, 2051 CLR vs. TBC (AM period)

4.1.3 *Network Impacts*

Table 4.6 shows the change in proportion of metropolitan train PKT under crowded conditions[5] for the AM period between the CLR project and the TBC. It can be seen that:

[5] See §1.3.4 for further details

- In 2036, the primary impacts of the project are a reduction in overall crowding within the Eastern and Inner FERs. Relief across the Eastern FER corresponds with capacity upgrades along parts of the Glen Waverley and Frankston lines that fall within this region. The Northern FER experiences a removal of all congested conditions[6].
- In 2051, the level of crowded metropolitan train travel within the Eastern and Inner FERs changes minimally. The Peninsula FER loses all of its crowded travel due to capacity uplifts at the end of the Frankston line. Interestingly, the Northern FER experiences a minor increase in crowding despite it containing most of the capacity upgrades implemented in this project. This impact will be explored subsequently.

[6] However, it is worth noting that the TBC only exhibited 1.4% crowded PKT to begin with.

FER	2036 TBC	2036 CLR		2051 TBC	2051 CLR	
Eastern	23.9%	18.5%	-5.5%	29.2%	29.1%	-0.1%
Inner	35.4%	30.4%	-5.0%	53.0%	50.1%	-2.9%
Northern	1.4%	≈0%	-1.4%	3.6%	5.0%	+1.4%
Peninsula	≈0%	≈0%	≈0%	7.9%	≈0%	-7.9%
Southern	4.2%	3.4%	-0.8%	36.0%	35.8%	-0.2%
Western	≈0%	≈0%	≈0%	34.0%	34.0%	+0.1%
Other	≈0%	≈0%	≈0%	≈0%	≈0%	≈0%

Table 4.6: CLR changes in crowded metropolitan train PKT (AM period)

Figure 4.5 and Figure 4.6 show the difference in passenger to capacity ratios across the public transport network in the morning peak for the CLR project compared to the TBC in 2036 and 2051 respectively. The key difference that arises in the CLR project lies along the northern section of the Upfield line south of Wallan, extending through the Upfield/Fawkner corridor and easing at Coburg. The restructuring of the network, made possible by the extension of the metropolitan system to Wallan, adds additional crowding to this section of the Upfield line when compared to the TBC. However, the increase in overall demand from the north is met by a balanced provision of services on both the Upfield and Craigieburn lines. Crowding on both these corridors are very consistent at similar distances from the CBD. In this respect, the CLR project is allowing spare capacity to be utilised along the Upfield line sensibly.

V/Line services also benefit from the introduction of the CLR project, specifically Seymour to Southern Cross services. In the TBC these services are close to exceeding their capacity in 2036 and are over capacity in 2051 through Donnybrook to Broadmeadows stations. With the introduction of the project these same services are operating at approximately 35% capacity.

Figure 4.5: Change in passenger/capacity ratio, 2036 CLR vs. TBC (AM period)

Figure 4.6: Change in passenger/capacity ratio, 2051 CLR vs. TBC (AM period)

As described in §4.1.1, the CLR project resulted in a redistribution of residents towards the northern parts of Melbourne. Despite this shift, and the accompanying increase in local trip generation, there has been a small decrease in private vehicle congestion. Table 4.7 shows the change in morning peak congested VKT between the CLR project and the TBC for 2036 and 2051.

FER	2036 TBC	2036 CLR		2051 TBC	2051 CLR	
Eastern	39.5%	39.3%	-0.2%	41.2%	40.9%	-0.3%
Inner	48.5%	48.3%	-0.2%	55.9%	54.8%	-1.1%
Northern	41.1%	40.9%	-0.2%	45.2%	44.9%	-0.3%
Peninsula	21.2%	20.2%	-1.0%	26.7%	25.1%	-1.6%
Southern	43.5%	43.2%	-0.3%	46.4%	46.2%	-0.2%
Western	32.5%	32.3%	-0.2%	42.4%	42.1%	-0.3%
Other	1.3%	1.3%	≈0%	2.2%	2.2%	≈0%

Table 4.7: CLR changes in congested VKT (AM period)

4.1.4 *Accessibility*

Figure 4.7 and Figure 4.8 show the change in average public transport travel times originating from a particular location between the CLR project and the TBC for the morning peak[7]. Changes in public transport travel times often demonstrate less obvious spatial patterns than vehicle travel – especially if new route choices involve greater or fewer interchanges. However, there are some key attributes to note:

- In 2036, Donnybrook, Beveridge, Wallan and their surrounding regions experience a clear reduction in average public transport travel times. As explained in §4.1.2, the CLR project allows residents in this region to use the metropolitan rail network to access intermediate stations between Upfield and the CBD. This has allowed for more direct access to a larger pool of destinations, contributing to a reduction in journey distances and corresponding journey times.

  Both Frankston and Glen Waverley exhibit increases in average public transport journey times. The reduction in crowding along these lines has made longer journeys more attractive for residents in these areas, resulting in longer corresponding travel times.

- The opposite trend is specifically observed for Donnybrook, Beveridge, Wallan and their surrounding regions in 2051. They experience a marked increase in average journey times. As outlined in §4.1.1, the 2051 CLR project involves a relatively significant redistribution of residents from the Inner Melbourne FUA towards the Growth Areas[8]. The corresponding redistribution of employment is much smaller, meaning that those new residents across the Growth Areas will be commuting a longer distance on average – driving the increases in travel times[9].

[7] Public transport travel time is affected by a combination of frequency as well as travel speed. The speed of on-road public transport is affected by the congestion around it.

[8] See Table 4.1.

[9] It is important to emphasise that this is not a reflection of network performance, but rather impacts of the population redistribution outcomes.

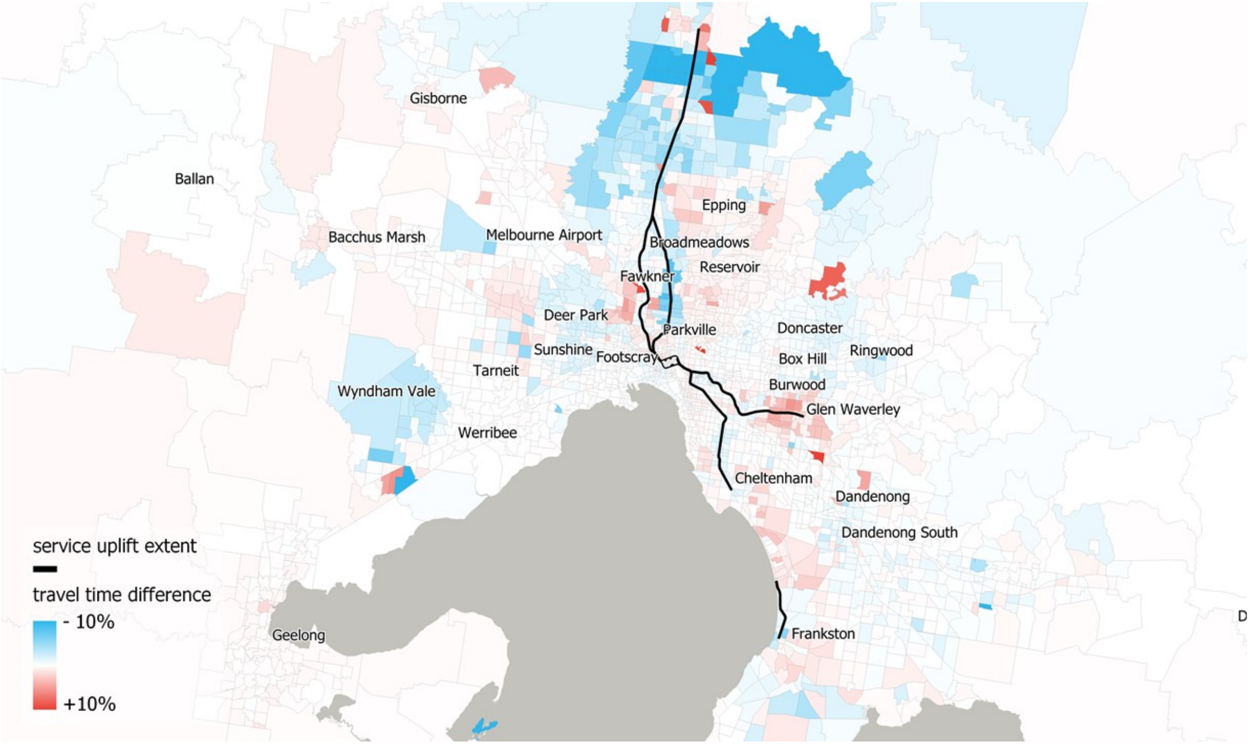

Figure 4.7: Changes in public transport travel time, 2036 CLR vs. TBC (AM period)

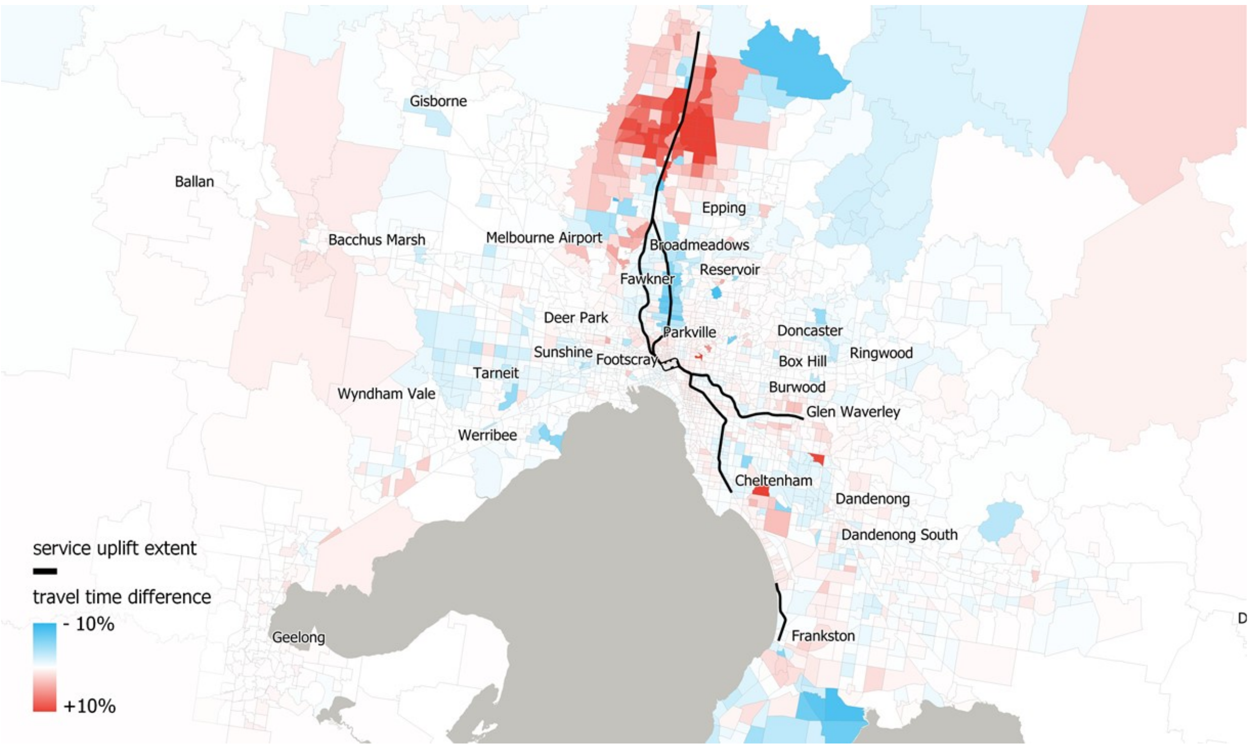

Figure 4.8: Changes in public transport travel time, 2051 CLR vs. TBC (AM period)

Figure 4.9 shows these changes by FUA, where the impact on the Growth Areas can be seen in 2051. Impacts across other FUAs are subtle.

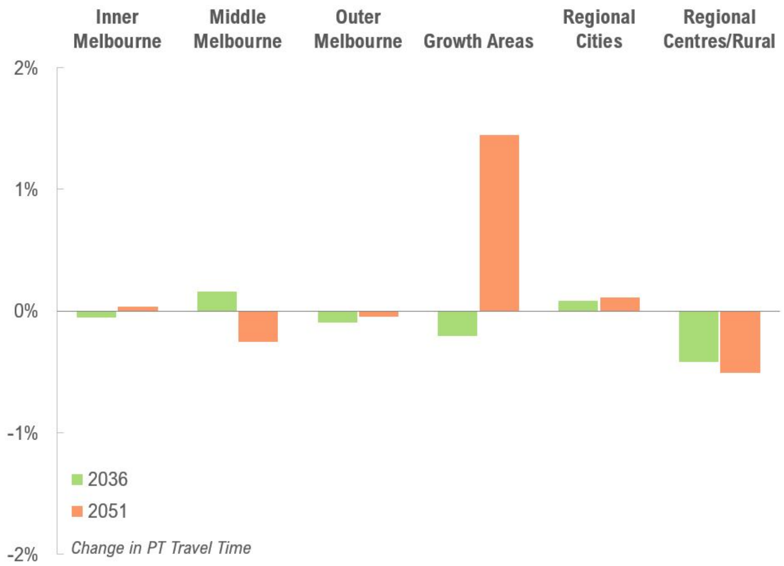

Figure 4.9: CLR changes in public transport travel time by FUA (AM period, originating)

There is a redistribution of jobs along the length of the CLR project that plays an important role in reducing average morning travel times by private vehicle relative to the TBC (see Figure 4.10). These differences are most pronounced in the north, but also extend to the south-east as far as the Mornington Peninsula. This is caused by increased population along the length of the project which is accompanied by growth in employment activity and a corresponding change in work location for Inner Melbourne and Middle Melbourne FUA residents. Unlike public transport trips, there is no substantial change in accessibility for private vehicles that might encourage travellers to travel further than they are in the TBC.

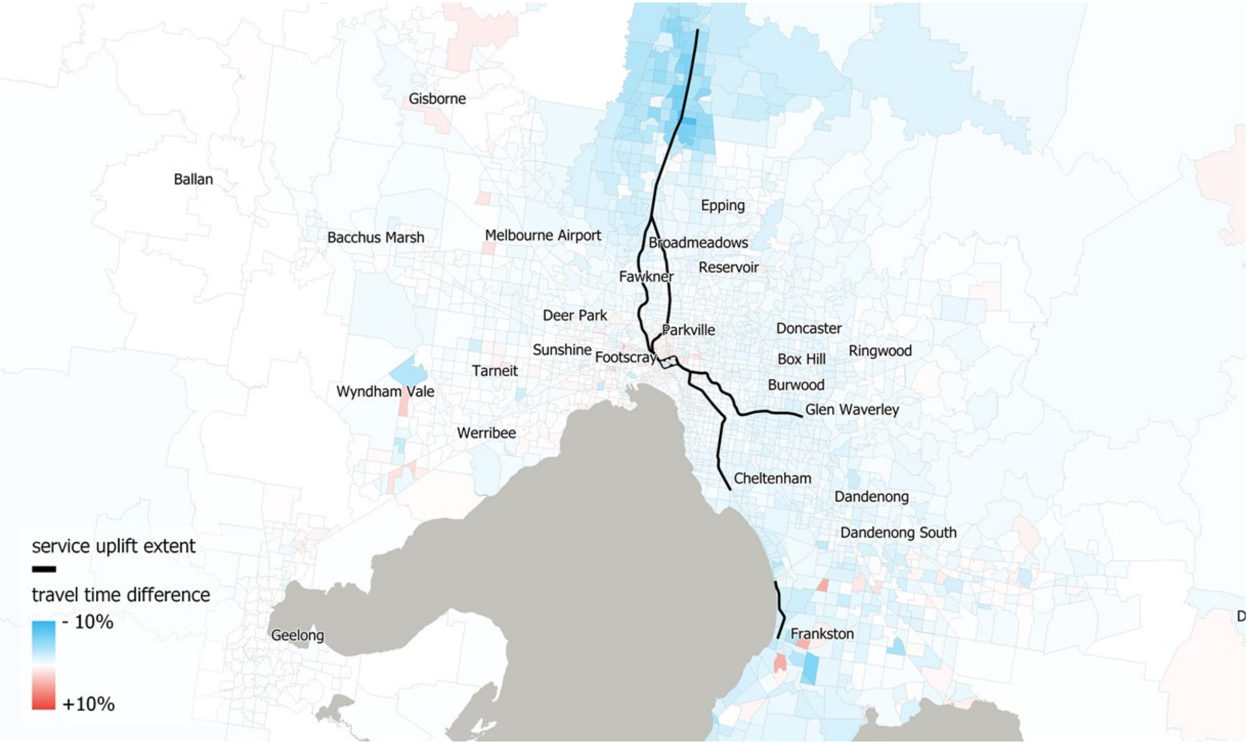

Figure 4.10: Changes in private vehicle travel time, 2051 CLR vs. TBC (AM period)

4.2 CROSS-CITY MOTORWAY

4.2.1 *Demographic Changes*

Table 4.8 and Table 4.9 show the change in population and employment distribution respectively for the CCM project compared to the TBC as produced by the VLUTI. The inclusion of the project results in a slower growth of residents in the Eastern FER, with faster growth seen in the Inner and Northern FER regions. Jobs similarly consolidate towards these two regions in both 2036 and 2051.

FER	2036 TBC	2036 CCM		2051 TBC	2051 CCM	
Eastern	849,000	-3,000	-0.4%	1,011,000	-4,000	-0.4%
Inner	1,934,000	+3,000	+0.2%	2,419,000	+6,000	+0.2%
Northern	1,113,000	+1,000	+0.1%	1,378,000	+2,000	+0.1%
Peninsula	362,000	≈0	≈0%	438,000	≈0	≈0%
Southern	1,350,000	-1,000	-0.1%	1,653,000	≈0	≈0%
Western	1,405,000	≈0	≈0%	1,755,000	-1,000	-0.1%
Other	1,848,000	≈0	≈0%	2,184,000	-1,000	≈0%

Table 4.8: CCM population changes

FER	2036 TBC	2036 CCM		2051 TBC	2051 CCM	
Eastern	376,000	-1,000	-0.3%	465,000	-1,000	-0.2%
Inner	1,580,000	+1,000	+0.1%	1,860,000	+3,000	0.2%
Northern	458,000	≈0	≈0%	578,000	≈0	≈0%
Peninsula	153,000	≈0	≈0%	193,000	≈0	≈0%
Southern	627,000	≈0	≈0%	773,000	≈0	≈0%
Western	482,000	≈0	≈0%	626,000	-1,000	-0.2%
Other	877,000	≈0	≈0%	1,054,000	-1,000	-0.1%

Table 4.9: CCM employment changes

The spatial distribution of these changes is more clearly demonstrated in Figure 4.11 and Figure 4.12. These show the difference in population and employment respectively between the CCM and TBC versions of 2051. There is a smaller level of growth in residents within the eastern suburbs such as Doncaster, complemented by a faster growth near inner Melbourne when comparing the CCM scenario to the TBC. Differences in the distribution of jobs are more focused in and around the CBD.

There is a redistribution of residents away from the eastern end of the CCM and Eastern Freeway. This has occurred because the presence of the CCM results in larger volumes of traffic travelling along these corridors in 2036 and 2051. This has made local travel to and from locations in the east such as Doncaster slightly more congested. These impacts will be explored in further detail across the subsequent sections.

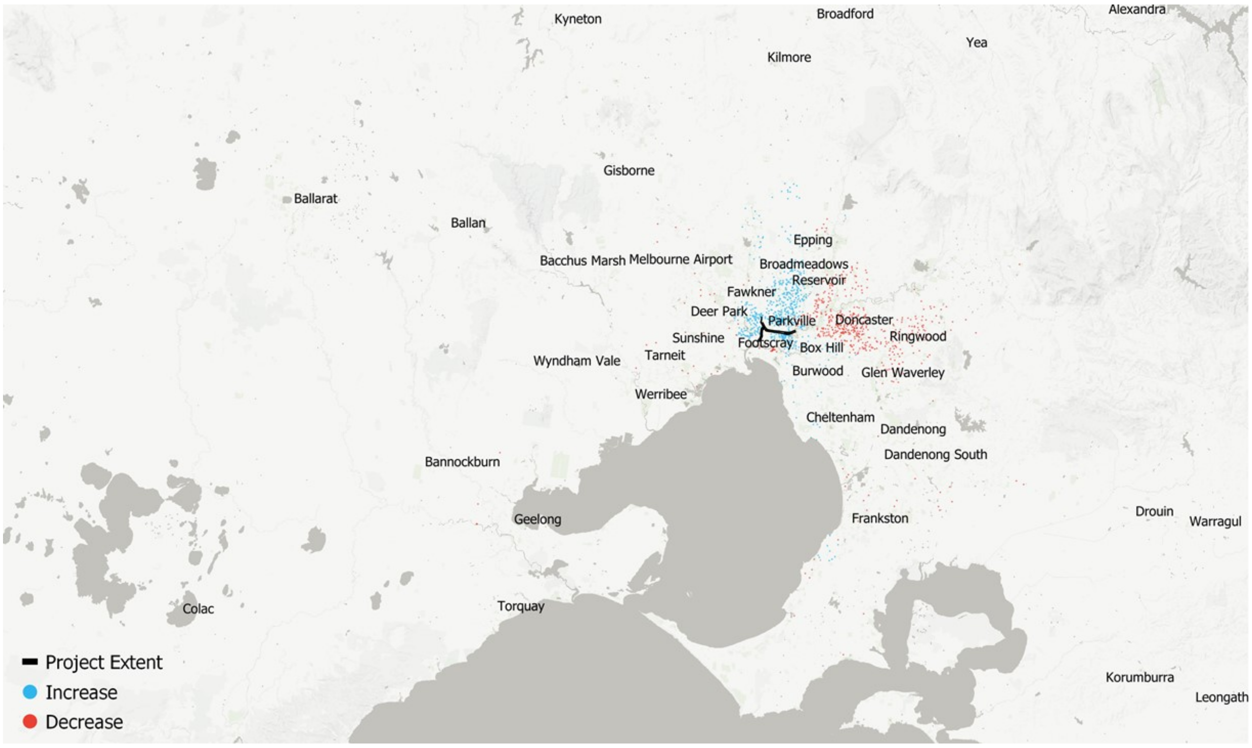

Figure 4.11: Change in population, 2051 CCM vs. TBC

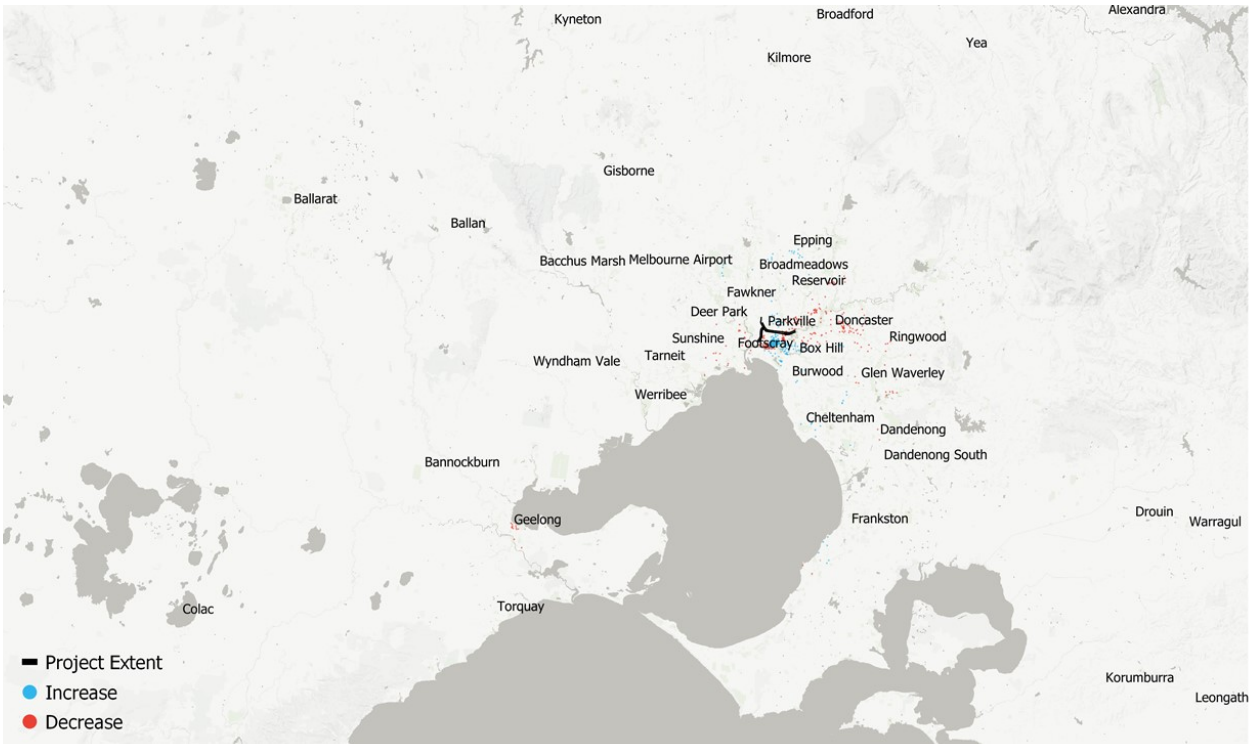

Figure 4.12: Change in jobs, 2051 CCM vs. TBC

4.2.2 *Travel Demand*

Table 4.10 shows the change in total private vehicle and public transport trips occurring during the morning peak for the CCM project when compared to the TBC. In both 2036 and 2051 there is minimal demand shift between private vehicle and public transport use. The overall magnitude of network impacts borne from this project are quite small[10]. Thus, whilst it is generally expected that a road project would induce more private vehicle travel, these effects have been counter-balanced by having more residents closer to the city centre where public transport use is more common.

[10] See §4.2.3.

Metric	2036 TBC	2036 CCM		2051 TBC	2051 CCM	
Private Vehicle Trips	3,240,000	-1,000	≈0%	3,789,000	+1,000	≈0%
Public Transport Trips	529,000	+1,000	+0.2%	663,000	-1,000	-0.2%
Mode Share	14.0%	14.1%	≈0%	14.9%	14.9%	≈0%

Table 4.10: CCM changes in morning peak trips

Figure 4.13 and Figure 4.14 show changes in morning peak road volumes between the 2036 and 2051 CCM and TBC scenarios. It is observed across both modelled years that the project shifts demand away from competing routes, namely:

- The North East Link and Metropolitan Ring Road for travel from the east to north west.
- The Monash Freeway and CityLink south of the CBD for travel from the south east.

The CCM also reduces demand on the local road network in its vicinity. Uplifts in demand are observed on key routes that feed into the project, including the Eastern Freeway, West Gate Tunnel and CityLink.

Table 4.11 shows the change in VKT and VHT in the morning peak for the CCM scenario against the TBC. In 2036 VKT increases whilst VHT decreases - both increase marginally in 2051. These outcomes show that the project is offering travel time savings for private vehicle users, allowing them to travel further in less time than they were in the TBC. This can be attributed to the CCM corridor providing a relief in congestion for its local vicinity, as well as a more direct route for specific journeys.

Figure 4.15 and Figure 4.16 show the morning peak two-hour volumes for the CCM corridor in the westbound and eastbound directions respectively for both modelled years. The section between Royal Parade and Hoddle Street is the most heavily utilised, with volumes peaking at approximately 4,700 vehicles in the westbound direction by 2036. By 2051, an additional 1,000 vehicles are attracted to this section when compared to 2036. The section of CCM between the interchange with

Metric	2036 TBC	2036 CCM		2051 TBC	2051 CCM	
Vehicle Kilometres Travelled	27,337,000	+18,000	+0.1%	32,126,000	+9,000	≈0%
Vehicle Hours Travelled	660,000	-3,000	-0.5%	834,000	+2,000	+0.2%

Table 4.11: CCM changes in VKT and VHT (AM period)

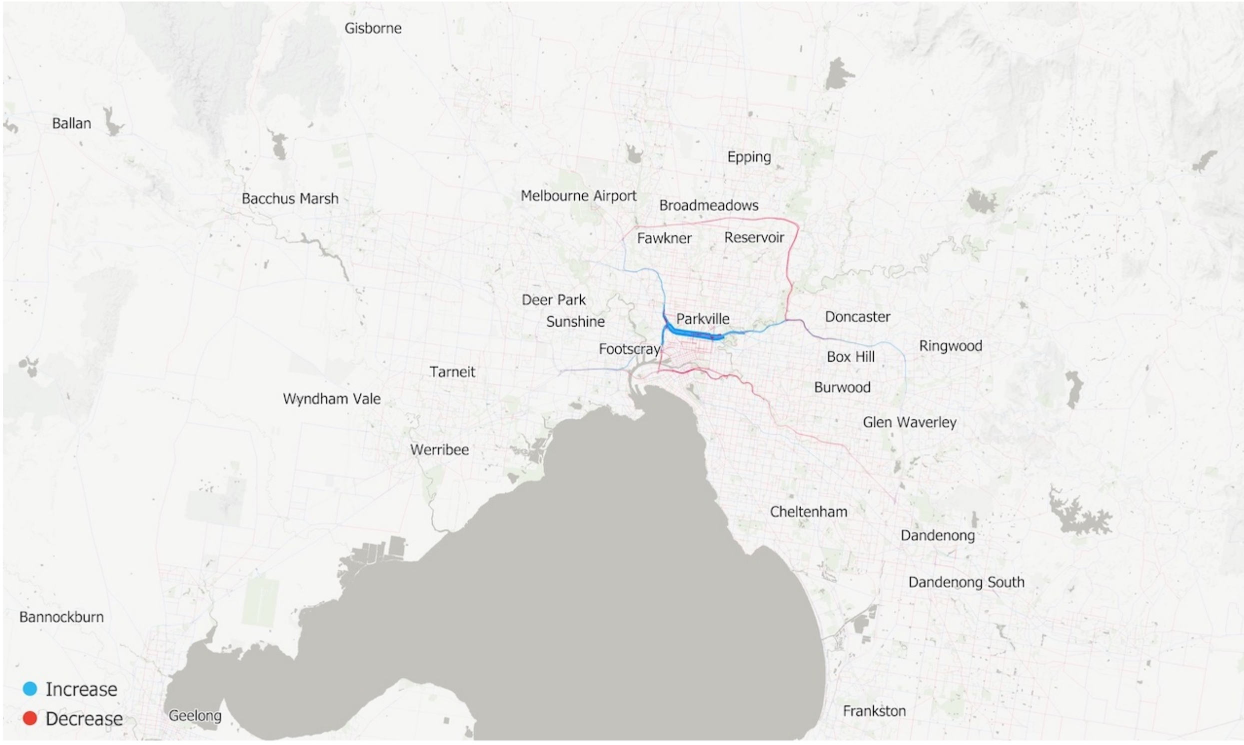

Figure 4.13: Change in road volumes, 2036 CCM vs. TBC (AM period)

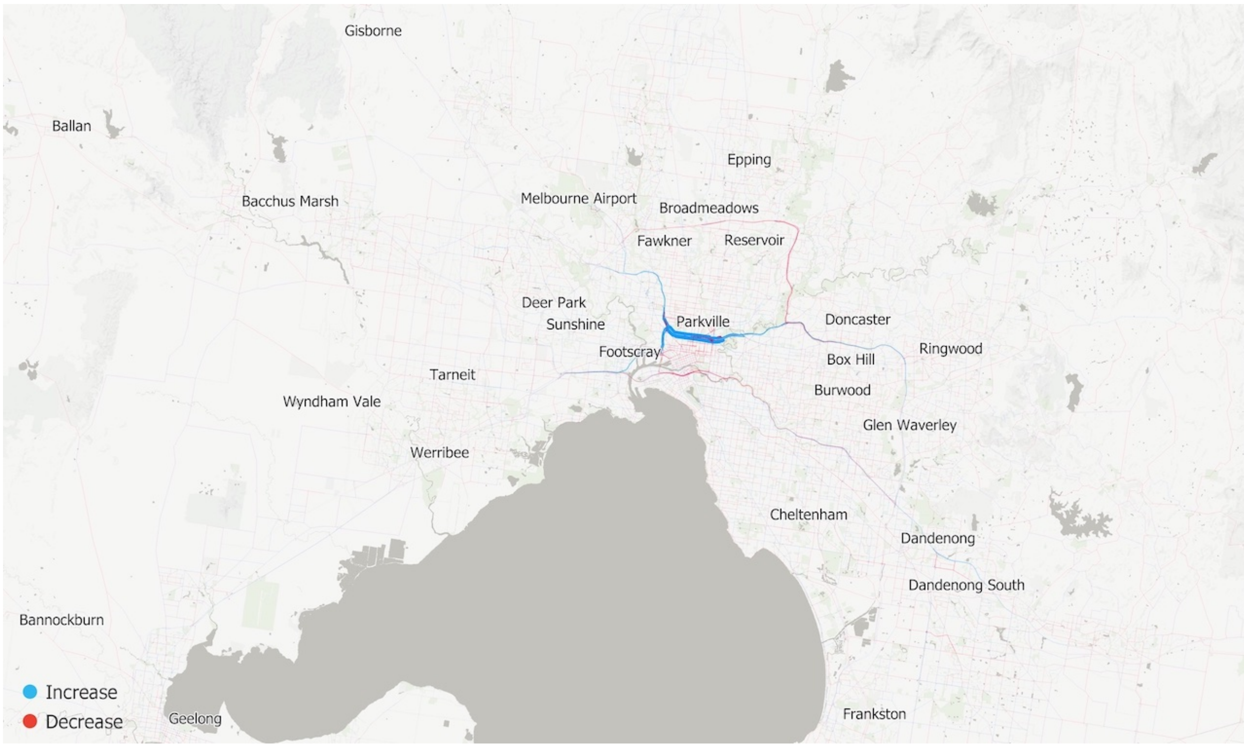

Figure 4.14: Change in road volumes, 2051 CCM vs. TBC (AM period)

CityLink and Footscray Road is underutilised in relation to its capacity, attracting 1,700 vehicles in the northbound direction by 2036. This figure is estimated to rise to approximately 2,000 vehicles by 2051.

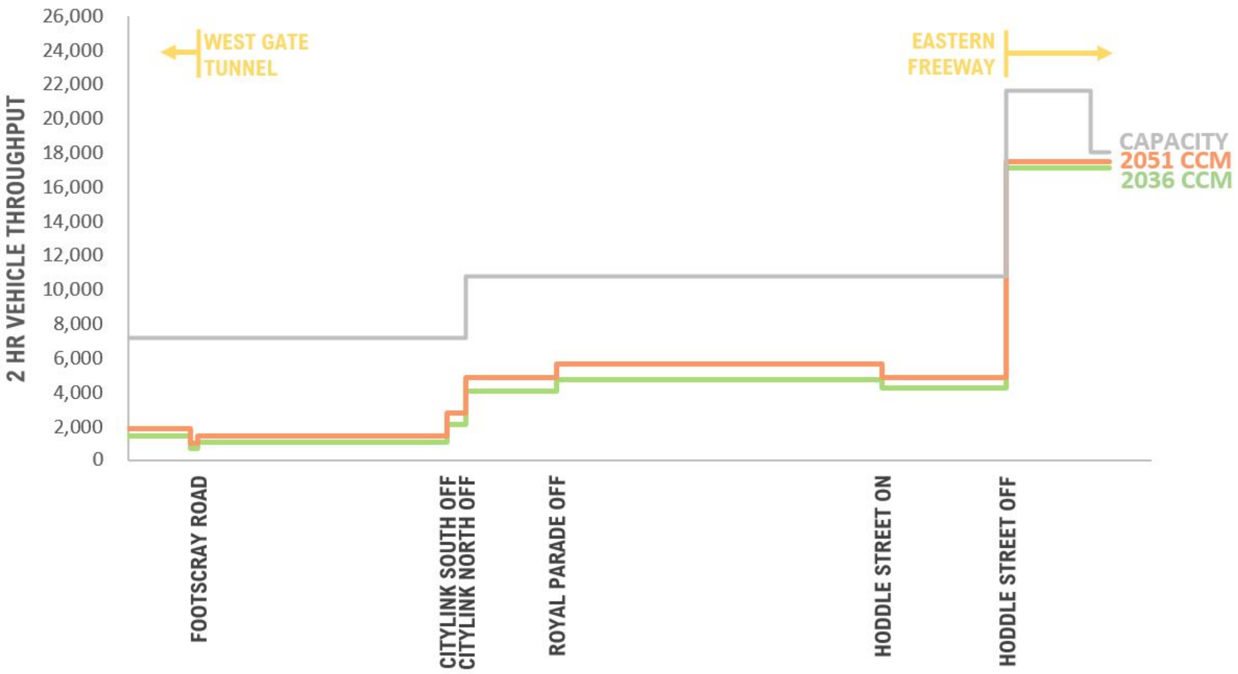

Figure 4.15: Volumes along the CCM corridor, westbound (AM period)

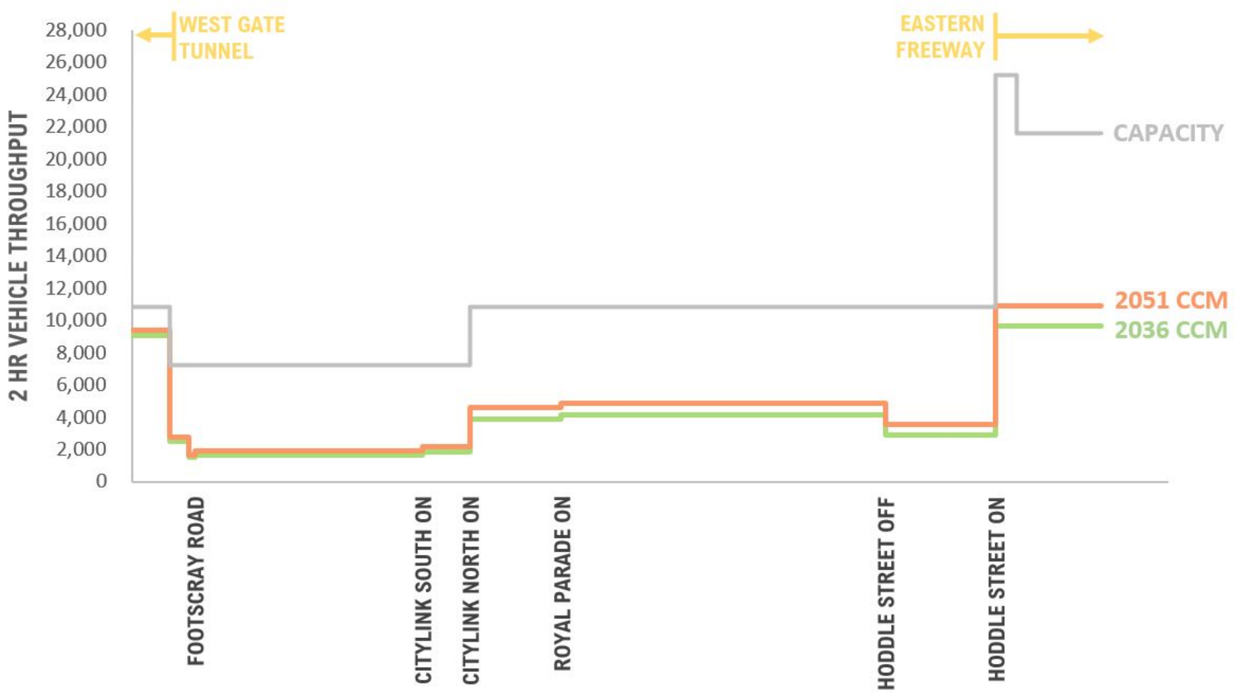

Figure 4.16: Volumes along the CCM corridor, eastbound (AM period)

Whilst the aggregate change in trip-making due to the CCM project is small, there are still minor changes in the way in which people move between different parts of metropolitan Melbourne. Figure 4.17 and Figure 4.18 show the absolute change in morning peak trips occuring between each of the FERs for the CCM project compared to the TBC across 2036 and 2051 respectively.

	Eastern	Inner	Northern	Peninsula	Southern	Western	Other
Eastern	-420	-740	-10	0	-10	-80	+10
Inner	-230	+1,190	-90	0	+50	-30	-10
Northern	-20	-190	+270	-20	0	+80	-10
Peninsula	0	0	-20	-80	+10	+10	0
Southern	-50	+70	+10	-30	-290	-10	+30
Western	-50	-80	+50	+10	+10	-70	+10
Other	+20	-10	0	0	-50	+20	-180

Figure 4.17: Change in total trips, 2036 CCM vs. TBC (AM period, row: *origin*, column: *destination*)

	Eastern	Inner	Northern	Peninsula	Southern	Western	Other
Eastern	-720	-590	+80	+10	+10	-30	+10
Inner	-360	+2,150	+10	0	+50	+110	0
Northern	-60	-60	+490	-10	+30	+210	-20
Peninsula	+10	+30	-10	-110	+30	+30	0
Southern	-10	+420	+50	-20	-560	+10	-20
Western	-10	+110	+70	+20	+30	-620	+170
Other	+20	+10	+10	0	+10	-60	-310

Figure 4.18: Change in total trips, 2051 CCM vs. TBC (AM period, row: *origin*, column: *destination*)

In relative terms, the change in total trips observed for 2036 are very small. Regardless, from the matrix it can be seen that:

- There is an increase in trips that stay within the Inner FER[11]. This is primarily due to an increase in both residents and jobs within this region in response to the CCM project relative to the TBC.

[11] Whilst this is the largest absolute difference seen across this scenario, it is worth noting that the change represents an uplift of only 0.2% beyond the number of similar trips occuring in the TBC scenario.

- There is a reduction in the number of people travelling from the east of Melbourne to the inner city. This has occurred partly due to the reduction in residents seen across areas like Doncaster relative to the TBC – prompted by changing network conditions and subsequent impacts to local accessibility.

For 2051, it can be seen that:

- The increase in Inner FER trips has intensified beyond that seen in 2036. This is attributable to the same factors – an increase in residents and jobs within this region.
- There is an increase in trips staying within the Northern FUA aligned with population growth. Furthermore, there is an increase in commuting to the Inner FUA from the south and west as jobs consolidate towards the city centre.
- The east continues to exhibit a reduction in the total number of trips originating from this region as population decreases relative to the TBC.

The overall impacts on travel patterns are relatively minimal compared to the absolute number of trips occurring between the FERs. However, it is worth noting a key difference between the 2036 and 2051 outcomes – the greater consolidation of employment towards the CBD in 2051 compared to 2036 has resulted in less intra-FER trips for the southern and western regions, whilst increasing journeys to inner Melbourne.

4.2.3 *Network Impacts*

Table 4.12 shows the proportion of VKT under congested conditions[12] for the morning peak period by FER. From this, it can be seen that:

[12] See §1.3.4.

- The greatest congestion benefits are realised across the Inner FER with the proportion of congested VKT reducing by 2.3% in 2036 and 2.0% in 2051. The local road network north and south of the CCM corridor all benefit from lower volumes of traffic, particularly the M1 through Fishermans Bend.
- Melbourne's east exhibits a small increase in congested VKT of 1.4% in 2051. This can be attributed to higher volumes of traffic utilising the Eastern Freeway to access the CCM corridor. The impact is comparatively minimal in 2036 because the same effect does not extend as far east along the Eastern Freeway in that year.

Overall, there are only subtle changes in congestion across the network in both 2036 and 2051. Once the combined impact of land use and traffic redistribution occurs, the CCM project does not significantly change traffic conditions for any single part of metropolitan Melbourne at an aggregate level. It is also worth noting that only minimal traffic is diverted away from Alexandra Parade (running above the CCM tunnel), which remains heavily congested regardless of the project's presence.

Metric	2036 TBC	2036 CCM	2051 TBC	2051 CCM
Eastern	39.5%	≈0%	41.2%	+1.4%
Inner	48.5%	-2.3%	55.9%	-2.0%
Northern	41.1%	-0.3%	45.2%	-0.3%
Peninsula[a]	21.2%	-1.0%	26.7%	-0.8%
Southern	43.5%	+0.1%	46.4%	-0.1%
Western	32.5%	+0.3%	42.4%	-0.2%
Other	1.3%	≈0%	2.2%	+0.1%

[a]The proportional reduction in congestion across the Peninsula is likely attributable to model noise – absolute changes in travel conditions are very minor.

Table 4.12: CCM changes in congested VKT (AM period)

Figure 4.19 and Figure 4.20 spatially show where increases and decreases in congestion have occurred on the road network during the morning peak period between the CCM and TBC projects for 2036 and 2051 respectively. Trends across the 2036 and 2051 years are similar, with the project forecast to reduce congestion on the local road network in its local vicinity as previously mentioned. The CCM corridor also draws volumes away from both North East Link and CityLink south of the CBD. However, it also increases congestion along the Eastern Freeway, the West Gate Tunnel and other parallel routes along these corridors.

Figure 4.19: Change in road volume/capacity ratio, 2036 CCM vs. TBC (AM period)

Figure 4.20: Change in road volume/capacity ratio, 2051 CCM vs. TBC (AM period)

4.2.4 *Accessibility*

The impacts of the CCM project on aggregate travel behaviour and journey characteristics were very minor in both 2036 and 2051. Figure 4.21 shows the change in average travel times during the morning peak period for the CCM project compared to the TBC. From this, it can be seen that the overall magnitude of change is minimal[13] and it is difficult to discern genuine project impacts from model noise. This small magnitude of change can be attributed to the following interrelated factors:

[13]Note that the vertical axis of Figure 4.21 is in minutes.

- The CCM project does little to facilitate more east-west movement across inner Melbourne than what was already occurring. Figure 4.17 and Figure 4.18 from the previous section demonstrate this. Whilst the new corridor demonstrably reduces travel times for those who use it, this is a relatively small cohort of people.
- The small benefits afforded by the CCM corridor are counter-balanced by an increase in congestion along the Eastern Freeway. This has consequences for much of the southern and eastern regions of Melbourne, with the latter losing a small number of residents in response to the accessibility changes.
- The greatest redistributive effects of the CCM project are to pull existing demand away from CityLink south of the CBD and the North East Link project – each of which are themselves tolled corridors. Particularly in the case of North East Link, there is a certain level of overlap between who these roads serve – limiting the resultant travel time benefits.

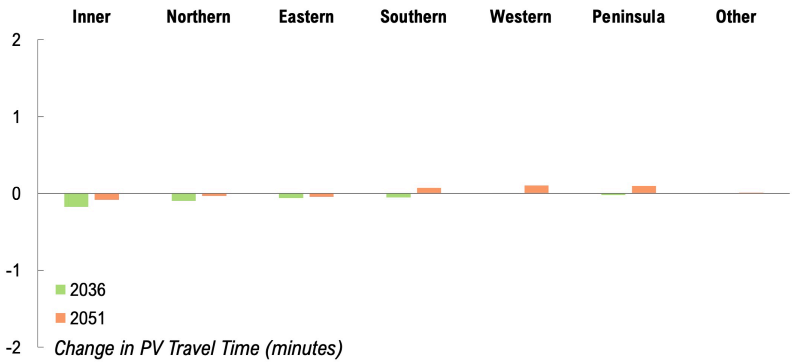

Figure 4.21: CCM changes in private vehicle travel time by FER (AM period, originating)

4.3 MELBOURNE METRO 2 AND SOUTH WEST RAIL CORRIDOR UPGRADE

4.3.1 *Demographic Changes*

Table 4.13 shows the change at 2036 and 2051 in population distribution respectively for the MM2G project relative to the TBC. By 2036, the presence of MM2G results in a lower growth of residents within the Inner and Middle Melbourne FUAs and a higher growth of residents largely focused in the Outer Melbourne and Growth Area FUAs compared to the TBC. By 2051 these effects extend to the regional cities as the scope of the MM2G project expands to Geelong.

Figure 4.22 and Figure 4.23 shows these changes spatially for 2036 and 2051 respectively, where population decreases across north-western and south-eastern Melbourne in both modelled years moving into areas surrounding rail capacity uplifts. By 2051, significant population shifts are observed towards Geelong aligning with the electrification of this corridor.

FUA	2036 TBC	2036 MM2G		2051 TBC	2051 MM2G	
Inner Melbourne	1,344,000	-3,000	-0.2%	1,709,000	-16,000	-0.9%
Middle Melbourne	2,078,000	-5,000	-0.2%	2,542,000	-12,000	-0.5%
Outer Melbourne	2,310,000	+7,000	+0.3%	2,612,000	+4,000	+0.2%
Growth Areas	1,010,000	+5,000	+0.5%	1,466,000	+13,000	+0.9%
Regional Cities	828,000	-1,000	-0.1%	974,000	+9,000	+0.9%
Regional Centres/Rural	1,292,000	-2,000	-0.2%	1,536,000	+1,000	+0.1%

Table 4.13: MM2G population changes

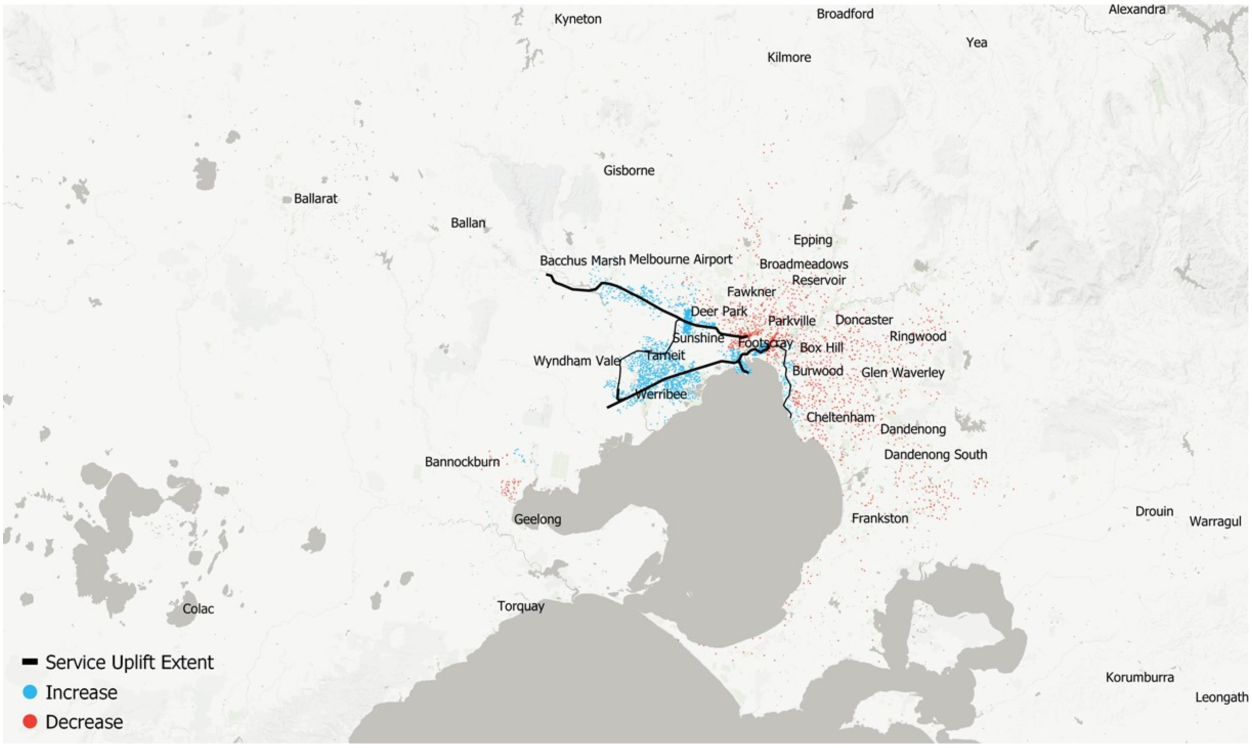

Figure 4.22: Change in population, 2036 MM2G vs. TBC

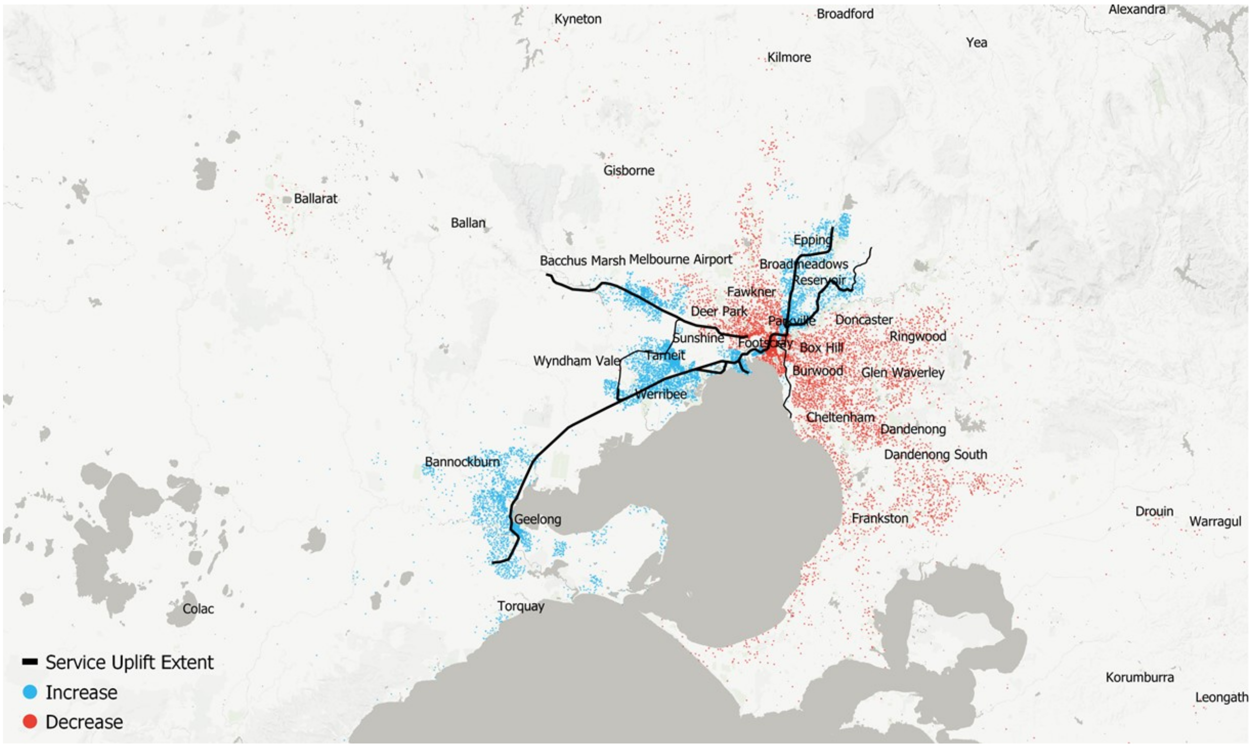

Figure 4.23: Change in population, 2051 MM2G vs. TBC

Although the VLUTI predicts fewer inner-city residents in the CBD compared to the TBC, it does show an uplift in employment activity within the general Inner Melbourne FUA. This is driven by the increased attractiveness of the CBD and Fishermans Bend as a destination (primarily due to travel time improvements). Table 4.14 shows these changes in employment distribution at 2036 and 2051 respectively, with Figure 4.24 showing them spatially for 2051.

FUA	2036 TBC	2036 MM2G		2051 TBC	2051 MM2G	
Inner Melbourne	1,359,000	+7,000	+0.5%	1,592,000	+11,000	+0.7%
Middle Melbourne	991,000	-3,000	-0.3%	1,209,000	-6,000	-0.5%
Outer Melbourne	1,086,000	-1,000	-0.1%	1,376,000	-7,000	-0.5%
Growth Areas	94,000	≈0	≈0%	136,000	-1,000	-0.7%
Regional Cities	444,000	-2,000	-0.5%	549,000	+8,000	+1.5%
Regional Centres/Rural	580,000	-1,000	-0.2%	686,000	-5,000	-0.7%

Table 4.14: MM2G employment changes

In 2051 Geelong's population and employment activity both grow. Population is attracted due to the increased accessibility the new rail services offer, whilst jobs are generated by the increase in household activity and need for additional retail and service provision.

In comparison to past central city-shaping initiatives, the introduction of MM2G is not a significant change to the overall growth in Melbourne's CBD activity. Population and employment growth in the Inner Melbourne FUA is still forecast to grow at a rate of 1.45% per annum between 2036 and 2051 with the project, and 1.48% per annum in the TBC.

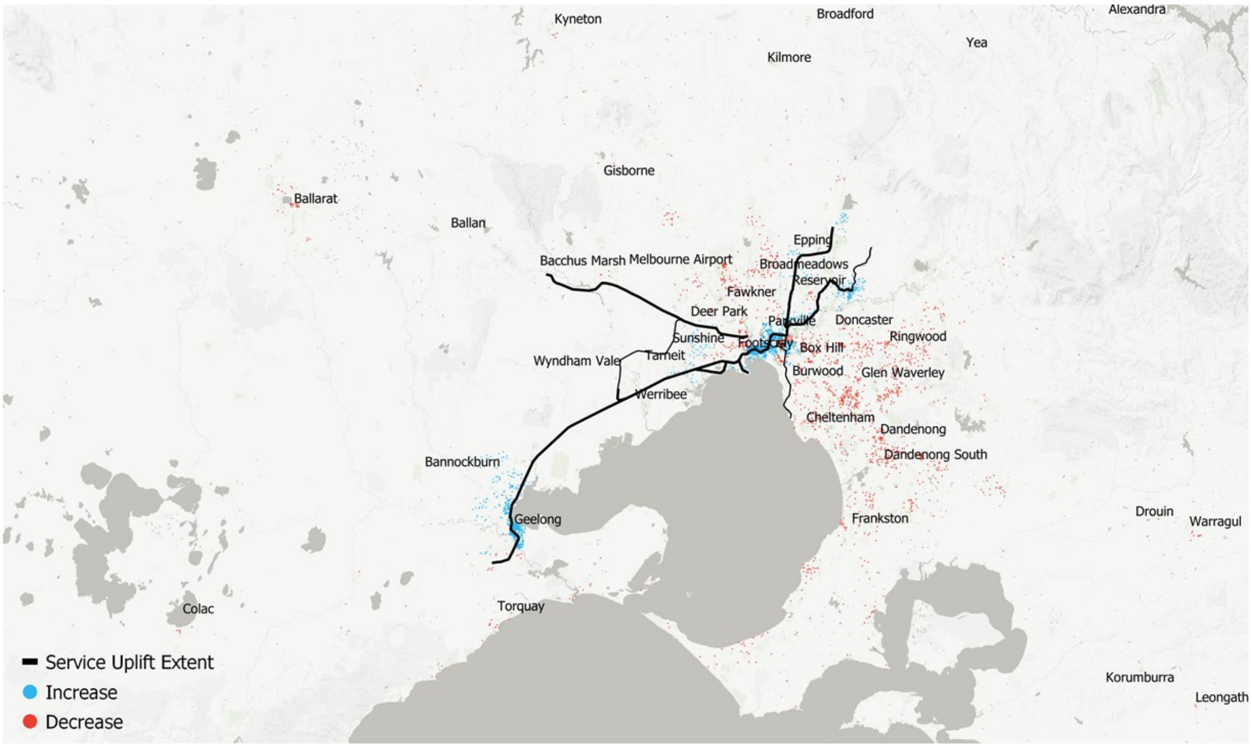

Figure 4.24: Change in employment, 2051 MM2G vs. TBC

4.3.2 *Travel Demand*

Table 4.15 shows the change in total morning peak trips by mode for the MM2G project relative to the TBC. The project results in an overall increase in the number of public transport trips undertaken, increasing statewide public transport mode share modestly.

Metric	2036 TBC	2036 MM2G		2051 TBC	2051 MM2G	
Private Vehicle Trips	3,240,000	≈0	≈0%	3,789,000	-4,000	-0.1%
Public Transport Trips	529,000	+5,000	+0.9%	663,000	+11,000	+1.7%
Mode Share	14.0%	14.2%	+0.1%	14.9%	15.1%	+0.2%

Table 4.15: MM2G changes in morning peak trips

Patronage uplift clearly correlates with the increase in services provided across the network. By 2036, these increases are primarily based in the Western FER, however the Northern and Other FERs also have more trips as additional infrastructure is provided by 2051. Table 4.16 shows the resultant change in morning peak public transport trips originating from each FER.

FER	2036 TBC	2036 MM2G		2051 TBC	2051 MM2G	
Eastern	44,000	≈0	≈0%	54,000	-1,000	-1.9%
Inner	248,000	≈0	≈0%	300,000	-1,000	-0.3%
Northern	60,000	≈0	≈0%	81,000	+4,000	+4.9%
Peninsula	8,000	≈0	≈0%	11,000	≈0	≈0%
Southern	70,000	≈0	≈0%	89,000	-2,000	-2.2%
Western	79,000	+5,000	+6.3%	103,000	+10,000	+9.7%
Other	20,000	≈0	≈0%	25,000	+1,000	+4.0%

Table 4.16: MM2G public transport trips by FER (AM period, originating)

MM2G provides access to new rail patronage markets (Fishermans Bend and Fitzroy) but, despite this, the Inner FER and FUA regions do not experience a large uplift in patronage. Instead, the new infrastructure serves to relieve pressure along existing tram and bus corridors within these regions.

Figure 4.25 and Figure 4.26 show the passenger difference maps for the MM2G project against the TBC across 2036 and 2051, further illustrating the aforementioned changes. Moreover, there are noticeable differences in patronage between Newport and Southern Cross by 2036 and Clifton Hill and Parliament Station by 2051. This is the result of rerouting services onto the new train paths and shows where additional capacity might be taken up by other services. The combined impact of redirecting Geelong services and the redistribution of population reduces pressure along the Wyndham Vale rail corridor.

The relocation of both residents and jobs to Geelong causes an increase in localised trip making beyond that expected due to the development of areas such as Armstrong Creek and North Geelong. The combination of growth encouraged by increased public transport accessibility and the opening of new development areas will likely create proportionally more walking[14], private vehicle and public transport trips around Geelong.

[14]Not explicitly modelled within the VLUTI.

Table 4.17 shows the change in total morning peak private vehicle trips between the MM2G project and the TBC by FUA. The Regional Cities FUA has close to a 1% increase in private vehicle trips at 2051, due mainly to a higher proportion of the population residing in Geelong. Conversely, the relatively lower number of residents distributed within Melbourne's CBD causes a corresponding drop in Inner Melbourne and Middle Melbourne FUAs of 1.0% and 0.6%. Otherwise, the impact on private vehicle travel is mostly negligible, particularly in 2036.

FER	2036 TBC	2036 MM2G		2051 TBC	2051 MM2G	
Eastern	324,000	-1,000	-0.3%	366,000	-4,000	-1.1%
Inner	530,000	-1,000	-0.2%	624,000	-6,000	-1.0%
Northern	441,000	≈0	≈0%	517,000	+1,000	+0.2%
Peninsula	135,000	≈0	≈0%	157,000	-1,000	-0.6%
Southern	519,000	-1,000	-0.2%	610,000	-5,000	-0.8%
Western	543,000	+4,000	+0.7%	642,000	+6,000	+0.9%
Other	748,000	-1,000	-0.1%	874,000	+4,000	+0.5%

Table 4.17: MM2G private vehicle trips by FER (AM period, originating)

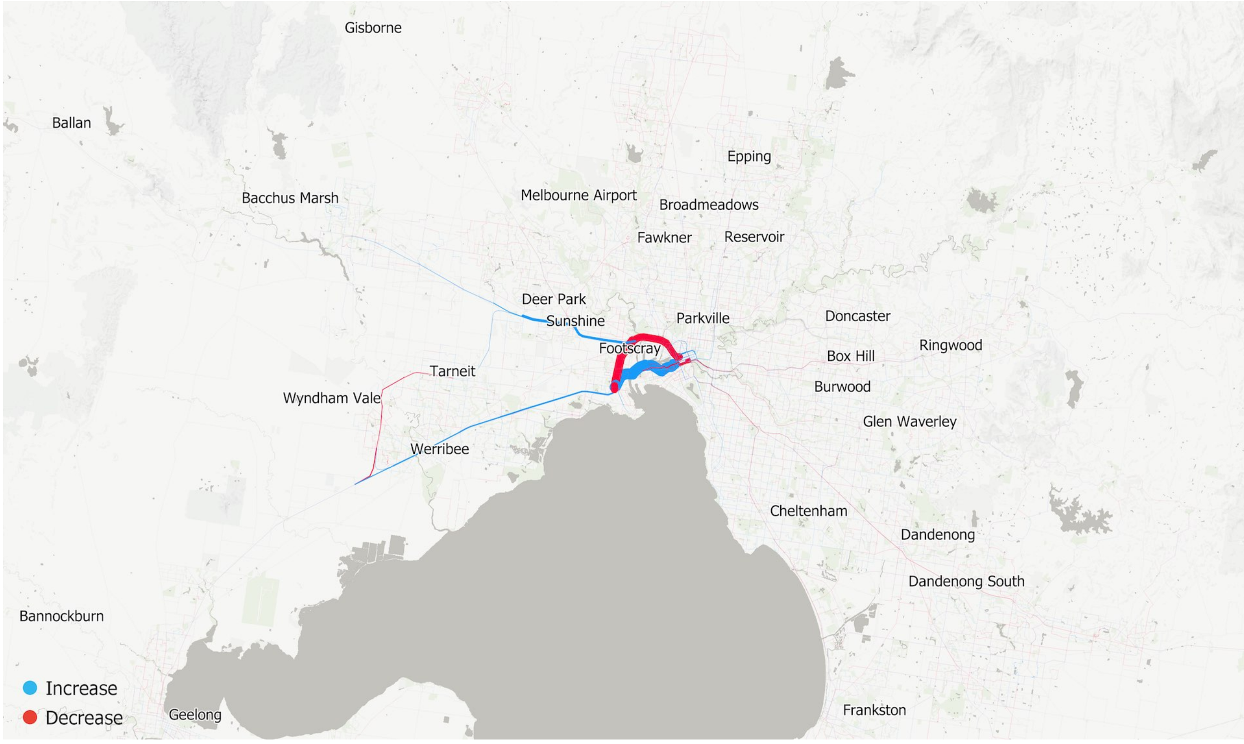

Figure 4.25: Change in public transport volumes, 2036 MM2G vs. TBC (AM period)

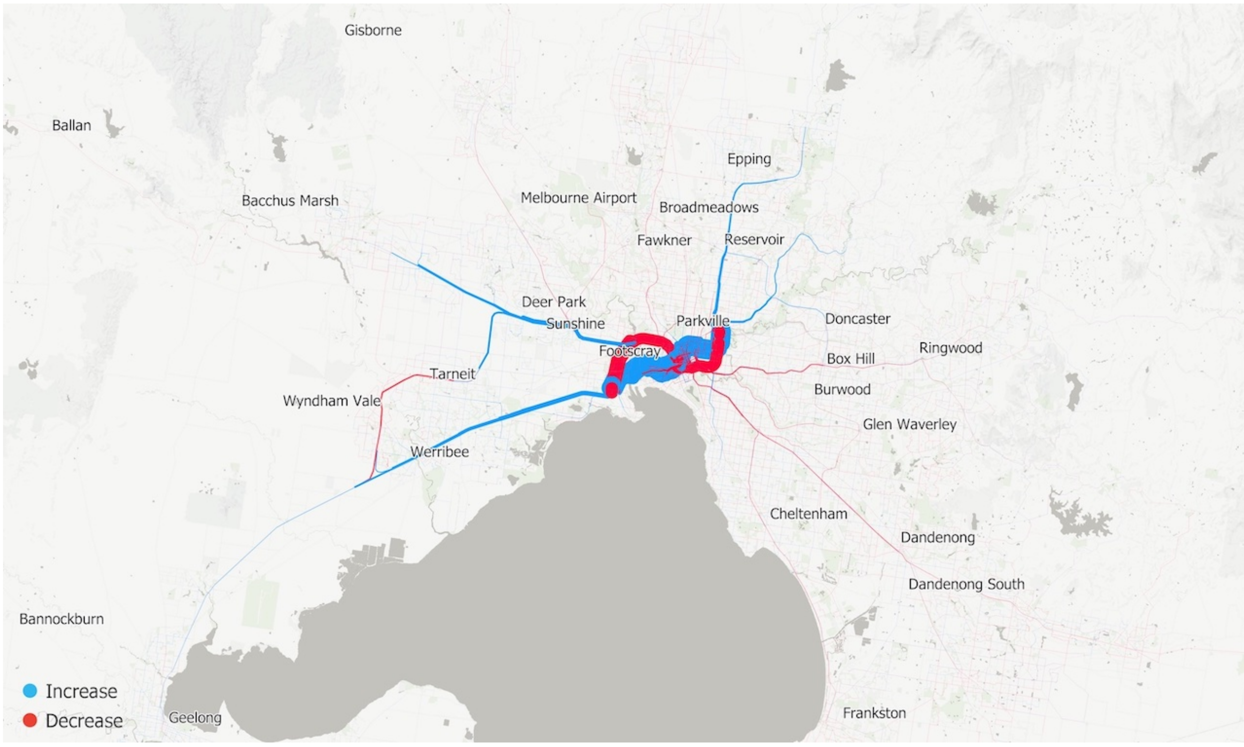

Figure 4.26: Change in public transport volumes, 2051 MM2G vs. TBC (AM period)

4.3.3 *Network Impacts*

The MM2G project provides a large capacity uplift across significant portions of the rail network. This has a commensurate impact in reducing crowded conditions along affected corridors. Table 4.18 shows the change in proportion of morning peak crowded metropolitan train PKT between the MM2G project and the TBC. Table 4.19 shows the equivalent for V/Line services. From these it can be seen that:

- Metropolitan train services exhibit a reduction in crowded travel corresponding to the locations of the capacity uplifts. This is most pronounced in the 2051 year, where population growth in the Western FER has resulted in 34% of metropolitan rail travel occurring under crowded conditions during the morning peak in the TBC scenario. With MM2G, this figure drops to only 5%.
- Given the location of the new tunnel, there is a marked reduction in crowded travel within the Inner Melbourne FER in 2036. By 2051 this is amplified as the full tunnel becomes active, with the MM2G project exhibiting a 15% reduction in crowded PKT compared to the TBC.
- V/Line services also expectedly experience a reduction in crowded travel. However, the effect is less pronounced than that exhibited across the metropolitan network. As outlined in §3.3.3 the MM2G project converts existing portions of the regional rail network to metropolitan services along the South West Rail Corridor. This relieves crowding pressure on the remaining regional services, resulting in small uplifts of passenger volumes compared to the TBC[15]. The net result is only a modest relief in crowding as those V/Line routes can better service regional Victoria.

[15] Visible in Figure 4.25 and Figure 4.26.

FER	2036 TBC	2036 MM2G		2051 TBC	2051 MM2G	
Eastern	23.9%	18.4%	-5.5%	29.2%	28.6%	-0.6%
Inner	35.4%	32.5%	-2.8%	53.0%	37.9%	-15.1%
Northern	1.4%	1.4%	≈0%	3.6%	≈0%	-3.6%
Peninsula	≈0%	≈0%	≈0%	7.9%	7.4%	-0.5%
Southern	4.2%	4.2%	≈0%	36.0%	34.1%	-1.8%
Western	≈0%	≈0%	≈0%	34.0%	5.4%	-28.5%
Other	≈0%	≈0%	≈0%	≈0%	≈0%	≈0%

Table 4.18: MM2G changes in crowded metropolitan train PKT (AM period)

Figure 4.27 and Figure 4.28 show the spatial change in passenger to capacity ratio across the public transport network for the morning peak in 2036 and 2051 respectively. By 2036, the uplift in service provision from Werribee and Melton leads to a decrease in crowded train travel compared to the TBC. By 2051, this extends to other areas of Melbourne via the Mernda and Hurstbridge corridors and regionally via the Geelong corridor, all experiencing some relief in line with capacity upgrades.

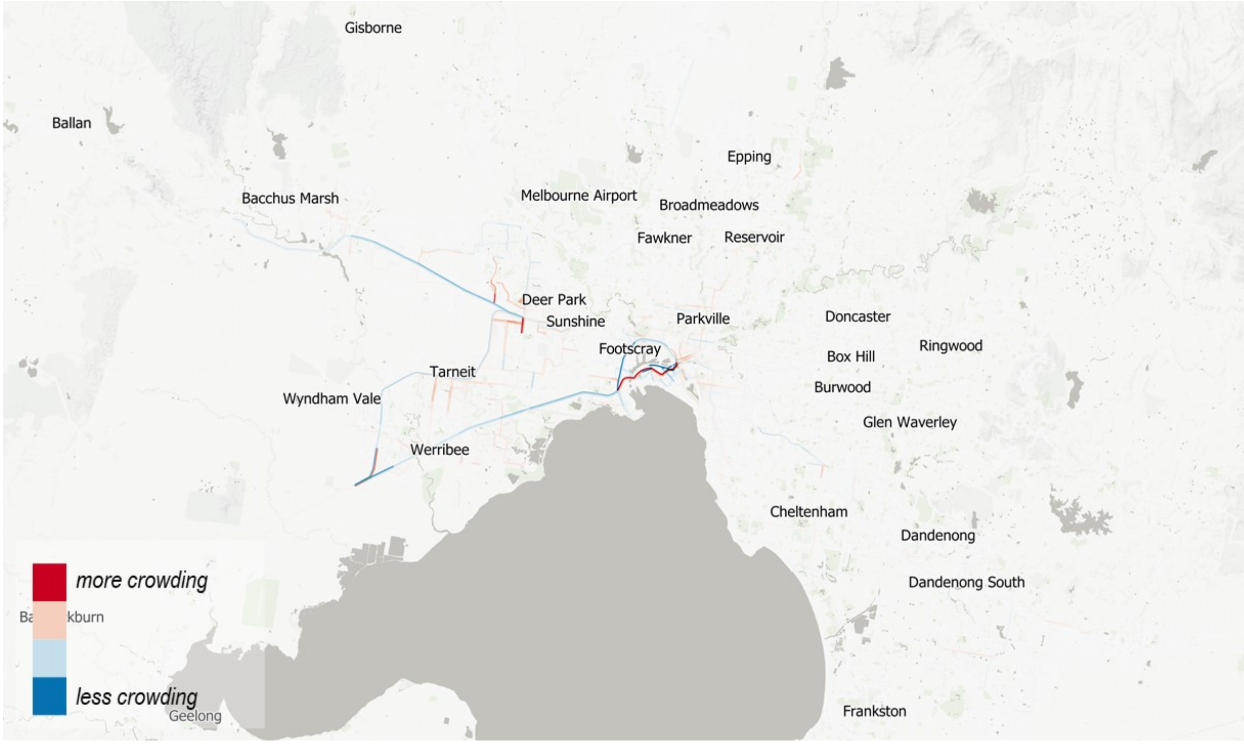

Figure 4.27: Change in passenger/capacity ratio, 2036 MM2G vs. TBC (AM period)

Figure 4.28: Change in passenger/capacity ratio, 2051 MM2G vs. TBC (AM period)

FER	2036 TBC	2036 MM2G		2051 TBC	2051 MM2G	
Eastern	≈0%	≈0%	≈0%	≈0%	≈0%	≈0%
Inner	20.0%	21.6%	+1.6%	37.7%	32.8%	-4.9%
Northern	50.4%	49.9%	-0.5%	38.8%	38.9%	+0.2%
Peninsula	≈0%	≈0%	≈0%	0.0%	0.0%	≈0%
Southern	23.0%	23.0%	≈0%	54.9%	55.1%	+0.2%
Western	26.2%	12.9%	-13.3%	59.5%	54.0%	-5.5%
Other	≈0%	≈0%	≈0%	7.2%	2.9%	-4.3%

Table 4.19: MM2G changes in crowded V/Line PKT (AM period)

This crowding relief is offset to a minor degree by migration of households into both the South West Rail Corridor and into the north-east of Melbourne. However, for both areas, the project produces less crowded conditions relative to the TBC at both 2036 and 2051.

Localised increases in bus crowding are visible in both Figure 4.27 and Figure 4.28, especially in the Werribee and Tarneit regions where a relative increase in population and accessibility compared to the TBC results in an increase in patronage for feeder buses visiting local stations. The proximity of the Regional Rail Link (RRL) and the South West Rail Corridor also means the choice of line (and even boarding station specifically) for many commuters is sensitive to changes in accessibility, increasing the potential for mode shift.

The MM2G project results in decreased crowding on local tram and bus routes within Fishermans Bend by 2036 and the inner north by 2051 as people shift to the metropolitan rail network where appropriate. Particularly for Fishermans Bend, this intervention plays an important role in keeping the precinct accessible via public transport into the future.

At both 2036 and 2051 there is negligible difference in private vehicle congestion. The VLUTI differs from a traditional transport modelling approach in that it allows population to move in response to the project. However, population migration is not enough to make any more than a minor difference to road volumes and congestion in this project compared to the TBC. Table 4.20 shows the change in the proportion of congested VHT during the morning peak for the MM2G project compared to the TBC.

FUA	2036 TBC	2036 MM2G		2051 TBC	2051 MM2G	
Inner Melbourne	64.9%	63.9%	-1.0%	71.7%	71.3%	-0.4%
Middle Melbourne	58.7%	57.7%	-1.0%	66.8%	66.4%	-0.4%
Outer Melbourne	55.6%	54.9%	-0.6%	62.0%	61.4%	-0.5%
Growth Areas	42.5%	42.3%	-0.2%	54.6%	54.1%	-0.5%
Regional Cities	8.2%	10.1%	+1.8%	10.6%	12.1%	+1.5%
Regional Centres/Rural	12.6%	12.3%	-0.2%	18.7%	18.5%	-0.2%

Table 4.20: MM2G changes in congested VHT (AM period)

From these outcomes it can be seen that congested road travel generally decreases in response to the MM2G project. However, as mentioned, the magnitude of the overall impact is small. In 2051 the Regional Cities FUA sees a slight increase in road congestion, attributable to higher population and employment growth rates in Geelong compared to the TBC.

4.3.4 *Accessibility*

Figure 4.29 shows the change in average morning peak public transport travel times for trips originating from each FUA for the MM2G project compared to the TBC. Travel time benefits are observed across the network, with the greated reductions seen in Regional Cities (-2.5%) and Growth Areas (-2.7%) in 2051.

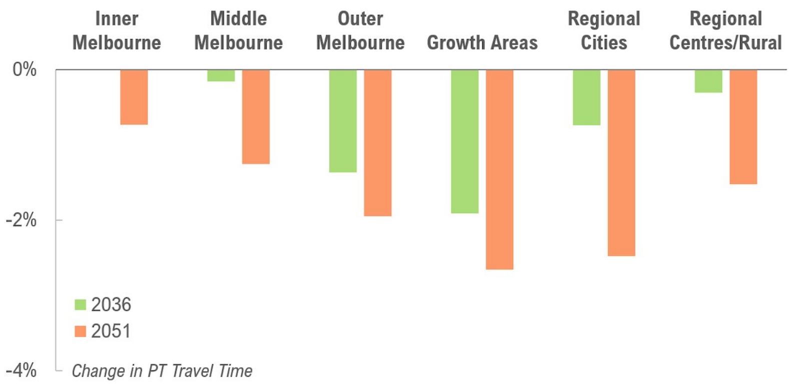

Figure 4.29: MM2G changes in public transport travel time by FUA (AM period, originating)

Figure 4.30 and Figure 4.31 show the distribution of these travel times spatially for 2036 and 2051 respectively. Reductions in average journey time closely follow the alignment of rail lines that offer increased capacity, particularly along the Werribee and Melton corridors in 2036 and the Mernda and Hurstbridge lines in 2051. Notable travel time benefits are seen to the south of Geelong with the project offering increased access to Melbourne for growth areas such as Armstrong Creek in 2051.

There are some noteworthy locations exhibiting increased average public transport journey times, particularly in the southern parts of Werribee as well as north of inner Geelong. This has occurred due to the nature of demographic redistribution that has accompanied the MM2G project. These particular locations have experienced a greater influx of residents than jobs, meaning that the average length of a commute increases in the project relative to the TBC[16].

In addition to general public transport travel time benefits, the MM2G project also offers a minor reduction in private vehicle travel times across the road network. Table 4.21 shows these changes for the morning peak by FUA.

[16] As was stressed for the CLR project (see §4.1.4), such a change is not a reflection of public transport provision *worsening* for residents in these locations.

FUA	2036 TBC	2036 MM2G		2051 TBC	2051 MM2G	
Inner Melbourne	14.4	≈0	-0.2%	14.6	≈0	0.2%
Middle Melbourne	15.2	≈0	-0.3%	15.5	-0.1	-0.3%
Outer Melbourne	16.4	-0.1	-0.7%	16.9	-0.1	-0.6%
Growth Areas	17.2	-0.1	-0.7%	18.4	-0.2	-1.1%
Regional Cities	7.5	≈0	≈0%	7.7	≈0	-0.1%
Regional Centres/Rural	13.2	≈0	-0.1%	13.6	≈0	-0.1%

Table 4.21: MM2G changes in average private vehicle travel times (AM period, originating)

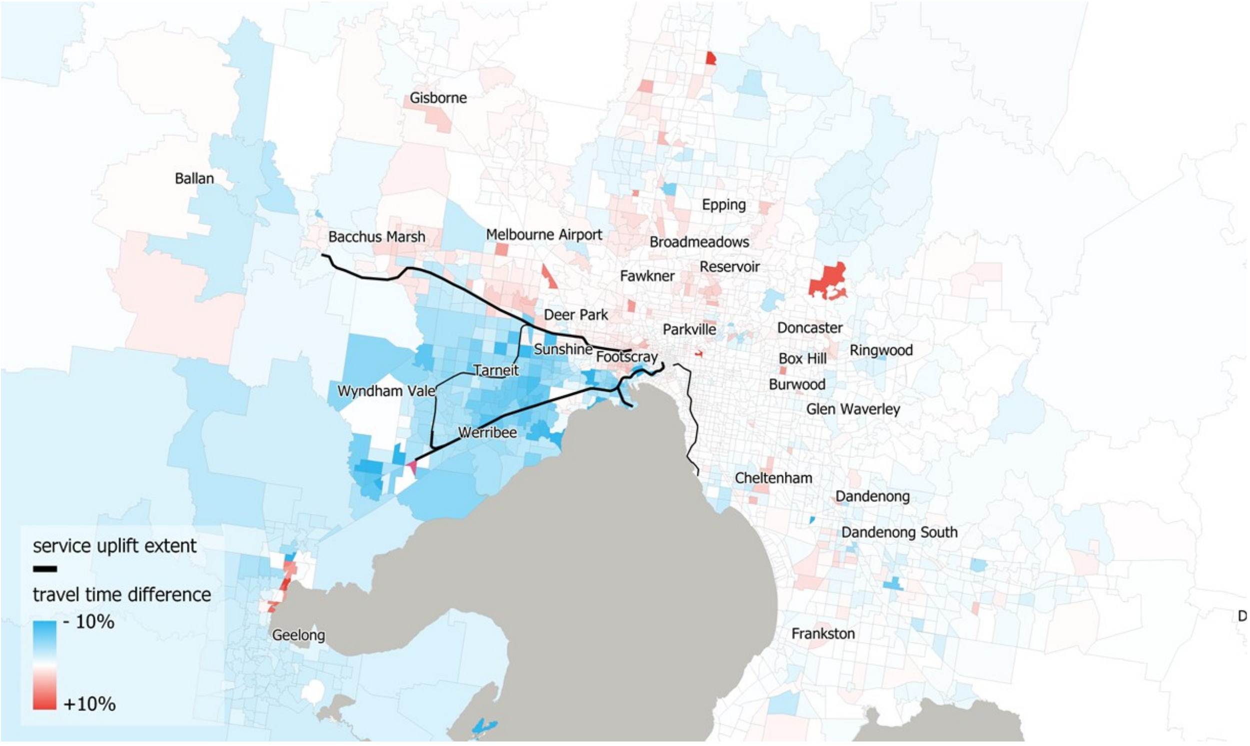

Figure 4.30: Changes in public transport travel time, 2036 MM2G vs. TBC (AM period)

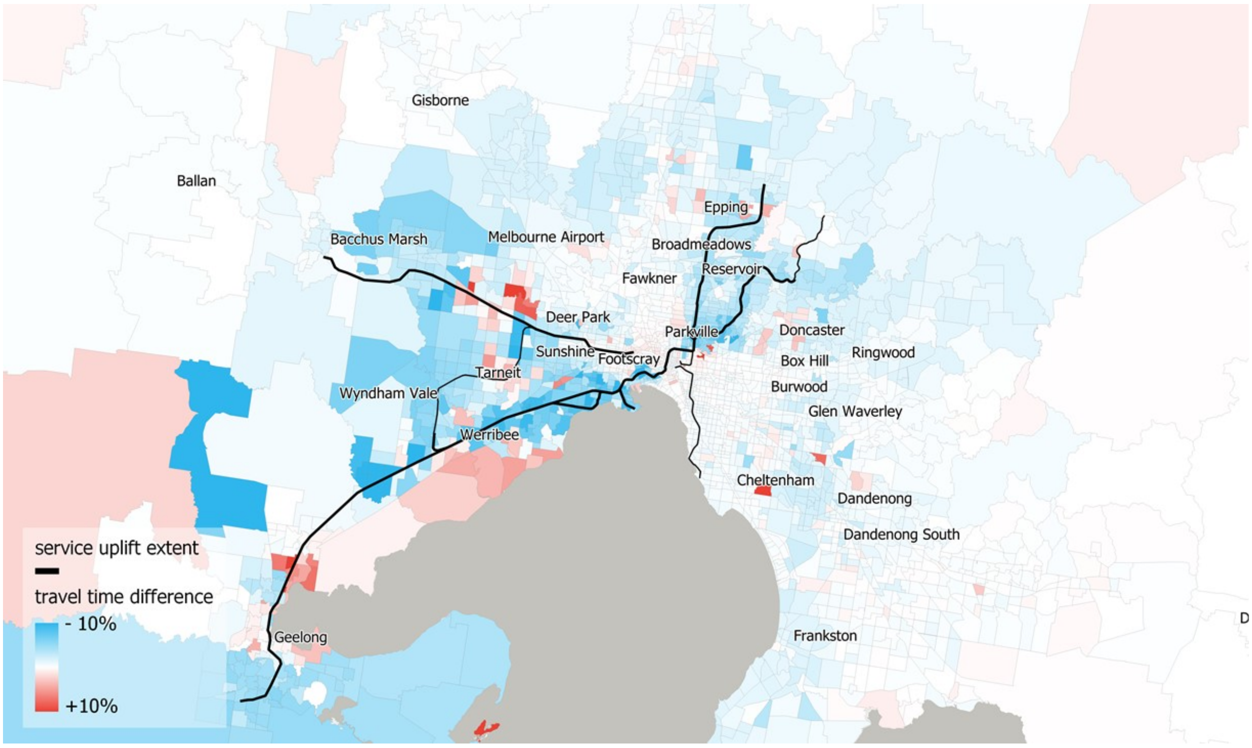

Figure 4.31: Changes in public transport travel time, 2051 MM2G vs. TBC (AM period)

4.4 OUTER METROPOLITAN RING ROAD

4.4.1 *Demographic Changes*

Table 4.22 and Table 4.23 show the change in population and employment distribution respectively for the OMR project compared to the TBC in 2036 and 2051. It can be seen that inclusion of the OMR results in a small redistribution of residents and jobs out of Victoria's regions and metropolitan Melbourne's growth areas towards central Melbourne relative to the TBC.

FUA	2036 TBC	2036 OMR		2051 TBC	2051 OMR	
Inner Melbourne	1,344,000	+5,000	+0.4%	1,709,000	+5,000	+0.3%
Middle Melbourne	2,078,000	+5,000	+0.2%	2,542,000	+11,000	+0.4%
Outer Melbourne	2,310,000	+8,000	+0.3%	2,612,000	+14,000	+0.5%
Growth Areas	1,010,000	-13,000	-1.3%	1,466,000	-18,000	-1.3%
Regional Cities	828,000	-1,000	-0.1%	974,000	-5,000	-0.5%
Regional Centres/Rural	1,292,000	-3,000	-0.3%	1,536,000	-7,000	-0.5%

Table 4.22: OMR population changes

FUA	2036 TBC	2036 OMR		2051 TBC	2051 OMR	
Inner Melbourne	1,359,000	+6,000	+0.4%	1,592,000	+9,000	+0.6%
Middle Melbourne	991,000	-3,000	-0.3%	1,209,000	-2,000	-0.2%
Outer Melbourne	1,086,000	≈0	≈0%	1,376,000	-2,000	-0.1%
Growth Areas	94,000	-1,000	-1.1%	136,000	-1,000	-0.7%
Regional Cities	444,000	-1,000	-0.1%	549,000	-3,000	-0.5%
Regional Centres/Rural	580,000	-1,000	-0.2%	686,000	-2,000	-0.2%

Table 4.23: OMR employment changes

The spatial distribution of these changes can be seen more clearly in Figure 4.32 and Figure 4.33, which show change in population and employment respectively between the OMR and TBC versions of 2051. The project's primary impact is the relief of congestion across the outer north and west of Melbourne[17]. This has increased the relative accessibility of regions within the 'ring' of the OMR for both residents and jobs.

[17] See §4.4.3 for further details.

4.4.2 *Travel Demand*

Table 4.24 shows the change in total private vehicle and public transport trips occurring during the morning peak for the OMR scenario when compared to the TBC for Victoria[18]. Despite the large size of the project, there is very minimal mode shift towards private vehicle travel. Given its location, existing users most affected by the presence of the OMR are not likely to be using modes other than private vehicle in the first place. Furthermore, the new routes facilitated by the OMR do not have direct competition from the existing rail and bus services.

[18] Other peaks show similar patterns.

Figure 4.34 and Figure 4.35 show changes in morning peak road volumes between the 2036 and 2051 OMR and TBC scenarios. Whilst mode share remained relatively unaffected by this project, a significant amount of re-routing is occurring in response. In 2036, the partial OMR and E6 corridors shift demand away from the Hume Freeway, sections

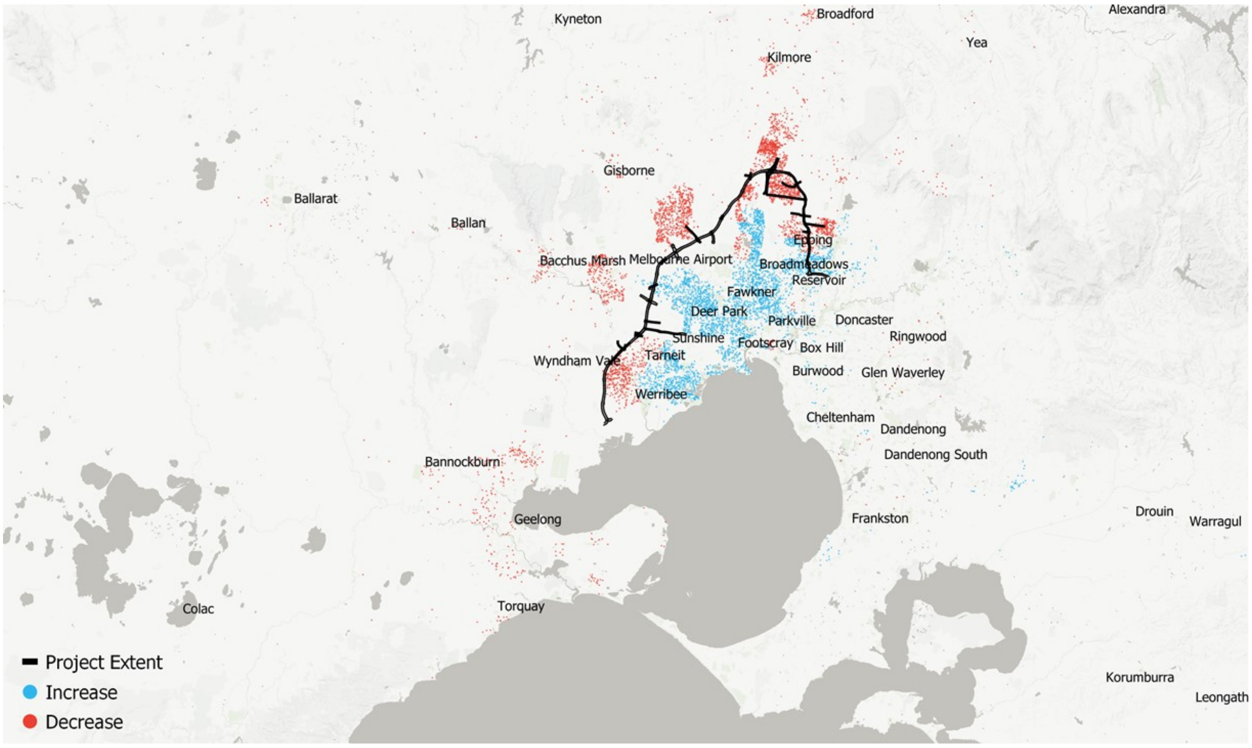

Figure 4.32: Change in population, 2051 OMR vs. TBC

Figure 4.33: Change in jobs, 2051 OMR vs. TBC

Metrics	2036 TBC	2036 OMR		2051 TBC	2051 OMR	
Private Vehicle Trips	3,240,000	+2,000	+0.1%	3,789,000	-1,000	≈0%
Public Transport Trips	529,000	+1,000	+0.2%	663,000	-3,000	-0.5%
Mode Share	14.0%	14.1%	≈0%	14.9%	14.8%	-0.1%

Table 4.24: OMR changes in morning peak trips

of the Western Ring Road and the surrounding arterial network. By 2051 this effect extends through the west of Melbourne as well as the remaining portions of the OMR come online.

Table 4.25 shows the change in VKT and VHT in the morning peak for the OMR scenario against the TBC. Across both 2036 and 2051 the amount of VKT increases indicating that people are travelling slightly longer distances on average with the OMR present. However, total VHT decreases meaning that those journeys are generally faster than they were in the TBC[19]. Thus, the average journey duration has decreased due to the presence of OMR – both through the reduction of congestion in the surrounding arterial road network and the provision of more direct routes for specific travellers.

[19]The OMR may be providing a less direct, but overall faster journey than alternatives. There are also small impacts to the nature of journeys undertaken given the minor amount of demographic redistribution.

Metric	2036 TBC	2036 OMR		2051 TBC	2051 OMR	
Vehicle Kilometres Travelled	27,337,000	+45,000	+0.2%	32,126,000	+213,000	+0.7%
Vehicle Hours Travelled	660,000	-15,000	-2.2%	834,000	-23,000	-2.8%

Table 4.25: OMR changes in VKT and VHT (AM period)

Figure 4.36 and Figure 4.37 show the morning peak two-hour volumes for the OMR and E6 corridors in the clockwise and anti-clockwise directions respectively for both modelled years. The project sees heavy utilisation across much of its length, with volumes peaking around the Sunbury Road interchange and the nearby Melbourne Airport Link for both 2036 and 2051[20]. The OMR corridor is also reaching capacity at this location across both 2036 and 2051, contributing to small volume differences between the years at this location.

[20]Reaching approximately 7,000 to 8,000 vehicles for the two-hour morning peak period in both directions.

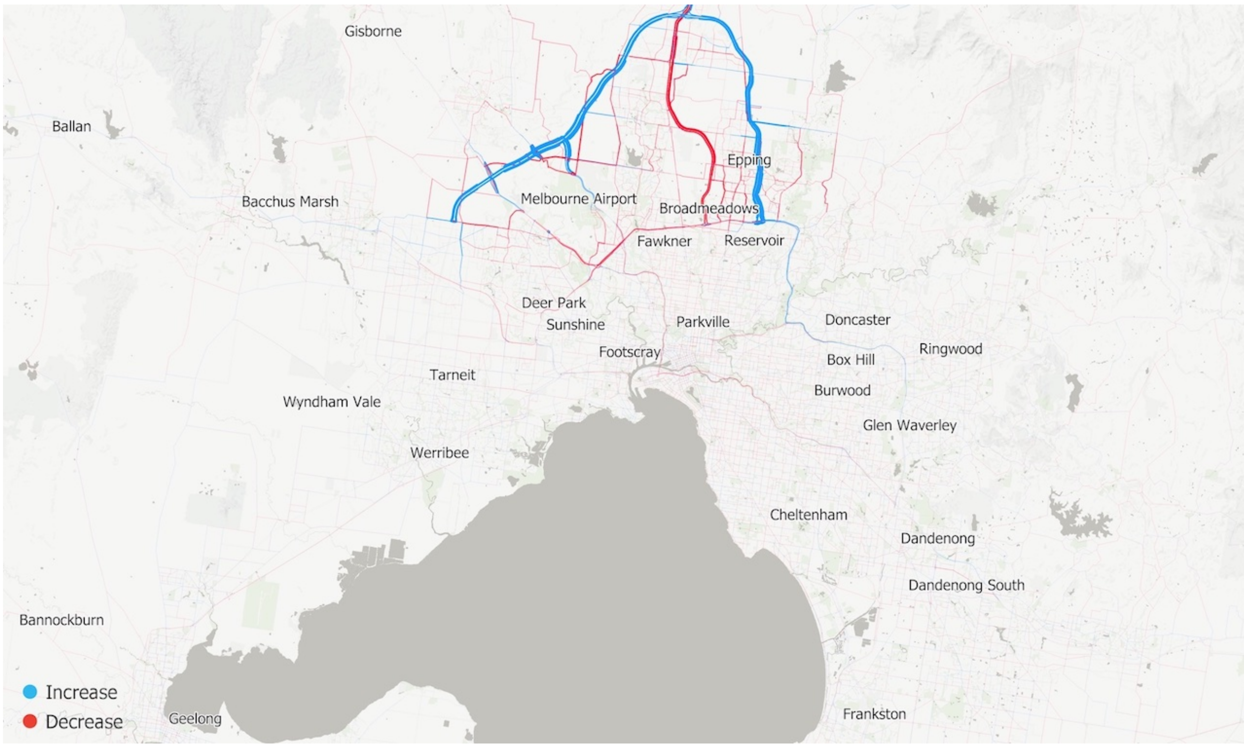

Figure 4.34: Change in road volumes, 2036 OMR vs. TBC (AM period)

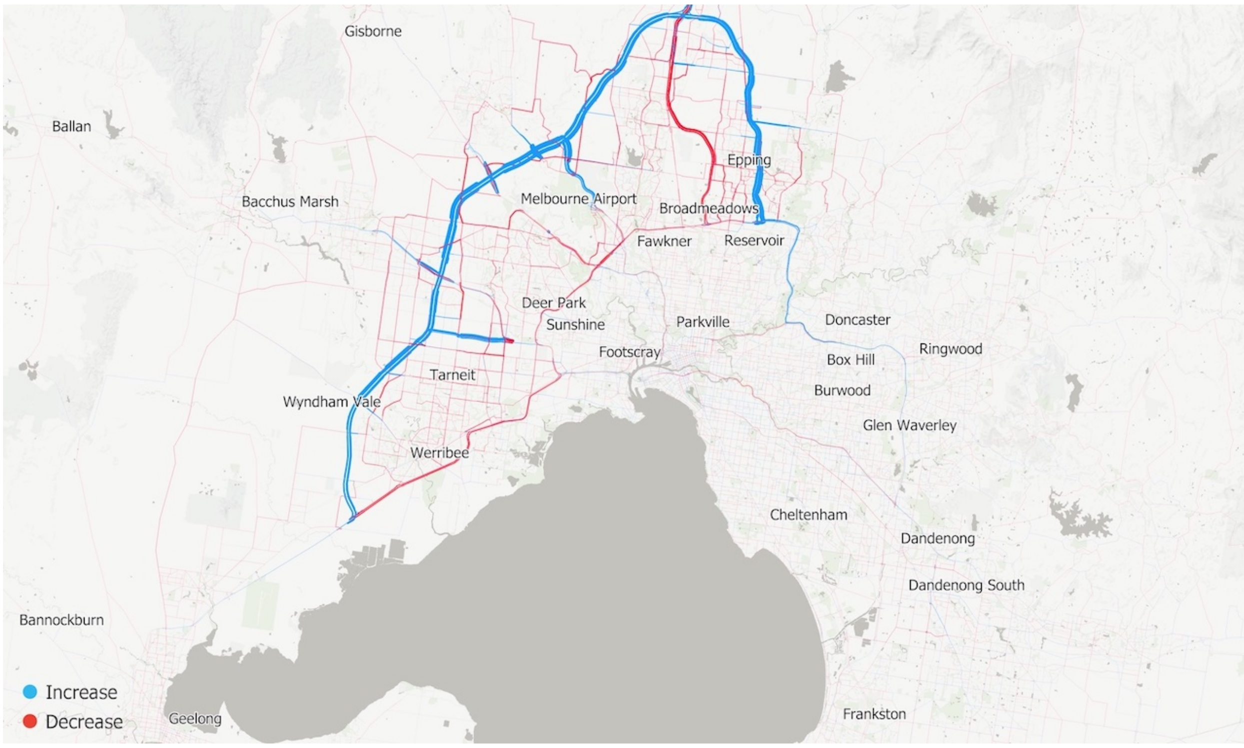

Figure 4.35: Change in road volumes, 2051 OMR vs. TBC (AM period)

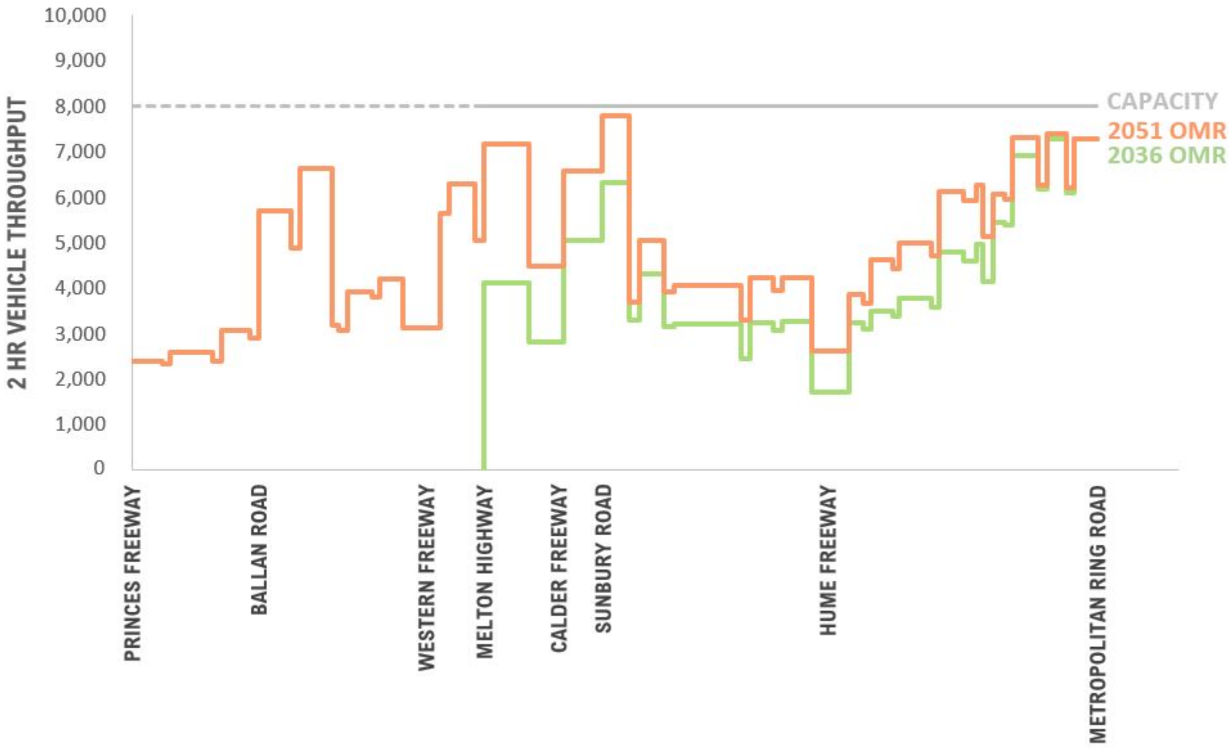

Figure 4.36: Volumes along the OMR and E6 corridors, clockwise (AM period)

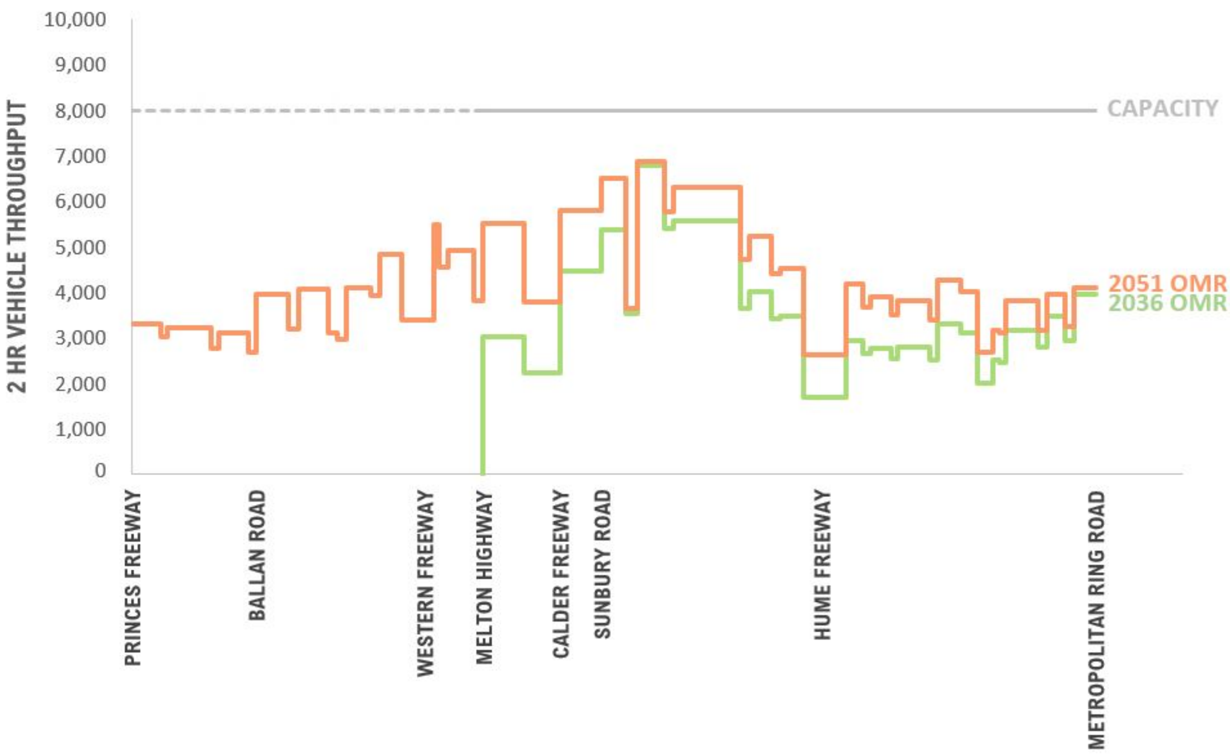

Figure 4.37: Volumes along the OMR and E6 corridors, anti-clockwise (AM period)

4.4.3 *Network Impacts*

As mentioned in §4.4.1 and §4.4.2, the OMR project plays a significant role in reducing congestion across Melbourne's outer north and west. Table 4.26 shows the proportion of VKT under congested conditions[21] for the AM period. It can be seen that:

[21] See §1.3 for further details.

- In 2036 the OMR scenario reduces the amount of congested VKT in the Northern FER by 10%. This is accompanied by other smaller congestion reductions in the Western and Inner FERs. The Western Ring Road and Princes Freeway also see small levels of congestion relief which is greatly beneficial given the volumes of people using those roads.
- In 2051 both the Northern and Western FERs experience significant reductions in congestion compared to the base case scenario, dropping 6% and 8% respectively.

FER	2036 TBC	2036 OMR	2051 TBC	2051 OMR
Eastern	39.5%	+0.2%	41.2%	+1.3%
Inner	48.5%	-1.7%	55.9%	-0.9%
Northern	41.1%	-10.0%	45.2%	-6.2%
Peninsula	21.2%	-0.2%	26.7%	-0.7%
Southern	43.5%	-0.5%	46.4%	+0.1%
Western	32.5%	-2.3%	42.4%	-8.1%
Other	1.3%	≈0%	2.2%	≈0%

Table 4.26: OMR changes in congested VKT (AM period)

Figure 4.38 and Figure 4.39 spatially show where increases and decreases in congestion have occurred on the road network during the morning peak between the OMR and TBC scenarios for 2036 and 2051 respectively.

- In 2036, significant congestion relief is provided along the length of the Hume Freeway, Donnybrook Road, Epping Road, Oaklands Road and Somerton Road. Specific roads feeding the OMR and E6 corridors increase in congestion, such as the Melton Highway and the eastern end of Donnybrook Road.
- The pattern is similar in 2051, with additional roads providing congestion relief including the Princes Freeway and many of the north-south roads that provide connectivity throughout the west.

Public transport network performance is largely unaffected by the presence of the OMR project. However, it is worth noting that the reduced congestion provided by the increased road supply results in slightly faster bus journeys throughout the north and west of Melbourne. In 2051, this effect is accompanied by a small (≈1%) increase in bus boardings.

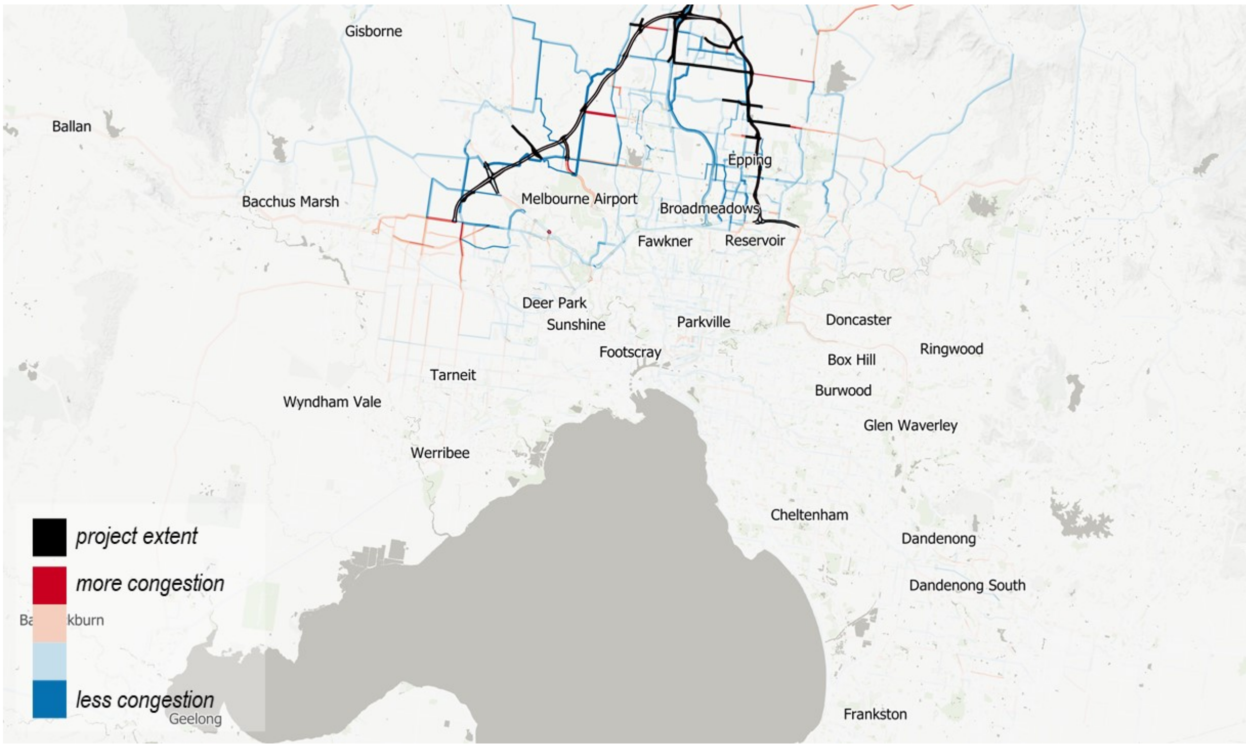

Figure 4.38: Change in road volume/capacity ratio, 2036 OMR vs. TBC (AM period)

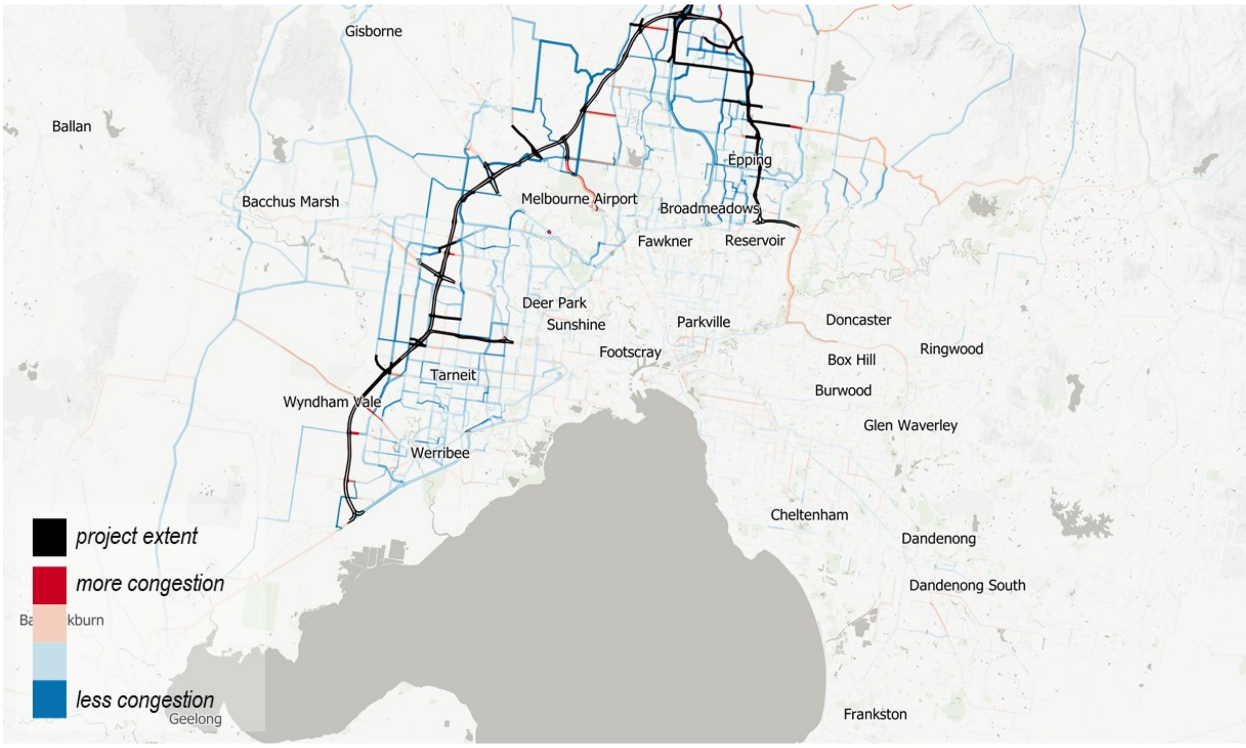

Figure 4.39: Change in road volume/capacity ratio, 2051 OMR vs. TBC (AM period)

4.4.4 *Accessibility*

Figure 4.40 shows the change in average morning peak travel time for the OMR project compared to the TBC. Consistent with the outcomes described in §4.4.2 and §4.4.3, the Outer Melbourne and the Growth Area FUAs benefit the most from the presence of the new corridor. Trips originating from those growth areas take on average 7% less time than in the base case.

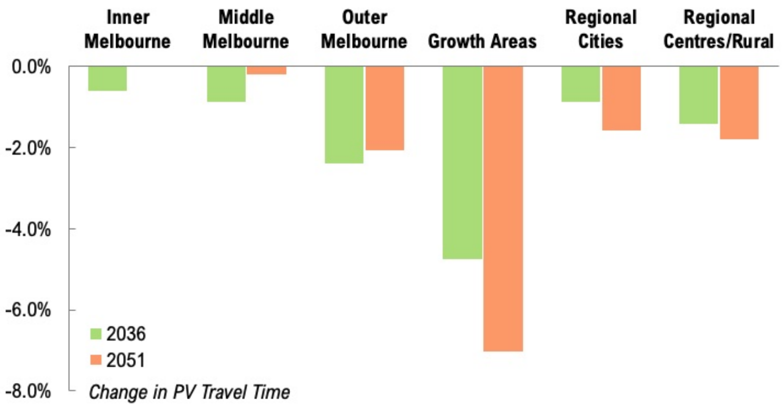

Figure 4.40: OMR changes in private vehicle travel time by FUA (AM period, originating)

Figure 4.41 shows the distribution of these travel time savings spatially for the 2051 year. The large impact of the OMR corridor can be seen throughout the outer-west and north of metropolitan Melbourne. Minor increases in average travel time are seen within the surrounds of Werribee. Whilst this may in part be attributed to increased local demand at the ends of the OMR corridor, it may also reflect people changing the nature of their journeys as population and employment is redistributed.

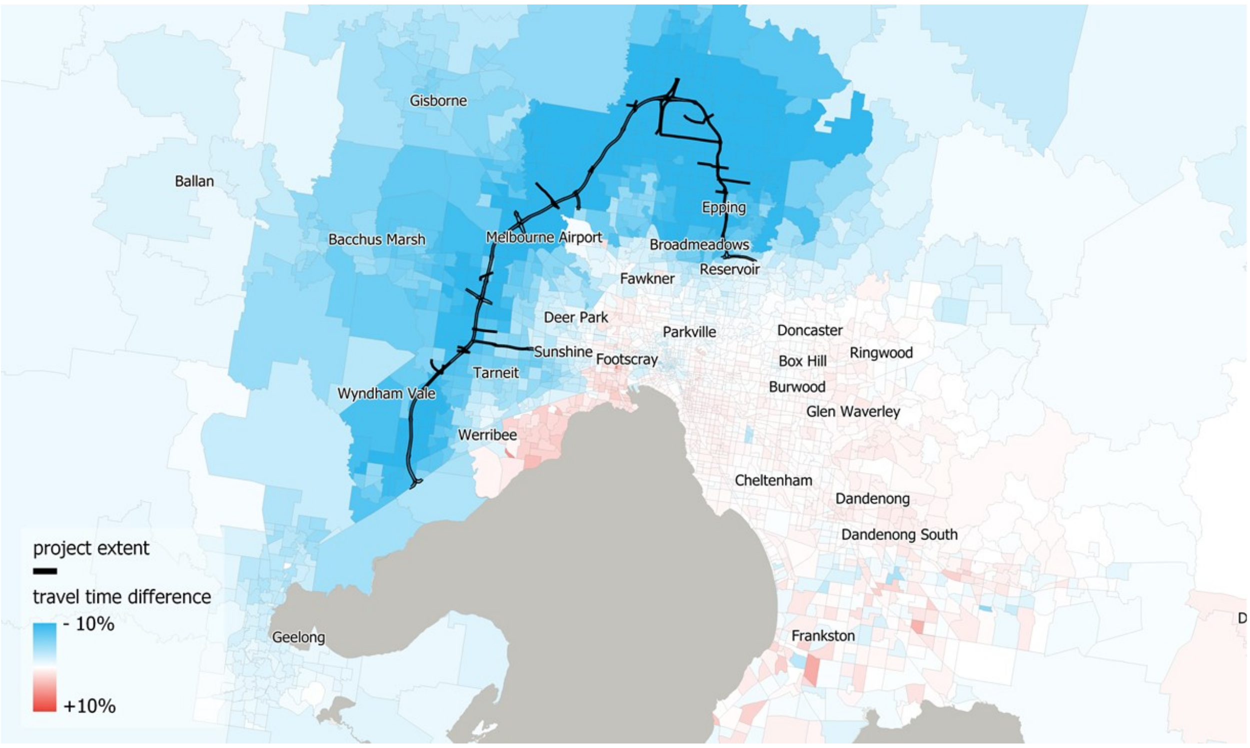

Figure 4.41: Changes in private vehicle travel time, 2051 OMR vs. TBC (AM period)

4.5 ROAD MANAGEMENT SYSTEMS

4.5.1 *Demographic Changes*

Table 4.27 and Table 4.28 show the change in population and employment distribution for the RMS project compared to the TBC. The primary intervention for this project is a general improvement in operations across arterial roads within the metropolitan Melbourne area. As a result, the overall impacts on land use are spread throughout the city.

In general, the RMS project is associated with a lower growth of residents and jobs in both the Inner Melbourne and regional FUAs, with higher growth across Outer Melbourne and the Growth Areas. This has occurred because private vehicle travel times have improved across the metropolitan network. This improved level of accessibility has made it relatively more attractive to live in these outer areas compared to the TBC, especially assuming lower, more affordable land prices.

FUA	2036 TBC	2036 RMS		2051 TBC	2051 RMS	
Inner Melbourne	1,344,000	-15,000	-1.1%	1,709,000	-22,000	-1.0%
Middle Melbourne	2,078,000	+1,000	≈0%	2,542,000	+2,000	+0.1%
Outer Melbourne	2,310,000	+20,000	+0.9%	2,612,000	+23,000	+0.9%
Growth Areas	1,010,000	+8,000	+0.8%	1,466,000	+13,000	+0.9%
Regional Cities	828,000	-8,000	-1.0%	974,000	-9,000	-0.9%
Regional Centres/Rural	1,292,000	-6,000	-0.5%	1,536,000	-7,000	-0.5%

Table 4.27: RMS population changes

FUA	2036 TBC	2036 RMS		2051 TBC	2051 RMS	
Inner Melbourne	1,359,000	≈0	≈0%	1,592,000	≈0	≈0%
Middle Melbourne	991,000	+5,000	+0.5%	1,209,000	+6,000	+0.5%
Outer Melbourne	1,086,000	+4,000	+0.4%	1,376,000	+4,000	+0.3%
Growth Areas	94,000	≈0	≈0%	136,000	-1,000	-0.7%
Regional Cities	444,000	-4,000	-0.9%	549,000	-5,000	-0.9%
Regional Centres/Rural	580,000	-5,000	-0.9%	686,000	-5,000	-0.7%

Table 4.28: RMS employment changes

Figure 4.42 and Figure 4.43 show the changes in population and employment spatially between the RMS and TBC versions of 2051. The general movement of residents away from the city centre in the RMS scenarios can be seen, whilst the movement of jobs is similar but smaller in scope. As employment centres like the CBD become more accessible through reduced congestion and faster travel times in the RMS scenarios, there is less need for people to live near these central areas to access opportunities in a timely manner.

The RMS project includes other interventions such as clearway implementations and dedicated bus lanes. As will be explored in §4.5.2 and §4.5.3, these interventions have positive impacts on localised travel behaviour in their vicinity but not to the extent that they materially influence land use distribution as produced by the VLUTI model.

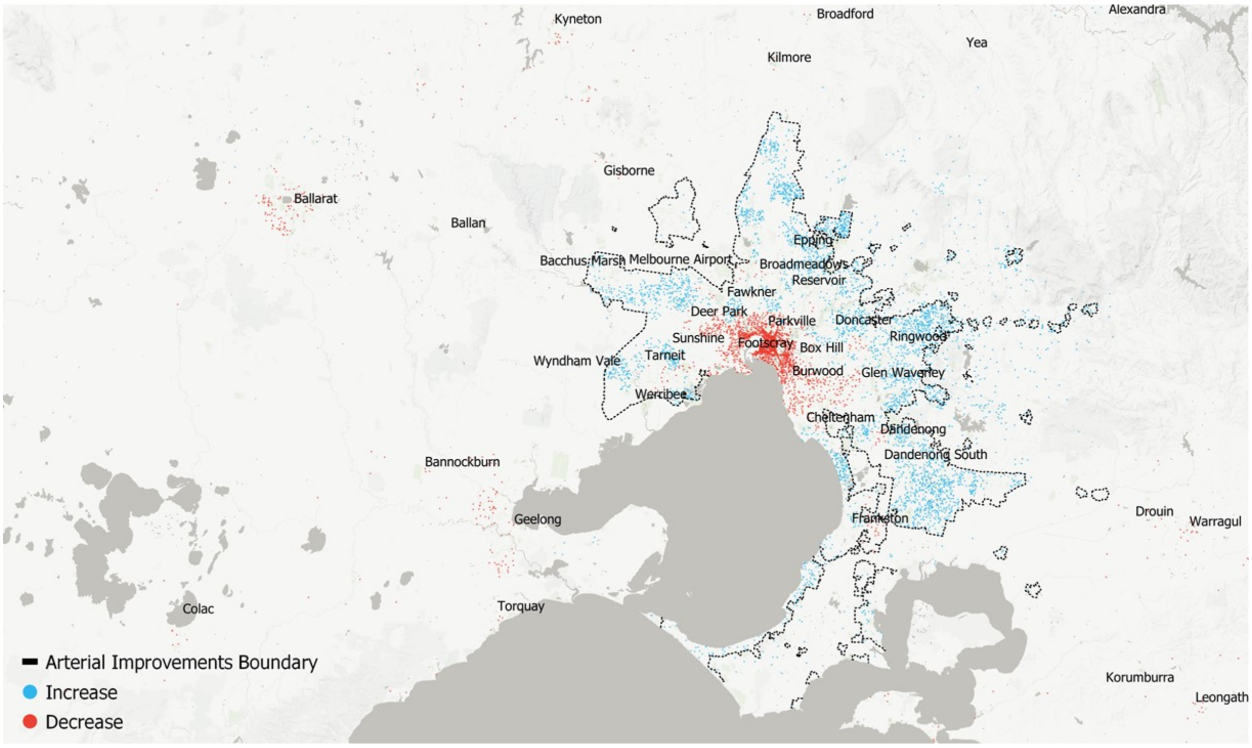

Figure 4.42: Change in population, 2051 RMS vs. TBC

Figure 4.43: Change in employment, 2051 RMS vs. TBC

4.5.2 *Travel Demand*

Table 4.29 shows the change in total morning peak trips by mode for the RMS project relative to the TBC. It can be seen that the RMS interventions result in a modal shift towards private vehicle travel. This is to be expected as the project is underpinned primarily by road operations improvements.

Metric	2036 TBC	2036 RMS		2051 TBC	2051 RMS	
Private Vehicle Trips	3,240,000	+8,000	+0.2%	3,789,000	+15,000	+0.4%
Public Transport Trips	529,000	-9,000	-1.7%	663,000	-13,000	-2.0%
Mode Share	14.0%	13.8%	-0.2%	14.9%	14.6%	-0.3%

Table 4.29: RMS changes in morning peak trips

Figure 4.44 and Figure 4.45 show changes in morning peak road and public transport volumes respectively between the RMS and TBC scenarios. Small uplifts in volume on the road network are evenly spread throughout the entire metropolitan area. A corresponding reduction in public transport volumes (most notably along rail corridors) is similarly seen.

As mentioned in §4.5.1, the smaller interventions included in this project do have a localised effect on travel behaviour. The most significant of these are the implementation of peak direction clearways in Kew and Fairfield[22]. However, it is to be noted that the improvement in arterial road operations largely drowns out the effects of these other changes.

Table 4.30 shows the statewide change in VKT, VHT, PKT and PHT in the morning peak for the RMS project against the TBC. As was the case with private vehicle trips, it can be seen that VKT also increases for the tested scenarios. Despite this increase, the operational improvements implemented across the road network lead to an overall reduction in VHT (with a more pronounced change in 2036). This indicates that despite the increased level of private vehicle travel (both through larger number of trips and longer journeys), journeys are on average shorter in duration. Both PKT and PHT reduce across 2036 and 2051, owing to a general reduction in public transport use associated with this project[23].

[22]The effects of which can be faintly seen in Figure 4.44.

[23]See Table 4.29.

Metric	2036 TBC	2036 RMS		2051 TBC	2051 RMS	
Vehicle Kilometres Travelled	27,337,000	+418,000	+1.50%	32,126,000	+578,000	+1.80%
Vehicle Hours Travelled	660,000	-11,000	-1.70%	834,000	-4,000	-0.50%
Passenger Kilometres Travelled	10,291,000	-171,000	-1.70%	13,344,000	-231,000	-1.70%
Passenger Hours Travelled	280,000	-5,000	-1.80%	351,000	-7,000	-2.00%

Table 4.30: RMS change in travel (AM period)

Figure 4.44: Change in private vehicle volumes, 2051 RMS vs. TBC (AM period)

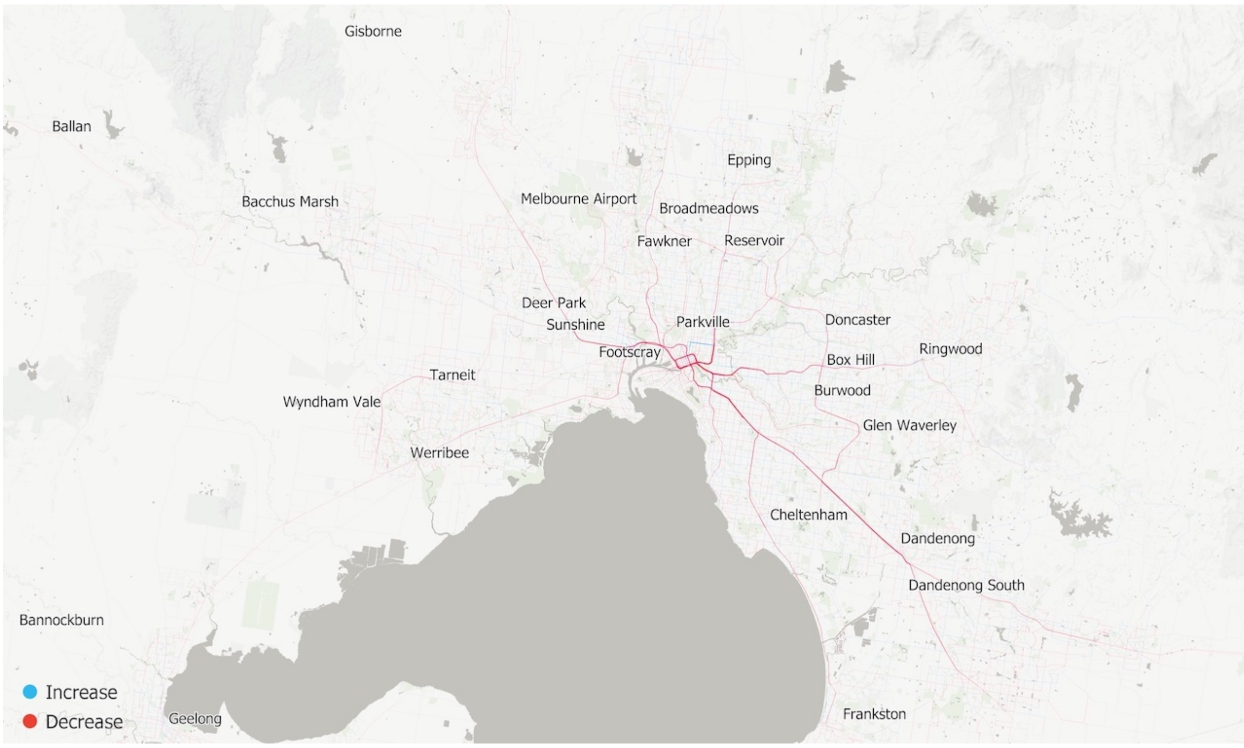

Figure 4.45: Change in public transport volumes, 2051 RMS vs. TBC (AM period)

4.5.3 *Network Impacts*

Table 4.31 shows the change in proportion of VKT occurring under congested conditions for the RMS project relative to the TBC in 2036 and 2051. From this, it can be seen that:

- In 2036, the primary impacts of the project are a minor reduction in congestion across the state compared to the TBC, with the exception of the Growth Areas FUA. These regions experience a minor increase in congestion levels owing to an increase in local residents.
- By 2051, small reductions in congestion are experienced across all FUAs. The greater provision of road supply found in this year across the Growth Areas FUA is able to absorb the increase in traffic volumes that result from population redistribution.

FUA	2036 TBC	2036 RMS	2051 TBC	2051 RMS
Inner Melbourne	50.1%	-1.8%	56.6%	≈0%
Middle Melbourne	46.4%	-0.3%	52.4%	≈0%
Outer Melbourne	41.3%	-0.9%	45.4%	-1.1%
Growth Areas	29.8%	+0.3%	40.7%	-0.9%
Regional Cities	4.1%	≈0%	5.5%	≈0%
Regional Centres/Rural	5.7%	-0.1%	8.1%	-0.3%

Table 4.31: RMS changes in congested VKT (AM period)

Figure 4.46 and Figure 4.47 show the change in morning peak road volume to capacity ratios for the RMS project compared to the TBC in 2036 and 2051. The implementation of small interventions such as the clearways are seen to provide a positive impact through reducing congestion on the local network within their vicinity. However, relative to the impact of the arterial road operations improvements their aggregate effect is very small.

Whilst these observed reductions in proportion of congested VKT may seem minor, it is worth noting they have occurred alongside an overall VKT increase of 1.5 to 2%. Thus, the tested interventions have facilitated an increased throughput of private vehicle travel across the metropolitan road network without a corresponding increase in congestion.

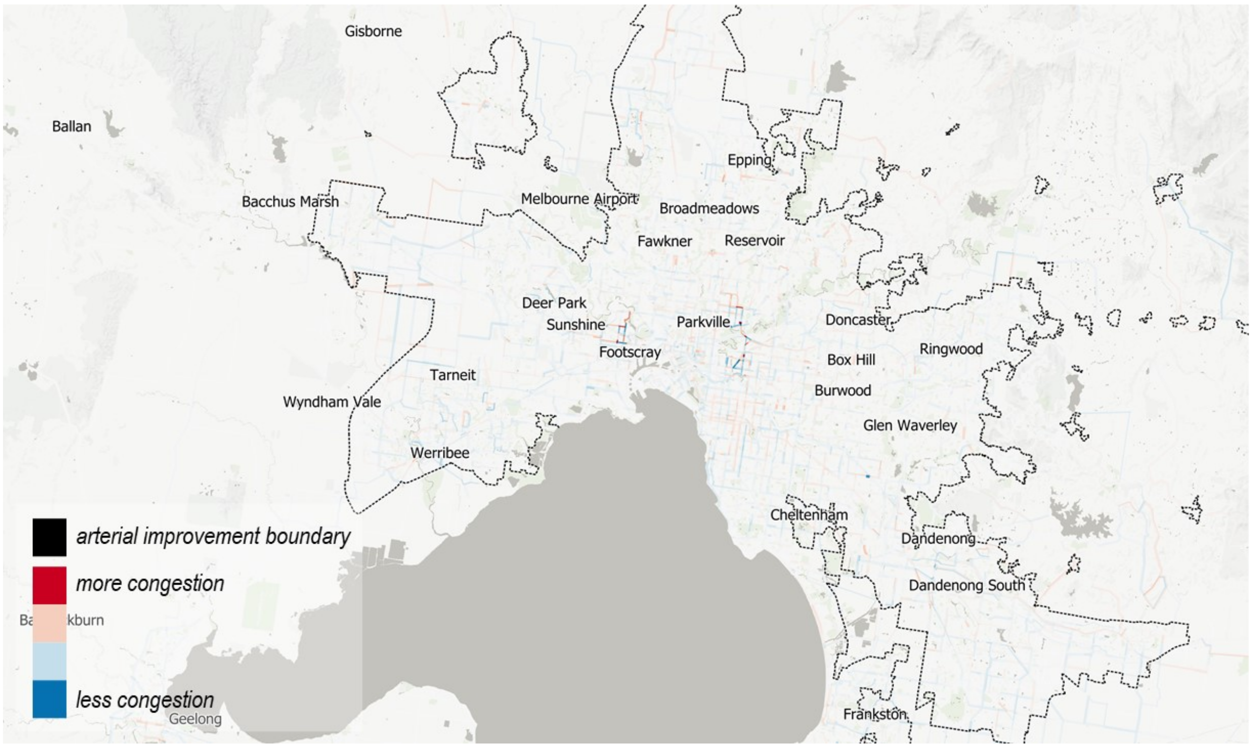

Figure 4.46: Change in volume/capacity ratio, 2036 RMS vs. TBC (AM period)

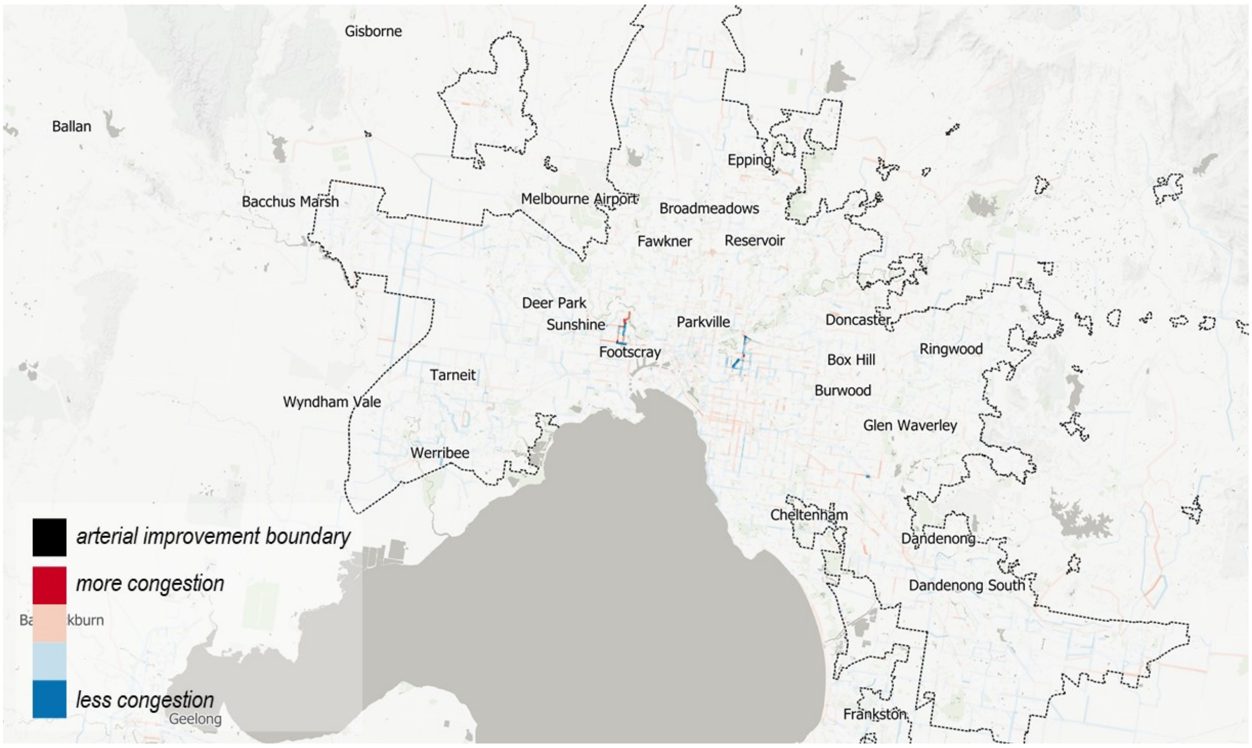

Figure 4.47: Change in volume/capacity ratio, 2051 RMS vs. TBC (AM period)

4.5.4 *Accessibility*

Figure 4.49 and Figure 4.50 show the change in morning peak private vehicle journey times originating from a particular location between the RMS project and the TBC in each of 2036 and 2051. Trends are similar across each modelled year, with reductions in travel time observed across the network. Figure 4.48 shows these changes by FUA, where it can be seen that the impacts are more noticeable in 2036.

Figure 4.48: RMS changes in private vehicle travel time by FUA (AM period, originating)

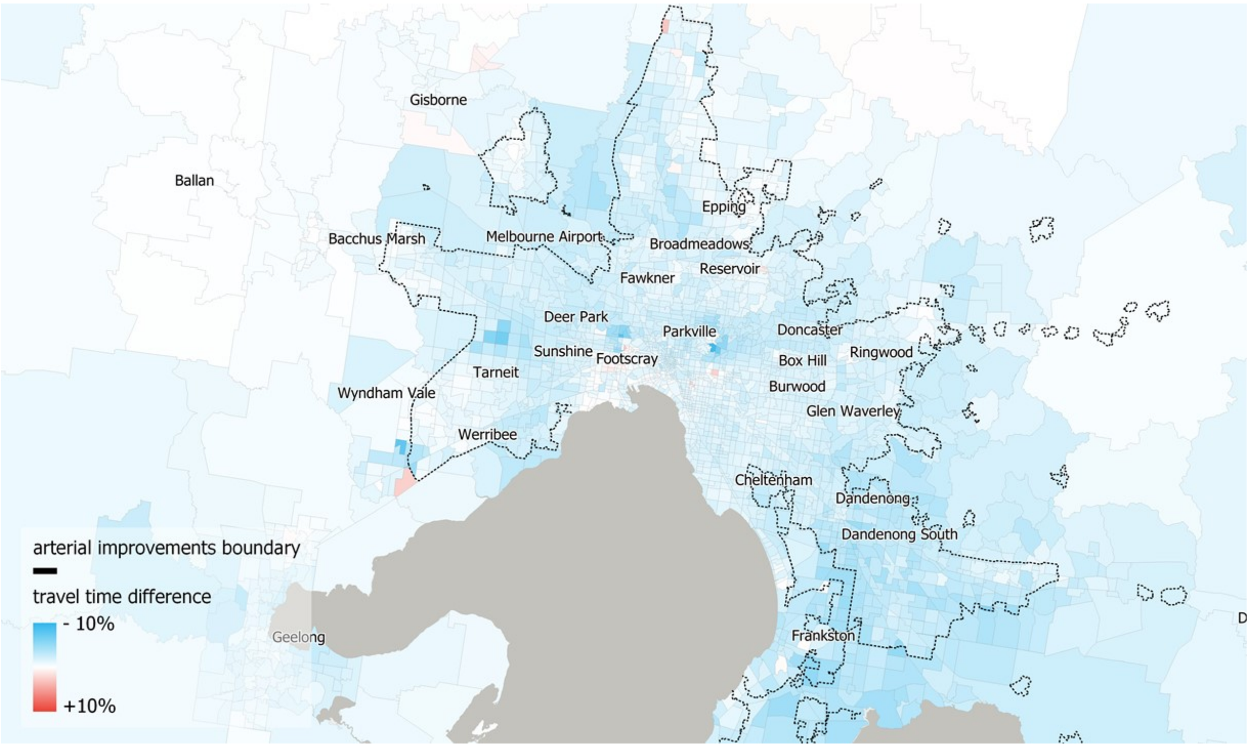

Figure 4.49: Changes in private vehicle travel time, 2036 RMS vs. TBC (AM period)

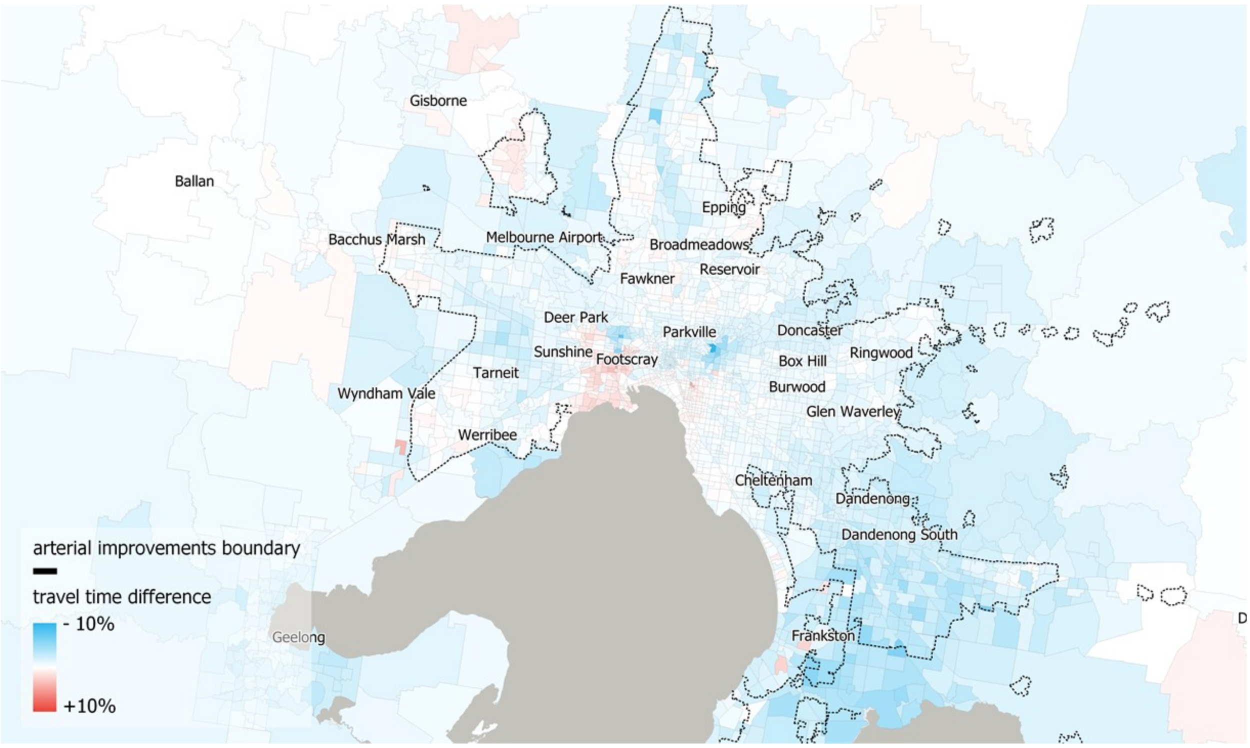

Figure 4.50: Changes in private vehicle travel time, 2051 RMS vs. TBC (AM period)

4.6 WESTERN RAIL CORRIDOR UPGRADE

4.6.1 *Demographic Changes*

Table 4.32 shows the change at 2036 and 2051 in population distribution respectively for the WRU project relative to the TBC. Across both 2036 and 2051 the WRU project demonstrates higher growth in residents in outer Melbourne and new growth areas compared to the TBC, with this being more pronounced in the latter year. Figure 4.51 shows these changes spatially for 2051, where higher concentrations of residents can be seen towards southern and western Melbourne along the extent of the project.

FUA	2036 TBC	2036 WRU		2051 TBC	2051 WRU	
Inner Melbourne	1,344,000	-2,000	-0.1%	1,709,000	-7,000	-0.4%
Middle Melbourne	2,078,000	-3,000	-0.1%	2,542,000	-3,000	-0.1%
Outer Melbourne	2,310,000	+6,000	+0.3%	2,612,000	+9,000	+0.3%
Growth Areas	1,010,000	+5,000	+0.5%	1,466,000	+8,000	+0.5%
Regional Cities	828,000	-2,000	-0.2%	974,000	-3,000	-0.3%
Regional Centres/Rural	1,292,000	-3,000	-0.2%	1,536,000	-4,000	-0.3%

Table 4.32: WRU population changes

Table 4.33 shows the changes in employment distribution across 2036 and 2051 relative to the TBC. Figure 4.52 then shows these changes spatially for the 2051 scenario. In the CBD, the VLUTI predicts fewer inner-city residents compared to the TBC but does show an uplift in employment activity. As with MM2G, this is a predictable response by the model reacting to the increased accessibility for travellers towards the ends of the line upgrade. Employment grows across both 2036 and 2051 in inner Melbourne and at the southern extent of the corridor (near Dandenong) relative to the TBC. Like the growth patterns seen for MM2G, the employment growth in the CBD is driven by the increased accessibility the project provides while the growth in the less central areas is generated primarily by the increased population.

FUA	2036 TBC	2036 WRU		2051 TBC	2051 WRU	
Inner Melbourne	1,359,000	+4,000	+0.3%	1,592,000	+4,000	+0.3%
Middle Melbourne	991,000	-2,000	-0.2%	1,209,000	-1,000	-0.1%
Outer Melbourne	1,086,000	+1,000	+0.1%	1,376,000	+1,000	+0.1%
Growth Areas	94,000	≈0	≈0%	136,000	≈0	≈0%
Regional Cities	444,000	-2,000	-0.5%	549,000	-2,000	-0.4%
Regional Centres/Rural	580,000	-2,000	-0.3%	686,000	-2,000	-0.3%

Table 4.33: WRU employment changes

Figure 4.51: Change in population, 2051 WRU vs. TBC

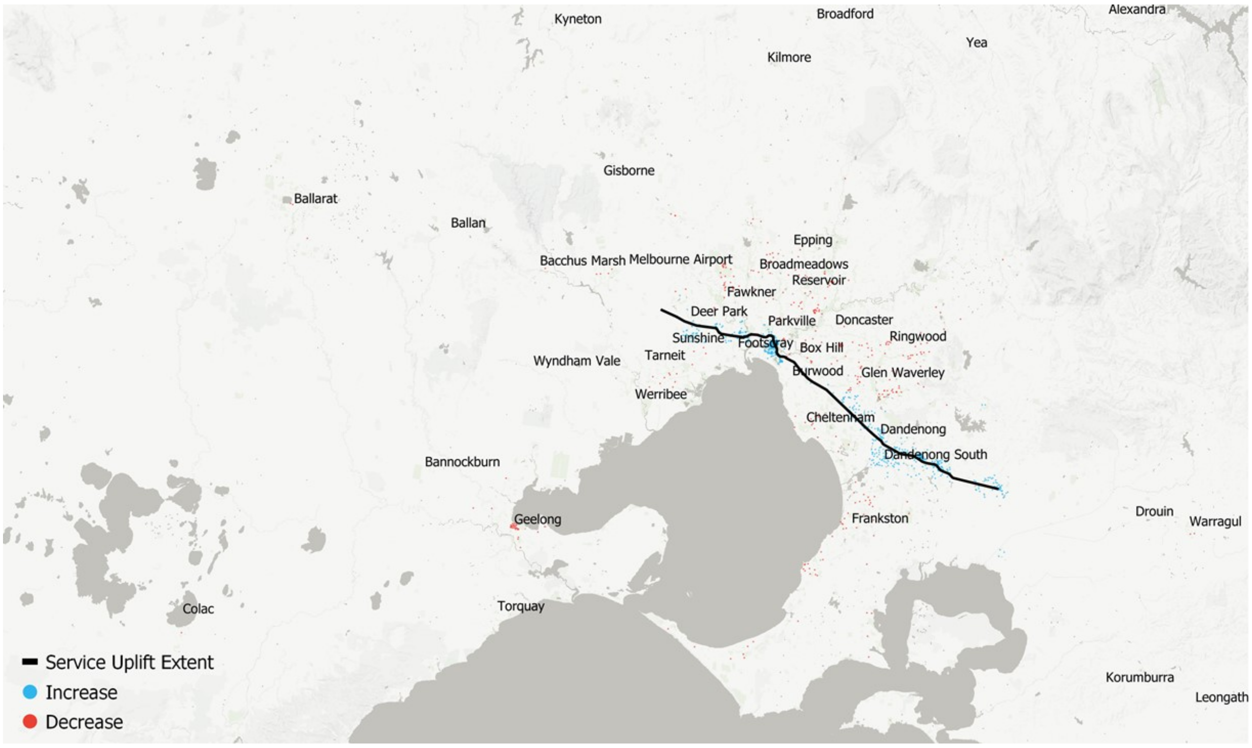

Figure 4.52: Change in employment, 2051 WRU vs. TBC

4.6.2 *Travel Demand*

Table 4.34 shows the change in total morning peak trips by mode for the WRU project relative to the TBC. The increase in public transport travel (and thus mode share) seen is similar in magnitude to the CLR project but less than the MM2G project across both 2036 and 2051.

Metric	2036 TBC	2036 WRU		2051 TBC	2051 WRU	
Private Vehicle Trips	3,240,000	-2,000	-0.1%	3,789,000	-5,000	-0.1%
Public Transport Trips	529,000	+5,000	+0.9%	663,000	+5,000	+0.8%
Mode Share	14.0%	14.2%	+0.1%	14.9%	15.0%	+0.1%

Table 4.34: WRU changes in morning peak trips

Table 4.35 shows the change in total morning peak public transport trips for the WRU project relative to the TBC by FER. Rail demand increases from the Southern and Western FERs, closely aligned with the capacity upgrades.

FER	2036 TBC	2036 WRU		2051 TBC	2051 WRU	
Eastern	43,900	-200	-0.4%	53,800	-300	-0.6%
Inner	248,000	+400	0.2%	299,800	-800	-0.3%
Northern	59,800	+400	0.7%	81,100	-600	-0.7%
Peninsula	8,400	-100	-0.7%	11,200	-100	-0.9%
Southern	69,900	+1,500	2.2%	89,100	+2,500	2.8%
Western	78,900	+2,900	3.7%	102,800	+4,900	4.8%
Other	20,500	≈0	≈0%	25,400	-100	-0.3%

Table 4.35: WRU public transport trips by FER (AM period, originating)

At 2051, some drop in patronage (both rail and connector bus) can be seen on the adjacent corridors, for example the Sunbury line, Epping corridor and Ringwood line. This is due to the WRU attracting demographic growth from these corridors. A reduction in growth on the South-Western Rail Corridor is also a response to the slight migration of movement away from Geelong and Wyndham. Figure 4.53 and Figure 4.53 show the change in morning peak passenger volumes between the WRU project and the TBC for 2036 and 2051 respectively.

WRU has a minimal impact on car demand. The only regional increase occurs in the Southern FER (0.5%) at 2051. Like the other public transport projects tested, car demand for WRU decreases in the Inner Melbourne FUA but this is attributable to the decrease in population rather than a shift to another mode. Table 4.36 shows the change in total morning peak private vehicle trips between the WRU projects and the TBC by FUA.

FUA	2036 TBC	2036 WRU		2051 TBC	2051 WRU	
Inner Melbourne	325,300	-600	-0.2%	386,400	-1,100	-0.3%
Middle Melbourne	726,900	-400	-0.1%	841,500	-2,300	-0.3%
Outer Melbourne	932,400	+1,000	+0.1%	1,018,000	+1,000	+0.1%
Growth Areas	405,800	+700	+0.2%	550,600	+1,000	+0.2%
Regional Cities	360,300	-1,100	-0.3%	422,000	-1,500	-0.4%
Regional Centres\Rural	489,000	-1,300	-0.3%	571,000	-1,700	-0.3%

Table 4.36: WRU private vehicle trips by FUA (AM period, originating)

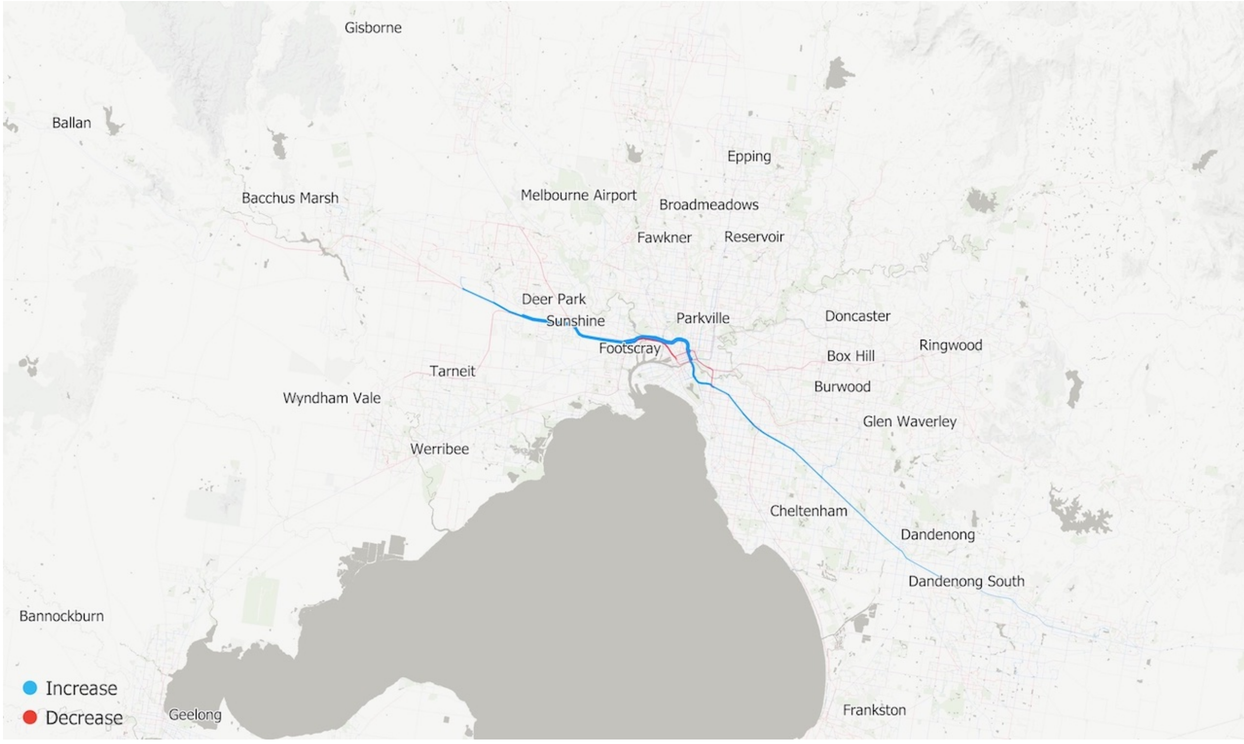

Figure 4.53: Change in public transport volumes, 2036 WRU vs. TBC (AM period)

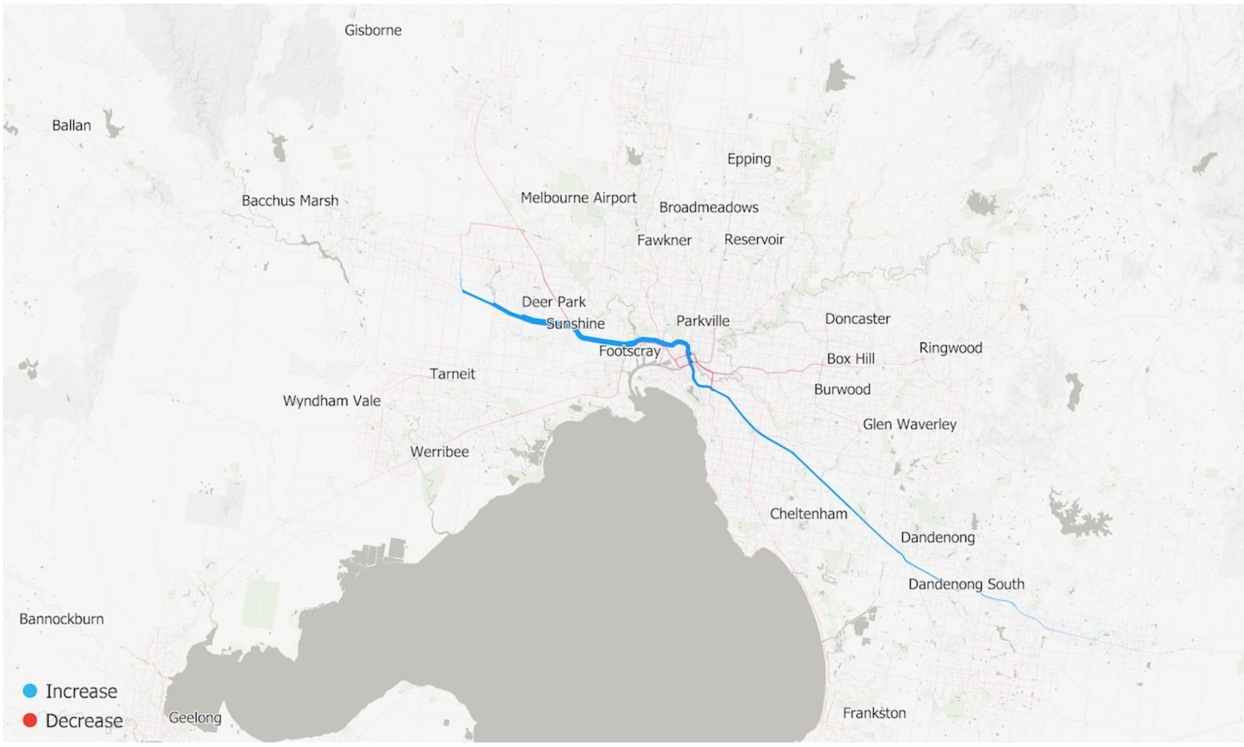

Figure 4.54: Change in public transport volumes, 2051 WRU vs. TBC (AM period)

4.6.3 *Network Impacts*

Table 4.37 shows the change in proportion of crowded morning peak metropolitan train PKT between the WRU project and the TBC. From this, it can be seen that:

- Impacts of the project in 2036 on the metropolitan train network are relatively minor, given the Southern and Western FERs do not exhibit much crowded travel in the TBC to begin with. The most significant change in this year is seen in Inner Melbourne, where the capacity uplifts serve to relieve pressure on the central portions of the rail network. The Eastern FER also sees a decrease in crowded rail travel – owing to a redistribution of residents away from areas surrounding Box Hill and Blackburn[24].

  Specific V/Line services from Bacchus Marsh and Melton to Southern Cross see some relief in local crowding with the presence of the WRU project. Upgrades to the corridor have taken some pressure off these routes, reducing their utilisation during the morning peak from approximately 110% to 90%.

- By 2051, the WRU project results in a decrease in crowded metropolitan train travel within the Southern FER of 7%. The Western FER actually sees a small increase in crowded travel. Capacity uplifts in this area have resulted in more public transport users. Additionally, the west also sees an increase in residents owing to population redistribution from the project. V/Line services do not see an improvement in crowded conditions in this year.

[24] See Figure 4.51.

FER	2036 TBC	2036 WRU		2051 TBC	2051 WRU	
Eastern	23.9%	18.5%	-5.4%	29.2%	29.1%	-0.2%
Inner	35.4%	22.4%	-12.9%	53.0%	51.3%	-1.7%
Northern	1.4%	1.4%	≈0%	3.6%	3.6%	≈0%
Peninsula	≈0%	≈0%	≈0%	7.9%	7.8%	-0.1%
Southern	4.2%	4.0%	-0.2%	36.0%	29.4%	-6.5%
Western	≈0%	≈0%	≈0%	34.0%	35.5%	+1.5%
Other	≈0%	≈0%	≈0%	0.0%	0.0%	≈0%

Table 4.37: WRU changes in crowded metropolitan train PKT (AM period)

Figure 4.55 shows change in passenger to capacity ratio for the morning peak in 2051 for this project compared to the TBC. The impact of service improvements extending from Mount Atkinson in the west and along the full length of the Dandenong line is evident. Further, as was similarly seen with the MM2G project[25], crowding on buses has increased due to more trip-makers seeking access to rail stations, particularly near Mount Atkinson and Caroline Springs.

[25] See Figure 4.28.

The WRU project had a minor impact on road congestion. Table 4.38 shows change in the proportion of congested morning peak VHT.

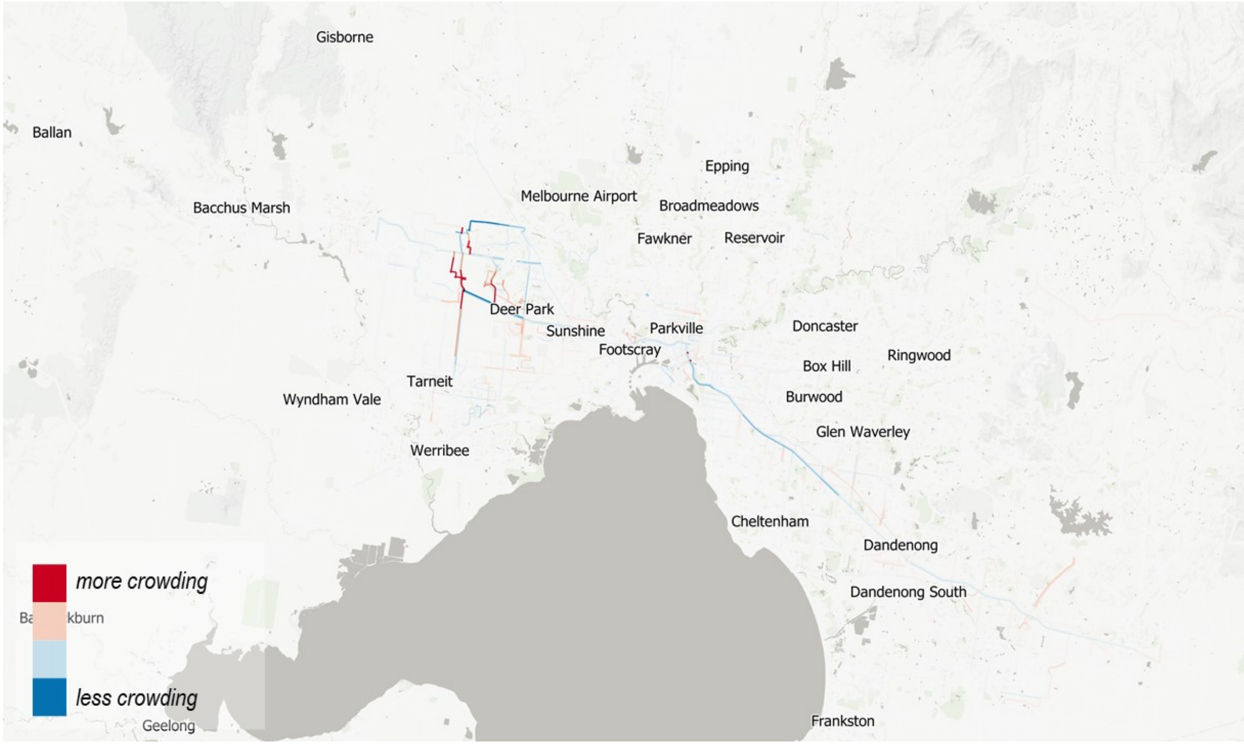

Figure 4.55: Change in passenger/capacity ratio, 2051 WRU vs. TBC (AM period)

FUA	2036 TBC	2036 WRU		2051 TBC	2051 WRU	
Inner Melbourne	64.9%	64.6%	-0.3%	71.7%	71.8%	+0.1%
Middle Melbourne	58.7%	58.4%	-0.3%	66.8%	66.7%	-0.1%
Outer Melbourne	55.6%	55.7%	+0.1%	62.0%	61.9%	-0.1%
Growth Areas	42.5%	42.5%	-0.0%	54.6%	54.4%	-0.2%
Regional Cities	8.2%	8.3%	+0.1%	10.6%	10.6%	+0.0%
Regional Centres\Rural	12.6%	12.5%	-0.1%	18.7%	18.6%	-0.1%

Table 4.38: WRU changes in congested VHT (AM period)

4.6.4 *Accessibility*

Figure 4.56 shows the change in average morning peak public transport travel times for the WRU project compared to the TBC originating from each FUA. The greatest reductions are realised in Growth Areas by 2051 (approximately 1%), followed by the Outer Melbourne FUA.

Figure 4.56: WRU changes in puiblic transport travel time by FUA (AM period, originating)

Figure 4.57 shows the change in public transport travel times spatially for 2051. The pattern for this project is less clear than for other public transport projects tested across this assessment, with a patchwork pattern of increases and decreases apparent in the western growth corridor. This makes it harder to identify an underlying trend. However, based on what is generally observed from VLUTI outcomes, an increase in residents and a small decrease in employment activity throughout the Western FUA would favour an uplift in longer trips towards the CBD.

Much like the other public transport projects, the capacity uplifts provided by the WRU are accompanied by a minor decrease in private vehicle travel times within their local vicinity. As shown in Figure 4.58, the Western FUA benefits the most, particularly surrounding Deer Park as public transport mode share in this region increases.

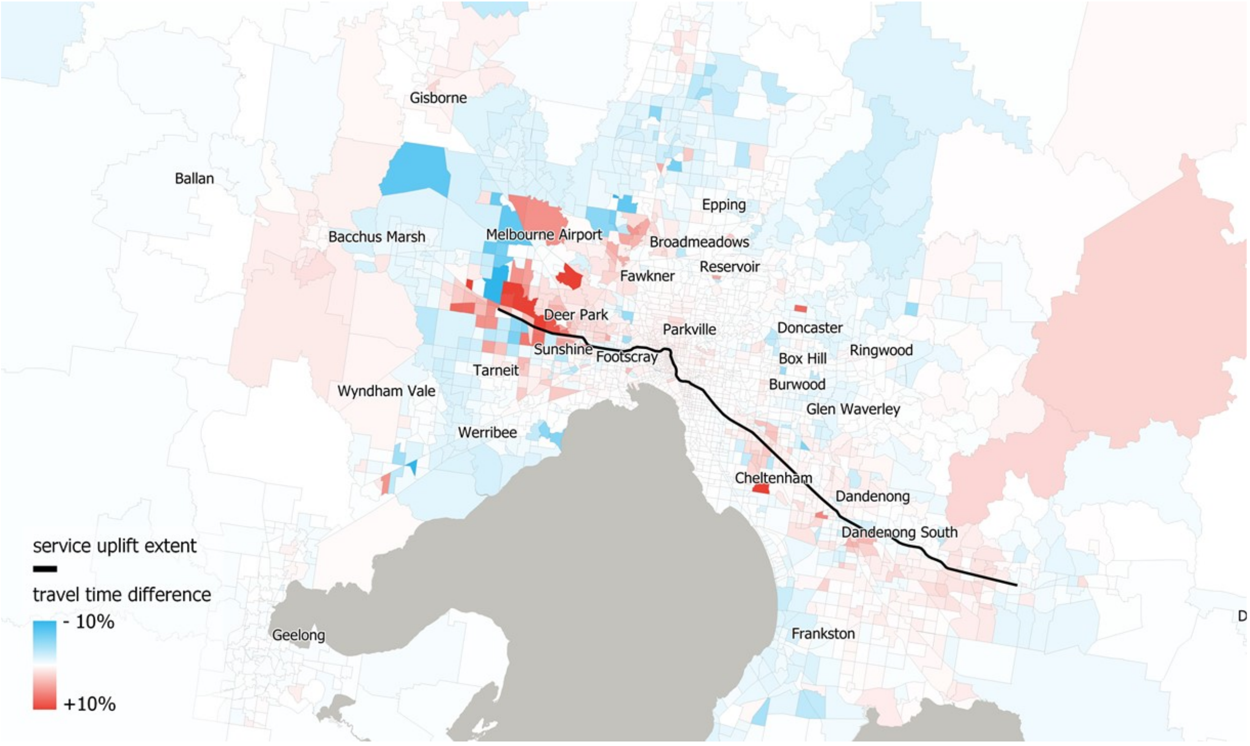

Figure 4.57: Changes in public transport travel time, 2051 WRU vs. TBC (AM period)

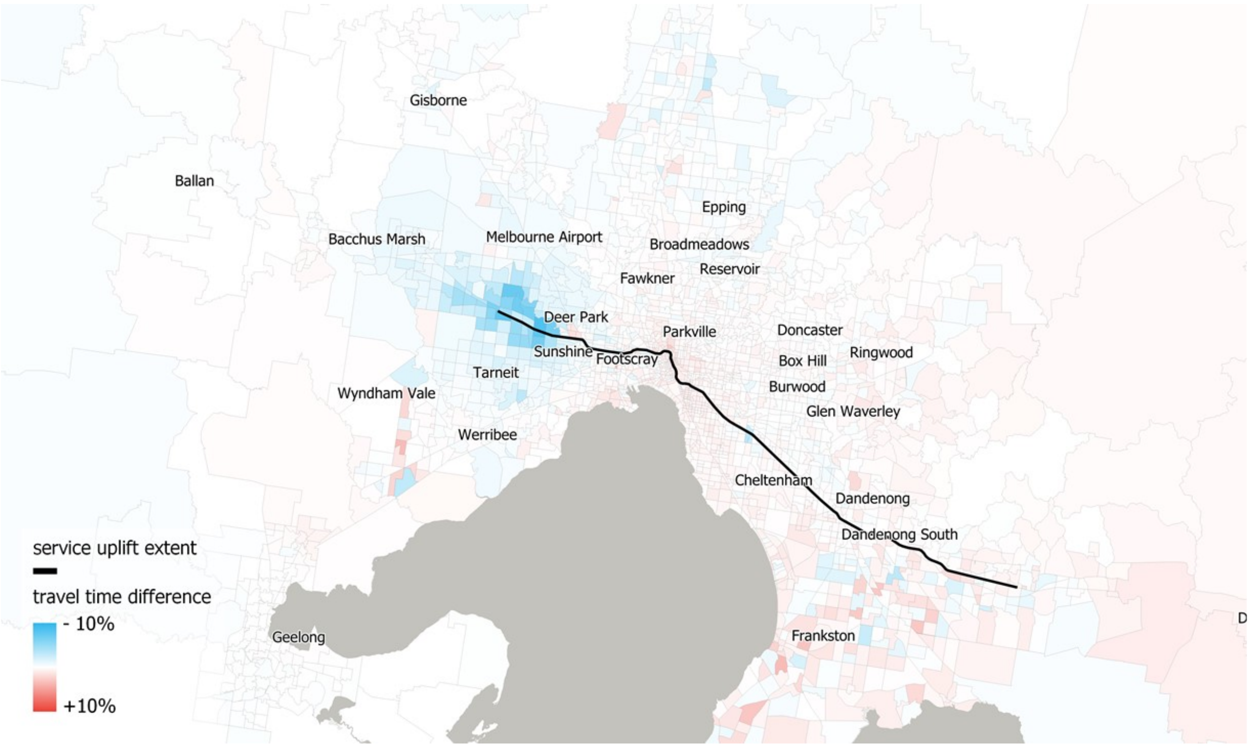

Figure 4.58: Changes in private vehicle travel time, 2051 WRU vs. TBC (AM period)

5

Sensitivity Tests

5.1 INCREASED WORKING FROM HOME

The WFH scenario increases the propensity for people of specific industries and locations to work from home. The primary impact of this is a slower growth of residents near centralised areas such as the CBD as the need to access specific employment hubs is reduced. Table 5.1 illustrates these changes in population with reductions seen across the Inner Melbourne and Regional Cities FUAs relative to the NDS.

Whilst population is redistributed away from Inner Melbourne, employment grows more quickly for the central city (Table 5.2) where businesses can reap the benefits of centrality and other conglomeration effects. Just as residents are more comfortable being further away from their place of employment given the reduced need to commute, it correspondingly becomes less burdensome to travel longer distances towards more central employment hubs.

FUA	2036 NDS	2036 WFH		2051 NDS	2051 WFH	
Inner Melbourne	1,351,000	-49,000	-3.6%	1,676,000	-59,000	-3.5%
Middle Melbourne	2,088,000	+1,000	≈0%	2,527,000	+5,000	+0.2%
Outer Melbourne	2,315,000	+30,000	+1.3%	2,644,000	+32,000	+1.2%
Growth Areas	994,000	+23,000	+2.3%	1,499,000	+35,000	+2.3%
Regional Cities	819,000	-15,000	-1.8%	972,000	-20,000	-2.1%
Regional Centres/Rural	1,295,000	+10,000	+0.8%	1,521,000	+7,000	+0.5%

Table 5.1: WFH population changes

FUA	2036 NDS	2036 WFH		2051 NDS	2051 WFH	
Inner Melbourne	1,362,000	+43,000	+3.2%	1,628,000	+54,000	+3.3%
Middle Melbourne	994,000	-4,000	-0.4%	1,197,000	-3,000	-0.3%
Outer Melbourne	1,080,000	-17,000	-1.6%	1,365,000	-22,000	-1.6%
Growth Areas	93,000	-2,000	-2.2%	136,000	-3,000	-2.2%
Regional Cities	439,000	-11,000	-2.5%	548,000	-14,000	-2.6%
Regional Centres/Rural	586,000	-8,000	-1.4%	674,000	-10,000	-1.5%

Table 5.2: WFH employment changes

Table 5.3 shows the change in morning peak trips for the WFH scenario. It is shown that the assumptions underpinning the scenario lead to an expected reduction in trips as fewer people are required to travel to work. This reduction is seen across both the road and public transport networks, with the former seeing a more significant change, leading to a modestly increased public transport mode share.

Metric	2036 NDS	2036 WFH		2051 NDS	2051 WFH	
Private Vehicle Trips	3,233,000	-119,000	-3.7%	3,770,000	-146,000	-3.9%
Public Transport Trips	534,000	-14,000	-2.6%	694,000	-19,000	-2.7%
Mode Share	14.2%	14.3%	+0.1%	15.5%	15.7%	+0.1%

Table 5.3: WFH changes in morning peak trips

Table 5.4 shows how this change in demand manifests in terms of network travel. A reduction in each of VKT and VHT is observed, aligning with the reduction in private vehicle trips. It is noted that the magnitude of change in reduction of VKT and VHT is less than that of the private vehicle trips. This is because whilst there are fewer people travelling, they are generally travelling further due to population redistribution. A similar trend is observed for public transport, where despite a reduction in public transport trips, there is an increase in PKT and PHT. This again is a response to broader changes in travel patterns with people moving away from centralised locations like Inner Melbourne, resulting in longer trips. This means more of any given trip is likely to experience crowded conditions rather than this only occurring near central areas.

Metric	2036 NDS	2036 WFH		2051 NDS	2051 WFH	
Vehicle Kilometres Travelled	27,305,000	-288,000	-1.1%	32,088,000	-425,000	-1.3%
Vehicle Hours Travelled	646,000	-4,000	-0.6%	793,000	-8,000	-1.0%
Passenger Kilometres Travelled	10,410,000	+356,000	+3.4%	14,711,000	+419,000	+2.8%
Passenger Hours Travelled	279,000	+5,000	+1.8%	370,000	+6,000	+1.6%

Table 5.4: WFH change in travel (AM period)

The movement of population towards specific areas causes a level of increased road congestion in some instances. This is notable in growth areas in 2036 and regional areas in 2051. Trends are not necessarily consistent across modelled horizon years, which may be due to the fact of changing infrastructure across the network between 2036 and 2051 leading to variation in the areas of congestion within the base case. Table 5.5 shows these changes in congested VKT for the morning period in both modelled years compared to the NDS.

Metric	2036 NDS	2036 WFH	2051 NDS	2051 WFH
Inner Melbourne	48.9%	-1.4%	55.0%	-3.4%
Middle Melbourne	46.1%	-0.6%	51.7%	-1.4%
Outer Melbourne	39.9%	≈0%	41.6%	+0.6%
Growth Areas	24.9%	+3.4%	26.6%	-0.1%
Regional Cities	4.1%	≈0%	6.1%	+3.0%
Regional Centres/Rural	5.1%	+1.7%	9.1%	+2.0%

Table 5.5: WFH changes in congested VKT (AM period)

Increases in crowding across the public transport network are more broadly felt as people opt to travel via public transport from outer areas of Melbourne due to the greater accessibility it provides. These increases in crowding are particularly notable in growth areas where a greater growth of residents has occurred relative to the NDS. Table 5.6 shows these changes in congested PKT for the morning period in both modelled years compared to the NDS.

FUA	2036 NDS	2036 WFH	2051 NDS	2051 WFH
Inner Melbourne	18.2%	+6.7%	10.6%	-0.4%
Middle Melbourne	15.1%	+2.7%	12.4%	+2.9%
Outer Melbourne	5.6%	+2.0%	3.5%	+3.1%
Growth Areas	22.9%	+5.1%	2.9%	+24.0%
Regional Cities	1.4%	≈0%	1.3%	-0.3%
Regional Centres/Rural	2.2%	+2.4%	4.8%	-0.1%

Table 5.6: WFH changes in congested PKT (AM period)

5.2 ELECTRIC AND AUTONOMOUS VEHICLES

Compared to the NDS, the EAV scenario tests across 2036 and 2051 adjust the cost of private vehicle travel downwards – both in terms of the perceived value of time as well as operating costs. Further, the availability of shared autonomous vehicle fleets also reduces the barrier to private car travel. Rather than having to own a car to drive somewhere, it is assumed that everyone has access to a fleet AV if they desire to use one.

The primary impact of these implemented assumptions is a marked increase in private vehicle travel. Table 5.7 shows the change in morning peak trips by mode when comparing the EAV sensitivity test to the NDS. From this, it can be seen that the number of morning peak private vehicle trips increases by 5.5% and 6.3% respectively for 2036 and 2051. The corresponding drop in public transport travel is significant, with public transport mode share dropping by approximately 2-3% across each modelled year.

Metric	2036 NDS	2036 EAV		2051 NDS	2051 EAV	
Private Vehicle Trips	3,233,000	+179,000	+5.5%	3,770,000	+237,000	+6.3%
Public Transport Trips	534,000	-80,000	-15.0%	694,000	-121,000	-17.4%
Mode Share	14.2%	11.8%	-2.4%	15.5%	12.5%	-3.0%

Table 5.7: EAV changes in morning peak trips

Table 5.8 shows how this change in demand manifests in terms of network travel. From this, it can be seen that:

- Private vehicle kilometres travelled[1] increases proportionally more than the number of private vehicle trips (11% vs. 5%) in 2036. This shows that those in the EAV scenario are driving longer journeys than in the NDS[2]. In 2036, this is accompanied by a doubly large increase in VHT (19%) – indicating that those journeys in the EAV scenario are much slower on average than the NDS[3].
- Reductions in PKT and PHT largely match the magnitude in the reduction of trips seen in Table 5.7.

The universal increase in private vehicle travel has a significant impact on congestion levels seen throughout metropolitan Melbourne and the broader state. Table 5.9 shows the change in proportion of VKT occurring under congested conditions during the morning peak. Metropoli-

[1] Whether it is conventionally drive, electric or autonomous.

[2] A similar pattern is seen in 2051.

[3] The VHT change in 2051 is more proportionate.

Metric	2036 NDS	2036 EAV		2051 NDS	2051 EAV	
Vehicle Kilometres Travelled	27,305,000	+3,203,000	+11.7%	32,088,000	+6,126,000	+19.1%
Vehicle Hours Travelled	646,000	+124,000	+19.2%	793,000	+123,000	+15.5%
Passenger Kilometres Travelled	10,410,000	-1,157,000	-11.1%	14,711,000	-2,175,000	-14.8%
Passenger Hours Travelled	279,000	-35,000	-12.5%	370,000	-59,000	-15.9%

Table 5.8: EAV change in travel (AM period)

tan Melbourne experiences the greatest increases in congestion, particularly in 2036 as the Inner Melbourne FUA experiences close to 10% more congested travel. Changes in 2051 are comparatively less severe, owing to the greater share of autonomous vehicles resulting in assumed operational improvements to traffic movements.

FUA	2036 NDS	2036 EAV	2051 NDS	2051 EAV
Inner Melbourne	48.9%	+9.5%	55.0%	+1.6%
Middle Melbourne	46.1%	+4.1%	51.7%	-0.8%
Outer Melbourne	39.9%	+2.2%	41.6%	-1.7%
Growth Areas	24.9%	+1.9%	26.6%	-3.4%
Regional Cities	4.1%	+0.4%	6.1%	-0.9%
Regional Centres/Rural	5.1%	+0.3%	9.1%	-0.5%

Table 5.9: EAV changes in congested VKT (AM period)

Increased congestion leads to longer average journey times across the entire metropolitan region in 2036. By 2051 this is concentrated to the Inner and Middle Melbourne FUAs.

These patterns of accessibility change are reflected in the resulting land use generated by the VLUTI model. Table 5.10 shows the change in population by FUA for the EAV sensitivity tests compared to the NDS. For both modelled years, Inner and Middle Melbourne's residents are redistributed across the rest of Victoria, with the Growth Areas gaining the most. Greater congestion in the central city has made those regions less desirable from an accessibility standpoint. Further, people are willing to travel longer distances due to the lower operating cost of their vehicles and a smaller perceived cost of in-vehicle travel time. This serves to make outer Melbourne and the regional areas of Victoria more attractive.

FUA	2036 NDS	2036 EAV		2051 NDS	2051 EAV	
Inner Melbourne	1,351,000	-40,000	-3.0%	1,676,000	-186,000	-11.1%
Middle Melbourne	2,088,000	-25,000	-1.2%	2,527,000	-22,000	-0.9%
Outer Melbourne	2,315,000	+10,000	+0.4%	2,644,000	+78,000	+3.0%
Growth Areas	994,000	+8,000	+0.8%	1,499,000	+54,000	+3.6%
Regional Cities	819,000	+6,000	+0.7%	972,000	+6,000	+0.6%
Regional Centres/Rural	1,295,000	+40,000	+3.1%	1,521,000	+69,000	+4.5%

Table 5.10: EAV population changes

Table 5.11 shows the corresponding change in jobs distribution across Victoria. These shifts are smaller in magnitude than the changes in residents, with regional and rural areas gaining the most in 2036 and Middle Melbourne growing in 2051.

FUA	2036 NDS	2036 EAV		2051 NDS	2051 EAV	
Inner Melbourne	1,362,000	-32,000	-2.3%	1,628,000	-99,000	-6.1%
Middle Melbourne	994,000	+3,000	+0.3%	1,197,000	+37,000	+3.1%
Outer Melbourne	1,080,000	+5,000	+0.5%	1,365,000	+22,000	+1.6%
Growth Areas	93,000	≈0	≈0%	136,000	-1,000	-0.7%
Regional Cities	439,000	+5,000	+1.1%	548,000	+6,000	+1.1%
Regional Centres/Rural	586,000	+19,000	+3.2%	674,000	+34,000	+5.0%

Table 5.11: EAV employment changes

Part III

EPILOGUE

References

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Part IV

TECHNICAL APPENDIX

A

VITM Background

▸ The Victorian Integrated Transport Model (VITM) is a state-wide strategic transport model owned and maintained by the Department of Transport (DoT). It is used to test and assess transport policies and strategies, estimate future demands on the transport network and analyse the potential impacts of road, public transport and land-use planning projects.

A.1 Features

The VITM version used within the VLUTI process for the IV118 strategic modelling assessment in this report was `VITM19_v2_02`. The following list summarises its features:

- Four time periods, encompassing the AM peak (7AM - 9AM), inter-peak (9AM - 3PM), PM peak (3PM - 6PM) and off-peak (6PM - 7AM).
- Representation of both road and public transport modes.
  - Multiple road vehicle types including cars, rigid trucks and articulated trucks.
  - Multiple public transport vehicle types including train (metro and V/Line), trams and buses.
- Optional public transport capacity constraint.
- Integration of the Freight Movement Model (FMM) to forecast freight truck movements and volumes.

All model runs as part of this report used *constrained capacities*, i.e. crowding effects on public transport were represented.

A.2 Limitations

It is crucial to acknowledge that model outputs are only an approximation of what can be expected in the real/built environment. The VITM as a strategic planning tool is more effective at representing strategic-level demands and patterns (i.e. across screenlines and cordons) than individual links within a network. Thus, certain outputs from the VITM must be treated with caution and interpreted with an understanding of the both the model's strengths and weaknesses, as well as the input assumptions inherent to the forecasting process.

Some limitations and key assumptions associated with the VITM worth considering in the context of this report are:

Land use forecasts

Land use forecasts directly affect the trips generated and where they originate/terminate in the model. If the timing or intensity of demographic growth at a travel zone level differs from forecasts, travel behaviour will likely differ from modelled results.

Future road and public transport

Assumptions surrounding the timing of road and public transport projects will affect modelled mode share and route choice. These shift over time as government expectations surrounding future investments evolve.

Intersections not explicitly modelled

During the traffic assignment phase of the model, link-based speed-flow relationship curves are used to calculate the travel time for a link based on the assigned volume and capacity of that link. This is a simplification of reality, where each section of the road will have unique operational behaviour and queuing back may impact adjacent intersections. This means that the model will not fully represent the impacts that significant capacity bottlenecks may cause over wider extents of the network. It also presents limitations in assessing projects that involve intersection improvements.

Commercial vehicles

Future commercial vehicle movements are estimated within the FMM component of the VITM. Forecast movements are thus directly linked to the assumptions present within the FMM, such as the Port of Melbourne remaining the sole container port for Melbourne in the timeframes modelled. More broadly, growth in commercial vehicle movements will be directly related to the rate of growth in industry – itself influenced by broader economic conditions at a city, state and national level. There are a series of additional factors that may impact the commercial vehicle demands that are ultimately realised. This includes considerations such as future land use patterns for commercial and industrial areas, changes to vehicle sizes/mass limits as well as government policy in relation to these items.

Active transport

Active transport (i.e. walking and cycling) is not explicitly modelled within the VITM. The proportion of travel that is undertaken through walking and cycling is estimated using a high-level process within the model but these trips are never assigned nor are these proportions used across any subsequent analysis of outcomes.

B

VLUTI Background

The Victorian Land Use Transport Integration (VLUTI) model was developed by Infrastructure Victoria (IV) in collaboration with Victoria University (VU), Arup and AECOM. It integrates the VITM[1] with a comparative static spatial computable general equilibrium model designed to capture long-run macro-economic and spatial impacts of policies and infrastructure investments. The *VLUTI Model Architecture Report*[2] provides an overview of the motivations behind the model's development and its structure.

[1] See §A.

[2] See [Vic21].

B.1 BACKGROUND

The goal of developing the VLUTI model was to more accurately assess interactions between land use and transport. The evolution of any particular region over time influences the nature of future infrastructure intervention, whilst those interventions in turn influence where people decide to live and work. The VITM uses demographic data as a static input, whilst the VLUTI model incorporates this into a feedback process that allows it to be altered through simulation. To illustrate the benefits of this approach, consider a major future infrastructure upgrade. In the VITM, this will almost certainly result in network performance improvements, but in the VLUTI model it may also result in a reallocation of population and employment that itself has secondary benefits.

The following paper describes the SCGE model specifically: *More Working From Home Will Change the Shape and Size of Cities*[3].

[3] See [Len20].

B.2 LIMITATIONS

The VLUTI model still uses the VITM as the basis for its trip generation and assignment. As such, all of the limitations described in §A.2 apply equally to the outcomes of the VLUTI model scenario tests. Further, it is to be noted that these are still early days in the development of an overall, unified approach to LUTI modelling. Confidence in its outcomes and a deeper understanding of how to interpret its results will be gained incrementally with further use and development of the model across a diverse range of future studies.

C

Detailed Specifications

C.1 INFRASTRUCTURE TESTS

C.1.1 *Cross-City Motorway*

An overview of the CCM project is provided in the main body of this report (§3.3.2). No additional scope information is presented in this section.

C.1.2 *Outer Metropolitan Ring Road*

In addition to the scope information provided in §3.3.4, a suite of complementary projects also form part of the OMR project. These are listed as follows along with their time of introduction across the modelled years:

- Tullamarine Freeway Extension Project (2036)
- M80 Ring Road, E6 to Greensborough Highway (2036)
- Gunns Gully Road Railway Overpass (2036)
- Bridge Inn Road Duplication (2036)
- Summerhill Road/Masons Road Extension (2036)
- Donnybrook Road Widening (2036)
- Sunbury Road Widening (2036)
- Sunshine Avenue/Calder Freeway Interchange (2036)
- Deer Park Bypass Connection (2051)

C.1.3 *City Loop Reconfiguration and Northern Rail Corridor*

In addition to the scope information provided in §3.3.1, Table C.1 shows the change in morning peak inbound services on impacted corridors between the CLR project and the TBC in 2036 and 2051. No change in rolling stock is assumed as part of the project.

Origin	2036			2051		
	TBC	CLR	Change	TBC	CLR	Change
Craigieburn	18	24	6	As per 2036		
Broadmeadows	2	2	-			
Essendon	9	8	-1			
Craigieburn Corridor	**29**	**34**	**5**			
Carrum	5	0	-5			
Cheltenham	9	13	4			
Frankston	16	21	5			
Frankston Corridor	**30**	**34**	**4**			
Upfield	11	12	1			
Wallan	0	12	12			
Upfield Corridor	**11**	**24**	**13**			
Glen Waverley	15	18	3			
Glen Waverley Corridor	**15**	**18**	**3**			
All Corridors	**85**	**110**	**25**			

Table C.1: CLR changes in service frequency vs. TBC (AM period)

C.1.4 *Melbourne Metro 2 and South West Rail Corridor Upgrade*

In addition to the scope information provided in §3.3.3, Table C.2 shows the change in morning peak inbound services on impacted corridors between the MM2G project and the TBC in 2036 and 2051[1]. Specific rolling stock is also upgraded from EMU (Werribee and Mernda corridors) and VL09 (Geelong corridor) to HCMT7.

[1]It is to be noted that there are further intricacies related to specific stopping patterns not documented within this report.

Origin	2036			2051		
	BC	MM2G	Change	BC	MM2G	Change
Sandringham	23	24	1	23	26	3
Sandringham Corridor	**23**	**24**	1	**23**	**26**	3
Williamstown	6	12	6	As per 2036		
Williamstown Corridor	**6**	**12**	6			
Laverton	6	6	-	6	12	6
Laverton Corridor	**6**	**6**	-	**6**	**12**	6
Werribee (via Footscray)	20	0	-20	20	0	-20
Werribee (via MM2G)	0	24	24	0	18	18
Geelong SAS (via MM2G)	0	0	-	0	12	12
Werribee Corridor	**20**	**24**	4	**20**	**30**	10
Waurn Ponds Exp (via Footscray)	6	6	-	6	0	-6
Waurn Ponds (via RRL)	6	0	-6	6	0	-6
Waurn Ponds (via Footscray)	0	6	6	0	0	-
Waurn Ponds Exp (via MM2G)	0	0	-	0	12	12
Geelong SAS (via MM2G)	0	0	-	0	12	12
Geelong Corridor	**12**	**12**	-	**12**	**24**	12
Werribee (via RRL)	10	18	8	As per 2036		
Waurn Ponds (via RRL)	6	0	-6			
Wyndham Vale Corridor	**16**	**18**	2			
Hurstbridge	6	6	-	6	6	-
Macleod	0	0	-	0	12	12
Greensborough	5	5	-	5	0	-5
Eltham	6	6	-	6	12	6
Hurstbridge Corridor	**17**	**17**	-	**17**	**30**	13
Mernda	22	22	-	22	30	8
Northcote	0	0	-	0	12	12
Mernda Corridor	**22**	**27**	-	**22**	**42**	20
Bacchus Marsh	3	4	1	As per 2036		
Melton	5	8	3			
Grampians Corridor	**8**	**8**	4			
All Corridors	**124**	**147**	23	**124**	**182**	70

Table C.2: MM2G changes in service frequency vs. TBC (AM period)

C.1.5 *Western Rail Corridor Upgrade*

In addition to the scope information provided in §3.3.6, Table C.3 shows the change in morning peak inbound services on impacted corridors between the WRU project and the TBC in 2036 and 2051. No change in rolling stock is assumed as part of the project.

Origin	2036			2051		
	TBC	WRU	Change	TBC	WRU	Change
Watergardens	12	12	-	As per 2036		
Sunbury	12	12	-			
Hopkins Road	0	10	10			
Airport	12	12	-			
Sunshine Corridor	**36**	**46**	**10**			
Pakenham	18	22	4			
Clyde	18	18	-			
Westall	0	6	6			
Dandenong Corridor	**36**	**46**	**10**			
All Corridors	**72**	**92**	**20**			

Table C.3: WRU changes in service frequency vs. TBC (AM period)

C.1.6 *Road Management Systems*

The RMS project involved the implementation of three sets of different interventions within the VLUTI model: *arterial operations improvements*, *clearway implementations* and *on-road public transport improvements*.

C.1.6.1 **Arterial Road Operations**

Based on internal DoT research, IV specified that an improvement in arterial road operations could result in a 5% reduction in VHT across the metropolitan road network. Based on this specification, the consultant team ran a number of highway assignment tests within the VITM to determine what changes in the free-flow speed and lane capacity assumptions would result in such an effect. The final outcomes of this testing landed on a *6.25%* increase in both free-flow speed and lane capacity. For the RMS project this change was applied to the following link classes:

- All outer primary and secondary roads (classes 8, 9, 12, 13, 16).
- All inner roads that have the *"Tram and Shopping and Parking"* link designation (classes 2, 6, 10, 14).
- All CBD roads (class 23).

It is noted that whilst the target reduction in VHT was 5%, the actual reduction in VHT that manifested from testing the project in the VLUTI was lower. This is because the VLUTI model redistributes population and jobs based on changes in network conditions. The improvements in travel time prompted residents to move away from the metropolitan centre, resulting in longer journeys on average and somewhat counteracting the targeted reduction in VHT.

C.1.6.2 **Clearway Implementations**

Selected corridors were converted clearways, effectively resulting in an extra lane of traffic available during the noted time periods:

- Peak period clearways on Power Street between Riversdale Road to Burwood Road, Denmark Street between Burwood Road and High Street, Princess Street between High Street and Earl Street, Grange Road between Heidelberg Road and Darebin Road.
- A 24/7 clearway for the westbound direction on Princes Street between Lygon Street and Nicholson Street allowing for three lanes of travel in this direction.
- Peak period clearway on Church Street between Barkers Road and Burwood Road.
- Peak period clearway on Barkley Street between Geelong Road and Summerhill Road, Gordon Street between Ballarat Road and River Street.

C.1.6.3 On-Road Public Transport Improvements

Selected bus and tram corridors received improvements to their operations, described as follows:

- Continuous bus lanes were implemented along Wellington Road between Princes Highway and Jells Road. It was assumed that Wellington Road would lose no traffic lanes during this process. An accompanying widening of the Wellington Road M1 bridge was adopted allowing for six lanes of traffic.
- A lane use management system was implemented on Johnston Street. From Wellington Street to Smith Street, the road offers a dedicated bus lane and two lanes of traffic in the peak direction. The counter-peak offers 1 lane of traffic and 1 lane for parking. From Smith Street to Nicholson Street, the counter-peak will only offer 1 lane of traffic with no parking as the road reserve narrows. During inter-peak periods, the road will offer one lane of traffic in each direction with no dedicated bus lanes.
- A dedicated bus lane was implemented on Plenty Road between Kingsbury Drive and McKimmies Road. This was assumed to occupy the same space as the current tram corridor. The 382 received a small change to its route, travelling through Latrobe University, Waterdale Road, Dohertys Road, Oriel Road and Southern Road to Northland Shopping Centre. Route 386 was also modified such that it directly interfaced with La Trobe University.
- The 59 tram's speed along Mt Alexander Road was increased by 5 km/h to emulate improvements in vehicle prioritisation and timing at intersections.

C.2 SENSITIVITY TESTS

C.2.1 *Increased Working from Home*

As discussed in §3.4.1, IV conducted internal research regarding the potential propensity for employees of specific occupations and industries to be able to work from home. This data was used to calibrate factors within the VLUTI's SCGE model to reduce the sensitivity of specific demographic groups to longer commuting times[2].

[2]The inference being that if people were commuting less, they may be more flexible in their choice of where to live

Further changes were made to the commuter trip rates adopted in the VITM component of the VLUTI model. For the purposes of the tests conducted, those employees who *could* potentially work from home according to the IV research were assumed to work from home two days per week. This manifest as an overall reduction in the number of home-based work trips that were modelled within the VITM. Impacts to specific trip chains were also represented by modifying a selection of non-home-based other trips to begin from the home. This accounts for the fact that if someone is now working from home, they will no longer be using their place of work as the origin of a trip while they are at work. No changes were made to the behaviour patterns of any other trip purpose represented within the VITM.

C.2.2 *Electric and Autonomous Vehicles*

The EAV sensitivity tests involve the implementation of a broad set of assumptions covering the increased adoption of both electric and autonomous vehicles[3]. This involved the following changes:

[3]For the purposes of these scenario tests all autonomous vehicles are assumed to also be electric vehicles.

Changes to the Value of Time (VOT) Given the broader flexibility of how one spends their time when riding within an AV, the perceived in-vehicle cost of travel was lowered compared to a conventionally driven vehicle (CDV). The lower VOT value was chosen to align with IV's previous research into automated and zero emissions vehicles.

Changes to Vehicle Operating Cost (VOC) Past IV research has indicated that the VOC of electric vehicles is lower than that of a CDV due to several factors. As such, the VITM's VOC for electric vehicles was lowered to match the outcomes of this research. VOC of fleet AV use was determined based on an assumed flagfall and distance price – reflecting the perceived cost of travel from the user's perspective. A 2.5 cent per kilometre charge was then added to these prices to represent a distance-based charging policy for electric vehicles.

Network Operating Efficiency Lane capacity assumptions across the statewide network were altered to reflect operating efficiency gains that could potentially be realised with an increasing share of AVs. The magnitude of this effect was derived from the relationship described in *"Congestion Effects Of Autonomous Taxi Fleets"*[4]. In using this, it was assumed that AVs would adopt 50% of the capacity of a CDV for freeways and motorways, whilst this would increase to 67%

[4][MB18], the same basis behind IV's previous research into autonomous and zero emission vehicles.

for arterials – representing diminishing returns in a more complex environment. For local and secondary roads, it was assumed that AVs will not perform any better than CDVs in terms of operation.

Dead Running It was assumed that a portion of private AV use would involve empty vehicles returning to their origin after their owners reach their destination. This was represented in the VITM by taking a proportion of trips within a time period and replicating them in reverse within the highway assignment process to represent this extra demand.

There is ultimately little literature surrounding predictions as to where dead running will occur. Given this, an illustrative set of assumptions were adopted in collaboration with IV to govern the proportion of private AV trips that would involve dead running. These assumptions are outlined in Table C.4.

Table C.4: Dead running trip proportions

From/To	Inner Melbourne	Rest of Melbourne	Regional
Inner Melbourne	20%	10%	5%
Rest of Melbourne	10%	10%	5%
Regional	5%	5%	5%

Increased Trip-Making due to Lower Perceived Costs Related to the impacts of increased AV share is an expected general reduction in the perceived cost of car travel, potentially leading to not only a shift in modal choices, but also an increase in overall trip making activity. In previous work for IV the VITM inputs were modified to effectively make all households have access to a car in an AV scenario, reflecting that even for non-car owning households the availability of fleet AVs presented a new reasonably priced choice that removed many constraints of non-car availability. This has been similarly adopted for the EAV sensitivity tests.

Table C.5 shows the fleet mix by region that will be assumed through both 2036 and 2051, developed by IV. This was used to reflect differences in the perceived value of time, vehicle operating cost and other factors that are affected by choice of vehicle.

Table C.5: EAV assumed fleet mix

Year	Region[a]	CDVs	Electric CDVs	Private AVs	Fleet AVs
2036	Inner	48%	32%	10%	10%
	Middle	55%	30%	8%	8%
	Outer	65%	25%	5%	5%
	Regional	68%	25%	4%	3%
2051	Inner	0%	20%	30%	50%
	Middle	5%	35%	35%	25%
	Outer	10%	50%	25%	15%
	Regional	20%	50%	20%	10%

[a]Regions correspond with the FUA system. *Outer* includes both Outer Melbourne and Growth Areas. *Regional* contains the remainder of the state.

The assumed parameter values adopted across CSVs, electric CDVs, private AVs and fleet AVs is outlined in Table C.6[5]. VOT and VOC values were baselined to 2016 and were adjusted to reflect future years. These values were derived based on a combination of both existing VITM parameters and previous research conducted by IV.

[5]Noting that these values do not incorporate the 2.5 cent per kilometre distance charge.

Parameter	*Base Case*	*Project Case*			
	CDVs	CDVs	Electric CDVs	Private AVs	Fleet AVs
VOT - Private ($/h)	15.96	15.96	15.96	7.98	8.05
VOT - Business ($/h)	51.07	51.07	51.07	25.54	25.54
VOC - Private (c/km)	17.19	17.19	4.88	4.88	21.49
VOC - Business (c/km)	24.19	24.19	6.87	6.87	21.49

Table C.6: EAV assumed cost of time and operating cost

Given testing constraints it was not practical to create separate modes or user classes to specifically represent each new private vehicle mode required for the EAV sensitivity test. Instead, the existing singular private vehicle mode within the VITM was adapted to represent a blended fleet of the four new modes. To represent regional variation, this blended fleet's costs were implemented such that they also varied based on the origin location of a trip.

D

Conventional VITM Infrastructure Tests

- Additional scenario testing was undertaken for both the CCM and CLR scenarios with conventional VITM land use assumptions as opposed to the dynamic land use generated by the VLUTI. These assumptions were specifically derived from the *Small Area Land Use Projections*[1] (SALUP). These conventional VITM scenario variants are referred to as sCCM and sCLR to differentiate them from their VLUTI equivalents. The corresponding conventional TBC scenario is referred to as the sTBC. Adopted infrastructure assumptions for these tests were equivalent to their VLUTI counterparts as described in §3.3 and §C.1, with the exception that the electrification to Wallan that forms part of the CLR scenario only extends to Beveridge in the sCLR scenario at 2036.

[1]Sourced from *SGS Economics and Planning*.

D.1 Cross-City Motorway

The VLUTI scenario outcomes for the CCM[2] showed only minor impacts across both demographic distribution and network performance in reaction to the project. Due to this, an additional set of conventional land use tests were conducted to better understand the impacts of the project without the influence of changing demographic distributions.

[2]See §4.2.

D.1.1 *Demographic Context*

To better contextualise the outcomes of the conventional VITM CCM scenario against its VLUTI counterpart, Figure D.1 shows the difference between the SALUP population distribution across FERs (sCCM) against the TBC and CCM scenarios in 2051. Key differences include the conventional land use allocating approximately 5% less people within the Inner FER, whilst the Northern and Western FERs have 5% and 7% more people respectively.

Figure D.2 shows the similar difference for employment. It can be seen that the SALUP assumptions allocate approximately 5% more jobs within the Inner FER compared to the VLUTI generated outputs, 7% less jobs in the Eastern FER and 10% less jobs across regional Victoria.

Overall, the conventional VITM land use allocates mores jobs in central Melbourne and more residents across the Northern and Western FERs compared to the dynamically generated VLUTI land use.

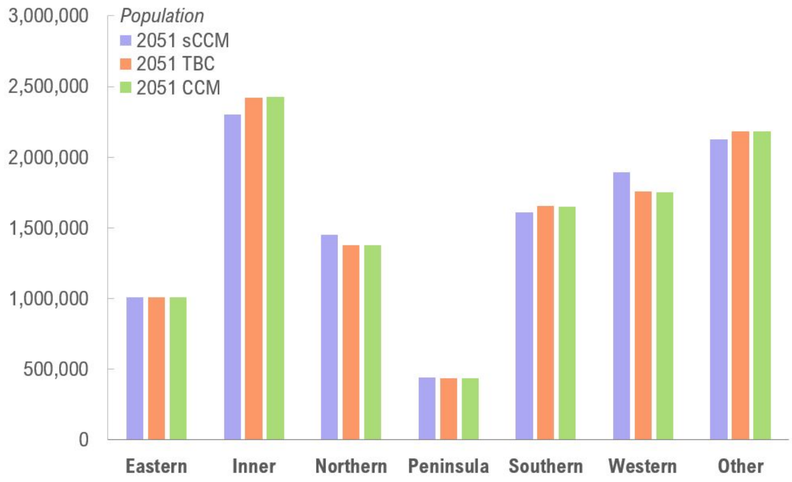

Figure D.1: SALUP population vs. VLUTI CCM, TBC scenarios in 2051

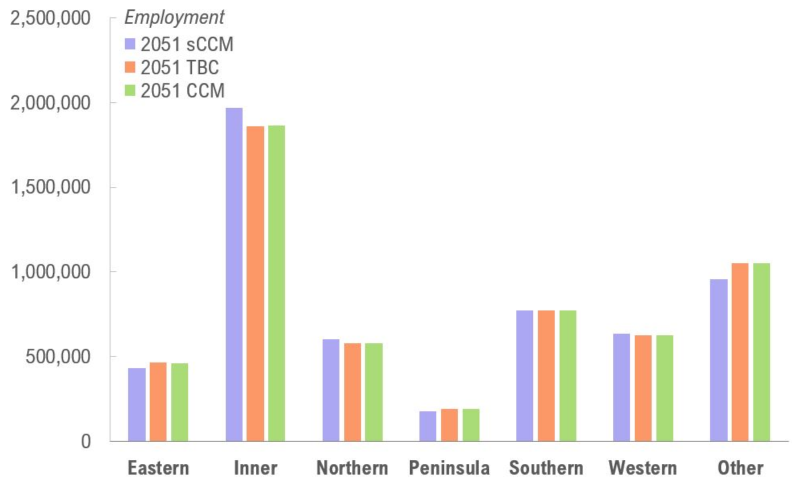

Figure D.2: SALUP employment vs. VLUTI CCM, TBC scenarios in 2051

D.1.2 *Travel Demand*

Table D.1 shows the change in total private vehicle and public transport trips occurring during the morning peak for the sCCM project when compared to the sTBC. Compared to the VLUTI scenarios, there is even less change in overall demand and shift across modes in reaction to the project's presence[3]. What this indicates is that the CCM is primarily redistributing existing private vehicle and freight travel rather than motivating people to change modes.

[3]See Table 4.10 for a comparison to the VLUTI scenario outcomes.

Metric	2036 sTBC	2036 sCCM		2051 sTBC	2051 sCCM	
Private Vehicle Trips	3,258,000	≈0	≈0%	3,832,000	≈0	≈0%
Public Transport Trips	521,000	≈0	≈0%	654,000	≈0	≈0%
Mode Share	13.8%	13.8%	≈0%	14.6%	14.6%	≈0%

Table D.1: sCCM changes in morning peak trips

Figure D.3 and Figure D.4 show changes in morning peak road volumes between the 2036 and 2051 sCCM and sTBC scenarios spatially. These patterns do not differ from the VLUTI scenario outcomes materially, indicating the same shifts in demand away from competing routes such as the North East Link, Metropolitan Ring Road, Monash Freeway and CityLink.

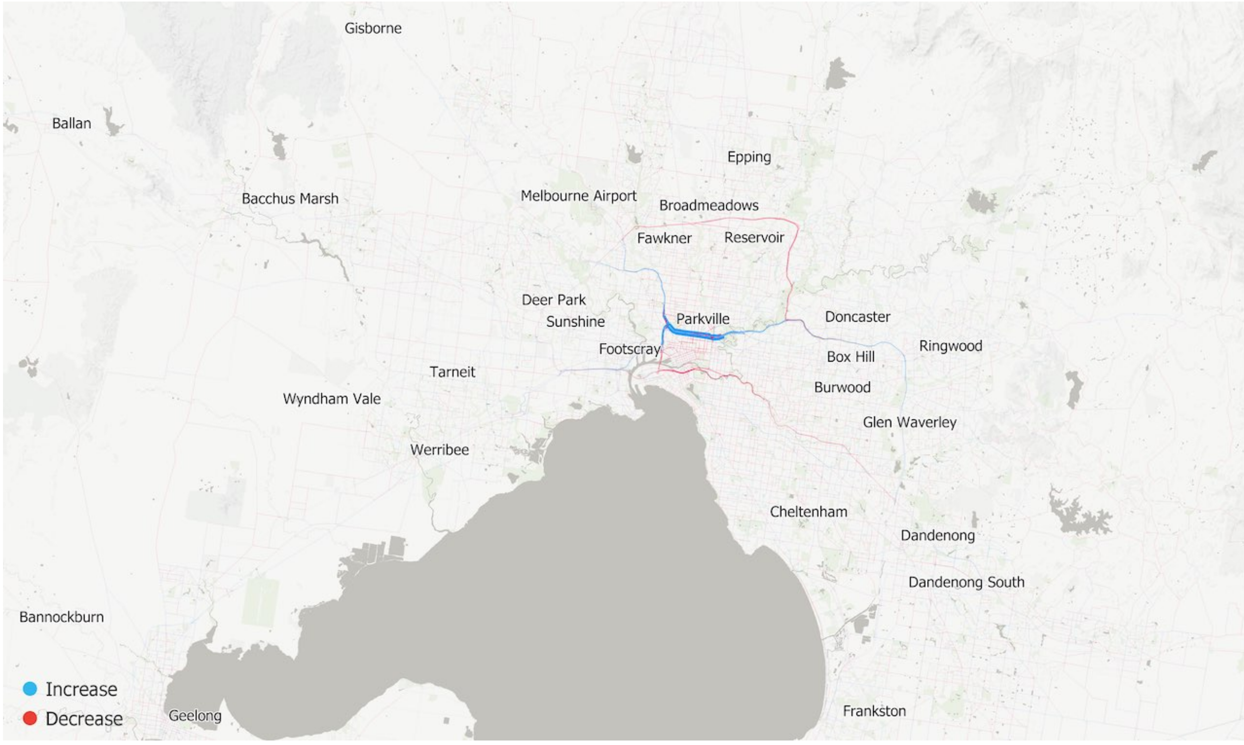

Figure D.3: Change in road volumes, 2036 sCCM vs. sTBC (AM period)

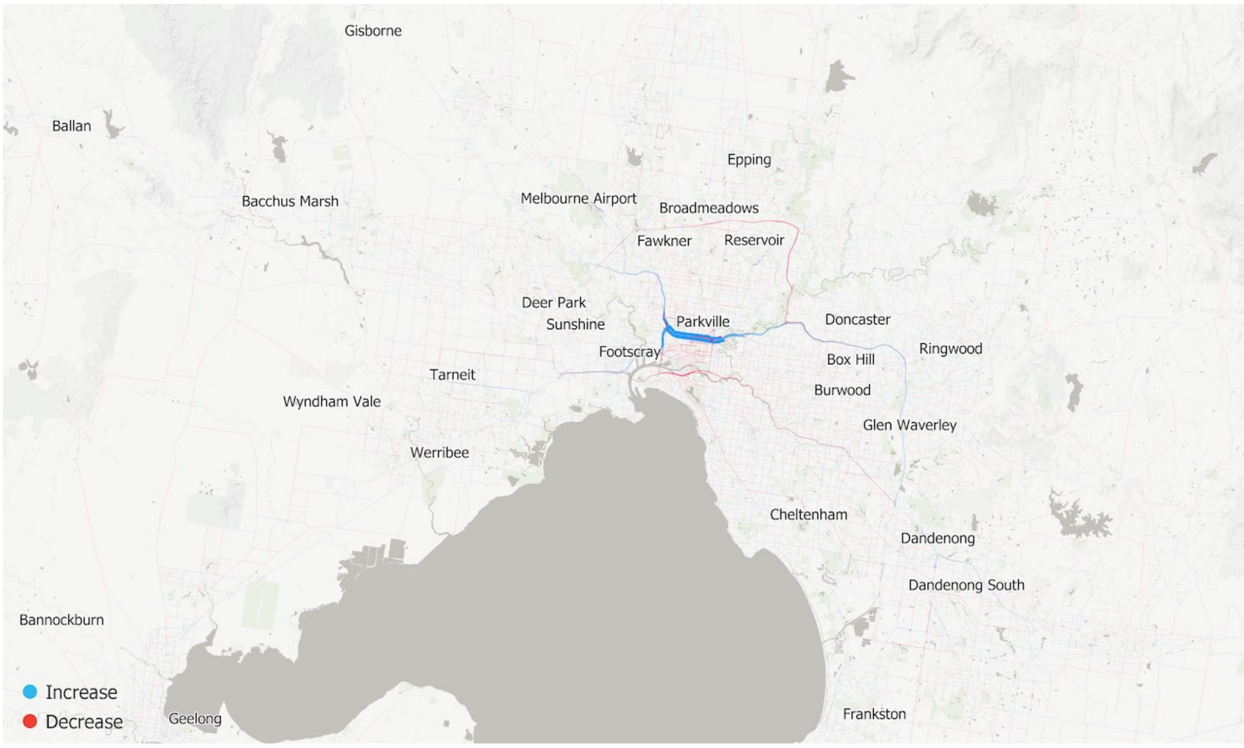

Figure D.4: Change in road volumes, 2051 sCCM vs. sTBC (AM period)

Figure D.5 shows the specific volume differences seen in 2051 between the conventional CCM scenario and its VLUTI equivalent. It can be seen that the magnitude of differences is minor across much of metropolitan Melbourne, with changes more reflecting the differing underlying distribution of population and employment rather than project-specific impacts. For example, the SALUP land use distribution defines approximately 5% more residents across the north of Melbourne compared to the generated VLUTI distribution. This is reflected in the lower road volumes seen across this part of the city when compared to the VLUTI volumes.

Blue indicates that the conventional scenario exhibited greater volumes than the VLUTI equivalent. Red indicates less.

Figure D.5: Change in road volumes, 2051 sCCM vs. CCM (AM period)

Table D.2 shows the change in VKT and VHT in the morning peak for the sCCM scenario against the sTBC. Across both 2036 and 2051 VKT increases in response to the project whilst VHT decreases. As was the case with the VLUTI scenarios, this indicates that the CCM is offering travel time savings for private vehicle users, allowing them to travel further in less time than they were in the sTBC. Overall, the cumulative impacts seen across travel demand for both the VLUTI and conventional tests remains small in magnitude.

Metric	2036 sTBC	2036 sCCM		2051 sTBC	2051 sCCM	
Vehicle Kilometres Travelled	26,549,000	+6,000	≈0%	31,240,000	+50,000	+0.2%
Vehicle Hours Travelled	631,000	-2,000	-0.3%	825,000	-2,000	-0.2%

Table D.2: sCCM changes in VKT and VHT (AM period)

Figure D.6 and Figure D.7 show the morning peak two-hour volumes for the sCCM corridor in the westbound and eastbound directions respectively for both modelled years. The overall utilisation of the corridor is very similar to that observed within the VLUTI scenarios.

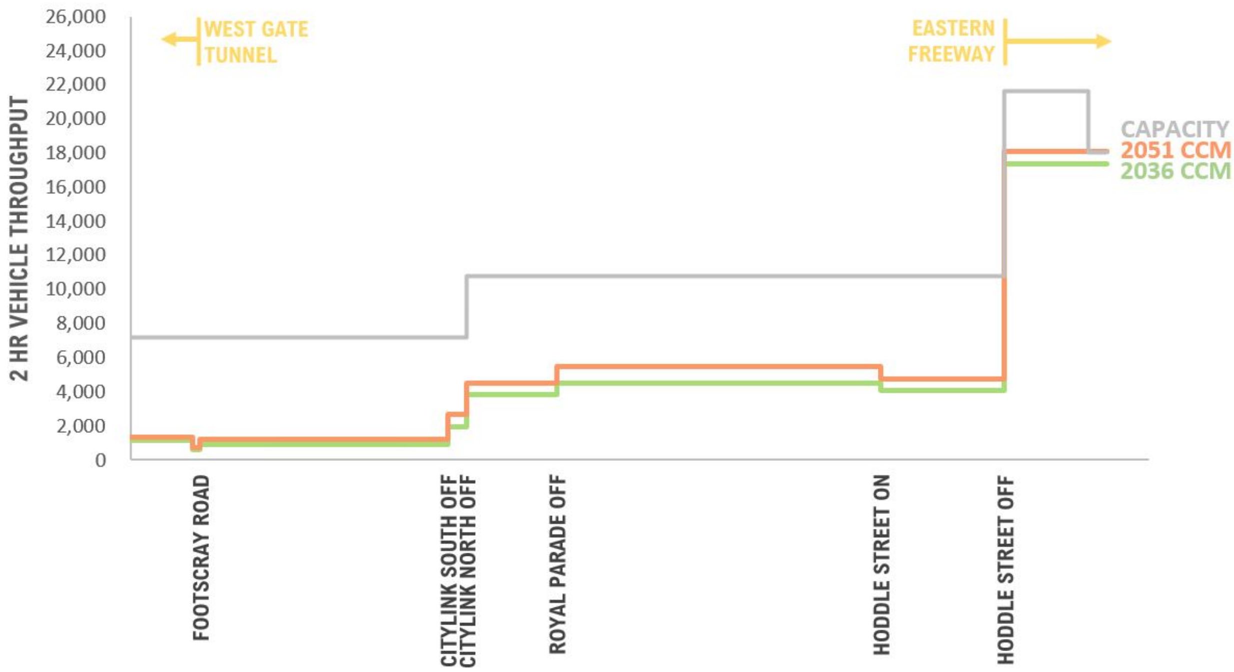

Figure D.6: Volumes along the sCCM corridor, westbound (AM period)

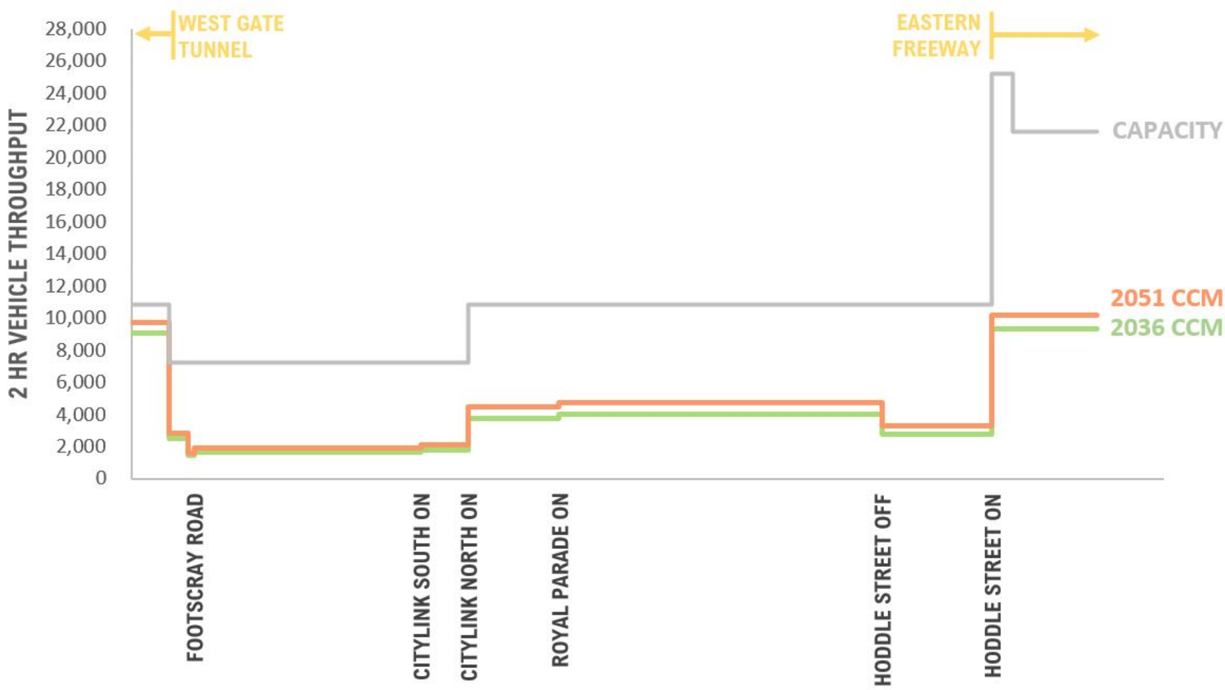

Figure D.7: Volumes along the sCCM corridor, eastbound (AM period)

Figure D.8 and Figure D.9 show the absolute change in morning peak trips occuring between each of the FERs for the sCCM project compared to the sTBC across 2036 and 2051 respectively. The overall magnitude of these changes is smaller than that seen with the VLUTI scenarios because residents and jobs have not had the opportunity to move in reaction to changed network conditions. However, these patterns show the same directionality seen across the VLUTI scenarios, with the exception of behaviour within the eastern FER. In the VLUTI scenarios, the presence of the CCM resulted in a movement of residents away from this part of Melbourne in reaction to increased congestion, reducing the total number of trips. This effect is not seen in the conventional scenarios because land use is fixed.

	Eastern	Inner	Northern	Peninsula	Southern	Western	Other
Eastern	+190	-480	+60	+10	+40	-70	+20
Inner	-180	+680	-120	0	+10	-40	-10
Northern	+30	-190	+40	-10	+10	+70	+10
Peninsula	0	0	-20	+20	+20	+10	0
Southern	-10	+120	+10	-10	-110	0	0
Western	-40	+30	+60	+10	+10	-60	0
Other	+20	-10	+10	0	-30	+20	-10

Figure D.8: Change in total trips, 2036 sCCM vs. sTBC (AM period, row: *origin*, column: *destination*)

	Eastern	Inner	Northern	Peninsula	Southern	Western	Other
Eastern	+240	-600	+60	+10	+20	-20	+20
Inner	-190	+950	-110	0	+40	-50	0
Northern	+30	-190	+140	-10	+20	+100	0
Peninsula	0	0	-10	+10	+30	+20	0
Southern	-50	+150	+30	0	-70	+10	0
Western	0	-20	+20	+20	+30	-180	-10
Other	+30	0	+10	0	-20	+10	-20

Figure D.9: Change in total trips, 2051 sCCM vs. sTBC (AM period, row: *origin*, column: *destination*)

D.1.3 *Network Impacts*

Table D.3 shows the proportion of VKT under congested conditions[4] for the morning peak period by FER. As was the case with the equivalent VLUTI scenarios, the greatest congestion benefits are realised across the Inner FER with the proportion of congested VKT reducing by 1.3% in 2036 and 2.7% in 2051. The local road network north and south of the CCM corridor all benefit from lower volumes of traffic, particularly the M1 through Fishermans Bend.

[4]See §1.3.4.

Metric	2036 sTBC	2036 sCCM	2051 sTBC	2051 sCCM
Eastern	38.1%	≈0%	35.7%	≈0%
Inner	46.6%	-1.3%	54.9%	-2.7%
Northern	41.2%	-1.2%	45.1%	-0.4%
Peninsula	17.6%	-0.8%	19.6%	≈0%
Southern	39.9%	≈0%	44.0%	+0.1%
Western	32.5%	-0.2%	39.9%	≈0%
Other	1.2%	≈0%	1.4%	≈0%

Table D.3: sCCM changes in congested VKT (AM period)

Unlike the VLUTI scenarios, the CCM project under the conventional tests is not associated with an increase in average congestion across the Eastern FER in 2051[5]. It is to be noted however that congestion in the east is lower to begin with under the conventional land use tests compared to the generated VLUTI distribution (36% vs. 41% for the TBC scenarios), in part due to the differing concentration of jobs across metropolitan Melbourne[6]. Overall, the conventional CCM project does not significantly affect traffic conditions for any single part of metropolitan Melbourne at an aggregate level.

Figure D.10 and Figure D.11 spatially show where increases and decreases in congestion have occurred on the road network during the morning peak period between the sCCM and sTBC projects for 2036 and 2051 respectively. These maps show the same patterns as their VLUTI counterparts[7].

[5]The VLUTI scenario saw an increase in congested VKT of 1.4% between the TBC and CCM for this year. However, it is to be noted that the Eastern Freeway still experiences higher volumes in reaction to the project.

[6]The SALUP assumes 7% more jobs in the Eastern FER compared to the corresponding VLUTI CCM scenario.

[7]See Figure 4.19 and Figure 4.20.

Figure D.10: Change in road volume/capacity ratio, 2036 sCCM vs. sTBC (AM period)

Figure D.11: Change in road volume/capacity ratio, 2051 sCCM vs. sTBC (AM period)

D.1.4 *Accessibility*

As was the case with the VLUTI scenarios, the impacts of the CCM project under the conventional tests on aggregate travel behaviour were very minior across both 2036 and 2051. Figure D.12 shows the change in average travel times during the morning peak period for the sCCM project compared to the sTBC. From this, it can be seen that the overall magnitude of change is minimal and it is difficult to distinguish genuine project from model noise.

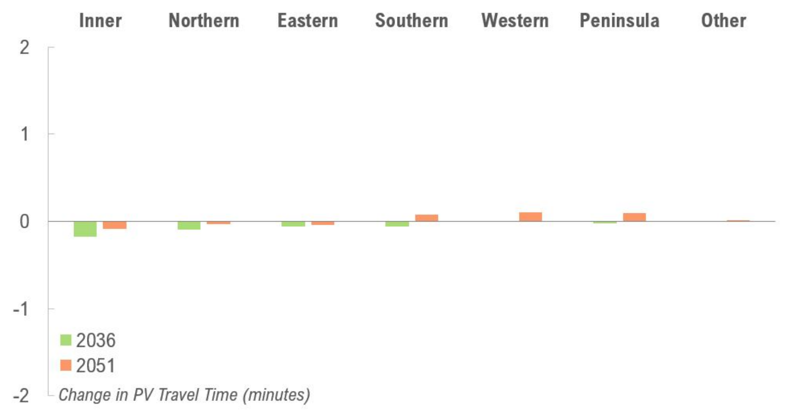

Figure D.12: sCCM changes in private vehicle travel time by FER (AM period, originating)

As was similarly described in §4.2.4, the small magnitude of change can be attributed to the following interrelated factors:

- The CCM project does little in facilitating more east-west movement across inner Melbourne than what was already occurring. Figure D.8 and Figure D.9 from the previous section demonstrate this. Whilst the new corridor demonstrably reduces travel times for those who use it, this is arelatively small cohort of people.
- The small benefits afforded by the CCM corridor are counter-balanced by an increase in congestion along the Eastern Freeway. This has consequences for much of the southern and eastern regions of Melbourne. Whilst this has not impacted land use as was the case with the VLUTI scenarios, it still negatively affects travel times for specific types of journeys affected by this route.
- The greatest redistributive effects of the CCM project are to pull existing demand away from CityLink south of the CBD and the North East Link project - each of which are themselves tolled corridors. Particularly in the case of North East Link, there is a certain level of overlap between who these roads serve – limiting the resultant travel time benefits.

D.2 CITY LOOP RECONFIGURATION

Specific patterns that arose during the economic analysis of the VLUTI CLR scenario prompted a reexamination of the project's impact without accompanying land use change. This section outlines the outcomes of those conventional land use tests. As was the case with the conventional CCM test[8], the SALUP land use provides a different demographic starting point, resulting in different base case network conditions compared to the VLUTI scenarios[9].

The infrastructure assumptions adopted for the conventional tests match those of the VLUTI tests with the exception that the electrification to Wallan that forms part of the CLR scenario only extends to Beveridge in the sCLR scenario at 2036.

[8] See §D.1.

[9] However, the overall impact of the project remained similar between the conventional and VLUTI tests when taking this difference into consideration.

D.2.1 *Demographic Context*

Figure D.13 shows the difference between the SALUP population distribution across FERs (sCLR) against the TBC and CLR scenarios in 2051. Key differences include the conventional land use allocating approximately 5% less people within the Inner FER, whilst the Northern and Western FERs have 4% and 8% more people respectively.

Figure D.14 shows the similar difference for employment. It can be seen that the SALUP assumptions allocate approximately 6% more jobs within the Inner FER compared to the VLUTI generated outputs, 7% less jobs in the Eastern FER and 10% less jobs across regional Victoria.

Overall, the conventional VITM land use allocates mores jobs in central Melbourne and more residents across the Northern and Western FERs compared to the dynamically generated VLUTI land use.

Figure D.13: SALUP population vs. VLUTI CLR, TBC scenarios in 2051

Figure D.14: SALUP employment vs. VLUTI CLR, TBC scenarios in 2051

D.2.2 *Travel Demand*

Table D.4 shows the change in total morning peak trips by mode for the sCLR project relative to the sTBC. The project increases public transport mode share, most noticeably in the Growth Areas and Middle Melbourne FUAs[10]. When considered by FER, the Northern region is most noticeably impacted.

[10]See Table D.5 for the change in public transport trips by FUA.

Metric	2036 sTBC	2036 sCLR		2051 sTBC	2051 sCLR	
Private Vehicle Trips	3,258,000	-5,000	-0.2%	3,832,000	-7,000	-0.2%
Public Transport Trips	521,000	+5,000	+1.0%	654,000	+8,000	+1.2%
Mode Share	13.8%	13.9%	+0.1%	14.6%	14.7%	+0.2%

Table D.4: sCLR changes in morning peak trips

FUA	2036 sTBC	2036 sCLR		2051 sTBC	2051 sCLR	
Inner Melbourne	183,000	+1,000	+0.5%	216,000	+1,000	+0.5%
Middle Melbourne	170,000	+2,000	+1.2%	211,000	+2,000	+0.9%
Outer Melbourne	100,000	+1,000	+1.0%	123,000	+1,000	+0.8%
Growth Areas	40,000	+1,000	+2.5%	67,000	+4,000	+6.0%
Regional Cities	10,000	≈0	≈0%	12,000	≈0	≈0%
Regional Centres/Rural	17,000	≈0	≈0%	24,000	≈0	≈0%

Table D.5: sCLR public transport trips by FUA (AM period, originating)

These patterns follow the same directionality and magnitude as was seen in the corresponding VLUTI scenarios, however it is to be noted that the SALUP land use adopted for the conventional tests results in more car travel and less public transport use than the generated VLUTI distributions[11].

[11]Generally, the SALUP land use assumes more residents will be occupying outer Melbourne and the growth areas.

Figure D.15 and Figure D.16 show growth in rail patronage across the north at 2036 and 2051 respectively. As was the case with the VLUTI scenarios, the observed growth in patronage is a direct result of uplifts in service provision along the existing Craigieburn and Upfield lines. There is also corresponding growth in rail patronage on the southern Frankston and Glen Waverley lines. The resulting shift from regional V/Line services to the metropolitan network in the project is represented in Figure D.15 and Figure D.16 as a decrease in patronage on the V/Line Albion-Jacana corridor.

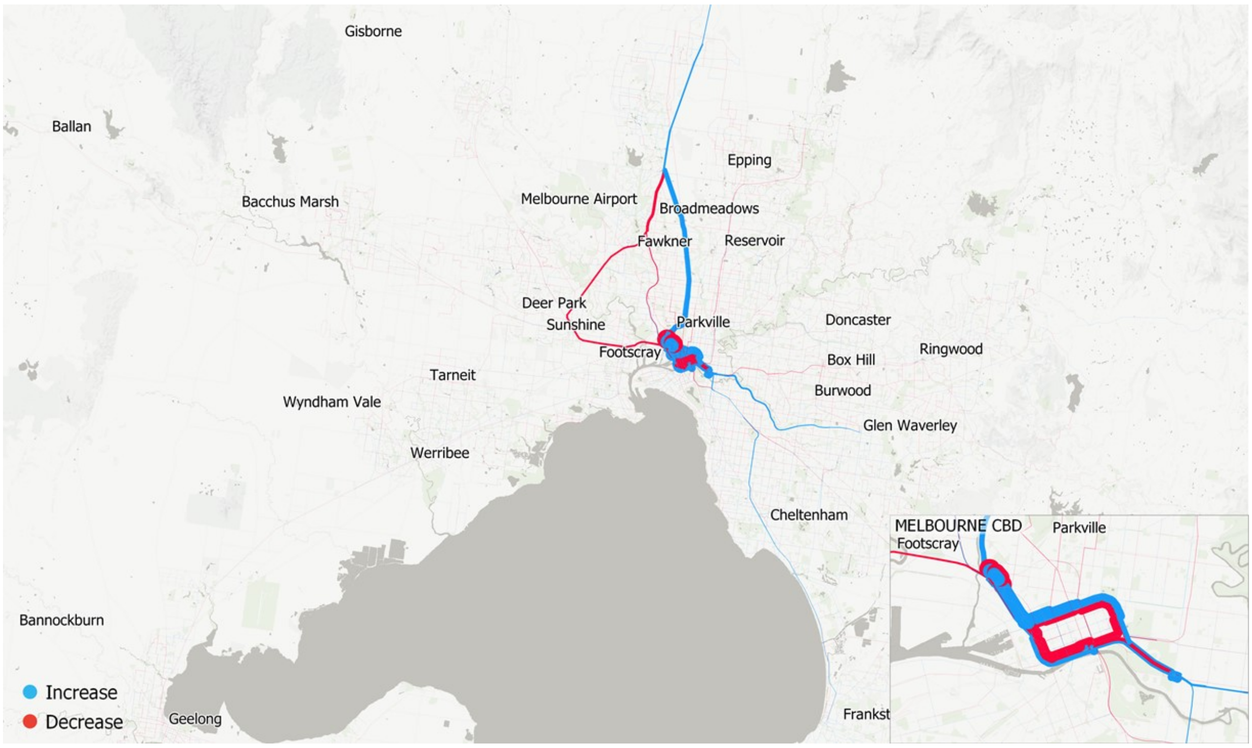

Figure D.15: Change in public transport volumes, 2036 sCLR vs. sTBC (AM period)

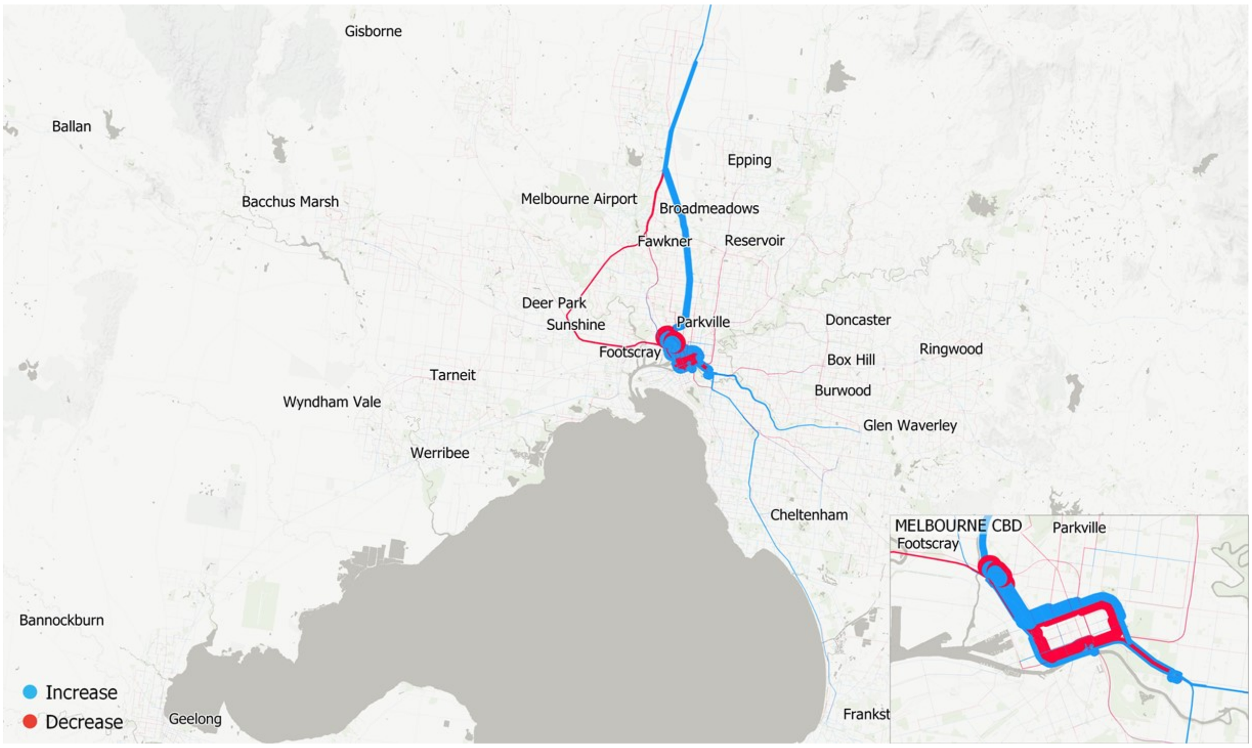

Figure D.16: Change in public transport volumes, 2051 sCLR vs. sTBC (AM period)

Figure D.17 shows the specific public transport volume differences seen in 2051 between the conventional CLR scenario and its VLUTI equivalent. As was the case with the conventional CCM test[12], the differences between these scenarios are more a reflection of the differing underlying distribution of population and employment rather than project-specific impacts. The SALUP land use distribution defines approximately 3.5% and 7.6% more residents within the Northern and Western FERs compared to the generated VLUTI distribution, resulting in higher patronage across public transport in these areas. It is important to note however, that as demonstrated by Figure D.15 and Figure D.16 the overall impact of the CLR project was very similar whether conventional land use was deployed or not.

[12]See Figure D.5.

Blue indicates that the conventional scenario exhibited greater volumes than the VLUTI equivalent. Red indicates less.

Figure D.17: Change in public transport volumes, 2051 sCLR vs. CLR (AM period)

The road network displays only a slight decrease in volumes at both 2036 and 2051. Table D.6 shows this change in trips by FUA, which are of similar magnitude to those seen within the VLUTI tests[13].

[13]See Figure 4.5

FUA	2036 sTBC	2036 sCLR		2051 sTBC	2051 sCLR	
Inner Melbourne	323,000	-1,000	-0.3%	381,000	-1,000	-0.3%
Middle Melbourne	734,000	-2,000	-0.3%	849,000	-2,000	-0.2%
Outer Melbourne	945,000	-1,000	-0.1%	1,036,000	≈0	≈0%
Growth Areas	413,000	-1,000	-0.2%	586,000	-3,000	-0.5%
Regional Cities	347,000	≈0	≈0%	397,000	≈0	≈0%
Regional Centres/Rural	496,000	≈0	≈0%	582,000	≈0	≈0%

Table D.6: sCLR private vehicle trips by FUA (AM period, originating)

D.2.3 *Network Impacts*

Table D.7 shows the change in proportion of metropolitan train PKT under crowded conditions[14] for the AM period between the sCLR project and the sTBC. It can be seen that:

[14] See §1.3.4 for further details

- In 2036, the primary impacts to the metropolitan network are a reduction in overall crowding within the Inner FER. This stands in contrast to the outcomes of the VLUTI scenario which saw a decrease in crowding within the Eastern FER as well. This difference arises from the fact that in response to the project there is a small movement of residents away from the east in the VLUTI scenarios – this has obviously not occurred under the conventional tests.
- In 2051, crowded metropolitan train travel within the Northern FER increases by 17.6%. This is a pattern not seen in the corresponding VLUTI scenarios[15]. The increased service provision provided by the CLR project presents an improved means of travelling along the Craigieburn and Upfield corridors to the extent that people are willing to do so under crowded conditions. The resultant crowding is more severe under the conventional land use tests because the SALUP assumes more people live in the Northern FER compared to the generated VLUTI distributions.

[15] These were associated with only a 1.4% increase in crowded metropolitan train travel in 2051, see Table 4.6.

FER	2036 sTBC	2036 sCLR		2051 sTBC	2051 sCLR	
Eastern	23.8%	23.8%	≈0%	34.3%	34.3%	≈0%
Inner	36.4%	31.5%	-5.0%	53.8%	50.3%	-3.5%
Northern	1.4%	1.1%	-0.3%	3.5%	21.1%	+17.6%
Peninsula	≈0%	≈0%	≈0%	7.8%	≈0%	-7.8%
Southern	4.4%	3.5%	-0.9%	31.4%	32.0%	+0.6%
Western	≈0%	≈0%	≈0%	40.8%	40.9%	+0.1%
Other	≈0%	≈0%	≈0%	≈0%	≈0%	≈0%

Table D.7: sCLR changes in crowded metropolitan train PKT (AM period)

Figure D.18 and Figure D.19 show the difference in passenger to capacity ratios across the public transport network in the morning peak for the sCLR project compared to the sTBC in 2036 and 2051 respectively. Despite the patronage volumes differing between the VLUTI and conventional land use tests as described previously, the pattern of change in crowded conditions is very similar between the two methodologies for both metropolitan and V/Line services.

The key impact borne by the CLR project lies along the northern section of the Upfield line south of Wallan, extending through the Upfield/Fawkner corridor and easing at Coburg. The restructuring of the network, made possible by the extension of the metropolitan system to Wallan, adds additional crowding to this section of the Upfield line when compared to the TBC. However, the increase in overall demand from the north is met by a balanced provision of services on both the Upfield and Craigieburn lines. Crowding on both these corridors are very consistent at similar distances from the CBD. In this respect, the CLR project is allowing spare capacity to be utilised along the Upfield line sensibly.

As was the case with the equivalent VLUTI tests, the Seymour to Shepparton V/Line services were approaching capacity in 2036 and over capacity by 2051 for the TBC. The introduction of the CLR project alleviates this crowding completely.

Figure D.18: Change in passenger/capacity ratio, 2036 sCLR vs. sTBC (AM period)

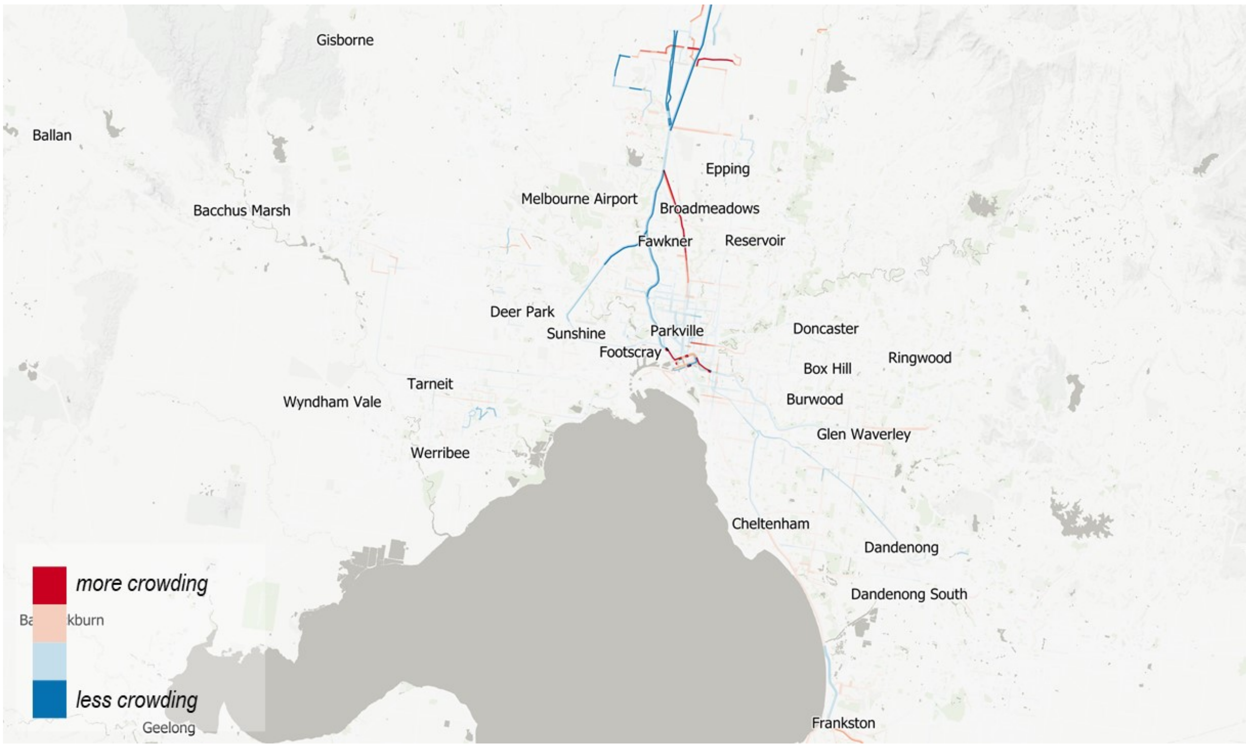

Figure D.19: Change in passenger/capacity ratio, 2051 sCLR vs. sTBC (AM period)

Table D.8 shows the change in morning peak congested VKT between the sCLR project and the sTBC for 2036 and 2051. There is a small decrease in private vehicle congestion across the network – consistent with the outcomes of the VLUTI scenario.

FER	2036 sTBC	2036 sCLR		2051 sTBC	2051 sCLR	
Eastern	38.1%	37.8%	-0.3%	35.7%	35.4%	-0.2%
Inner	46.6%	46.3%	-0.3%	54.9%	54.3%	-0.6%
Northern	41.2%	41.0%	-0.2%	45.1%	44.6%	-0.5%
Peninsula	17.6%	17.6%	≈0%	19.6%	19.8%	+0.2%
Southern	39.9%	39.6%	-0.3%	44.0%	43.8%	-0.2%
Western	32.5%	32.5%	≈0%	39.9%	39.5%	-0.4%
Other	1.2%	1.2%	≈0%	1.4%	1.5%	≈0%

Table D.8: sCLR changes in congested VKT (AM period)

D.2.4 *Accessibility*

Figure D.20 and Figure D.21 show the change in average public transport travel times originating from a particular location between the sCLR project and the sTBC for the morning peak[16]. Changes in public transport travel times often demonstrate less obvious spatial patterns than vehicle travel – especially if new route choices involve greater or fewer interchanges. However, there are some key attributes to note:

- As was the case with the VLUTI scenarios, in 2036 Donnybrook, Beveridge, Wallan and their surrounding regions all experience a clear reduction in average public transport travel times. The CLR project has allowed residents in this region to use the metropolitan rail network to access intermediate stations between Upfield and the CBD. This has allowed for a more direct access to a larger pool of destinations, contributing to a reduction in journey distances and corresponding journey times.
- In 2051, the opposite trend is observed for Donnybrook, Beveridge, Wallan and their surrounding regions (although to a lesser extent than was seen in the VLUTI scenario). A key trend to note is that in 2036 there are approximately 8% more trips to the CBD from this region of Melbourne in response to the CLR project. By 2051 this proportion is 16%. Residents are needing to commute longer distances due to the consolidation of employment within the city centre. This is being facilitated by the presence of the CLR project, resulting in longer journeys on average within this modelled year. In the VLUTI scenarios this impact was additionally compounded by the redistribution of residents and employment.

[16] Public transport travel time is affected by a combination of frequency as well as travel speed. The speed of on-road public transport is affected by the congestion around it.

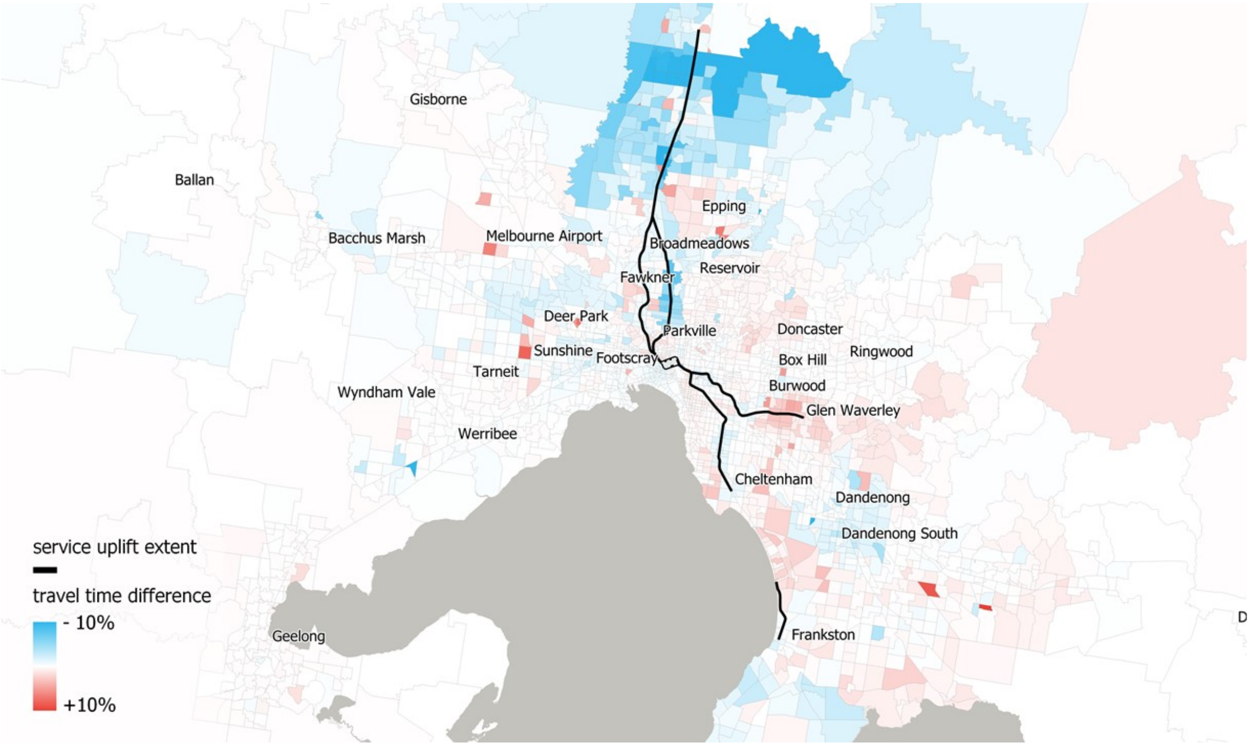

Figure D.20: Changes in public transport travel time, 2036 sCLR vs. sTBC (AM period)

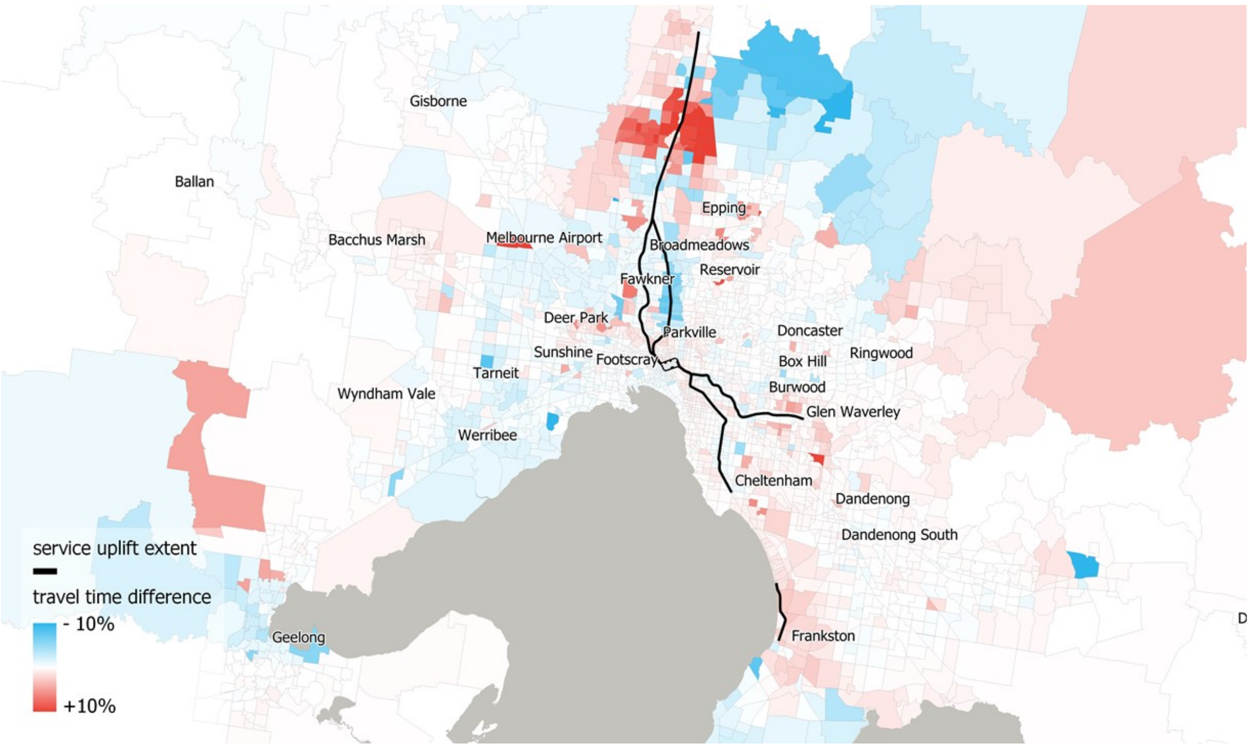

Figure D.21: Changes in public transport travel time, 2051 sCLR vs. sTBC (AM period)

Figure D.22 shows these changes by FUA, where the impact on Growth Areas can be seen in 2051. Impacts across other FUAs are subtle as was the case with the VLUTI scenarios.

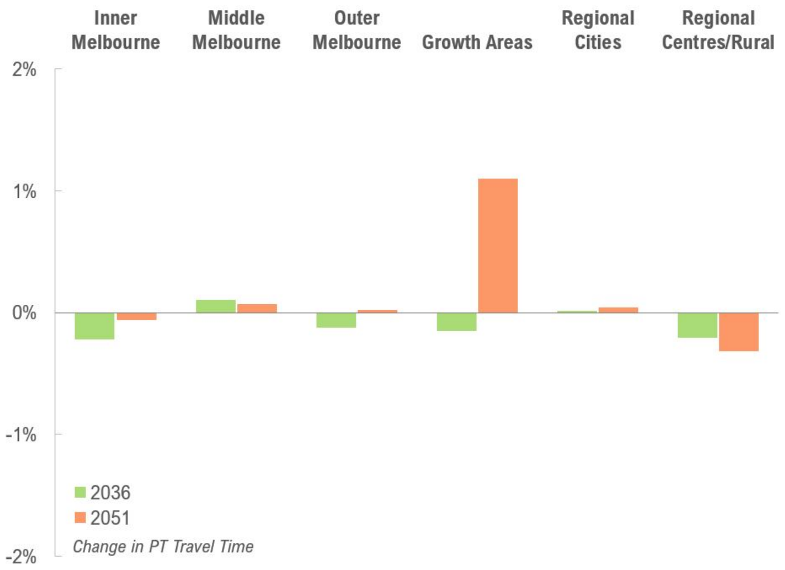

Figure D.22: sCLR changes in public transport travel time by FUA (AM period, originating)

Figure D.23 shows the reduction in private vehicle travel times during the morning peak in 2051 as a result of the CLR project. The improvements observed from the conventional land use tests are larger than those seen from the corresponding VLUTI scenarios[17]. This is because the VLUTI CLR scenario resulted in a greater consolidation of residents in proximity to the rail upgrades, correspondingly increasing demand on the road network. This increase in demand then counteracts some of the original transport network improvements that would have arisen were land use fixed.

[17] See Figure 4.10.

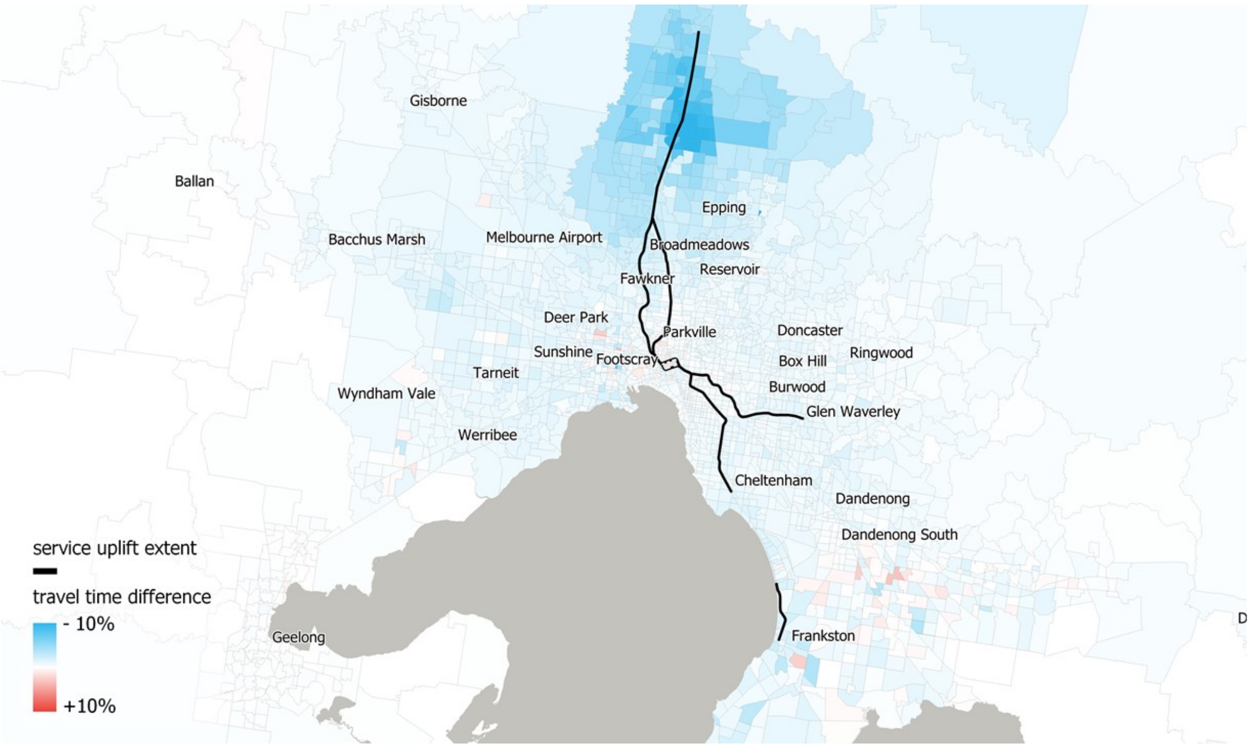

Figure D.23: Changes in private vehicle travel time, 2051 sCLR vs. sTBC (AM period)

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