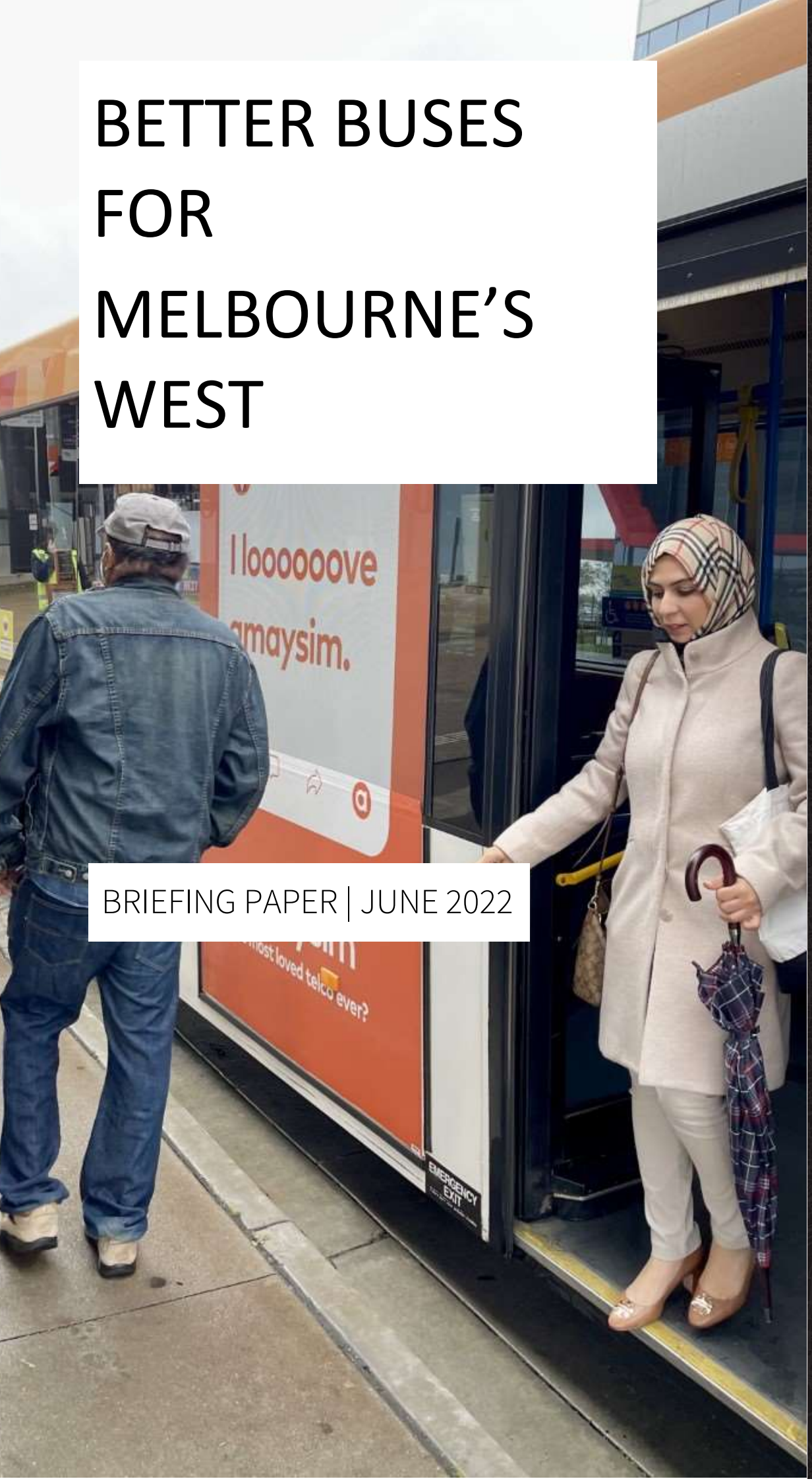
BETTER BUSES FOR MELBOURNE'S WEST



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THE UNIVERSITY OF MELBOURNE

Melbourne Centre for Cities

BETTER BUSES FOR MELBOURNE'S WEST

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INTRODUCTION

RAPID POPULATION GROWTH ACROSS MELBOURNE'S WESTERN SUBURBS HAS STRAINED THE REGION'S TRANSPORT NETWORK TO ITS LIMITS. BUS SERVICES ARE VERY LOW QUALITY WITH LONG TRAVEL TIMES AND POOR CONNECTIONS. THIS EXACERBATES THE INEQUITIES AND COSTS OF CAR DEPENDENCE. AS MELBOURNE EMERGES FROM THE COVID19 PANDEMIC AND CONFRONTS THE URGENT CHALLENGE OF THE CLIMATE CRISIS, VIABLE ALTERNATIVES TO THE REGION'S CAR DEPENDENCY ARE CRITICAL. THIS WILL REQUIRE REFORMS TO THE BUS NETWORK WHICH ARE BOTH AFFORDABLE AND CAN BE IMPLEMENTED IN THE NEXT TERM OF STATE GOVERNMENT.

This paper demonstrates the benefits of a new 'clean-slate' bus network to replace the existing collection of routes which are no longer fit for purpose. Our new network is built on a grid of fewer, but more frequent and direct bus routes, operating on a budget of bus service-hours comparable to the existing network.

Using the Remix spatial accessibility and transit planning software (www.remix.com), we have calculated the changes in size of the resident population living within a 30-minute travel time of each of 21 key activity centres in the western suburbs identified in Plan Melbourne. This allows us to test the conceptual advantages of the frequent and direct grid-based bus networks long-supported in the academic literature and recently advocated for Melbourne by a diverse group of government, private, and not-for-profit organisations.

The results are astounding. If investments were made in on-road priority to increase average bus speeds, re-allocation of existing service-hours into a new network would increase the population catchment within 30 minutes of western-suburbs activity centres by over 250% in weekday peak periods and over 300% on evenings and weekends. Even in a scenario where capital investments were not available to improve average bus speeds, similar dramatic uplifts in accessibility could be achieved through a modest increase in operating costs that could easily be justified in line with population growth.

These findings both reinforce the theoretical rigour of prior academic theory, but more critically, present an astonishing and cost-effective opportunity to revolutionise transport equity and meet climate targets in suburban Melbourne.

TRANSPORT PROBLEMS IN MELBOURNE'S WEST[1]

In the past decade, Melbourne's western suburbs have experienced some of Australia's fastest growth rates. Since 2011, population of the Wyndham local government area (LGA) has doubled to 300,000 (ProfileID, 2021). Before COVID, population growth of 380,000 new residents by 2036 was projected for the 'interface' LGAs of Wyndham and Melton, and the established municipalities of Brimbank and Maribyrnong were forecast to add nearly 90,000 people in the same period (DEWLP, 2019). Collectively, the population of Canberra was expected to be added to Melbourne's west in just 15 years. The pandemic gives us a pause in which to prepare for this future.

Transport infrastructure which has failed to keep up with this explosive population growth. Before COVID19, residents faced chronic congestion, manifesting in long and unpredictable travel times. This reduces access to services, to education and to employment opportunities.

In short, the people of the west cannot properly benefit from the riches of city life (BITRE, 2013).

Across Melbourne's west, average public transport travel times are significantly higher than the metropolitan average, particularly so for the outer LGAs of Melton and Wyndham (see Table 1). Unlike inner and middle suburbs elsewhere in the city, Melbourne's west does not enjoy the relatively dense, frequent network of trams well suited to local trips. The local bus network is generally both infrequent and indirect (see Figure 1 & Table 2). Standard local route weekday frequencies are often 40 minutes or less (Public Transport Victoria, 2021) – meaning wait times alone can be twice the average trip time of journeys by car (DoT, 2018). Although the west's mode share for journey to work by public transport is comparable to the city-wide figure (see Table 1), these trips dominantly comprise longer distance, rail-based CBD commutes. Journey to work trips which include travel by bus make up a tiny 1.3% of all work trips originating in the west.

[1] In this paper, 'western suburbs' refers to the municipalities of Wyndham, Melton, Brimbank, Hobsons Bay and Maribyrnong.

Table 1: Western Melbourne travel times, mode split, and household car ownership

	Average trip time by car (mins) [a]	Average trip public transport (mins)[a]	Public transport mode share - all trips (%) [a]	Public transport mode share JTW (%) [b]	Bus as main mode for JTW (%) [c]	Households with 3 or more vehicles (%) [b]
Brimbank	21.8	62.8	8.2	13.7	1.2	20.8
Hobsons Bay	22.8	55.9	9.2	17.3	1.3	14.3
Maribyrnong	19.8	52.5	14.5	26.0	3.0	9.1
Melton	22.5	71.5	4.3	9.9	0.9	21.9
Wyndham	21.8	71.4	7.9	15.3	0.8	18.3
Average Western Region	21.7	62.3	8.8	16.4	1.3	16.9
Average Inner Melbourne [d]	22.0	37.0	13.9	26.1	2.0	8.8
Greater Melbourne	21.3	47.0	8.6	15.6	1.8	16.8

a. Victorian Integrated Survey of Travel and Activity 2018
b. ABS 2016 Census: Quickstats
c. ABS 2016 Census TableBuilder
d. The municipalities of Melbourne, Yarra, Stonnington, Port Philip, Moonee Valley, Boroondara, Darebin and Moreland

Because existing public transport services fail to meet many day-to-day needs, households suffer a financial burden of the costs of owning and running multiple cars: estimated to be at least $7,500 per annum for even the cheapest light car (see RACV, 2021b) Despite lower incomes, there are proportionally many more three-car households in Melbourne's western growth suburbs (and outer metropolitan areas generally) than the inner-metropolitan average (ABS, 2016). As we emerge from the COVID19 pandemic in 2022, 'returning to normal' is thus not something relished by residents of Melbourne's booming western suburbs.

Current public transport services in the western suburbs are shown in Figure 1. The 80 bus routes illustrated here are designed according to the Victorian Government's ambition of a bus stop within 400m of all dwellings (Vic Bus Plan, p. 3). To maximise this ambition, bus services are spread very thin, with many operating at extremely low frequencies and limited coverage (that is, hours of operation). The complex and illegible character of the existing service pattern is immediately obvious. The problems with the service pattern have been previously identified by Auditor General (VAGO, 2014, pp. 31-33).

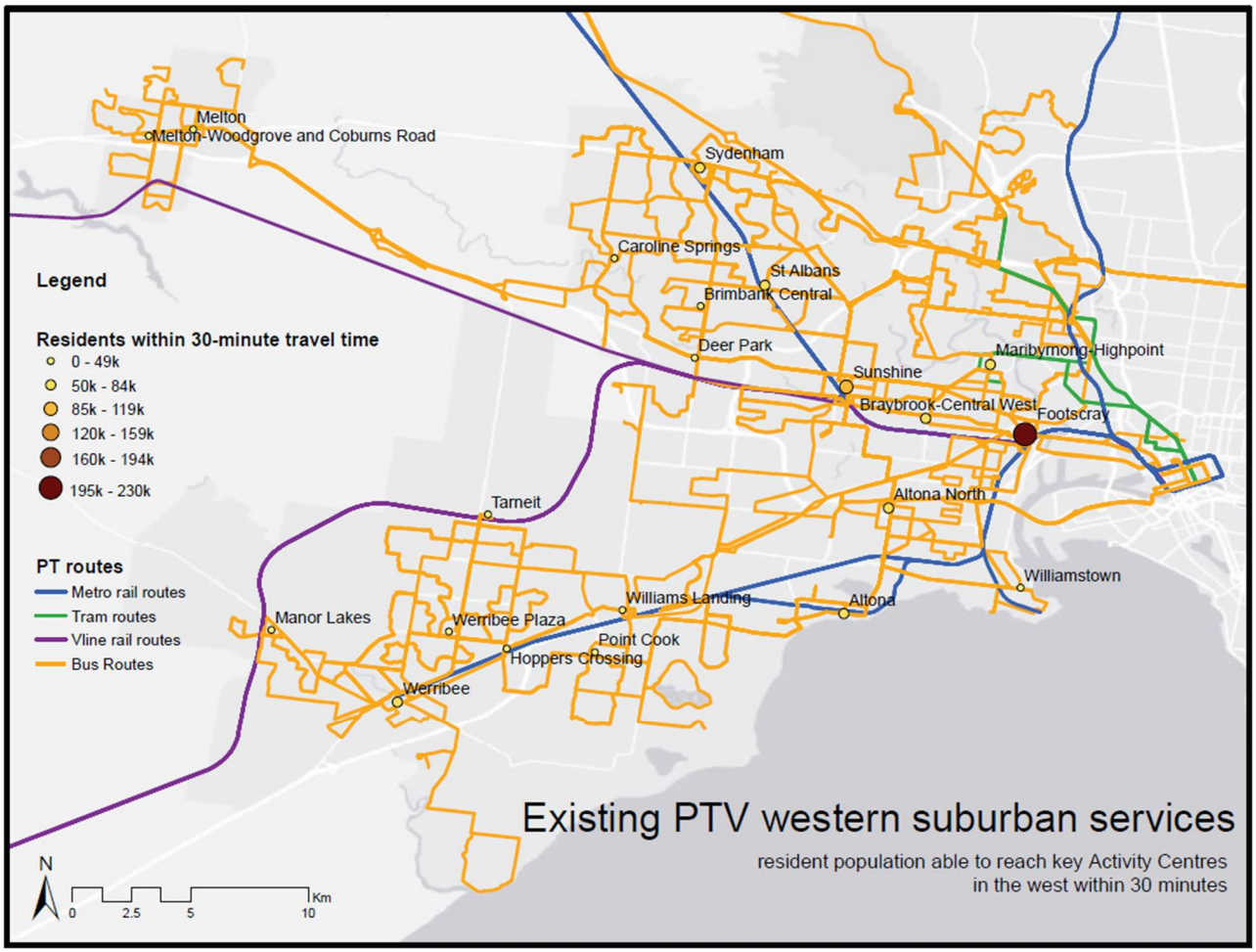

Figure 1: Existing western suburban public transport services and accessibility to key Activity Centres (data from PTV and Remix modelling)

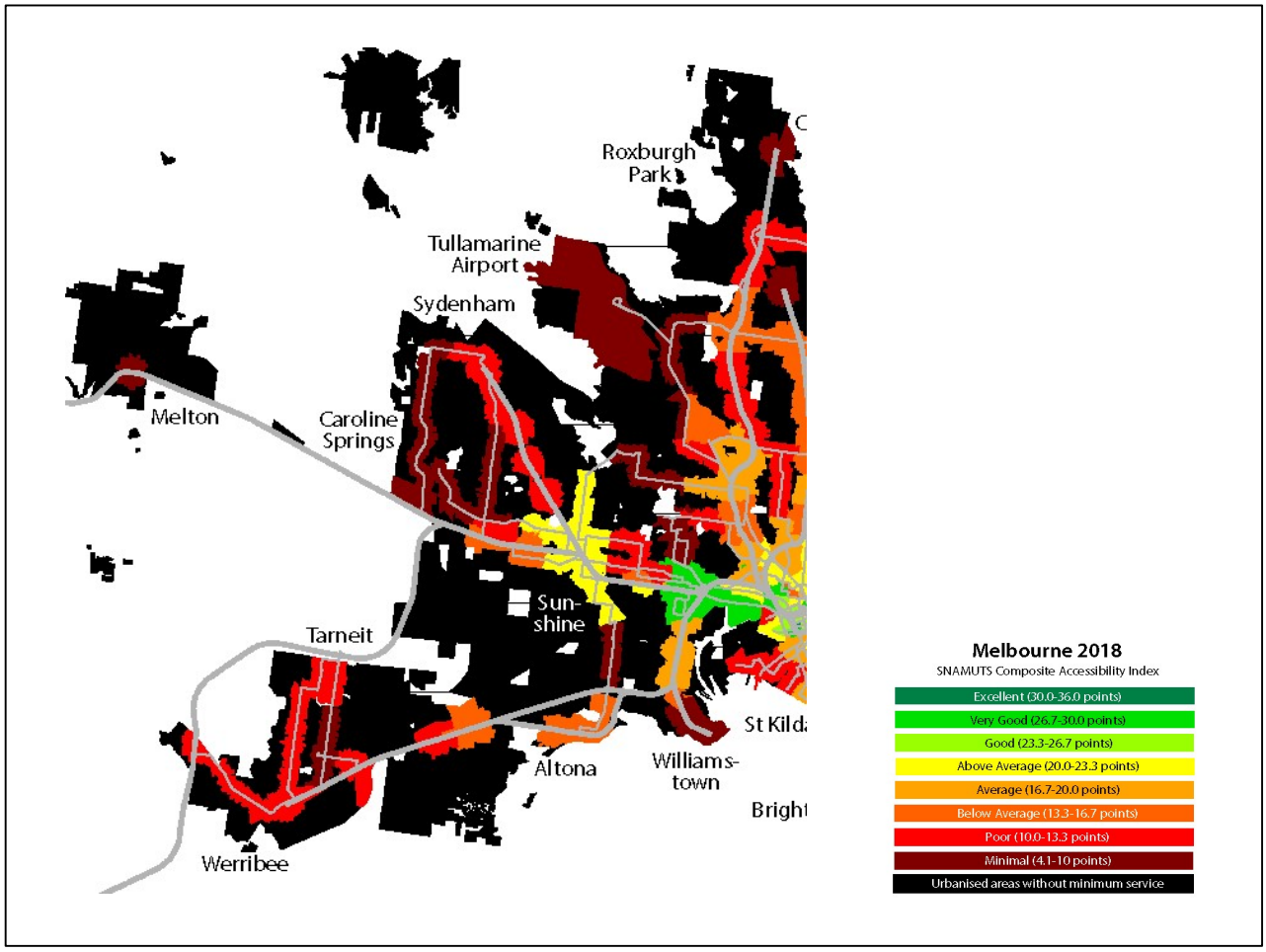

Figure 2: Public transport accessibility in Melbourne's west in 2018 using an international comparative index. (Source: www.snamuts.com)

Accessibility analysts have identified a minimum service threshold below which public transport services cannot be considered as a viable alternative for users with a choice of modes (www.snamuts.com). Figure 2 shows accessibility by public transport according to these standards: the limitations of current service patterns are clear.

WHAT IS BEING DONE ABOUT THESE PROBLEMS?

The Victorian government is attempting to resolve the west's transport challenges by investing heavily in transport infrastructure capacity. The premise is that congestion can be relieved, travel times reduced, and access improved through such expanded capacity.

Public transport capacity is being enhanced by the Metro Rail project and the Western Rail Plan projects. Metro Rail is a new rail tunnel from South Kensington to Hawksburn through the CBD. It is expected to open in 2025, but none of the much-anticipated Western Rail Plan initiatives are yet under construction. These initiatives include a rail connection to Tullamarine airport, electrification of the Melton and Wyndham Vale regional lines, and 'fast rail' to Geelong (Premier of Victoria, 2019). In fact, the current plans for airport rail appear to rule out any early electrification to Melton. These projects would certainly enhance rail capacity between the western suburbs, the CBD, and locations directly served by Melbourne's radially oriented rail network. However, the pace of growth is such that projects may merely satisfy demand generated from already committed urban development. New lines are at risk of quickly filling up in a manner similar to the capacity crunch experienced on Geelong services in 2015 shortly after opening of the Regional Rail Link services to Wyndham Vale and Tarneit (see VAGO, 2018).

The Western Rail Plan investments, as critical as they are in maintaining viable public transport connections over longer distances to the central city, will do little to improve local public transport accessibility. Long distances between stations and a legacy of weak land use-transport integration limit the 'walk-up' catchment to stations. Poor bus services and the obvious limits to growth in station parking mean that rail is inaccessible for many in the west. Therefore, investments such as Wyndham Vale and Melton electrification, while important, will likely do little to generate mode shift to public transport for local trips. This is critical: trips of less than 5 km dominate trip-making across the city (DoT, 2018). Indeed, improving active and public transport mode shares for local trips is a key objective of Plan Melbourne, the city's official strategic planning vision (see DEWLP, 2018)

Meanwhile, expanded existing and new roads are being provided through a series of public-private partnerships. In the outer west, arterial roads are being duplicated under the 'Western Roads Upgrade' package, where a private consortium is managing construction and maintenance of 260 kilometres of road over a 20-year period (DoT, 2021b). The controversial and expensive West Gate Tunnel, created by the tolling company Transurban outside established planning frameworks, will expand road capacity between the western suburbs and inner city (Low, 2017). Further road building is planned for the west through the gazetted Outer Western Ring Road and its associated radial connections.

Expanding road capacity is very unlikely to relieve congestion. Decades of academic research, and global and local experience has demonstrated that cities can't build their way out of road congestion (Mogridge, 1990; SACTRA, 1994). Congestion relief through new and wider roads is ephemeral. In the immediate period after their opening, expanded roads may indeed reduce congestion levels, shortening travel times (and travel time uncertainty). In response however, some trips which had occurred on active or public transport change to car. Other trips, which were avoided due to prior congestion, are now encouraged. These additional 'induced' trips mean that congestion will return – but at a higher overall level, impacting both the expanded links, but also the many unaltered sections of the road network. These effects are likely exacerbated in the context of rapid urban growth – reinforcing the many limitations and inequities of car dependency (Downs, 2005; Goodwin, 1996; Khalaj, Pojani, Sipe, & Corcoran, 2020; Mogridge, 1990).

If this, and the ongoing crippling inequities of suburban car dependence, were not problematic enough, continuation of a car-dominated transport system, even if all vehicles were powered with 'green' electricity', is at odds with Victoria's commitment to reduce greenhouse gas emissions by 45-50% over

2005 levels by 2030 (see Victorian Government, 2021c). Victoria has acknowledged this as a signatory to the COP26 declaration on decarbonising transport. This declaration states that:

> alongside the shift to zero emission vehicles, a sustainable future for road transport will require wider system transformation, including support for active travel, public and shared transport.

This approach is endorsed by the usually conservative International Energy Agency, which says that "decarbonisation of the transport sector … relies on policies to promote modal shifts" (IEA, 2021, p. 132).

WHAT ELSE COULD WE DO?

What alternatives might be implemented quickly enough to meet existing and expanding travel demand and make a significant contribution to reducing transport carbon emissions before 2030?

The expected costs of planned, but not yet committed, road expansion to further prioritise private car use across the western suburbs run to many billions of dollars (DoT, 2021b), so there is an expectation of considerable spending on transport. Are there other more efficient, equitable and effective uses of this funding?

Many analysts have argued that there would be benefits in improving public transport by restructuring bus routes into a grid network of simple, frequent and direct services (Dodson, Mees, Stone, & Burke, 2011; Mees, 2010; Nielsen & Lange, 2008; Pemberton, 2020; Scheurer, 2020). The principle is that a slightly longer walk to the bus stop for some is compensated by all day 'turn up and go' fast and frequent services for all. Overall accessibility is greatly improved. The service offering becomes something akin to a bus-based version of globally recognised public transport exemplars like the London Underground or Paris Metro. Connections between services require only a very short wait, regardless of the route or the time of day. And, these connections mean that vastly greater areas of the city become conveniently accessible by public transport.

The benefits in both attractiveness to users and efficiency dividends for operators have been dubbed the public transport 'network effect' (Mees, 2010). While these principles have been understood for some time (originating at least as early as the 1970s – (see Sullivan, 1976; Thomson, 1972), recent advances in spatial data modelling have enabled the efficiency and accessibility advantages to be more easily demonstrated (see, for example, www.snamuts.org).

The broad approach of transforming Melbourne's complex and impenetrable collection of bus routes into a network that offers simpler, faster, more frequent and connected services is supported by groups as diverse as Infrastructure Victoria (2016, 2021), the RACV (2021a), Public Transport Users Association (2020) and Friends of the Earth (2021). Indeed, the Victorian Department of Transport's 2021 Victorian Bus Plan identifies the need to 'restructure the network to provide faster, more reliable journeys enabling travellers to get to more destinations and save time', so that buses can 'perform an increasing mass transit role' (DoT, 2021a, p. 10).

What might a network of this type look like for Melbourne's west? And how might it perform compared to the existing network?

A 'CLEAN-SLATE' BUS NETWORK

To assess the extent of accessibility improvement that might be possible through bus reform, we have developed a conceptual 'clean-slate' network for the western suburbs based on the principles which underpin creation of the 'network effect' (informed by (Dodson et al., 2011; Mees, 2010; Scheurer, 2020)). The new network was assessed using the Remix spatial accessibility modelling software[2], allowing simple, but powerful comparisons to be made between our concept and existing service patterns.

Our conceptual network is based on:

- Routes set in a grid at 1.5-2.0-kilometre intervals, operating along major roads. This would ensure much of the region would be within a 750 – 1000 metre walking distance of stops. Although sparser than the existing network, a substantial body of research has confirmed the willingness of many users to walk such distances where services are frequent (Cervero, 2001; Cervero, Round, Goldman, & Wu, 1995; Guerra, Cervero, & Tischler, 2012; O'Neill, Ramsey, & Chou, 1992; Staricco & Vitale Brovarone, 2020).
- Routes aligned to optimise access to the 21 western suburban Major and Metropolitan Activity Centres and the Sunshine National Employment and Innovation Cluster (NEIC) identified in Plan Melbourne (DEWLP, 2018). Naturally, the new routes would also serve a range of schools, hospitals, medical centres, and secondary retail centres (among much else) that are critical to day-to-day suburban life but are dispersed across the region.
- Services operating at a standard 10-minute frequency throughout the day – from 6am-9pm weekdays and 7am-9pm on weekends. Very early morning and late evening services would operate on a slightly reduced (typically 12 minute) frequency. The high frequencies and long service hours compensate for the increased walking distance to bus stops for some trips.
- No improvements to rail service frequencies, although any such changes would further enhance the effectiveness of the bus network.
- Selected capital infrastructure upgrades – including several dedicated bus-only bridges and roads, and the addition of 7 new stations along the Sunbury and Regional Rail Link corridors to achieve optimal interchanges and station spacing.
- Provision of local demand-responsive services within suburban precincts to link residents requiring mobility support to the new network.

The new network would comprise 25 new routes to replace the existing 80 routes (Figure 1).

Figure 2 shows the concept for a 'clean-slate' network with an 800-metre catchment based on the walkable street network. The grid structure is clearly visible.

Two variations of the concept are included in our analysis.

The 'basic concept' assumes that buses travel at an average speed of 25 km/h. This is comparable to the performance of Melbourne's 'Smartbus' services, for which modest on-road priority measures have been implemented.

The 'enhanced concept' includes capital investments for significant on-road priority treatments to isolate buses from general traffic. This would allow average

[2] www.remix.com This software is used for service planning by many public transport agencies, including DoT/PTV. It incorporates ABS Census population and employment data so that impacts on accessibility can be measured. It also includes operational parameters so that costs for staff and vehicles can be assessed.

speeds of 30km/h along arterial roads and permit reliable trip times and improved competitiveness with private cars. These treatments would include dedicated lanes, priority signalling at intersections, and improved bus stop infrastructure to enhance transfer convenience, passenger comfort and level access provision.

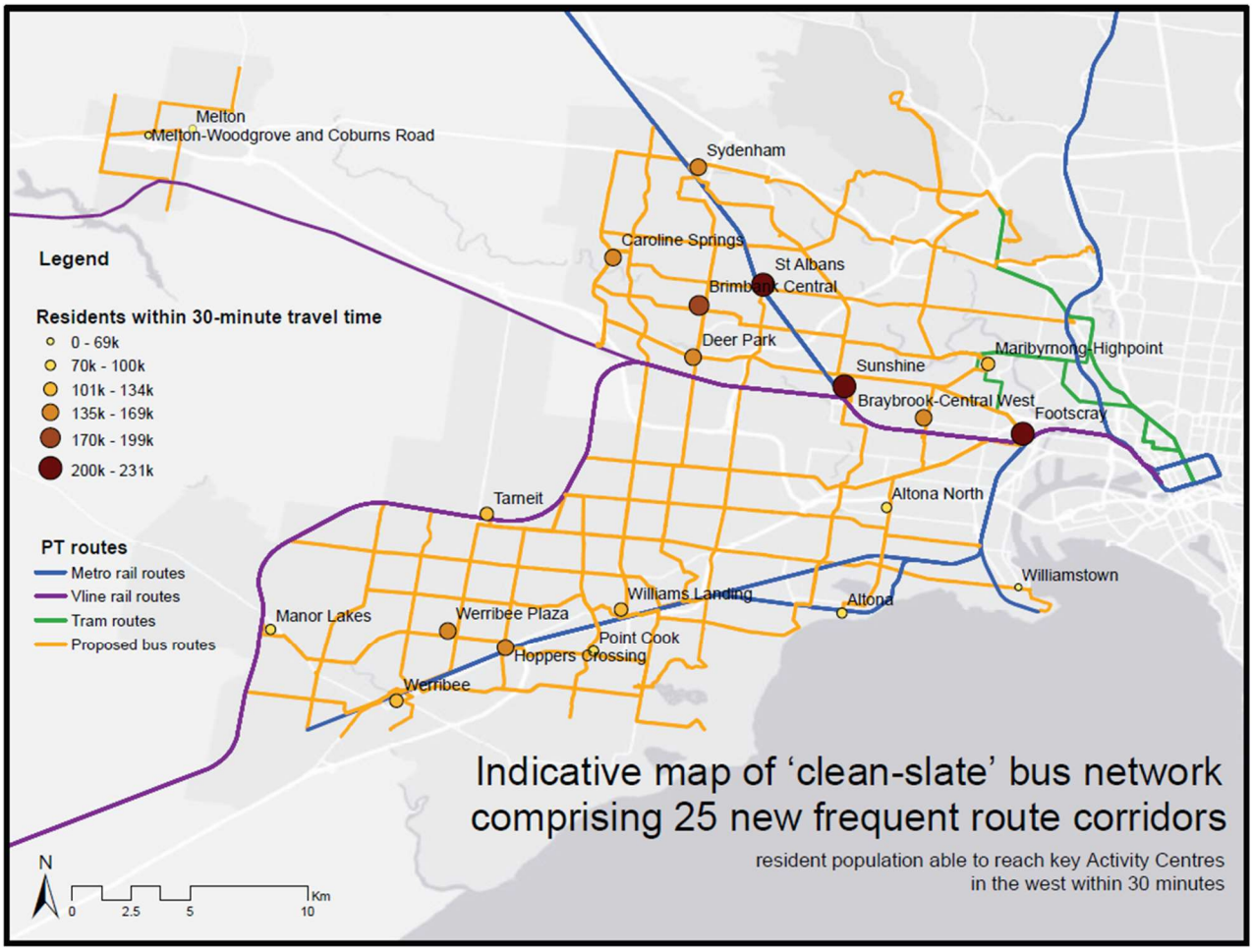

Figure 3: Indicative map of 'clean-slate' bus network, comprising 25 new frequent service corridors.

(Source: PTV and Remix modelling)

HOW DO THE DIFFERENT NETWORKS PERFORM?

Using the Remix spatial modelling tool, changes in accessibility were calculated based on a 30-minute travel time catchment to the 21 key Activity Centres identified in Plan Melbourne in the western suburbs (DEWLP, 2018).

Remix works by creating isochrones. These are essentially maps identifying areas that can be reached by public transport from a selected location within a chosen travel time. Remix assembles these from the key network parameters (service frequency, average speed, stop locations, walking distance to stops and wait times at connection points). Resident populations within isochrone boundaries are calculated using ABS 2016 census data.

A 30-minute travel time was selected because:

- The large majority of trips in Melbourne occur within this timeframe (DoT, 2018)
- This time band is broadly consistent with the accessibility and containment objectives of Plan Melbourne (DEWLP, 2018).
- 30 minutes represents the Marchetti constant – the average one-way travel time that appears consistent across centuries of urban development and transport technology evolution (Marchetti, 1994).

In considering a network's potential, resident population were calculated for 30-minute isochrones at 8 am and 10 pm on weekdays and 10 am Sunday morning. This ensures a more nuanced understanding of a network's utility as day-to-day transport, rather than the focus on peak capacity for the journey to work which dominates much transport planning – see (PTV, 2012) for example.

Table 2 and Figure 3 shows the differences in the numbers of people living within 30-minutes travel time by public transport from the key activity centres in the west under existing service patterns and under two versions of our new conceptual network.

The results are astounding. In weekday peak periods, the population able to reach their nearest Activity Centres within 30 minutes on the enhanced network increases by between 18% (for Williamstown) and a staggering 1155% (for Hoppers Crossing). Increases for evenings and Sunday morning are even greater. Most Activity Centres experience more than a doubling in population accessible within a 30-minute travel time. Accessibility improvements remain impressive even for the basic 'clean-slate' network reform, reflecting the inherent efficiency of a frequent, grid-based network structure.

Table 2: Comparison resident population able to reach key Activity Centres in the west within 30 minutes: existing services and 'clean-slate' networks.

Plan Melbourne Activity Centres	Residents within 30-minute travel time								
	Existing services			Basic 'Clean-slate' Network			Enhanced 'Clean-slate' Network		
	Weekday 8am	Weekday 10pm	Sunday 10am	Weekday 8am	Weekday 10pm	Sunday 10am	Weekday 8am	Weekday 10pm	Sunday 10am
Footscray	231,870	99,034	102,497	231,676	158,807	117,238	281,767	167,256	134,667
Sunshine NEIC	119,585	49,686	45,643	205,733	145,494	61,730	212,034	141,462	90,189
Altona	69,767	21,948	22,580	97,603	31,269	41,446	114,868	41,257	42,105
Altona North	56,644	18,334	18,479	93,175	55,317	66,241	102,367	68,631	87,055
Braybrook-Central West	73,324	59,598	53,125	140,528	93,689	90,541	143,471	103,912	106,565
Brimbank Central	39,684	29,379	29,857	176,299	148,730	165,980	157,895	130,325	147,051
Caroline Springs	36,100	32,080	34,430	134,742	120,578	130,248	157,105	137,607	147,518
Deer Park	49,059	33,562	25,558	152,519	116,913	134,499	174,072	134,963	154,170
Hoppers Crossing	12,783	12,782	12,782	146,657	92,613	115,136	160,433	126,263	146,887
Manor Lakes	25,133	18,789	15,903	69,260	44,350	34,766	44,623	37,726	42,180
Maribyrnong-Highpoint	54,981	38,160	39,981	125,265	87,636	102,723	150,982	106,792	126,728
Melton	18,856	13,704	15,962	35,999	31,429	34,047	28,031	24,589	25,931
Melton-Woodgrove & Coburns	32,572	21,507	24,514	45,338	43,510	44,894	43,114	41,720	42,660
Point Cook	30,299	24,417	26,337	89,598	81,995	88,131	233,021	223,387	230,205
St Albans	79,195	36,748	45,672	222,488	166,631	146,403	200,851	147,628	132,750
Sydenham	80,915	30,688	36,075	156,066	129,424	112,689	170,894	147,145	139,898
Tarneit	37,253	17,622	28,133	122,305	89,538	85,231	81,558	55,528	67,903
Werribee	74,654	28,717	58,278	133,152	97,773	110,431	127,880	96,408	107,974
Werribee Plaza	31,279	26,469	26,966	142,631	116,203	133,445	153,732	127,623	145,424
Williams Landing	42,831	15,025	22,314	115,907	77,069	95,121	129,102	96,393	108,808
Williamstown	32,633	20,353	18,382	36,977	27,595	26,949	38,592	31,879	30,849
MEDIAN	41,258	25,443	26,652	129,209	91,076	92,831	147,227	105,352	108,391

Table 3: Existing and 'Clean-slate' network key parameters

	Existing service patterns	Basic 'clean-slate' network	Enhanced 'clean-slate' network
Number of routes	80	25	25
Annual bus service-hours	1.14 million	1.41 million	1.14 million
Interpeak weekday frequency	Variable 12 – 60 mins (most 40 minutes)	10 minutes	10 minutes
Evening and weekend frequency	Variable: 30-60 minutes to no service	10-12 minutes	10-12 minutes
Residents within 800 metres of a frequent* bus service	0	694,100	694,100
Jobs within 800m of frequent bus service	0	228,700	228,700
(*) Defined as having at least 10-minute frequency in the peak & interpeak			

Accessibility improvements are most pronounced for currently car-dominated regional hubs, such as Highpoint and Werribee Plaza. Under the enhanced 'clean-slate' network, the Sunday morning 30-minute residential catchment (a relevant time to assess weekend trade and employment opportunities) for Highpoint increases by over 200%, while accessibility for Werribee Plaza increases by over 400% (see Figures 5 & 6).

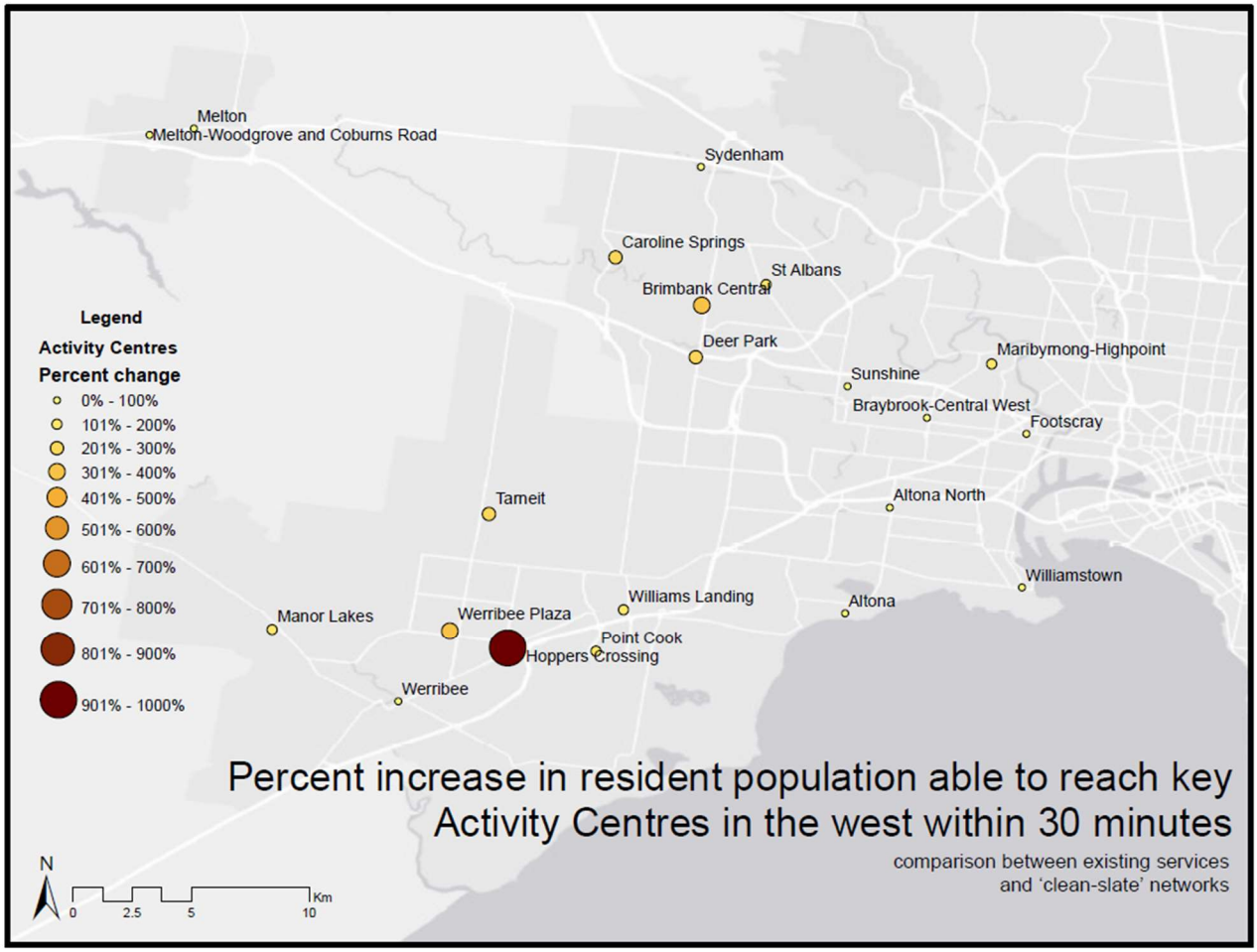

Figure 4: Accessibility improvements achieved with 'clean slate' network. (Source: Remix modelling)

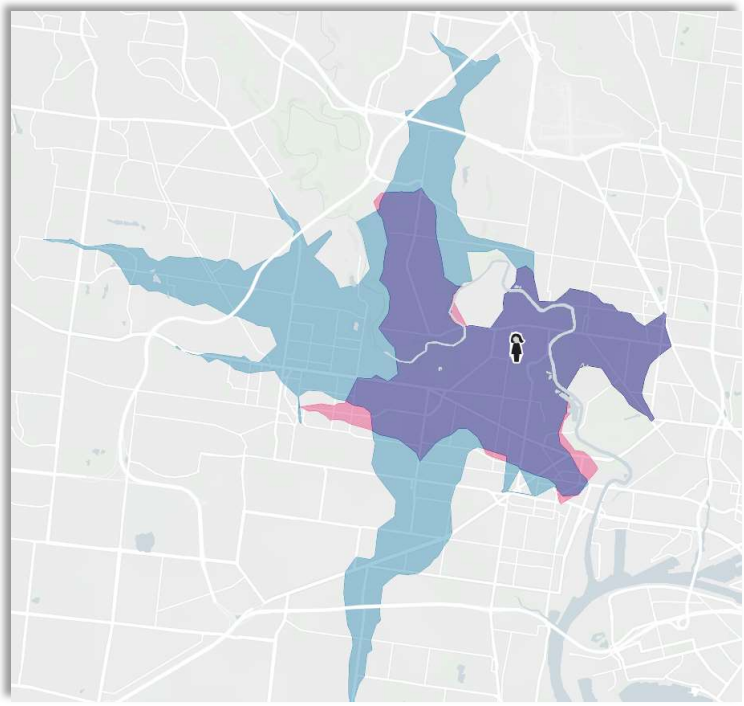

Figure 5: Accessibility: enhanced 'clean-slate' v existing network: Highpoint 10am Sunday. (Source: PTV and author via Remix.com)

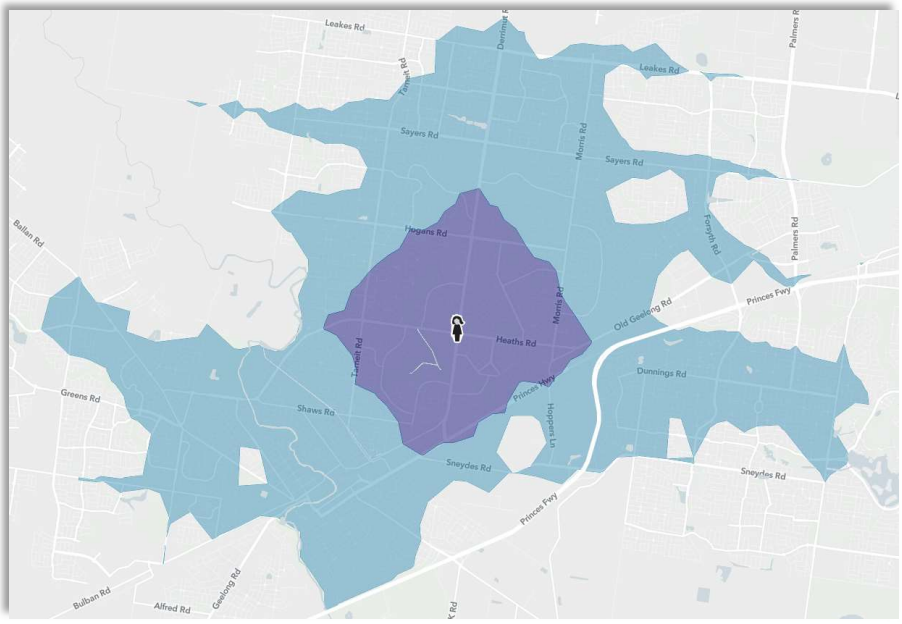

Figure 6: Accessibility: enhanced 'clean-slate' v existing network: Werribee Plaza 10am Sunday. (Source: PTV and author via Remix.com)

CHALLENGES, LIMITATIONS, AND OPPORTUNITIES

Our 'clean-slate' network is by no means fully developed. It is a 'thought experiment' to test this approach to network reform. Our analysis has shown that a high-quality bus network for Melbourne's west can contribute significantly to the twin objectives of increasing accessibility to city life and de-carbonising the transport sector.

The key issues that will need to be addressed in any implementation plan relate to:

- Changes to road-space allocation to give buses sufficient priority to achieve targeted travel speeds and to facilitate connections.
- Operating budgets.
- Gaps in service coverage and local access.

DIRECT ROUTES AND ON-ROAD BUS PRIORITY

Substantial capital investments would be required to achieve the direct routes, reliable average service speeds, and improvements to access to and around bus stops, that are necessary for our enhanced 'clean-slate' network. A detailed calculation of such costs is well beyond the scope of this paper, but it is conceivable that capital investment in the order of $5 billion dollars would be necessary. Along with on-road priority and enhanced stops, these investments would include some road links that would be used only by buses, bikes and walkers. These links would address the west's many suburb-to-suburb severances caused by waterways, freeways and disconnected subdivisions. Although expensive, such connections would permanently reduce travel time for public and active transport, enhancing the competitive position of these modes against private vehicles.

Although significant, such a capital sum is consistent with many 'one-off' investments regularly made in freeway and arterial road construction and maintenance (see for example (DoT, 2021b; Victorian Government, 2021a, 2021b)). Unlike those investments however, benefits would be long-lasting if service levels are maintained. Unlike road widenings and freeway expansion, the travel time and reliability improvements of a bus network free from general traffic congestion would not be eroded by induced demand as we have repeatedly seen with capacity expansion for cars. By way of example, with regular maintenance, Melbourne's suburban rail lines today offer comparable capacity and speed as was offered when the network was first electrified in the 1920s. The same could not be said of our freeway or arterial road network, which has required regular immense investment in widenings to maintain prior levels of service (see for example Major Road Projects Victoria (2019); Tullamarine-Calder Interchange Alliance (2006); VicRoads (2008) relating to the Tullamarine freeway).

However, capital costs are unlikely to be the major barrier to implementing an improved bus network. Major challenges will be found in tackling established approaches to road space allocation.

The enhanced 'clean-slate' network would require substantial changes to existing arterial road conditions to achieve the 30km/h average operating speeds and to enable easy connections between services. In some locations, this would involve reduced lanes for general traffic; in others, restrictions on parking or turning manoeuvres. Such interventions, although well-understood and widely implemented in other jurisdictions, are contrary to deeply entrenched road management practice in Melbourne.

OPERATING BUDGETS

The remarkable thing about our enhanced 'clean slate' network is that it can be delivered at similar operating costs to current services. But, if improvements in on-road priority and other

treatments are not sufficient to operate a high-frequency network at average speeds of 30 km/h, then more bus service-hours would be needed to maintain desired frequencies.

Our basic 'clean-slate' network was modelled at average bus speed of 25 km/h. The capital requirements for priority measures to achieve this speed are comparable to what has been delivered for the existing Melbourne 'Smartbus' services. This basic network offers comparable accessibility benefits to the enhanced network, but the lower speed necessitates an estimated increase in operating cost from 1.14 million to 1.41 million service-hours per annum.

Across Melbourne, per capita expenditure on bus services has fallen significantly since 2012 (see Figure 7) and, given the rapid population growth in the west, bus supply in this region is at levels well below the Melbourne average. So, there is a strong case for an increase in per capita expenditure on bus services in Melbourne's west to allow our basic network to be implemented. Then, if it proved successful, the political argument for greater on-road bus priority would be strengthened and any future capital expenditure would reduce on-going operating costs.

SERVICE GAPS AND LOCAL ACCESS

Some modifications of the service pattern are likely to necessary to avoid larger coverage gaps in our conceptual network. One such area is in the suburbs south-west of Sunshine (see Figure 2). These gaps could be reduced to some extent without compromising the fundamental requirement for a grid of direct routes.

In many local precincts, residents will have to walk somewhat further to join the new frequent and connected network. Here, improvements to conditions for pedestrians (shade, vehicle speed restrictions, etc) will help to encourage walking to bus stops. Local demand responsive and MaaS services will also be required to maintain access for all.

The approach to education and consultation taken by authorities in Auckland before and during their recent successful bus network reform provides useful guidance in what will inevitably be a contested process.

Figure 7: Declining per capita investment in bus services in Melbourne

(Source: PTV and DoT Annual Reports)

IMPLEMENTING A 21ST CENTURY BUS NETWORK IN MELBOURNE'S WEST

To move to the implementation of the ideas discussed in this paper, the conceptual network designs will need to be refined through detailed examination of route layouts and modal interchanges, supported by open processes of public consultation and negotiations of new contracts with operators. This is clearly the task of the Department of Transport as identified in its Bus Reform Plan.

As we have noted, improvements to the efficiency and effectiveness of bus services by exploiting the 'network effect' have been achieved in other jurisdictions. These principles have also guided previous improvements to bus services in Melbourne. However, past timetable upgrades have been hindered both by their incremental approach and by adherence to a coverage standard of "a bus stop withing 400m of every household" regardless of the minimal levels of accessibility that this produces given existing budgets.

To achieve the step-change that is necessary to trigger a significant shift to bus travel in Melbourne's suburbs, reforms need to be bold and cover as large an area as possible. It will also be vital that a constituency of local support for better buses is built to create a climate for strong political commitments to reform.

If commitments were made by late 2022, the 'first stage' of fast, frequent, and connected bus network for the western suburbs, based on our 25km/hr 'clean-slate concept, could be in operation by early 2024. This network would be supported by affordable and inclusive on-demand services for mobility-impaired residents. We estimate that this would require an additional $30 million per annum above current operational expenditure and a once-off capital investment for bus stops and simple intersection priority of around $25 million

Operating the network with clean electric buses would be an important way to signal the renaissance of buses in the west. These buses could be brought into the fleet if the current timetable for replacement of diesel buses was accelerated. We have outlined the steps needed to do this in our recent paper on Melbourne's zero-emission bus transition.

Changes to bus services can be unpopular with some existing users, and so it is important for the community to understand that the changes are designed to boost public transport. This perception can be strengthened if the 'first stage' is accompanied by development of a detailed strategy for delivery of a 'second stage' of a world-class bus network, based on our 'enhanced' network concept, that truly puts public transport out in front of the car. This strategy will include clear timelines for monitoring the performance of the 'first stage' network, scoping of required works, community engagement, allocation of budgets, and establishment of construction schedules.

CONCLUSION

This paper argues that a complete 'clean-slate' redesign of bus services, closely integrated with existing (and select additional) rail services and targeted infrastructure improvements in terms of priority bus treatments could radically improve transport opportunities for Melbourne's west. This has several implications for spatial planning, across not only Melbourne's growing west, but the city more broadly.

First, in dramatically improving public transport access to these and other non-rail based locations, the 'clean-slate' network would reinforce the intent of Plan Melbourne's 'Principle 5' spatial objectives, where most day to day activities are sought to be achieved within a 20-minute active or public transport travel time (DEWLP, 2018, p. 10). Consistent with well-established spatial economic theories (see for example, King (2020)), the new network would influence western Melbourne's economic geography in a manner consistent with the intent of Plan Melbourne. Expanded Activity Centre catchments, achieved with the 'clean-slate' network, would combine with reliable travel times (achieved through on-road priority measures for buses) to ensure those centres would remain economically vibrant and attract ongoing investment. By isolating buses from private vehicle congestion, Activity Centres would maintain and grow their catchments over time, underpinning both public and private investment in these locations over purely car-based centres.

Second, the development of such a 'clean-slate' network would, for the first time, provide a public transport network which provided the accessibility and (almost) 'go anywhere any time' convenience of private car travel. While it would not be able to fully match the travel flexibility of private vehicle ownership, it would enable low, or no car households to engage fully with the social, cultural and economic opportunities of life in Melbourne's growing west. It would liberate households from the financial burden of multiple car ownership – money that could otherwise contribute to better purposes including local economic development. The capital investment required to realise this outcome is justifiable on this criterion alone.

Third, through provision of an efficient public transport network, the 'clean-slate' network could effectively cap increasing levels of congestion on western Melbourne's roads. The burden of heightened traffic congestion can be offset by the 'clean-slate' network's ability to bypass congestion through provision of bus priority measures. Frustrations of gridlock can be offset by the provision of a genuine alternative.

Fourth, although the proposed network is entirely conceptual, and would likely face localised political sensitivities in delivery, it demonstrates the latent potential for drastic improvements within the existing (or modestly increased) public transport operating budget parameters. That alone should prompt a rethink of our status quo approach to public transport provision.

Finally, Victoria cannot achieve our zero emissions objectives without mode shift in transport. The transition to 'green' electric cars will play a role, but a simple shift in propulsion will not deliver the requisite reduction in emissions. Nor, given current political logjams, will any climate gains be made quickly enough. In contrast, the Victorian Bus Plan (DoT, 2021a) outlines a timetable to commence electrification of the bus fleet from 2025. Given the typical 10–15-year lifespan of urban buses, this task will be largely completed by the late 2030s. This could be accelerated and, combined with the network reform described in this paper, contribute to a significant mode shift away from cars before 2030. In short, this is our best hope of major reductions in urban transport emissions in this vital decade.

By adopting established public transport planning principles, the 'clean-slate' network achieves a staggering improvement in network accessibility at a viable capital and recurrent cost. It is an opportunity for bold leadership to deliver equitable, reliable, clean, and cost-effective transport to Melbourne's west.

REFERENCES

ABS. (2016). *Census*.
BITRE. (2013). *Multimodal public transport use in Australia's capital cities: modelling and forecasting*. (Research Report 129). Canberra: Bureau of Infrastructure Transport and Regional Economics
Cervero, R. (2001). Walk-and-ride: factors influencing pedestrian access to transit. *Journal of Public Transportation, 3*(4), 1.
Cervero, R., Round, A., Goldman, T., & Wu, K.-L. (1995). Rail access modes and catchment areas for the BART system.
DEWLP. (2018). *Plan Melbourne 2017-2050*. Melbourne: Victorian Department of Environment Land Water and Planning
DEWLP. (2019). *Victoria in Future*. Melbourne: Department of Envirinment, Water, Land & Planning.
Dodson, J., Mees, P., Stone, J., & Burke, M. (2011). The Principles of Public Transport Network Planning: A review of the emerging literature with select examples. .
DoT. (2018). *Victorian Integrated Survey of Travel and Activity*.
DoT. (2021a). *Victoria's Bus Plan*. Melbourne: Victorian Department of Transport
DoT. (2021b). Western Roads Upgrade. Retrieved from tenders.vic.gov.au
Downs, A. (2005). *Still Stuck in Traffic: Coping with Peak-Hour Traffic Congestion*. Washington DC: Brookings Institution Press.
Friends of the Earth. (2021). About the Better Buses Campaign. Retrieved from https://www.melbournefoe.org.au/about_the_better_buses_campaign
Goodwin, P. (1996). Empirical Evidence on Induced Traffic, A review and Synthesis. *Transportation, 23*(1), 35-54.
Guerra, E., Cervero, R., & Tischler, D. (2012). Half-mile circle: Does it best represent transit station catchments? *Transportation Research Record, 2276*(1), 101-109.
IEA. (2021). *Net Zero by 2050: A Roadmap for the Global Energy Sector*. Paris: International Energy Agency.
Infrastructure Victoria. (2016). *Victoria's 30-Year Infrastructure Strategy December 2016*. Melbourne
Infrastructure Victoria. (2021). *Victoria's infrastructure strategy 2021-2051*. Melbourne
Khalaj, F., Pojani, D., Sipe, N., & Corcoran, J. (2020). Why are cities removing their freeways? A systematic review of the literature. *Transport Reviews, 40*(5).
King, L. J. (2020). Central place theory.
Kroen, A., Goodman, R., Gunn, L., & Pemberton, S. (2021). *Early delivery of equitable and healthy transport options in new suburbs - Final report*. Melbourne: Centre for Urban Research, RMIT.
Low, N. (2017). Governance by private corporation the West Gate tunnel. *Planning News, 43*(9), 10-11.
Major Road Projects Victoria. (2019). CityLink Tulla Widening. *Projects.* Retrieved from https://roadprojects.vic.gov.au/projects/citylink-tulla-widening
Marchetti, C. (1994). Anthropological invariants in travel behavior. *Technological forecasting and social change, 47*(1), 75-88.
Mees, P. (2010). *Transport for suburbia : beyond the automobile age*. London ; Sterling, VA: Earthscan.
Mogridge, M. (1990). *Travel in Towns: jam yesterday, jam today, jam tomorrow?* London: The Macmillan Press.
Nielsen, G., & Lange, T. (2008). Network design for public transport success–theory and examples. *Norwegian Ministry of Transport and Communications, Oslo*.
O'Neill, W. A., Ramsey, R. D., & Chou, J. (1992). Analysis of transit service areas using geographic information systems. *Transportation Research Record*(1364).
Pemberton, S. (2020). Optimising Melbourne's bus routes for real-life travel patterns. *Case Studies on Transport Policy, 8*(3), 1038-1052.
Premier of Victoria. (2019). Getting On With The Western Rail Plan [Press release]
ProfileID. (2021). City of Wyndham population forecast. Retrieved from https://forecast.id.com.au/wyndham
PTUA. (2020). Every ten minutes to everywhere. Retrieved from https://www.ptua.org.au/campaigns/every10minutes/#:~:text=%E2%80%9CEvery%2010%20minutes%20to%20everywhere,%2Ddays%2Da%2Dweek.
PTV. (2012). *Network development plan–Metropolitan rail*.
Public Transport Victoria. (2021). Timetables. Retrieved from https://www.ptv.vic.gov.au/timetables
RACV. (2021a). Public Transport: RACV advocates for better public transport services across Victoria. Retrieved from https://www.racv.com.au/on-the-road/public-transport.html
RACV. (2021b). Vehicle Running Costs 2021.
SACTRA. (1994). *Trunk Roads and The Generation of Traffic*. London, UK: epartment of Transport (UK) Standing Advisory Committee on Trunk Road Assessment
Scheurer, J. (2020). Public transport network planning. In *Handbook of Sustainable Transport*: Edward Elgar Publishing.
Staricco, L., & Vitale Brovarone, E. (2020). Implementing TOD around suburban and rural stations: an exploration of spatial potentialities and constraints. *Urban Research & Practice, 13*(3), 276-299.
Sullivan, B. E. (1976). *The timed transfer focal point: a refinement in public transport service design*. Retrieved from
Thomson. (1972). *Methods of traffic limitation in urban areas: Working Paper 3*. OECD, Paris.

Tullamarine-Calder Interchange Alliance. (2006). Welcome to the Tullamarine-Calder Project website. Retrieved from https://web.archive.org/web/20051124013322/http://www.tullacalder.com.au/

VAGO. (2014). *Coordinating Public Transport*. Melbourne: Victorain Auditor General's Office.

VAGO. (2018). *Assessing Benefits from the Regional Rail Link Project*. Melbourne: Victorian Auditor-General's Office

VicRoads. (2008). City Link Project Overview. *Roads and Projects.* Retrieved from https://web.archive.org/web/20080723140627/http://www.vicroads.vic.gov.au/Home/RoadsAndProjects/RoadProjects/InnerCity/CityLink/ProjectOverview.htm

Victorian Government. (2021a). Victoria's Big Build. Business Case, North East Link Program. Retrieved from https://bigbuild.vic.gov.au/projects/north-east-link-program/planning/business-case#

Victorian Government. (2021b). Victoria's Big Build. Major Road Projects Victoria. Retrieved from https://bigbuild.vic.gov.au/projects/major-road-projects-victoria

Victorian Government. (2021c). Victoria's greenhouse gas emissions reduction targets. Retrieved from https://www.climatechange.vic.gov.au/victorias-greenhouse-gas-emissions-reduction-targets

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