Veitch Lister Consulting Pty Ltd

Prepared for

Australian Government
Infrastructure Australia

Transport Planning for the Australian Infrastructure Audit

# Transport Modelling Report for ACT and Queanbeyan

March 2019

Transport Planning for the Australian Infrastructure Audit

# FINAL

Transport Modelling Report for ACT and Queanbeyan

Project No. 18-025



**LIMITATION**: This report is confidential and has been prepared on behalf of and for the exclusive use of VLC's Client, and is subject to and issued in connection with the provisions of the agreement between VLC and its Client.

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By issuing this report VLC is not recommending any course of action or investment undertaking.

| Date | Revision | Prepared By | Checked By | Approved By | Description |
|---|---|---|---|---|---|
| 30/10/2018 | A | N Ng | D Veryard | D Veryard | Draft Report |
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| 20/03/2019 | E | N Ng | D Veryard | D Veryard | Final Report |

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# 1. Introduction

## 1.1 Background

The first Infrastructure Audit, undertaken over 2014-15, for the first time provided evidence developed on a consistent basis to support the identification of current and emerging infrastructure problems. This helped IA to identify the most nationally significant problems that were not necessarily being identified or addressed by bottom-up state, territory and private sector proposals. Combining bottom-up submissions with top-down evidence developed through the Infrastructure Audit allows a more comprehensive and independent picture of national priorities.

Veitch Lister Consulting (VLC) supported the first Audit by modelling travel demands in six major mainland cities under base year (2011) and future year (2031) conditions using our multi-modal Zenith model. In the intervening four years, the landscape of Australian cities has changed considerably. New major transport projects have received significant political and financial commitment, while certain projects included in the original Audit have been cancelled or scaled down. Similarly, population growth has run ahead of projections in some urban areas but has slowed in other parts of the country.

It is important to note Infrastructure Australia does not view this modelling as a single version of the future. The modelling necessarily uses a set of assumptions about future projects, transport costs and technology. The chosen assumptions reflect a business as usual future, where there is minimal change to current conditions. However, in reality there is significant uncertainty about how these important inputs will change over time. The results in this modelling are therefore indicative and one of many potential futures.

## 1.2 Scope of this report

In response to these changed circumstances IA is updating their evidence base and VLC is assisting in this update by revising the travel modelling. Specific changes include:

- Updated future population and employment assumptions
- Revised transport system assumptions, including both networks and cost parameters
- Modelling with capacity-constrained public transport networks, and
- A wider range of transport-related indicators of success and challenges, including access to opportunities for employment, education, health and recreation, as well as the economic costs of crowding and road congestion.

This report summarises the results of this updated modelling for the ACT and Queanbeyan. Specifically, it evaluates the performance of the ACT and Queanbeyan's transport network in 2031 based on an evaluation framework that includes transport, economic, environmental and social indicators.

VLC is also assisting IA to test an alternative road-user charging regime. The results of this alternative policy scenario will be documented in a separate report.

***A note on tables and figures in this report***:

*All tables and figures which quote numbers have been rounded to reflect that these forecasts are subject to considerable uncertainty. Where a numerical or per centage change has been quoted, it has been calculated using the unrounded data.*

# 2. ACT and in the future

Understanding how the ACT and Queanbeyan's transport network might perform in the future requires a detailed vision of what the region may look like at specific future planning horizons. The scale and distribution of population and job opportunities, upgrades to the transport network, as well as the cost of parking, public transport fares and fuel all require consideration in order to produce robust travel demand forecasts. This section of the report provides an overview of the assumptions underpinning the Zenith model of the ACT. More detailed assumptions can be found in the appendices.

## 2.1 People and jobs

The number of people living and working in the ACT and surrounds, as well as the locations in which they live and work, are the main determinants of the nature and scale of its transport task.

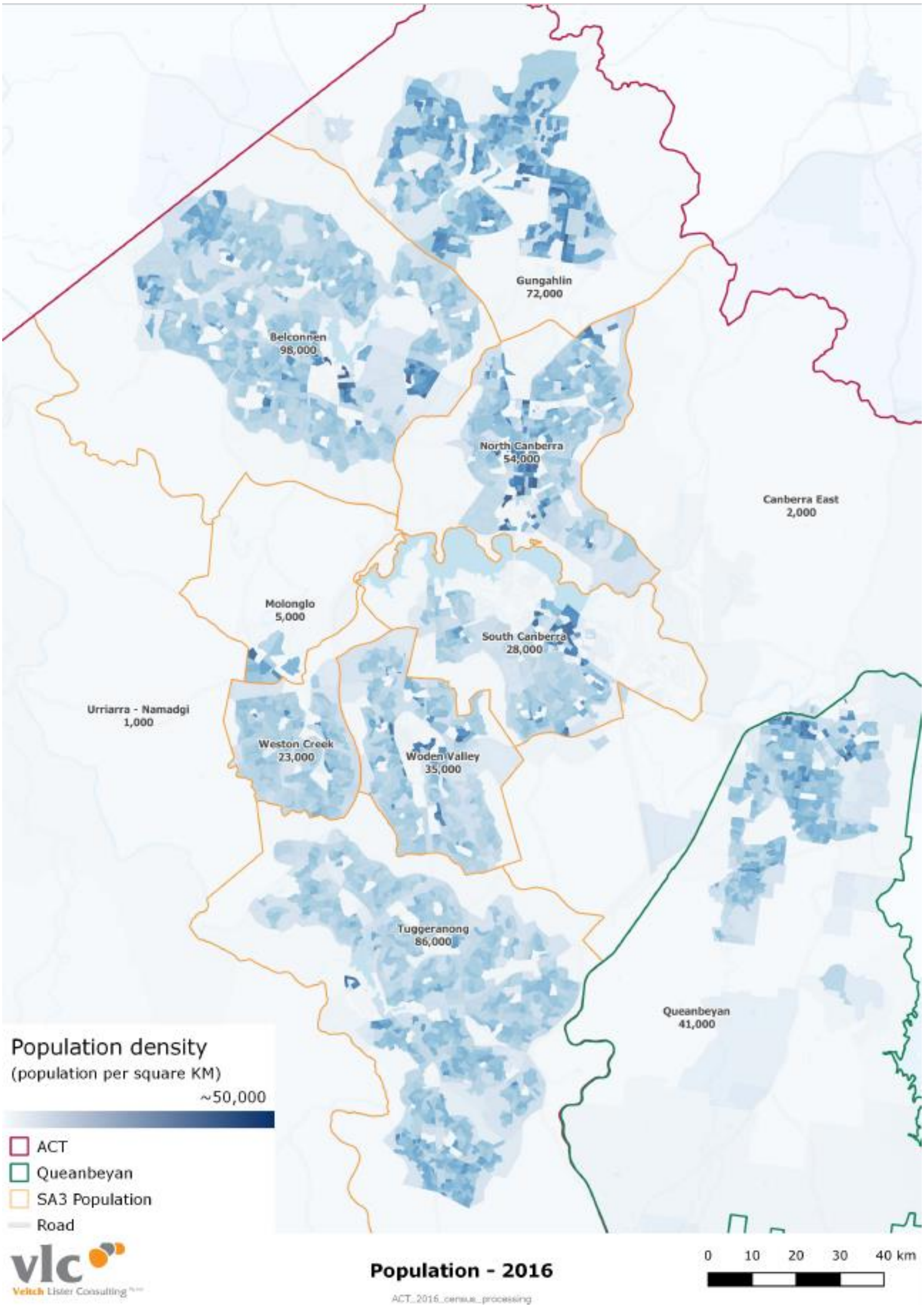
In 2016, around 445,000 people resided in the ACT and Queanbeyan. Figure 2-1 describes the territory's population in more geographic detail using two metrics – total population by Level 3 Statistical Area (SA3) and gross population density by travel zone[1]. The highest population density areas are Belconnen and Gungahlin in the north, with 24 per cent and 18 per cent of ACT residents respectively, as well as Tuggeranong in the south, with 21 per cent of residents. Queanbeyan, just east of the ACT border, is also a significant urban centre, with approximately 41,000 residents.

By 2031, ACT Government projections indicate that ACT and Queanbeyan's total population will increase by approximately one quarter to around 558,000 (Figure 2-2). The strongest growth is expected from greenfield development in the Molonglo Valley, with an increase in population of 27,000 (see the Molonglo SA3 in Figure 2-3). This is likely to put pressure on both the infrastructure in Molonglo, as well as the corridors connecting it with other major activity centres in the ACT.

Significant infill development is projected in Canberra's inner suburbs, with North and South Canberra expected to accommodate at least 35 per cent more people by 2031. Other ACT SA3s, including Gungahlin and Belconnen are also expected to grow substantially at approximately 20 per cent, reflecting gradual planned greenfield developments in these areas. Tuggeranong's population is expected to be relatively stable. Population in the Queanbeyan area is forecast to grow by 30 per cent, driven by greenfield development planned for Tralee and Googong.

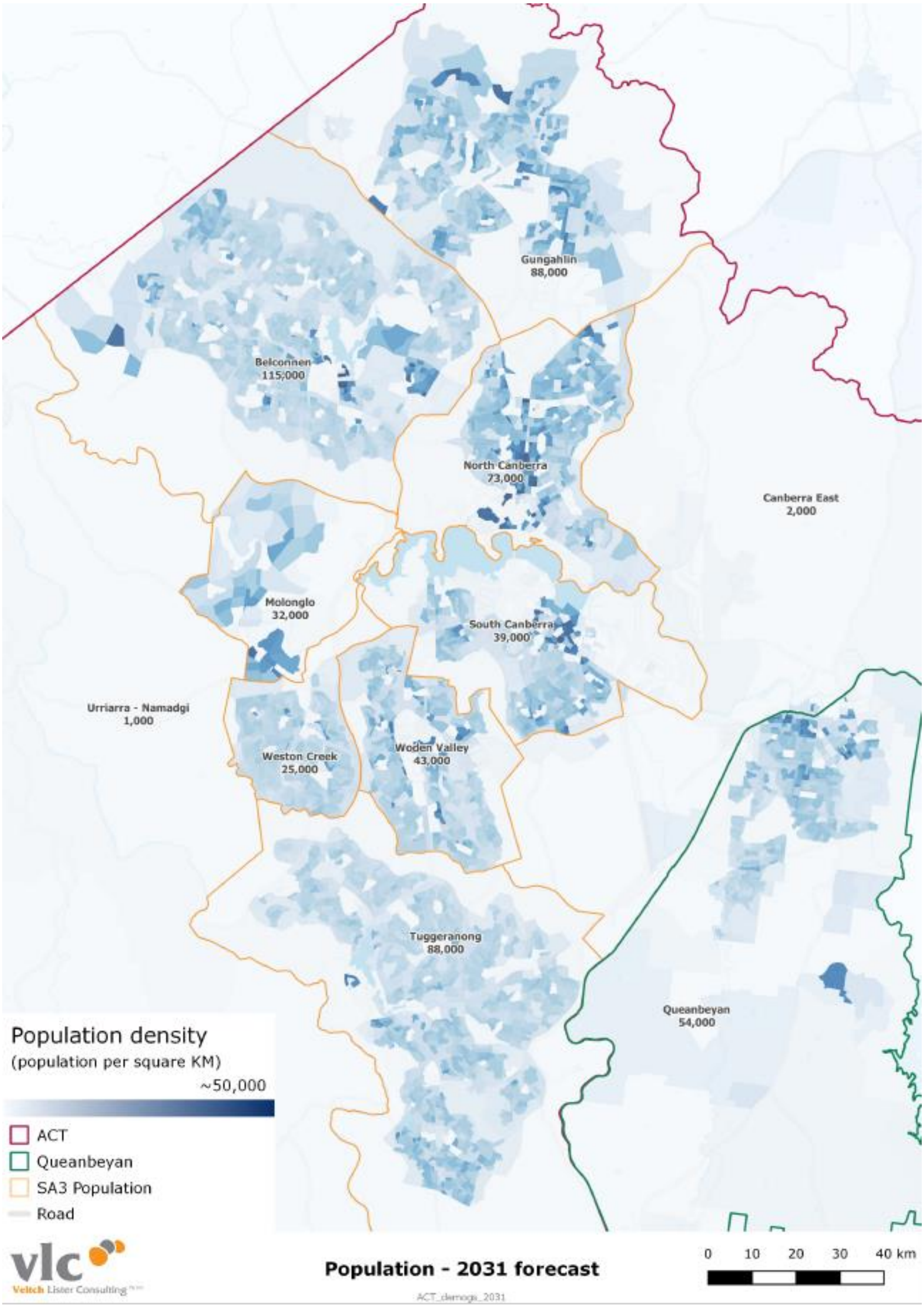
[1] Due to the geographical size of the SA3 that Queanbeyan is located in, VLC have restricted the analysis of the Queanbeyan urban area to travel zones in concordance with those that the ACT Government have used to represent Queanbeyan.

***Figure 2-1 – ACT and Queanbeyan population density and SA3 totals in 2016***



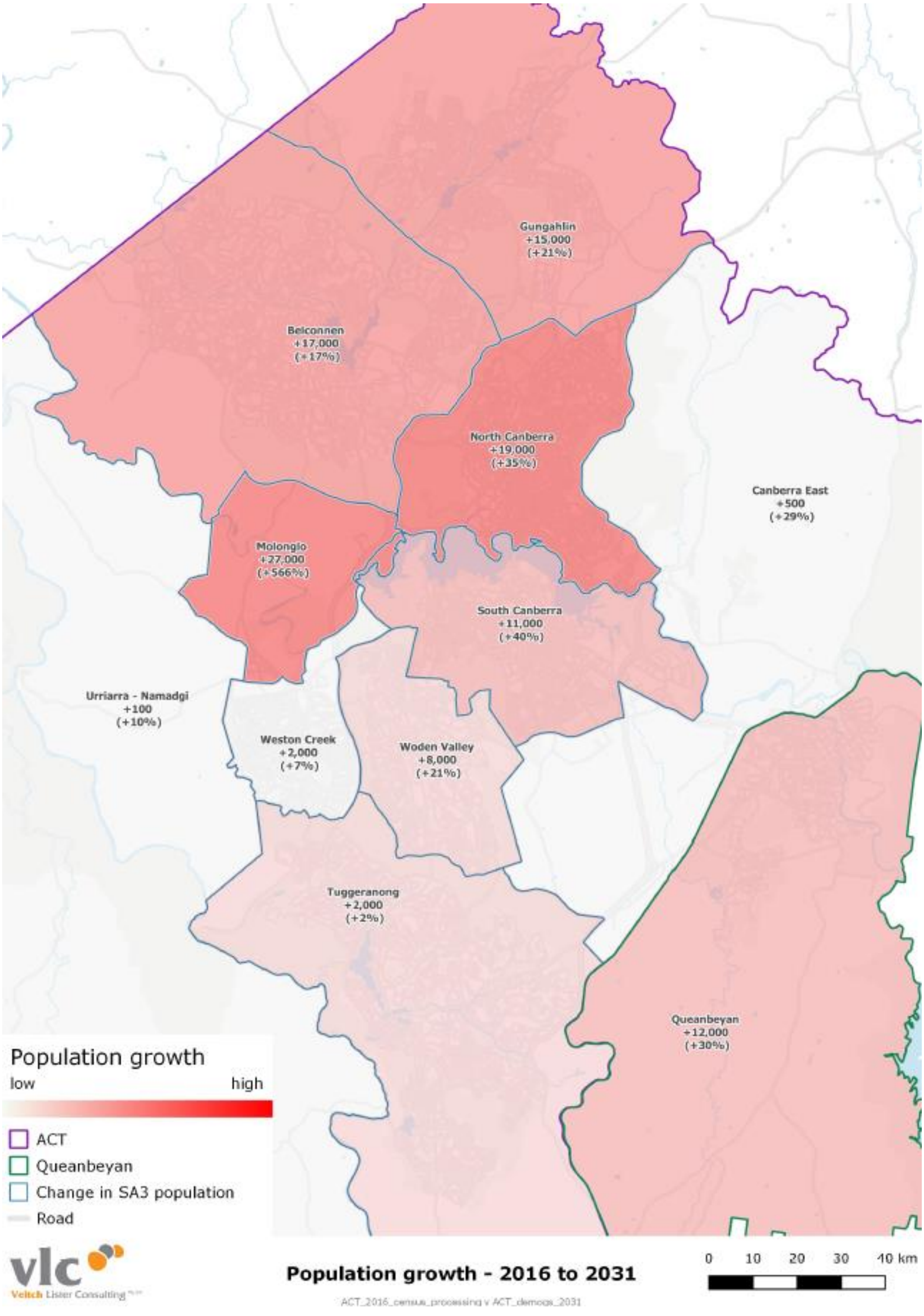

Source: ABS 2016 Census, disaggregated to Zenith travel zones

***Figure 2-2 – ACT and Queanbeyan population density and SA3 totals in 2031***




Source: ACT Government population forecasts, disaggregated to Zenith travel zones

***Figure 2-3 – ACT and Queanbeyan population growth by SA3 2016 to 2031 forecast***




Source: ABS 2016 Census and ACT Government population forecasts, disaggregated to Zenith travel zones

In addition to location of residence, the location of employment is a further determinant of travel choices. In 2016, around 255,000 jobs were located in the ACT and Queanbeyan. Figure 2-4 describes both the total number of jobs by SA3 and density of jobs at a travel zone level.

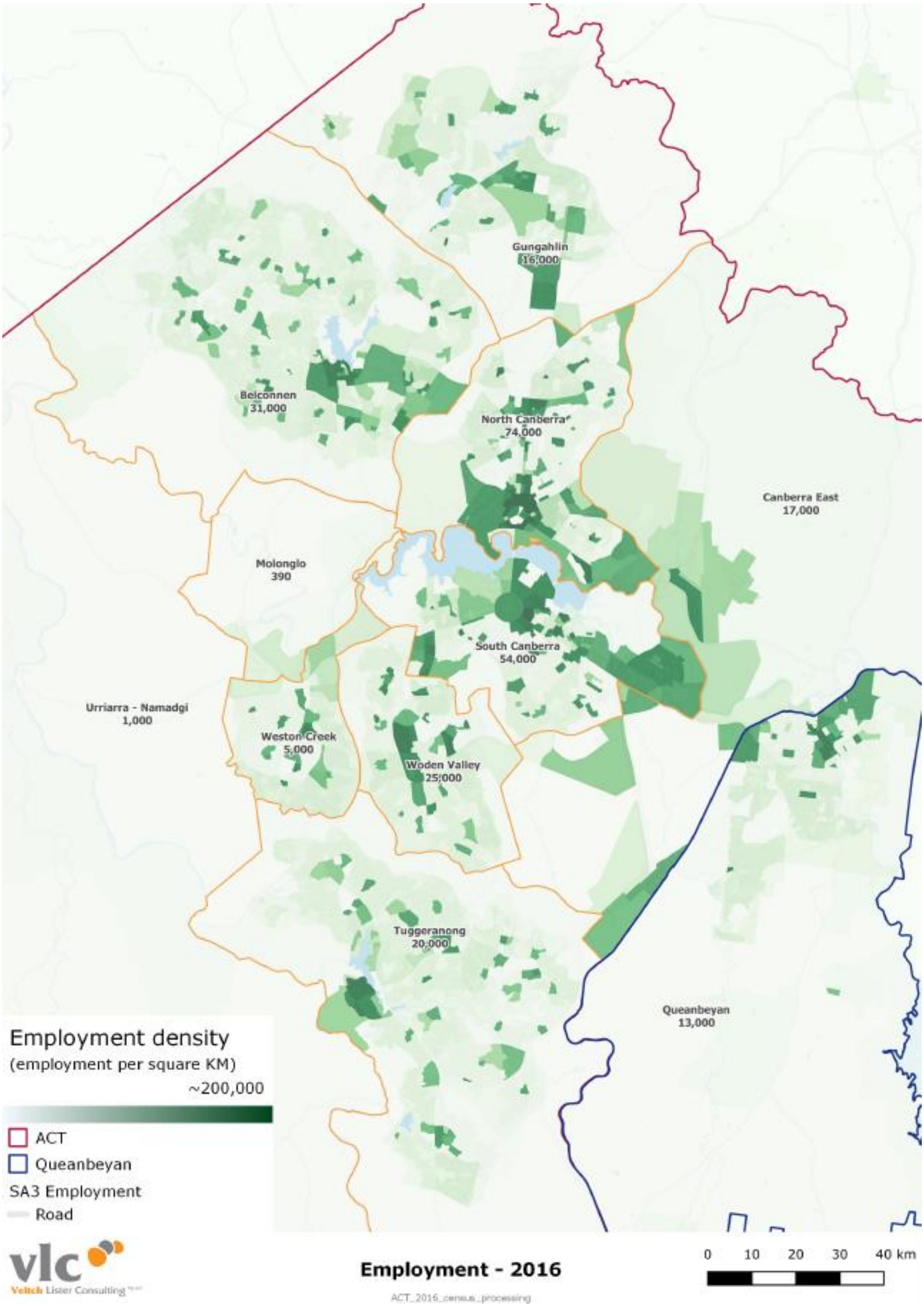
Employment is highly concentrated in North Canberra (29% of jobs) and South Canberra (21%). This is followed by employment clusters in Belconnen (12%) and Woden Valley (10%).

By 2031, it is expected that around 322,000 jobs will be located in the ACT and Queanbeyan (an increase of almost 67,000 jobs or approximately 26 per cent, in line with population growth forecasts) (Figure 2-5). North and South Canberra continue to be the largest employment hubs in the ACT, with growth of 22 and 29 per cent respectively (Figure 2-6). Significant employment growth is expected in Woden and Belconnen. Employment in Molonglo is forecast to grow substantially, but more slowly than population growth, suggesting a degree of commuting out of this new development is likely. Tuggeranong is also predicted have strong employment growth.

The ACT Government forecasts a small increase in employment in the Queanbeyan area (1,000), however, due to small data definition differences between VLC's and the Government's use of the 2016 ABS Census, the area displays as a small decrease in employment to 2031. Differences in data definition include:

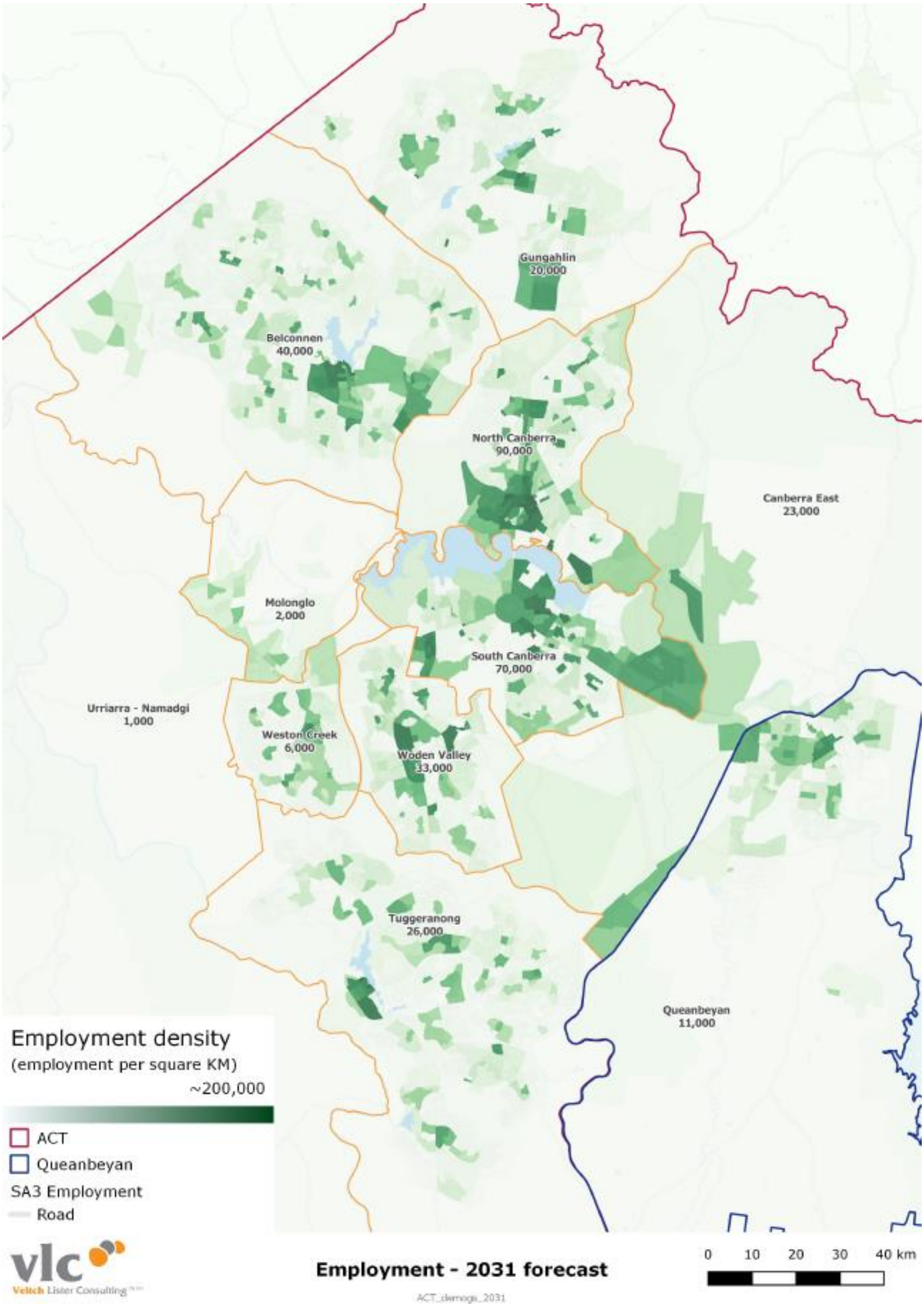
- Application of an undercount adjustment factor of 3.3 per cent (ACT Government applies this, VLC does not)
- Proportional distribution of employment with no fixed address to meshblock level (ACT Government) compared with SA2 (VLC).

***Figure 2-4 – ACT and Queanbeyan employment density and SA3 totals in 2016***



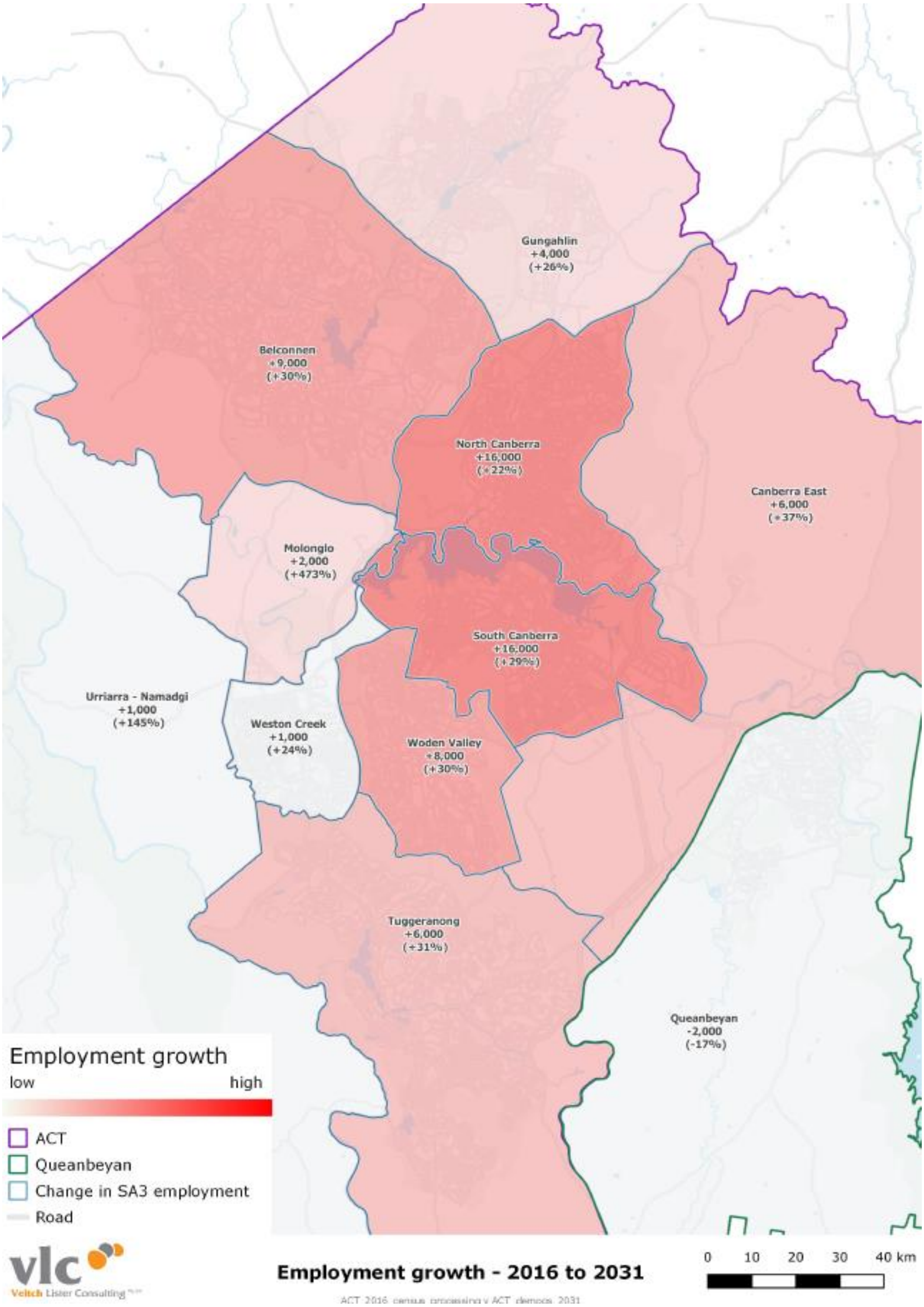

Source: ABS 2016 Place of Work, disaggregated to Zenith travel zones

## *Figure 2-5 – ACT and Queanbeyan employment density and SA3 totals in 2031 forecast*




Source: ACT Government employment forecasts, disaggregated to Zenith travel zones

***Figure 2-6 – ACT and Queanbeyan employment growth by SA3 2016 to 2031 forecast***




Source: ABS 2016 Place of Work and ACT Government employment forecasts, disaggregated to Zenith travel zones

## 2.2 Transport networks

The transport network assumed in any given year will determine how (and how easily) populations will get between their homes, jobs, schools, shops and other activity areas. The 2031 transport network for the ACT and Queanbeyan has been developed using a minimal-intervention approach. Included projects were (at the time of modelling in August 2018) either under construction, under procurement, or had a public commitment to fund construction from all relevant governments. It is important to note that some projects fall outside of government's budget forward estimates, so some modelled projects may not be fully funded. Finally, some bus routes have also been expanded to support the development of new suburbs. A full list of network assumptions can be found in Appendix A, with the most significant projects described in more detail below and shown in Figure 2-7.

**Capital Metro** is a light rail project. The first stage, currently under construction, is a 12km route to connect Gungahlin in the north, to Civic in Canberra's city centre, with 13 stops. Upon completion, expected in 2019, services will run every six minutes during the peaks, and every 10-15 minutes outside of peak periods.

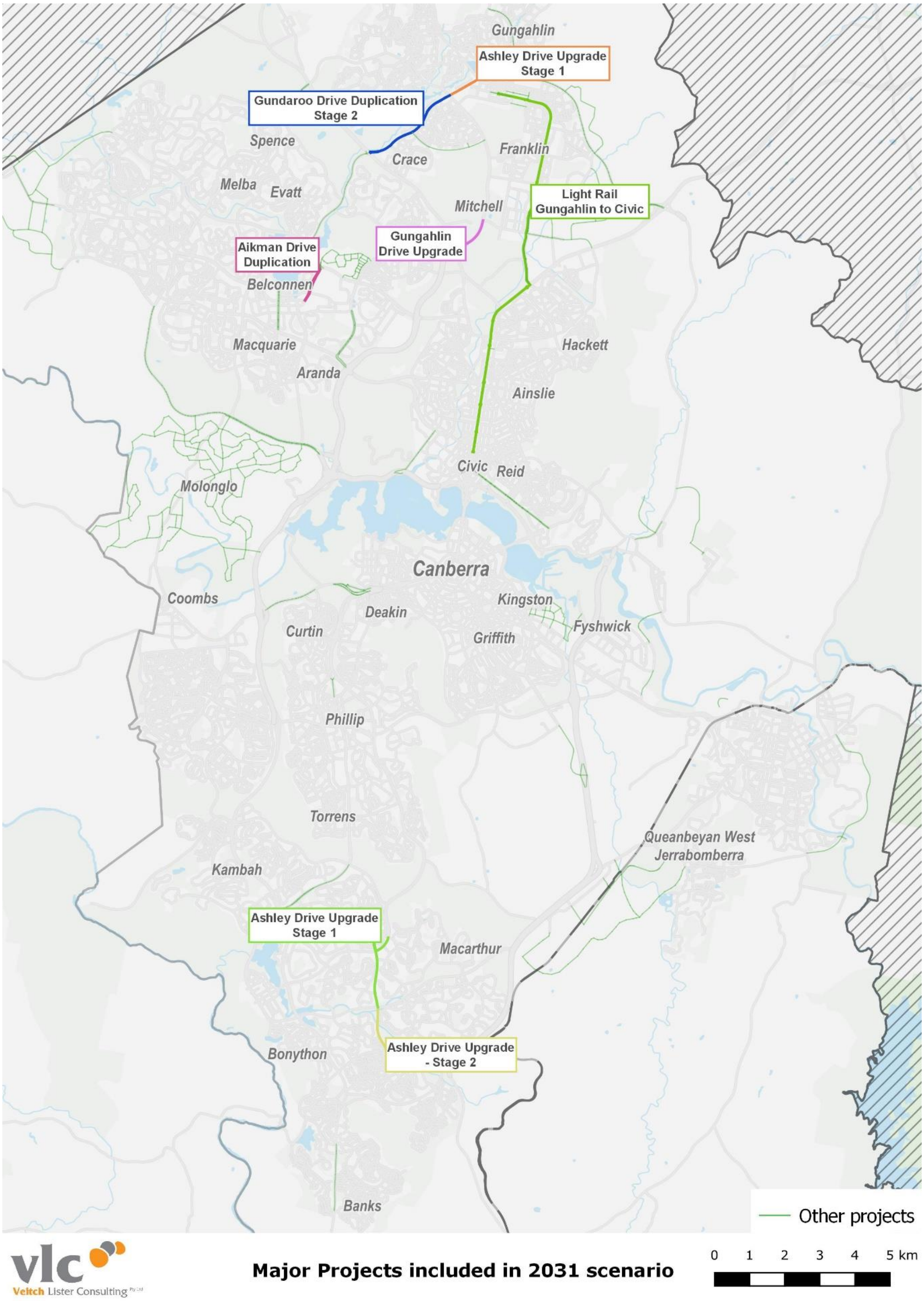
**Duplication of Ashley Drive** to a dual carriageway has largely been completed in 2018. Ashley drive is a major arterial road between Richardson and Wanniassa, south of Canberra, and caters for over 20,000 vehicles a day. The duplication will be carried out between Erindale Drive and Johnson Drive in both directions, including cycle lanes, duplication of existing underpasses and more footpaths.

**Duplication of Aikman Drive** in Belconnen between Ginninderra Drive and Emu Bank (completed in 2017) improves access to the new University of Canberra Public Hospital. An internal road connection from the hospital's roundabout to Pantowora Street also improves bus access in Lawson, a new suburb. A shared path along the length of Aikman Drive was also constructed.

**Widening of Gungahlin Drive** was completed in 2017, where a southbound lane was added between the Sandford Street intersection and the Barton Highway off-ramp in Gungahlin.

**Duplication of Gundaroo Drive** in Gungahlin town centre is being carried out in two stages; from Gungahlin Drive to Mirrabei Drive / Anthony Rolfe Avenue (expected to be completed by 2019), and then from Gungahlin Drive to the Barton Highway (expected to be completed in 2021).

## *Figure 2-7 – ACT and Queanbeyan major projects included in 2031 forecast*



By 2031 bus services are assumed to improve incrementally through increased service frequencies and the extension of routes into growth areas. The introduction of the Canberra Metro light rail adds significant capacity, albeit with relatively modest service kilometres due to the large capacities per light rail vehicle. The combined impact of bus and light rail changes are assumed to amount to a 48 per cent increase in total in-service kilometres by 2031. A significant part of this increase is due to improvements outside peak periods from the ACT Government's Rapid Route services, which run services every 6 to 15 minutes during extended hours of operation from 7am to 7pm. Services are also assumed to run every 15 to 30 minutes in the off-peak and weekends. In the context of a 25 per cent increase in population, the increase in service kilometres reflects a slight expansion of public transport's role (Table 2-1).

*Table 2-1 – ACT and Queanbeyan weekday public transport service kilometres*[2]

| Metric | Time period | 2016 | 2031 | Change | % change |
|---|---|---|---|---|---|
| **Light Rail** | AM peak (7-9AM) | 0 | 500 | +500 | - |
| | Inter-peak (9AM-4PM) | 0 | 1,000 | +1,000 | - |
| | PM peak (4-6PM) | 0 | 500 | +500 | - |
| | Off-peak (6PM-7AM) | 0 | 1,000 | +1,000 | - |
| | **Daily total** | **0** | **3,000** | **+3,000** | **-** |
| **Bus** | AM peak (7-9AM) | 15,000 | 19,000 | +4,000 | +29% |
| | Inter-peak (9AM-4PM) | 27,000 | 37,000 | +11,000 | +40% |
| | PM peak (4-6PM) | 14,000 | 19,000 | +4,000 | +30% |
| | Off-peak (6PM-7AM) | 16,000 | 28,000 | +12,000 | +74% |
| | **Daily total** | **72,000** | **102,000** | **+31,000** | **+43%** |
| **Total PT** | AM peak (7-9AM) | 15,000 | 19,000 | +5,000 | +32% |
| | Inter-peak (9AM-4PM) | 27,000 | 38,000 | +12,000 | +44% |
| | PM peak (4-6PM) | 14,000 | 19,000 | +5,000 | +34% |
| | Off-peak (6PM-7AM) | 16,000 | 29,000 | +13,000 | +81% |
| | **Daily total** | **72,000** | **106,000** | **+34,000** | **+48%** |

[2] Service kilometres include all public transport lines servicing the ACT and Queanbeyan (and not exclusively kilometres operating within the ACT and Queanbeyan modelled area).

# 3. Travel demands

The growth in population and employment between 2016 and 2031 is likely to increase the transport task in the ACT and Queanbeyan. This section provides the Zenith model's estimates and forecasts for travel in 2016 and 2031. Individual metrics are reported on under the following themes:

- Growth in person travel,
- Growth in road network demand, and
- Growth in public transport demand.

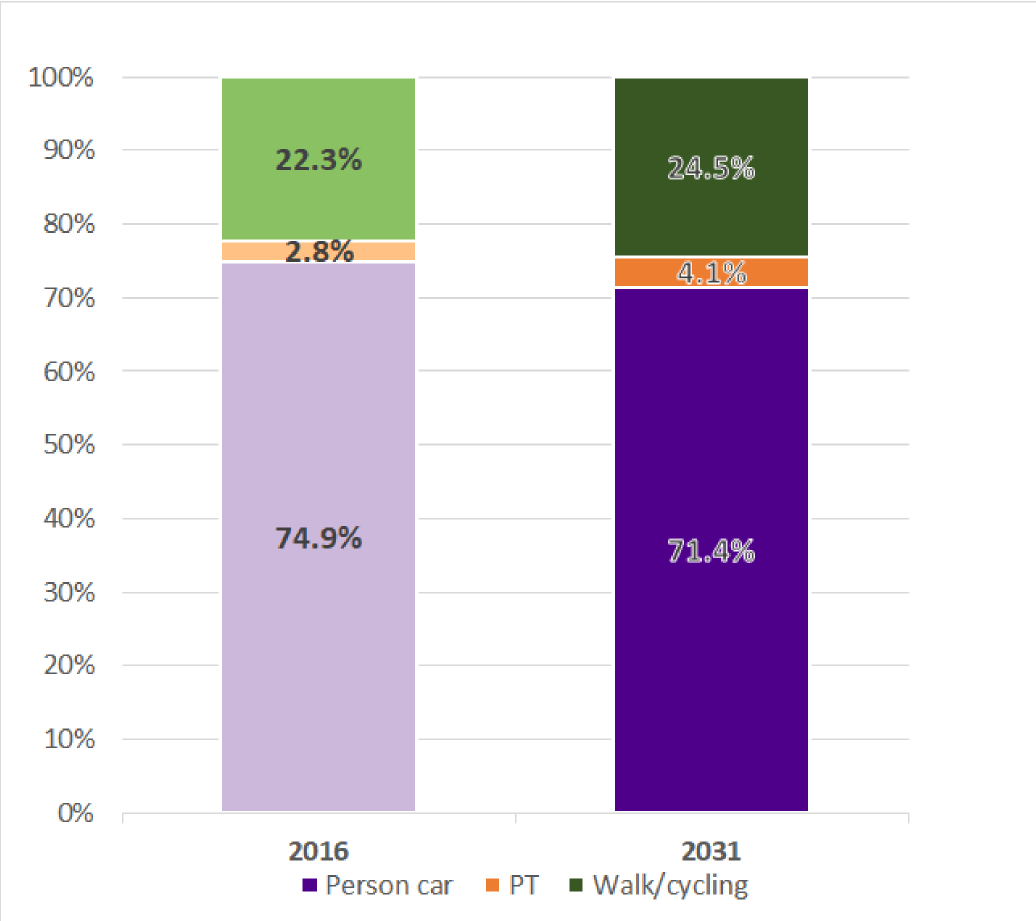
## 3.1 Growth in person travel

Between 2016 and 2031 the total number of weekday trips in the ACT and Queanbeyan is forecast to increase by 27 per cent, with over 360,000 extra daily trips by car (Table 3-1). This closely matches population growth (25%), implying an approximately stable trip rate. Car travel's dominance over other modes weakens to 2031, with car mode share forecast to fall somewhat from 75 per cent in 2016 to 71 per cent in 2031 (Figure 3-1). Nevertheless, in spite of significant public transport investment, those with access to a car will still find driving to be a convenient option for most of their trips. This in turn reflects sustained road infrastructure investments to improve connections between the urban centres and suburbs.

***Table 3-1 – ACT and Queanbeyan person trips by mode***

| Mode | Time period | 2016 | 2031 | Change | % change |
|---|---|---|---|---|---|
| **Car** | AM peak (7-9AM) | 289,000 | 339,000 | +50,000 | +17% |
| | Inter-peak (9AM-4PM) | 823,000 | 1,019,000 | +197,000 | +24% |
| | PM peak (4-6PM) | 278,000 | 331,000 | +52,000 | +19% |
| | Off-peak (6PM-7AM) | 339,000 | 404,000 | +65,000 | +19% |
| | **Daily total** | **1,729,000** | **2,092,000** | **+364,000** | **+21%** |
| **Public transport** | AM peak (7-9AM) | 16,000 | 28,000 | +13,000 | +80% |
| | Inter-peak (9AM-4PM) | 26,000 | 47,000 | +20,000 | +76% |
| | PM peak (4-6PM) | 14,000 | 26,000 | +12,000 | +91% |
| | Off-peak (6PM-7AM) | 8,000 | 19,000 | +10,000 | +122% |
| | **Daily total** | **64,000** | **120,000** | **+55,000** | **+86%** |
| **Walk and cycle** | AM peak (7-9AM) | 70,000 | 103,000 | +33,000 | +48% |
| | Inter-peak (9AM-4PM) | 281,000 | 384,000 | +102,000 | +36% |
| | PM peak (4-6PM) | 75,000 | 109,000 | +34,000 | +45% |
| | Off-peak (6PM-7AM) | 88,000 | 121,000 | +33,000 | +37% |
| | **Daily total** | **514,000** | **717,000** | **+202,000** | **+39%** |
| **Total** | AM peak (7-9AM) | 374,000 | 470,000 | +96,000 | +26% |
| | Inter-peak (9AM-4PM) | 1,130,000 | 1,450,000 | +319,000 | +28% |
| | PM peak (4-6PM) | 367,000 | 466,000 | +99,000 | +27% |
| | Off-peak (6PM-7AM) | 436,000 | 543,000 | +108,000 | +25% |
| | **Daily total** | **2,307,000** | **2,928,000** | **+621,000** | **+27%** |

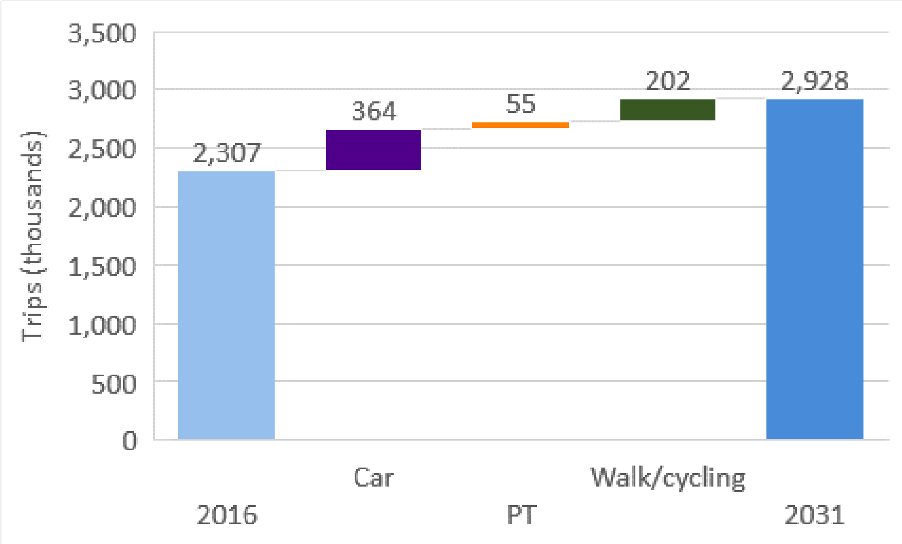
*Figure 3-1 – ACT and Queanbeyan mode share of daily trips, 2016 and 2031*




Public transport trips are forecast to grow by 86 per cent across the day with an additional 55,000 trips (Figure 3-2). This growth is from a low base, with public transport's share of trips growing marginally from 3 per cent in 2016 to 4 per cent in 2031 (with higher shares in the AM and PM peak periods). The growth in public transport use to 2031 will be driven by population growth and an expansion of the public transport network and services. Growth is likely also partly attributable to the future levels of road congestion; congested roads make public transport more competitive. Also a factor is the rate at which parking charges grow, with parking charges assumed to increase at 1.5 per cent above CPI, while public transport fares grow at CPI.

Walking and cycling trips are forecast to grow by around 39 per cent between 2016 and 2031 (above the rate of population growth), to an increased share of 24 per cent. This is a function of increased population density, which allow for some activities (e.g. shopping and recreation) to be undertaken closer to home. Such short trips are good candidates for active modes. A real increase in parking charges are also a factor; as parking charges are applied in ACT's denser urban centres.

*Figure 3-2 – ACT and Queanbeyan growth in weekday person trips, 2016 to 2031*




## 3.2 Growth in vehicle travel

Traffic on the road network is split between car (95%) and commercial vehicle travel (5%). (See Appendix A.2 for VLC's commercial vehicle definitions.) Car trip growth (20%) is forecast to be slightly less than population growth (25%), due to some commuters shifting towards public transport (Table 3-2), while trip growth for commercial vehicles remains largely in line with population growth, at 24 per cent (Table 3-3).

*Table 3-2 – ACT and Queanbeyan weekday car traffic statistics*

| Metric | Time period | 2016 | 2031 | Change | % change |
|---|---|---|---|---|---|
| Trips | AM peak (7-9AM) | 219,000 | 253,000 | +35,000 | +16% |
| | Inter-peak (9AM-4PM) | 604,000 | 747,000 | +143,000 | +24% |
| | PM peak (4-6PM) | 217,000 | 255,000 | +38,000 | +18% |
| | Off-peak (6PM-7AM) | 242,000 | 286,000 | +43,000 | +18% |
| | **Daily total** | **1,283,000** | **1,541,000** | **+259,000** | **+20%** |
| Kilometres | AM peak (7-9AM) | 1,921,000 | 2,325,000 | +404,000 | +21% |
| | Inter-peak (9AM-4PM) | 4,401,000 | 5,720,000 | +1,319,000 | +30% |
| | PM peak (4-6PM) | 1,947,000 | 2,370,000 | +424,000 | +22% |
| | Off-peak (6PM-7AM) | 2,180,000 | 2,683,000 | +503,000 | +23% |
| | **Daily total** | **10,449,000** | **13,098,000** | **+2,649,000** | **+25%** |
| Hours | AM peak (7-9AM) | 41,000 | 53,000 | +12,000 | +30% |
| | Inter-peak (9AM-4PM) | 77,000 | 102,000 | +25,000 | +32% |
| | PM peak (4-6PM) | 39,000 | 51,000 | +12,000 | +29% |
| | Off-peak (6PM-7AM) | 35,000 | 44,000 | +8,000 | +23% |
| | **Daily total** | **192,000** | **249,000** | **+57,000** | **+30%** |
| Average assigned speed (kph) | AM peak (7-9AM) | 47 | 44 | -3 | -7% |
| | Inter-peak (9AM-4PM) | 57 | 56 | -1 | -2% |
| | PM peak (4-6PM) | 49 | 46 | -3 | -6% |
| | Off-peak (6PM-7AM) | 62 | 62 | 0 | 0% |
| | **Daily total** | **54** | **53** | **-2** | **-3%** |

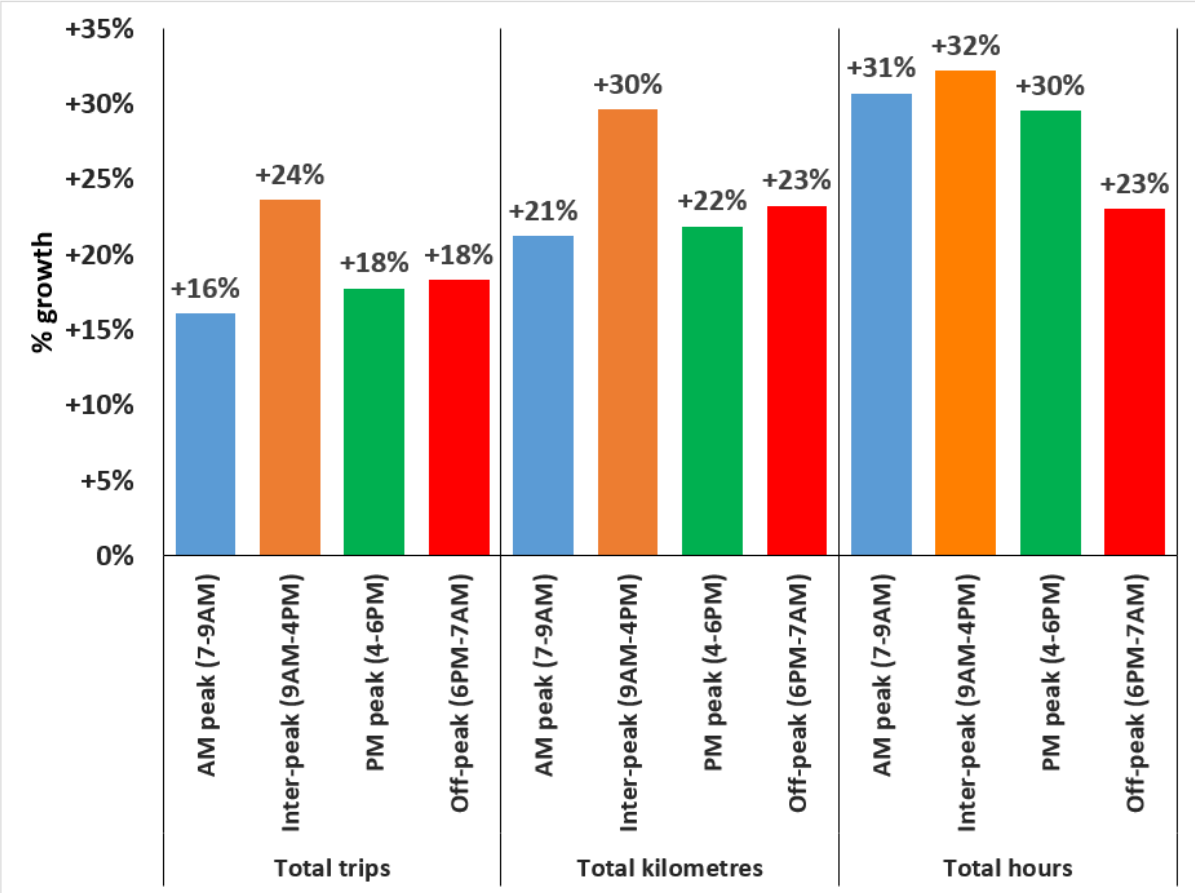
### *Table 3-3 – ACT and Queanbeyan weekday commercial vehicle traffic statistics*

| Metric | Time period | 2016 | 2031 | Change | % change |
|---|---|---|---|---|---|
| **Trips** | AM peak (7-9AM) | 9,000 | 11,000 | +2,000 | +25% |
| | Inter-peak (9AM-4PM) | 29,000 | 36,000 | +7,000 | +25% |
| | PM peak (4-6PM) | 11,000 | 13,000 | +2,000 | +22% |
| | Off-peak (6PM-7AM) | 16,000 | 20,000 | +4,000 | +24% |
| | **Daily total** | **65,000** | **81,000** | **+16,000** | **+24%** |
| **Kilometres** | AM peak (7-9AM) | 88,000 | 112,000 | +24,000 | +27% |
| | Inter-peak (9AM-4PM) | 290,000 | 363,000 | +73,000 | +25% |
| | PM peak (4-6PM) | 102,000 | 127,000 | +25,000 | +24% |
| | Off-peak (6PM-7AM) | 183,000 | 230,000 | +47,000 | +26% |
| | **Daily total** | **664,000** | **832,000** | **+168,000** | **+25%** |
| **Hours** | AM peak (7-9AM) | 2,000 | 2,000 | +1,000 | +36% |
| | Inter-peak (9AM-4PM) | 5,000 | 6,000 | +1,000 | +28% |
| | PM peak (4-6PM) | 2,000 | 3,000 | +1,000 | +33% |
| | Off-peak (6PM-7AM) | 3,000 | 3,000 | +1,000 | +26% |
| | **Daily total** | **11,000** | **14,000** | **+3,000** | **+30%** |

Growth in total vehicle kilometres between 2016 and 2031 is highest during the inter-peak period (30%), compared to around 21 per cent in the AM and PM peaks (Figure 3-3). Growth in total vehicle kilometres is higher than total trip growth in all time periods, which indicates that the average trip length will increase. This is a result of population growth in outer areas, such as in Belconnen, Gungahlin and Queanbeyan (Section 2.1).

The growth rates for total hours travelled are also variable across the day. The inter-peak period is forecast to have the highest growth with an increase of 32 per cent, this is slightly above the growth in total inter-peak kilometres travelled (a 30% increase). This outcome suggests a modest worsening of congestion during the middle of the day (Figure 3-3). In peak periods, a significant worsening of congestion is forecast. This is shown by the way in which total vehicle hours are predicted to grow by around 30 per cent, materially above the growth in kilometres (around 21%). The off-peak is expected to remain relatively uncongested, with the increase in the amount of time spent driving similar to the increase in kilometres travelled (23%).

**Figure 3-3 – ACT and Queanbeyan weekday total vehicle metrics - growth between 2016 and 2031**




## 3.3 Growth in public transport ridership

By 2031 the demand placed on the public transport system is expected to increase substantially. Public transport boardings, in-vehicle passenger kilometres and in-vehicle passenger hours are all forecast to double from 2016 levels (Table 3-4).

***In-vehicle passenger kilometres*** *(or passenger kilometres) are a measure of movement of passengers for a particular mode or the public transport network as a whole. In-vehicle passenger kilometres are calculated through the network wide summation of the distances travelled by users onboard vehicles. This excludes the distance travelled (by car, walk or bike) accessing the service.*

***In-vehicle passenger hours*** *(or passenger hours) are an analogous metric which is calculated through the network wide summation of the time spent by users onboard vehicles.*

*A **boarding** counts a person entering any public transport vehicle, irrespective of whether this is the first vehicle they have boarded for their trip, or whether they have transferred from another vehicle. One trip may include multiple boardings.*

### Table 3-4 – ACT and Queanbeyan weekday public transport metrics

| Metric | Time period | 2016 | 2031 | Change | % change |
|---|---|---|---|---|---|
| **Boardings** | AM peak (7-9AM) | 17,000 | 33,000 | +15,000 | +89% |
| | Inter-peak (9AM-4PM) | 30,000 | 54,000 | +24,000 | +79% |
| | PM peak (4-6PM) | 15,000 | 30,000 | +15,000 | +101% |
| | Off-peak (6PM-7AM) | 9,000 | 21,000 | +12,000 | +135% |
| | **Daily total** | **71,000** | **137,000** | **+66,000** | **+93%** |
| **In-vehicle passenger kilometres** | AM peak (7-9AM) | 161,000 | 299,000 | +138,000 | +86% |
| | Inter-peak (9AM-4PM) | 215,000 | 417,000 | +203,000 | +94% |
| | PM peak (4-6PM) | 147,000 | 287,000 | +139,000 | +95% |
| | Off-peak (6PM-7AM) | 72,000 | 179,000 | +107,000 | +148% |
| | **Daily total** | **595,000** | **1,182,000** | **+587,000** | **+99%** |
| **In-vehicle passenger hours** | AM peak (7-9AM) | 5,000 | 10,000 | +5,000 | +90% |
| | Inter-peak (9AM-4PM) | 6,000 | 12,000 | +6,000 | +96% |
| | PM peak (4-6PM) | 4,000 | 9,000 | +4,000 | +99% |
| | Off-peak (6PM-7AM) | 2,000 | 5,000 | +3,000 | +152% |
| | **Daily total** | **18,000** | **35,000** | **+18,000** | **+101%** |

Buses are likely to remain the most heavily utilised mode in the 2031 ACT and Queanbeyan public transport system – even after the introduction of light rail that replaces trunk bus routes between Gungahlin and Civic (Table 3-5 to Table 3-7). Buses are expected to experience significant growth across the three transport metrics, with a 66 per cent increase in boardings, and an increase of around 80 per cent in weekday passenger kilometres and hours. The bus network will be augmented by the commencement of the Rapid network in 2019, which will include longer operating hours and more frequent services in inner areas (Section 2.2), as well as additional services across outer areas of the ACT. Bus passenger kilometres and hours are forecast to grow faster than boardings, indicating longer trips (a result of service upgrades in outer areas).

Stage one of the Canberra Metro is expected to attract almost 30 per cent of total growth in public transport commuters, and accounts for around 15 per cent of total public transport demand in 2031. This suggests the Metro has not only captured the existing demand in the Gungahlin to Civic corridor, but also facilitated its expansion.

### *Table 3-5 – ACT and Queanbeyan weekday public transport boardings*

| Mode | Time period | 2016 | 2031 | Change | % change |
|---|---|---|---|---|---|
| **Light Rail** | AM peak (7-9AM) | 0 | 4,000 | +4,000 | - |
| | Inter-peak (9AM-4PM) | 0 | 6,000 | +6,000 | - |
| | PM peak (4-6PM) | 0 | 4,000 | +4,000 | - |
| | Off-peak (6PM-7AM) | 0 | 4,000 | +4,000 | - |
| | **Daily total** | **0** | **19,000** | **+19,000** | **-** |
| **Bus** | AM peak (7-9AM) | 17,000 | 28,000 | +11,000 | +64% |
| | Inter-peak (9AM-4PM) | 30,000 | 47,000 | +17,000 | +58% |
| | PM peak (4-6PM) | 15,000 | 26,000 | +11,000 | +74% |
| | Off-peak (6PM-7AM) | 9,000 | 17,000 | +8,000 | +88% |
| | **Daily total** | **71,000** | **119,000** | **+47,000** | **+66%** |

### *Table 3-6 – ACT and Queanbeyan weekday in-vehicle passenger kilometres*

| Mode | Time period | 2016 | 2031 | Change | % change |
|---|---|---|---|---|---|
| **Light Rail** | AM peak (7-9AM) | 0 | 29,000 | +29,000 | - |
| | Inter-peak (9AM-4PM) | 0 | 34,000 | +34,000 | - |
| | PM peak (4-6PM) | 0 | 27,000 | +27,000 | - |
| | Off-peak (6PM-7AM) | 0 | 22,000 | +22,000 | - |
| | **Daily total** | **0** | **113,000** | **+113,000** | **-** |
| **Bus** | AM peak (7-9AM) | 161,000 | 270,000 | +109,000 | +68% |
| | Inter-peak (9AM-4PM) | 215,000 | 383,000 | +169,000 | +79% |
| | PM peak (4-6PM) | 147,000 | 259,000 | +112,000 | +76% |
| | Off-peak (6PM-7AM) | 72,000 | 157,000 | +85,000 | +117% |
| | **Daily total** | **595,000** | **1,070,000** | **+474,000** | **+80%** |

### *Table 3-7 – ACT and Queanbeyan weekday in-vehicle passenger hours*

| Mode | Time period | 2016 | 2031 | Change | % change |
|---|---|---|---|---|---|
| **Light Rail** | AM peak (7-9AM) | 0 | 1,000 | +1,000 | - |
| | Inter-peak (9AM-4PM) | 0 | 1,000 | +1,000 | - |
| | PM peak (4-6PM) | 0 | 1,000 | +1,000 | - |
| | Off-peak (6PM-7AM) | 0 | 1,000 | +1,000 | - |
| | **Daily total** | **0** | **4,000** | **+4,000** | **-** |
| **Bus** | AM peak (7-9AM) | 5,000 | 9,000 | +4,000 | +70% |
| | Inter-peak (9AM-4PM) | 6,000 | 11,000 | +5,000 | +77% |
| | PM peak (4-6PM) | 4,000 | 8,000 | +4,000 | +79% |
| | Off-peak (6PM-7AM) | 2,000 | 4,000 | +2,000 | +113% |
| | **Daily total** | **18,000** | **31,000** | **+14,000** | **+79%** |

# 4. Road network performance

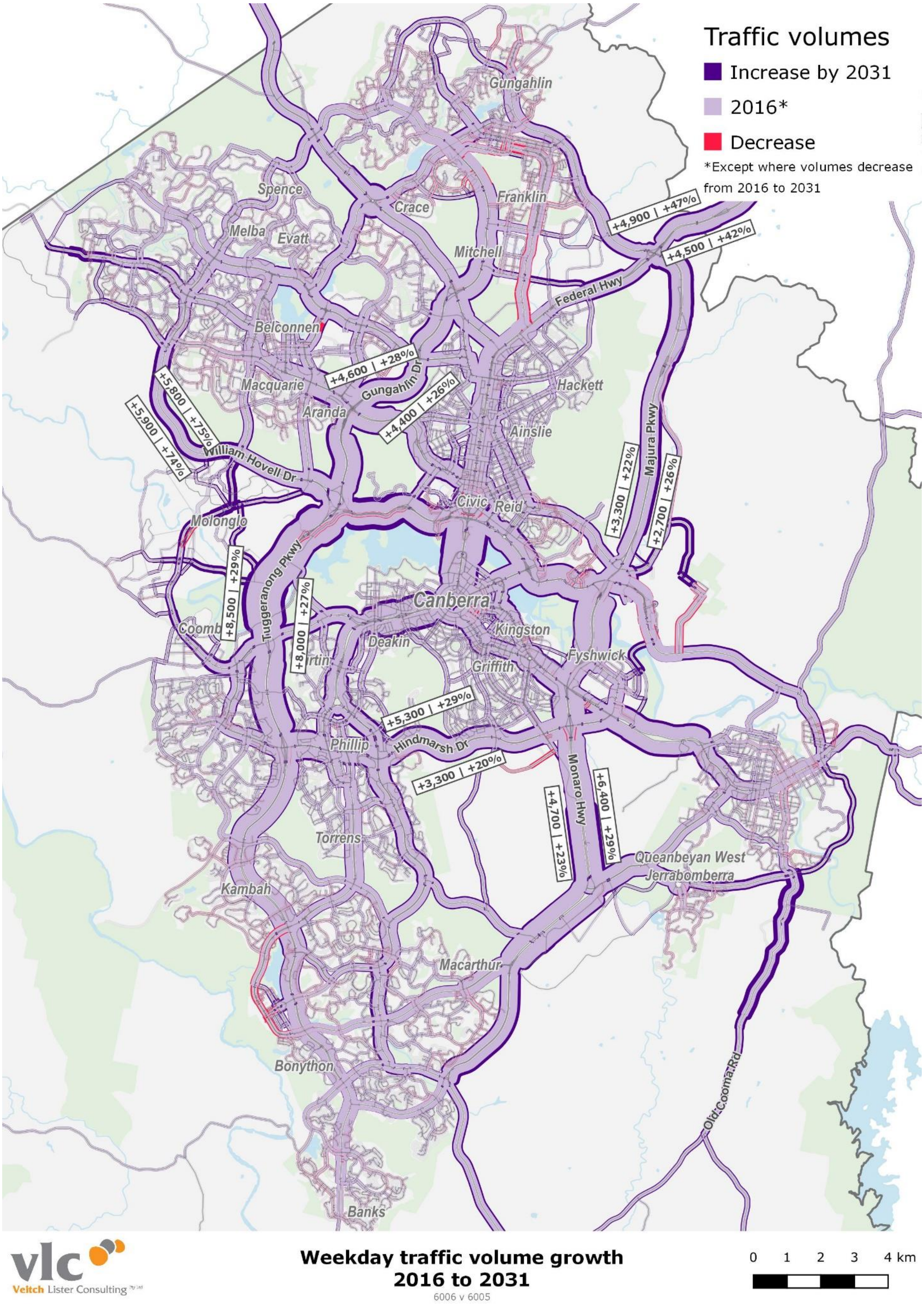
The previous section demonstrated that travel demand in the ACT and Queanbeyan is expected to increase significantly by 2031, and gave some indications of deteriorating road network performance. This section analyses this performance in more detail using the following metrics:

- *Volume capacity (V/C) ratio*. The V/C ratio for a section of road is a useful metric to gauge its level of congestion during a period of the day. As the demand placed on the link approaches capacity, the travel speed deteriorates, causing congestion. In strategic modelling it is possible for the V/C ratio to exceed 1.0. When this occurs, travel speed on this link deteriorates further.
- *Average speed*. Average speed reflects the amount of delay on the road network as a whole, it is the total distance travelled on a network divided by the time taken to do so. Average speed can be calculated either for an entire day or for a particular time period.

The ACT's major highways and arterials are expected to accommodate a large share of the projected increase in road demand by 2031 (Figure 4-1). Monaro Highway and Federal Highway attract substantial volumes of additional traffic, as growth in the ACT's east draws motorists from across the NSW border. Similarly, Majura Parkway is also expected to experience an increase in demand, particularly in connecting Gungahlin in the north and Fyshwick in the south, as well as traffic travelling towards Canberra Airport. These suburbs are likely to experience increased demand, with development in Gungahlin, and plans for commercial development in Fyshwick. In the ACT's west, Tuggeranong Parkway and Gungahlin Drive facilitate a similar north-south movement. A significant increase in traffic volumes on these arterials, as well as on William Hovell Drive through Cotter Road, is a result of significant population growth in Molonglo Valley and Belconnen (Section 2.1). Significant growth in demand is also expected on Hindmarsh Drive, east-west between Weston Creek and Fyshwick, as well as along Old Cooma Road, between Queanbeyan and the Googong growth area. Overall, arterials that connect growing urban centres across the ACT and Queanbeyan are expected to experience the most growth in traffic.

Conversely, moderate decreases in traffic volume are forecast on Flemington Road, between Gungahlin and Federal Highway towards the Canberra CBD. This may be due to the widening of Gungahlin Drive, as well as the addition of the Canberra Metro, which provide travellers with alternative routes to travel between Gungahlin and North Canberra.

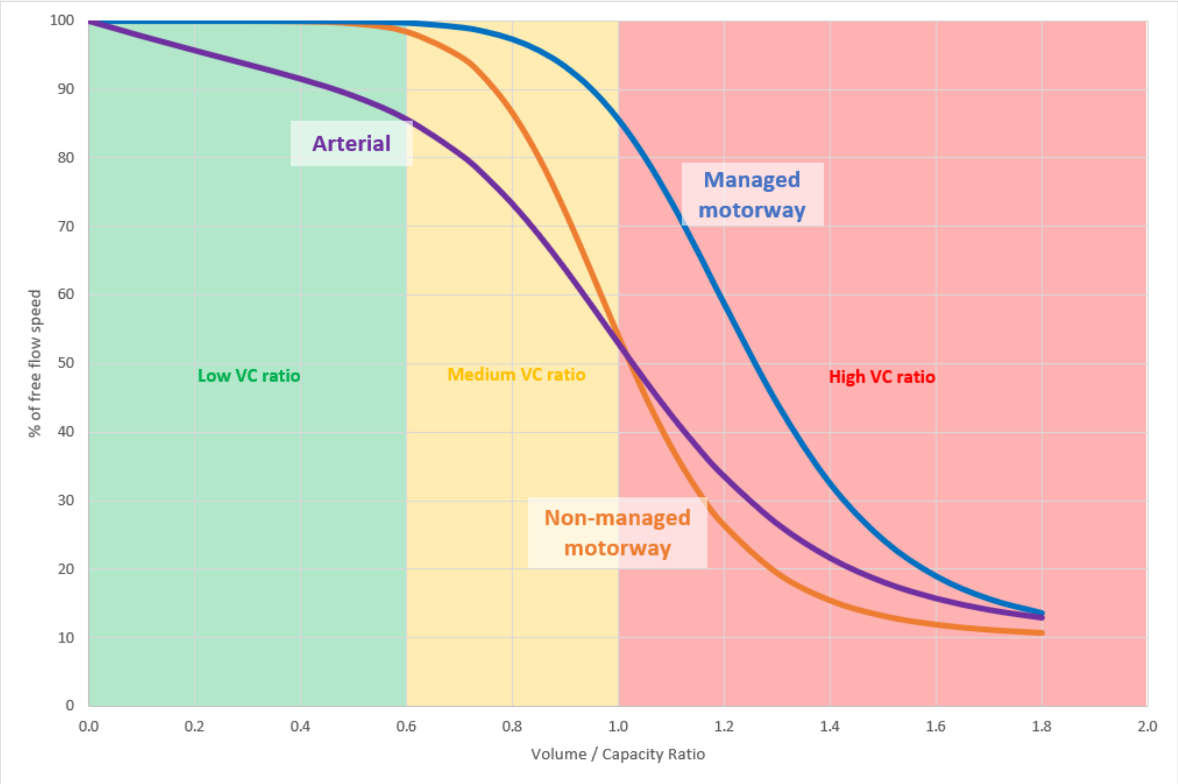
*Figure 4-1 – ACT and Queanbeyan weekday traffic volume growth - 2016 to 2031*



The following traffic volume / road capacity (V/C) images illustrate the levels of congestion observed in 2016 and in 2031. The colour of the bandwidth indicates the level of congestion, and the width is proportional to the volume of traffic using this link. (Minor links have been excluded for clarity, as in general these minor roads carry low volumes of traffic and are relatively uncongested.)

Figure 4-2 shows how congestion in the model impacts travel speeds on the network. For arterials, increasing V/C ratios result in a gradual decline in travel speeds to about 0.6 (where speeds reduce to 85% of free flow), with a steeper decline between ratios of 0.6 and 1.0 (50% of free flow). Travel speeds on motorways are less affected by congestion up to a V/C ratio of 0.6 but experience a much steeper reduction in travel speeds thereafter. Managed motorways can accommodate far more vehicles relative to capacity before travel speeds are materially impacted (though there are no managed motorways in the 2031 forecast for ACT).

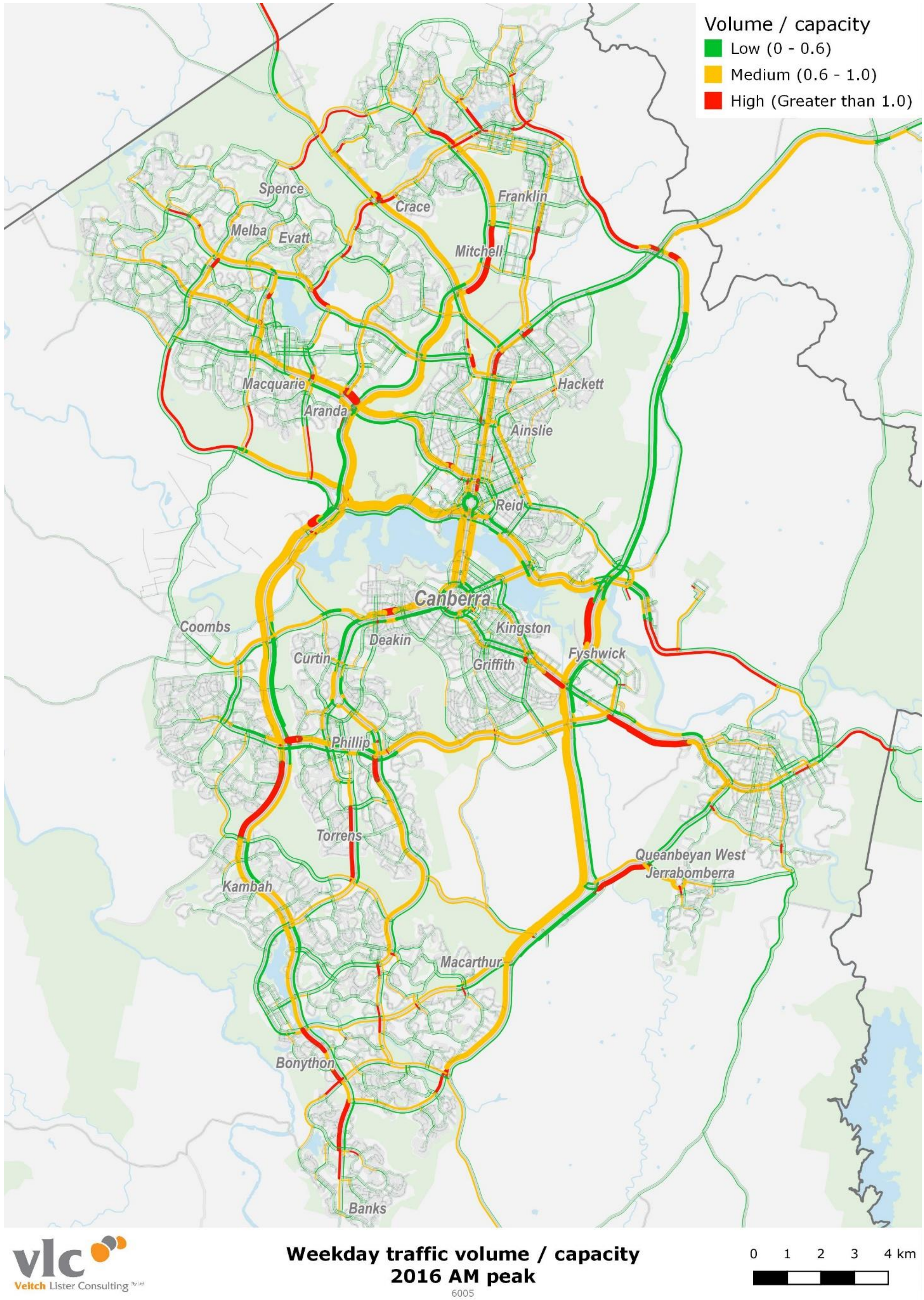
***Figure 4-2 – Speed flow to volume / capacity ratio relationship***



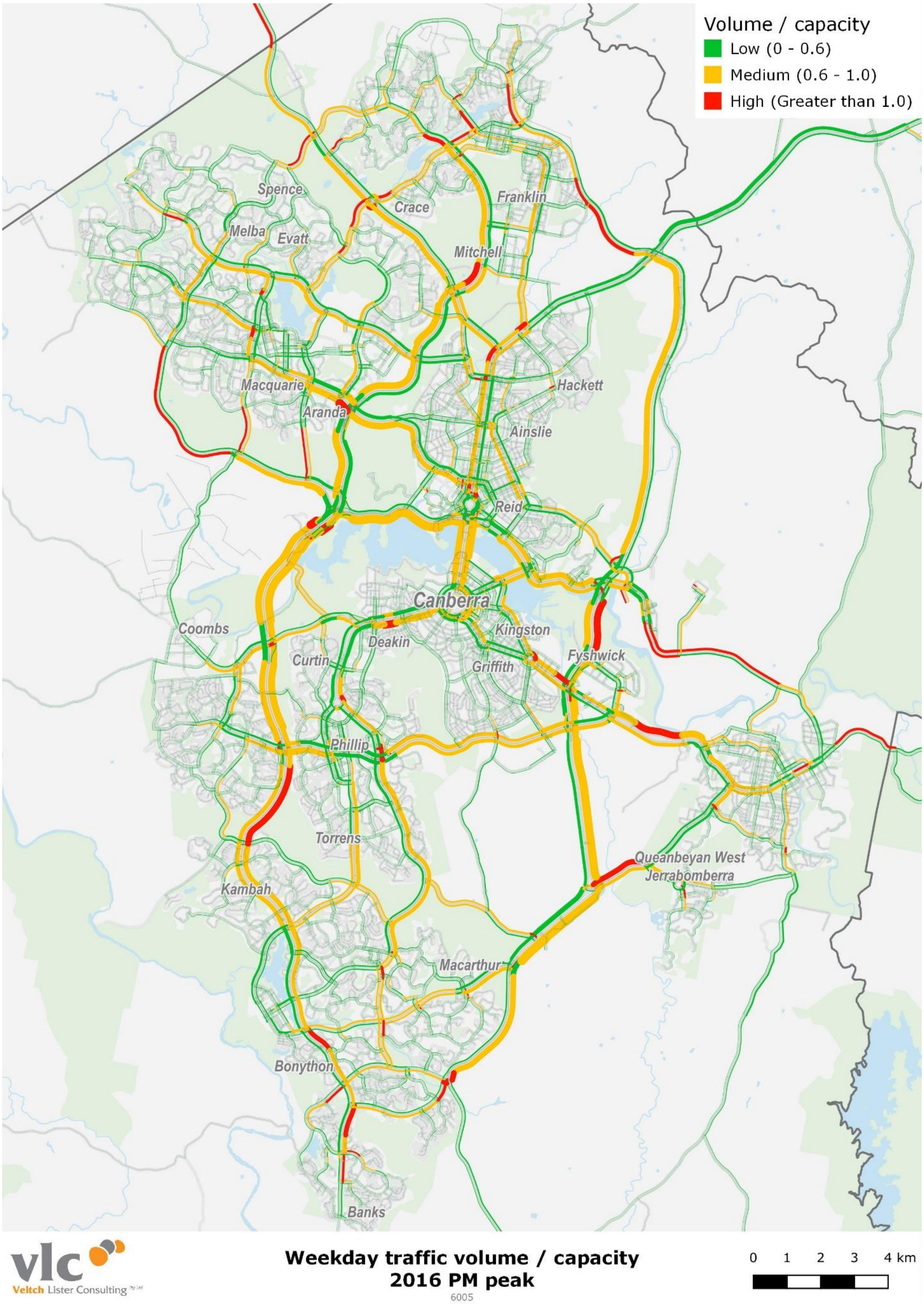

In 2016, roads connecting the ACT's urban centres have the highest levels of congestion (Figure 4-3). In this period there is substantial congestion on routes from outer ACT towards Civic, with some pinch points nearest to urban centres. Volumes on Canberra Avenue, Lanyon Drive and Pialligo Avenue exceed capacity, west of Queanbeyan. The Tuggeranong Parkway, Athllon Drive and Yamba Drive similarly exceed capacity due to demand from Tuggeranong towards Woden Valley and central areas. Traffic from Belconnen, on William Hovell Drive and its parallel roads, and Gungahlin, on Gungahlin Drive, Horse Park Drive and Mirrabel Drive, also experience high levels of congestion. Other major arterials between urban centres experience larger volumes of traffic, and also experience comparable levels of congestion despite having higher capacities. For instance, traffic on the Monaro Highway, Gungahlin Drive and Parkes Way approaches capacity towards North Canberra.

In the PM peak a very similar pattern of congestion can be seen in the opposite direction (Figure 4-4). Traffic largely travels away from inner areas, although there is moderate two-way congestion on the Tuggeranong Parkway.

## Figure 4-3 – ACT and Queanbeyan weekday traffic volume / road capacity - 2016 1-hour AM peak



## *Figure 4-4 – ACT and Queanbeyan weekday traffic volume / road capacity - 2016 1-hour PM peak*



Between 2016 and 2031 congestion on some key roads is expected to worsen substantially, with volumes on more sections of the Tuggeranong Parkway expected to exceed capacity (Figure 4-5 and Figure 4-6). In the 2031 AM peak period, the Monaro and Barton Highways, and William Hovell Drive are also forecast to be highly congested, particularly in the city-bound direction (with the reverse expected in the PM peak). Old Cooma Road is predicted to experience severe congestion, as motorists travel between Queanbeyan and Googong. Severe congestion is also predicted in both directions on the Tuggeranong Parkway near the Molonglo Valley growth area in the AM peak, as well as on the Monaro Highway, which skirts Canberra's east. Increases in congestion is also expected on other major arterials, including the Majura Parkway, and Morshead Drive near Russell. This means that by 2031, motorists traveling from outer areas to inner areas can expect to encounter congestion earlier on the morning commute and for longer on their way home. This delay will not only impact on travel time for motorists but also on the buses using these roads.

Conversely, a number of other major roads are forecast to experience a reduction in congestion. Gundaroo and Horse Park Drive in Gungahlin and William Hovell Drive in Molonglo Valley are upgraded, and road users experience some congestion relief as a result, in spite of traffic growth in these areas. Congestion on Gungahlin Drive is also predicted to remain stable, due to its duplication. Bindubi St, between Cook and Aranda, is expected to experience reduced congestion, as parallel routes (Gungahlin/Caswell Drive and William Hovell Drive) are upgraded.

Overall, while congestion does increase to 2031 in much of the ACT and Queanbeyan, the projects included in the 'do-minimum' infrastructure scenario that has been applied for the 2031 forecast are expected to be effective in relieving congestion in the face of growing population and employment.

## Figure 4-5 – ACT and Queanbeyan weekday traffic volume / road capacity - 2031 1-hour AM peak

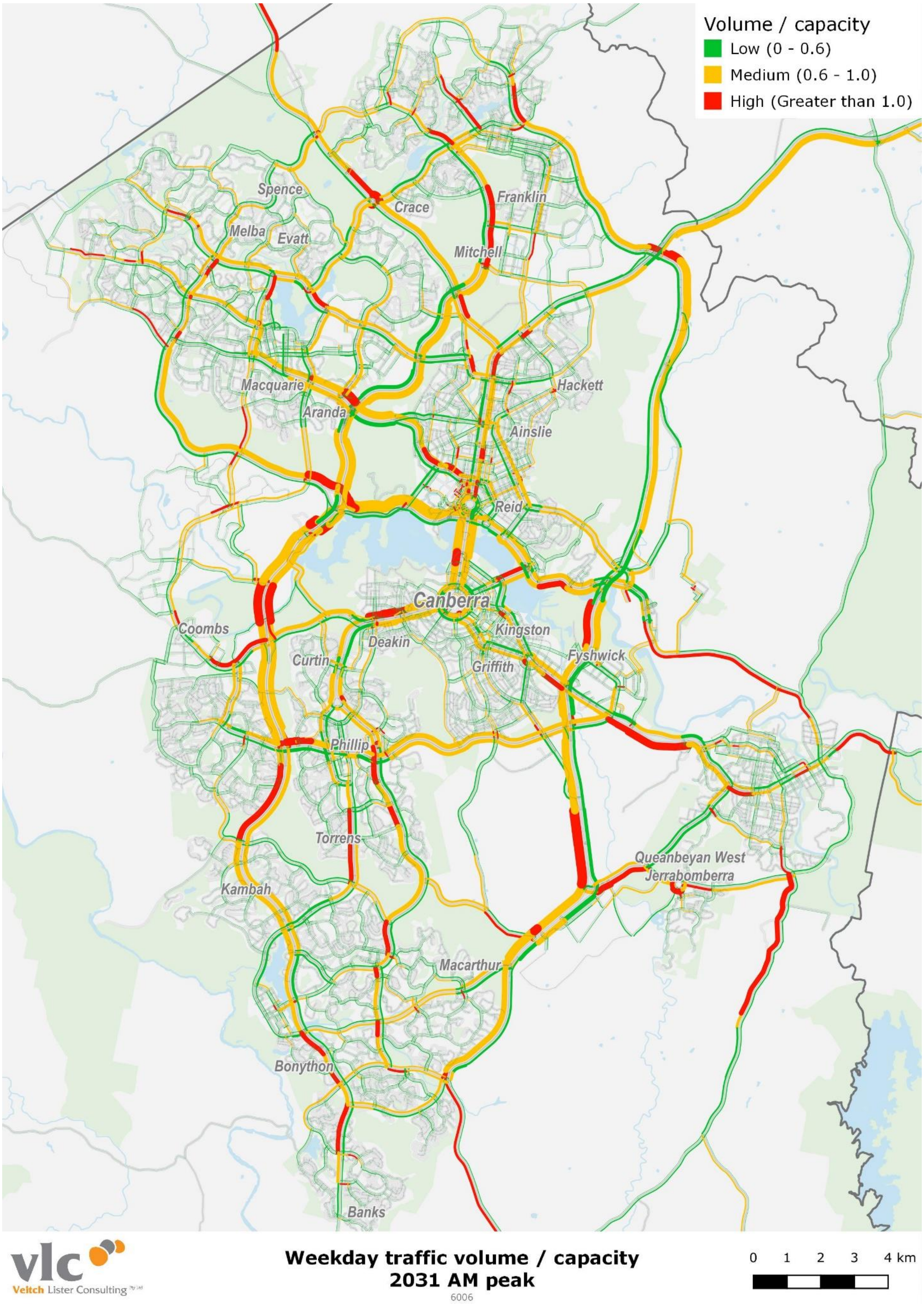
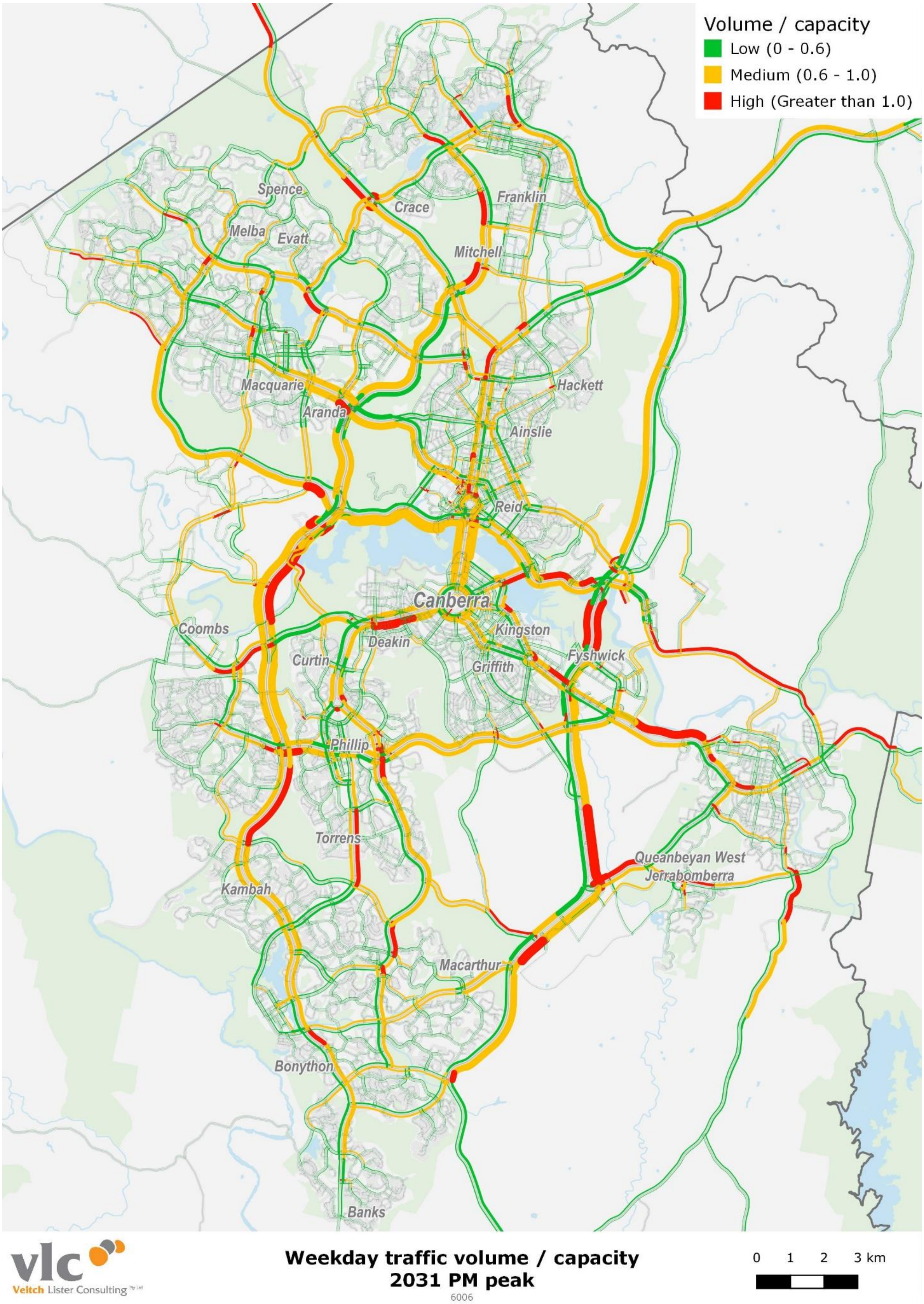
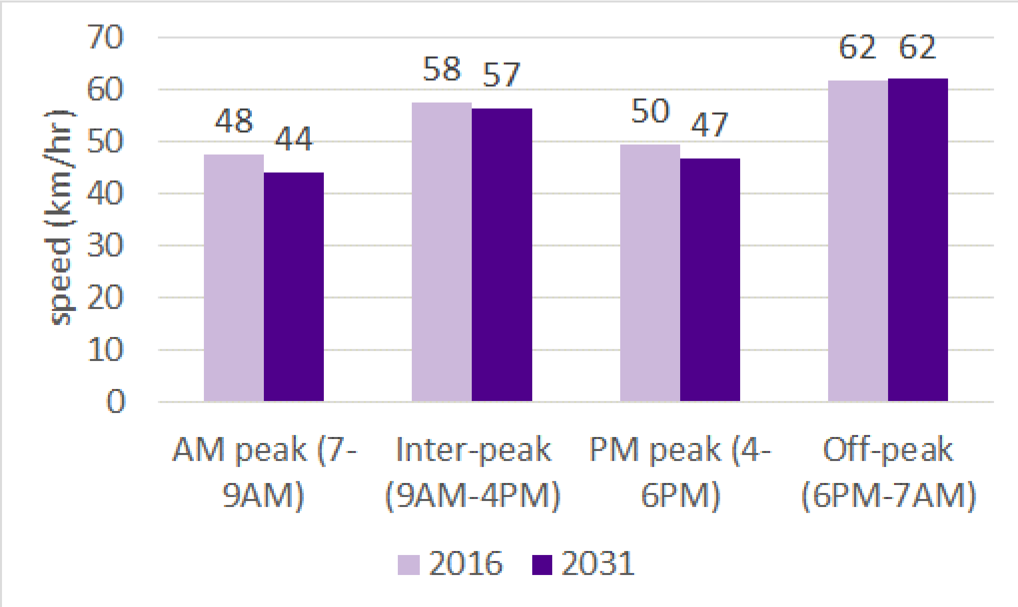


**Figure 4-6 – ACT and Queanbeyan weekday traffic volume / road capacity - 2031 1-hour PM peak**



Canberra's road network continues to offer relatively high levels of service to motorists, though in some areas emerging congestion is expected to reduce the average speeds. The most significant declines in network speeds are in the AM and PM peaks (reducing by 4km and 3km per hour respectively), but future congestion also slows traffic slightly in the middle of the day (Figure 4-7). The off-peak time period offers an indication of vehicle speeds on a relatively uncongested network, and does not decline to 2031.

***Figure 4-7 – ACT and Queanbeyan average speeds on the road network***




Delay hours for vehicles on the road networks of the ACT and Queanbeyan are expected to increase by 2031 (Table 4-1). Delay is most intense during the AM and PM peak periods, with delays in these periods growing by around 60 per cent. Vehicle delay across the seven hour inter-peak time period grows most (by about 79%). Only minor vehicle delays are expected for the off-peak.

***Table 4-1 – ACT and Queanbeyan road network total delay hours***

| Time period | 2016 | 2031 | Change | % change |
|---|---|---|---|---|
| AM peak (7-9AM) | 9,800 | 16,000 | +6,200 | +63% |
| Inter-peak (9AM-4PM) | 5,800 | 10,400 | +4,600 | +79% |
| PM peak (4-6PM) | 8,700 | 13,800 | +5,100 | +59% |
| Off-peak (6PM-7AM) | 1,200 | 1,700 | +500 | +39% |
| **Daily total** | **25,500** | **41,900** | **+16,400** | **+64%** |

# 5. Public transport system performance

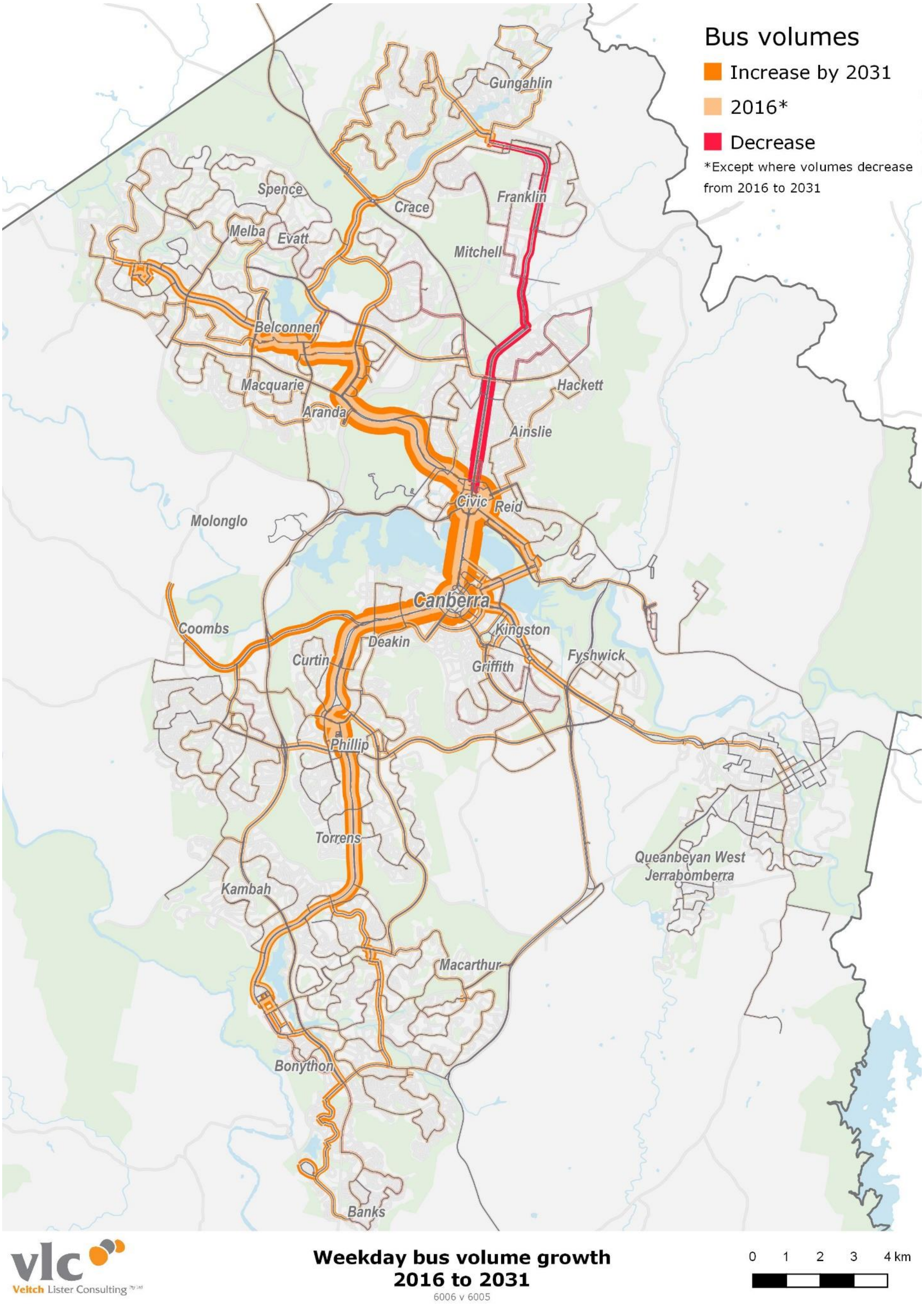
This section analyses the impact of passenger demand on the ACT and Queanbeyan's public transport network.

The ACT and Queanbeyan's public transport network connects its major urban centres, largely centring on Civic. The network is currently delivered by buses, with plans for an overhaul of the network by 2019 for an integrated public transport network that includes Rapid buses and the Canberra Metro light rail. These Rapid buses provide high frequency services along major corridors with limited stops, to connect significant urban centres. Regular buses will continue to provide localised services from these Rapid routes into lower density suburbs. The light rail line will replace bus services that connect Gungahlin to Civic.

Demand for the ACT and Queanbeyan's public transport network is modest, with most demand centred on peak periods in peak directions. Use of public transport for travel in the counter-peak directions is limited. Patronage is forecast to grow throughout the bus network, particularly between Belconnen, Molonglo and Tuggeranong, to North and South Canberra (Figure 5-1). This is due to substantial population and employment growth in these areas. Furthermore, these routes are serviced by multiple Rapid bus lines, increasing the attractiveness of buses compared to private transport. Increased patronage is also expected on services on William Slim Drive between Belconnen and Crace.

A decrease in bus patronage on Northbourne Avenue is forecast in 2031, this is a result of the implementation of Canberra Metro stage 1 on this corridor. The light rail is forecast to attract significant patronage, with heavier usage closer to Civic (Figure 5-7 and Figure 5-8). Small decreases in bus patronage on other routes into Dickson and Lyneham are due to re-alignment of bus routes that are planned as part of the integrated public transport network.

**Figure 5-1 – ACT and Queanbeyan weekday bus passenger volume growth - 2016 to 2031**



The rest of this chapter focuses on crowding on the public transport network. Levels of crowding on the bus network has been measured by using a V/C ratio, where the number of passengers on each service is divided by the crush capacity of the bus during the worst hour in the peak period. The worst hour in the 2-hour peak is assumed to be 55 per cent of that period.

***Limitations of crowding measures**:*

*While the model provides a sophisticated representation of the impacts of passenger crowding on the public transport network, there are two primary limitations to the crowding metric used in this report:*

*Firstly, the model represents 'timetabled' public transport operating conditions. When severe crowding occurs, it is often a result of service delays, cancellations or incidents not captured in the modelling.*

*Secondly, the V/C ratios represent a weighted average of all services on each corridor. This means that the measure does not reflect the complexity of the crowding on each individual service. For example, there may be uneven demand across services on the same line (e.g. more passengers on an express service compared with an all-stopper or higher loadings at 8 a.m. compared with 7.15 a.m.), or within a single service (e.g. one carriage is at capacity while another is much less crowded).*

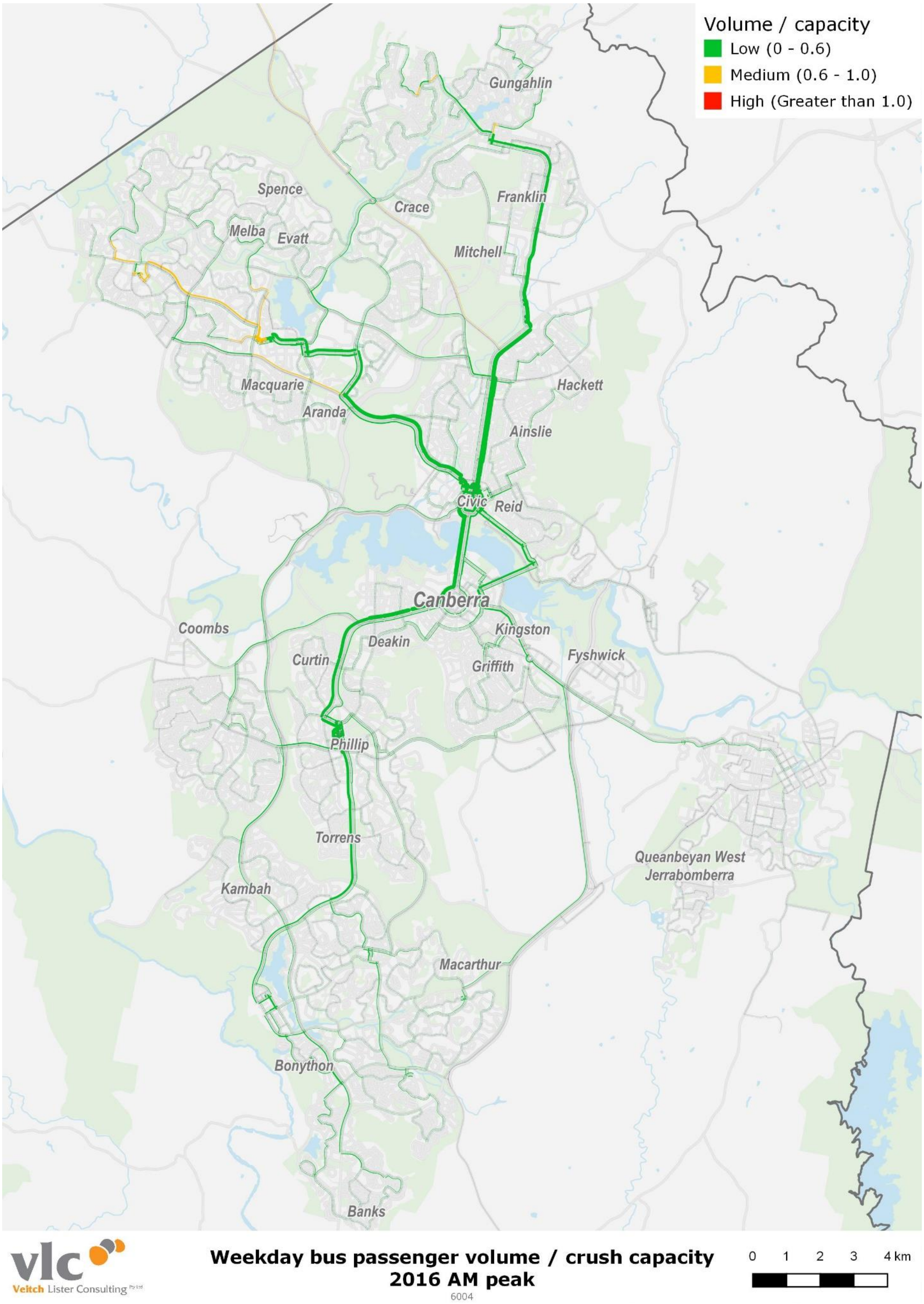
In 2016, buses are generally well below crush levels throughout the network, in both the AM and PM peak periods (Figure 5-2 and Figure 5-3). Crowding does, however, approach crush capacity on Belconnen Way between Belconnen and Macquarie, as well as Ginninderra Drive, towards the University of Canberra. In the morning peak, bus services become more crowded on approach to Civic, with volumes exceeding seated capacity particularly on the Barton Highway approach into North Canberra. The opposite pattern is observed during the evening peak. Patronage in the counter-peak direction is relatively low, suggesting that most bus commuters travel to and from North and South Canberra. Very low patronage is observed south-east of the ACT, towards Queanbeyan, as comparatively infrequent bus services in this area mean that private transport is more convenient for many commuters.

Buses in the ACT and Queanbeyan are expected to become more crowded in the 2031 peak periods (Figure 5-4 and Figure 5-5). In particular, services along John Gorton Drive near Molonglo, Belconnen Way, as well as some sections of the bus route in outer Belconnen are expected to exceed crush capacity. This is due to greenfield development in West Belconnen and Molonglo, which may be insufficiently serviced under the 2031 'do-minimum' infrastructure scenario. Services on the Barton Highway are also forecast to experience severe crowding, as development in the ACT continues to draw demand from across the NSW border.

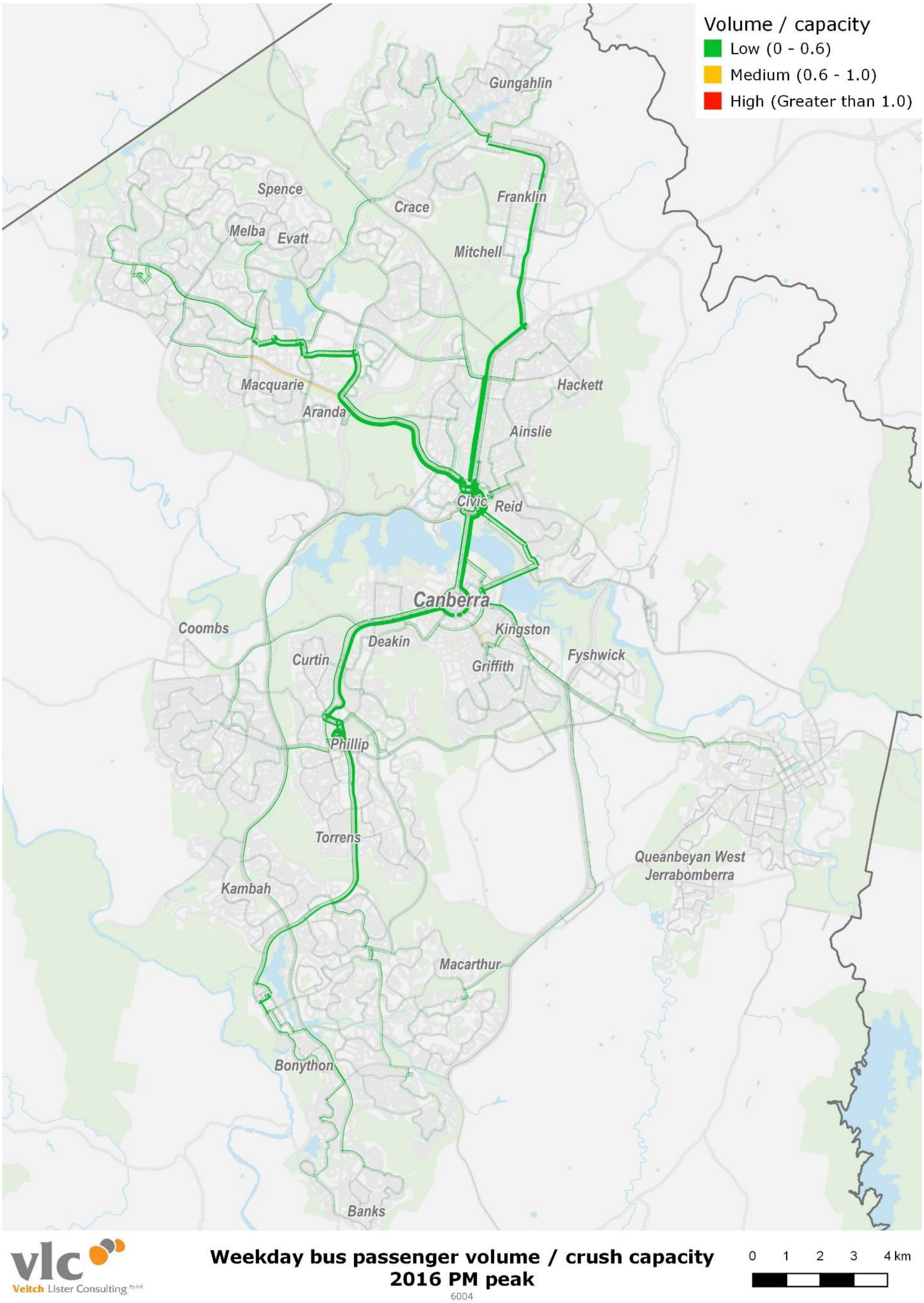
In addition, services on Barry Drive, which connects Belconnen to Civic, is expected to experience a significant increase in demand, approaching crush capacity by 2031. Commuters travelling by bus along the Monaro Highway and Canberra Avenue towards Queanbeyan, Tuggeranong Parkway, as well as roads within Gungahlin are also forecast to experience significant crowding. Crowding is again expected to worsen on William Slim Drive to Aikman Drive, and Ginninderra Drive towards the University of Canberra.

During the PM peak period, crowding is also expected on bus services travelling from Civic to Deakin, and particularly onwards to Molongolo. Between Deakin and Molongolo, services exceed crush capacity, though at much smaller volumes. Again, it seems the pace of greenfield development in the Molonglo Valley exceeds the capacity of services between Deakin and Molonglo. Significant crowding is also expected between the University of Canberra and Gungahlin.

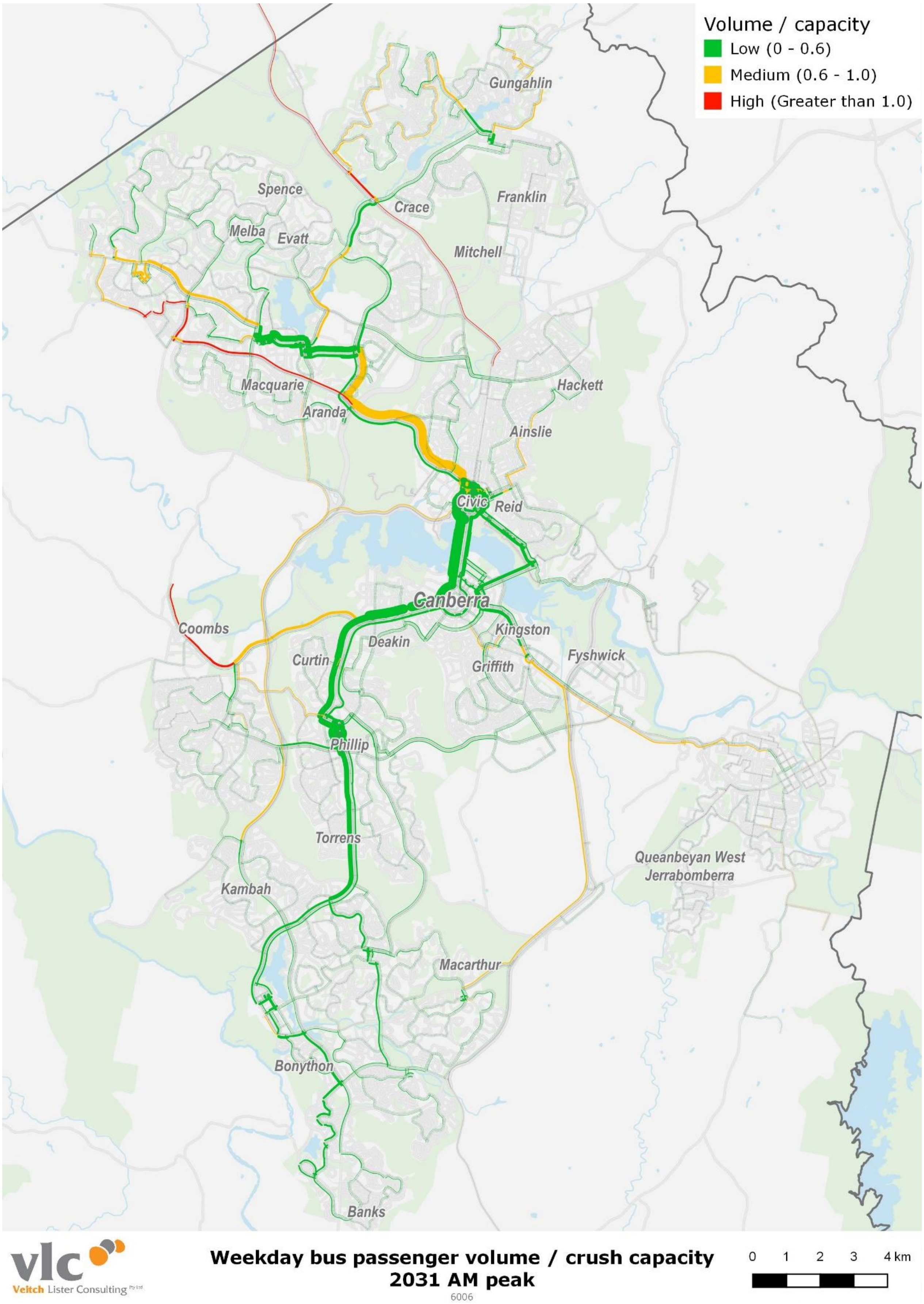
**Figure 5-2 – ACT and Queanbeyan weekday bus passenger volume / crush capacity – 2016 1-hour AM peak**



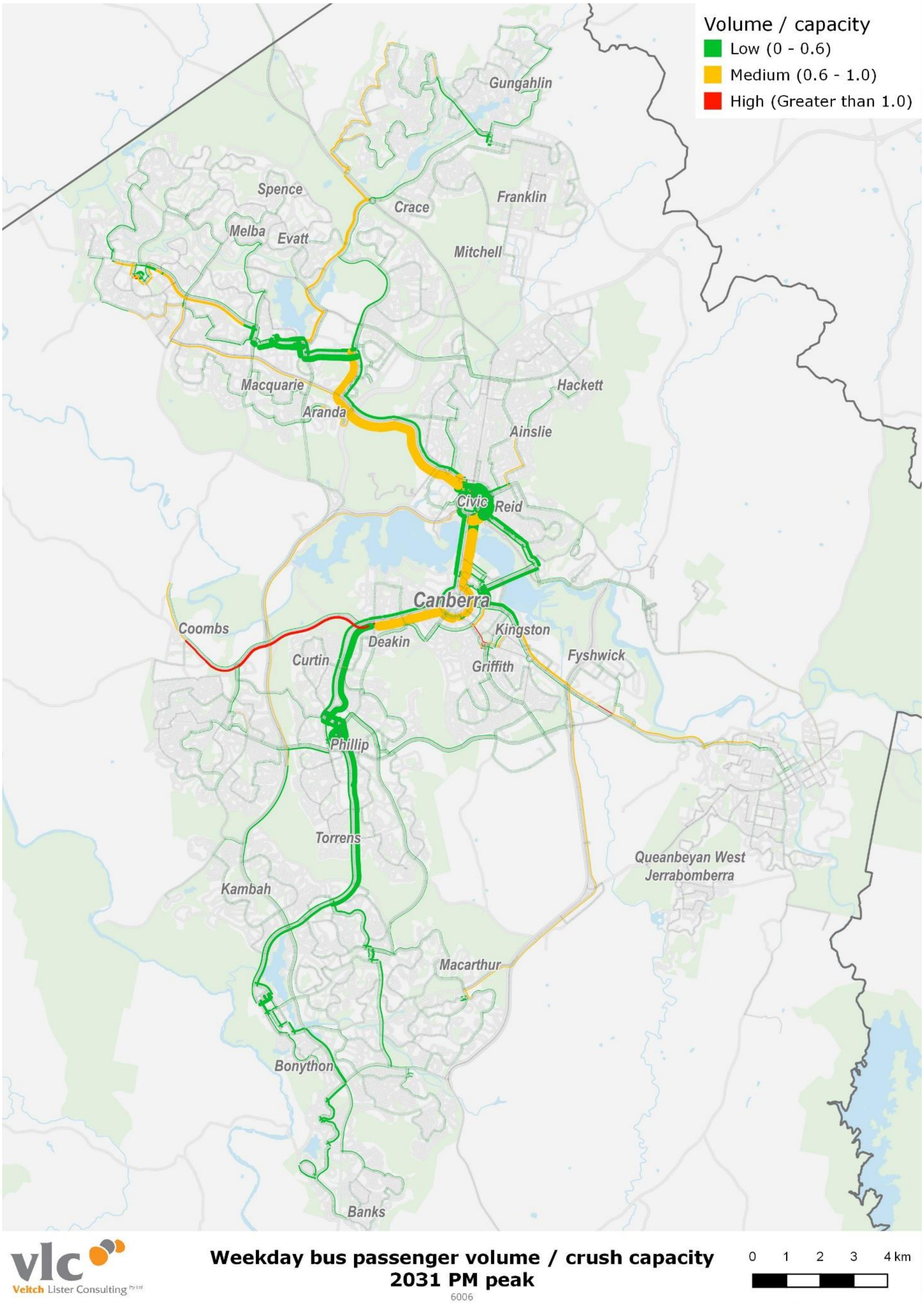
## *Figure 5-3 – ACT and Queanbeyan weekday bus passenger volume / crush capacity - 2016 1-hour PM peak*



## *Figure 5-4 – ACT and Queanbeyan weekday bus passenger volume / crush capacity - 2031 1-hour AM peak*

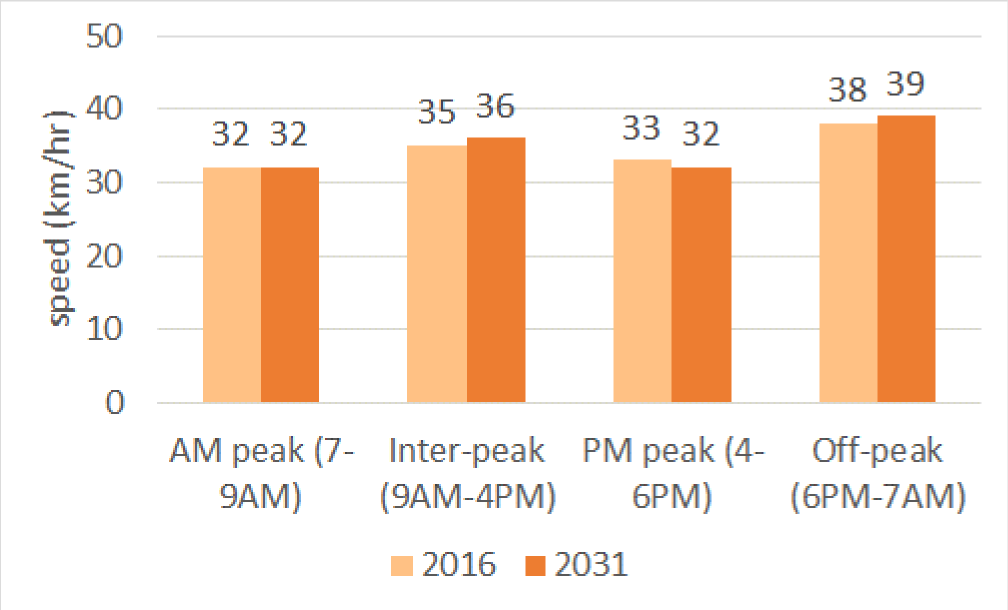


## Figure 5-5 – ACT and Queanbeyan weekday bus passenger volume / crush capacity - 2031 1-hour PM peak



Buses in Canberra have relatively high average operating speeds, reflecting the provision of bus priority measures on key corridors. Nevertheless, in parts of the network where this priority is not provided, buses can be delayed by general traffic. Between 2016 and 2031 very little additional delay is expected for buses, and in non-peak periods, bus speeds are actually forecast to improve slightly (Figure 5-6).

***Figure 5-6 – ACT and Queanbeyan average bus speeds***




In the 2031 AM peak, commuters on stage one of the Canberra Metro light rail are not expected to experience significant crowding between Gungahlin Place and Phillip Avenue, and between Gungahlin Place and Dickson Interchange during the PM peak period (Figure 5-7 and Figure 5-8). Between Phillip Avenue and Dickson Interchange, to the end of the line at Alinga St in Civic, moderate crowding is expected. This reflects the gradual build-up of city-bound passengers closer to Civic, including those transferring from bus services at Dickson Interchange.

**Figure 5-7 – ACT weekday light rail passenger volume / crush capacity – 2031 1-hour AM peak**

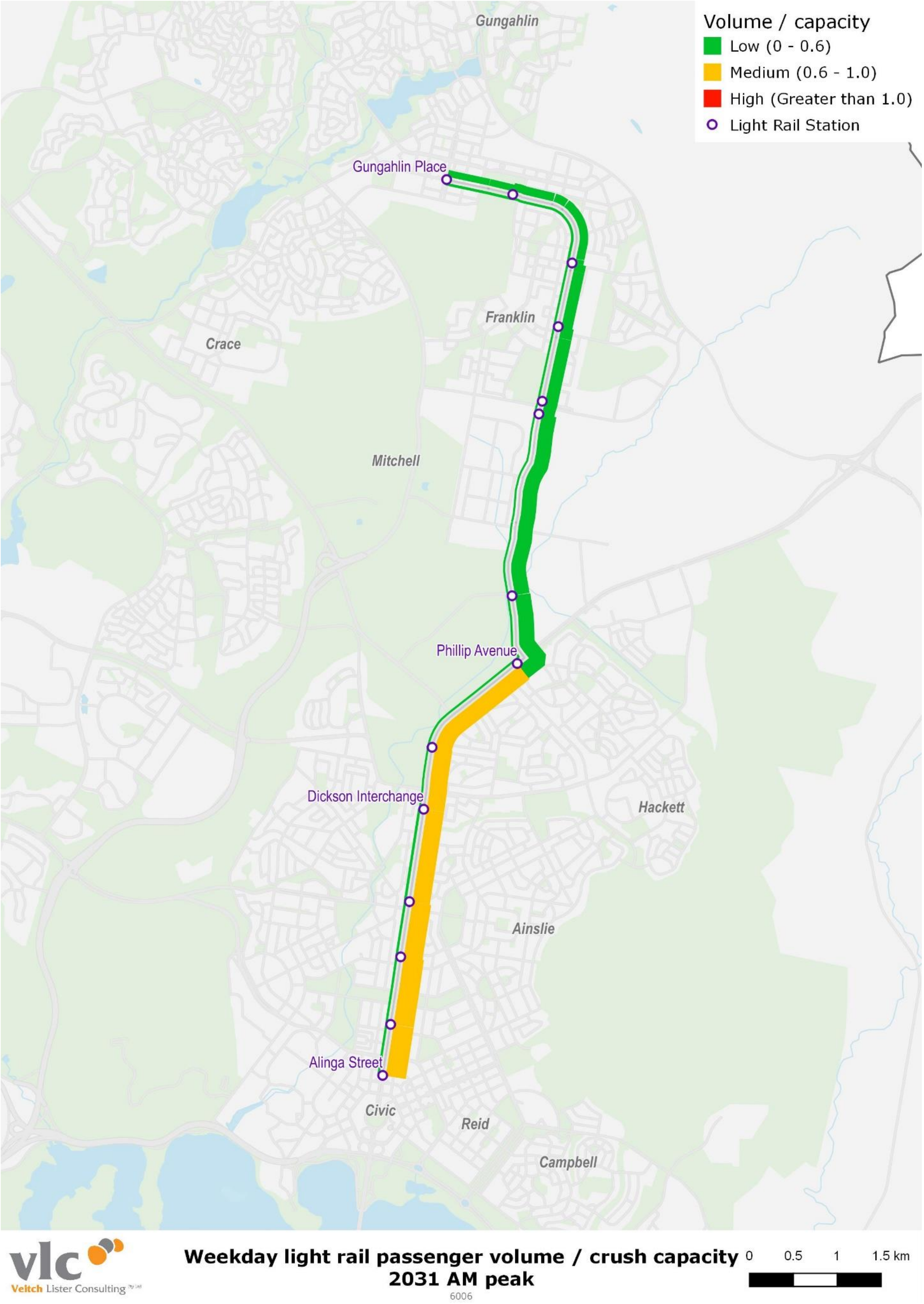
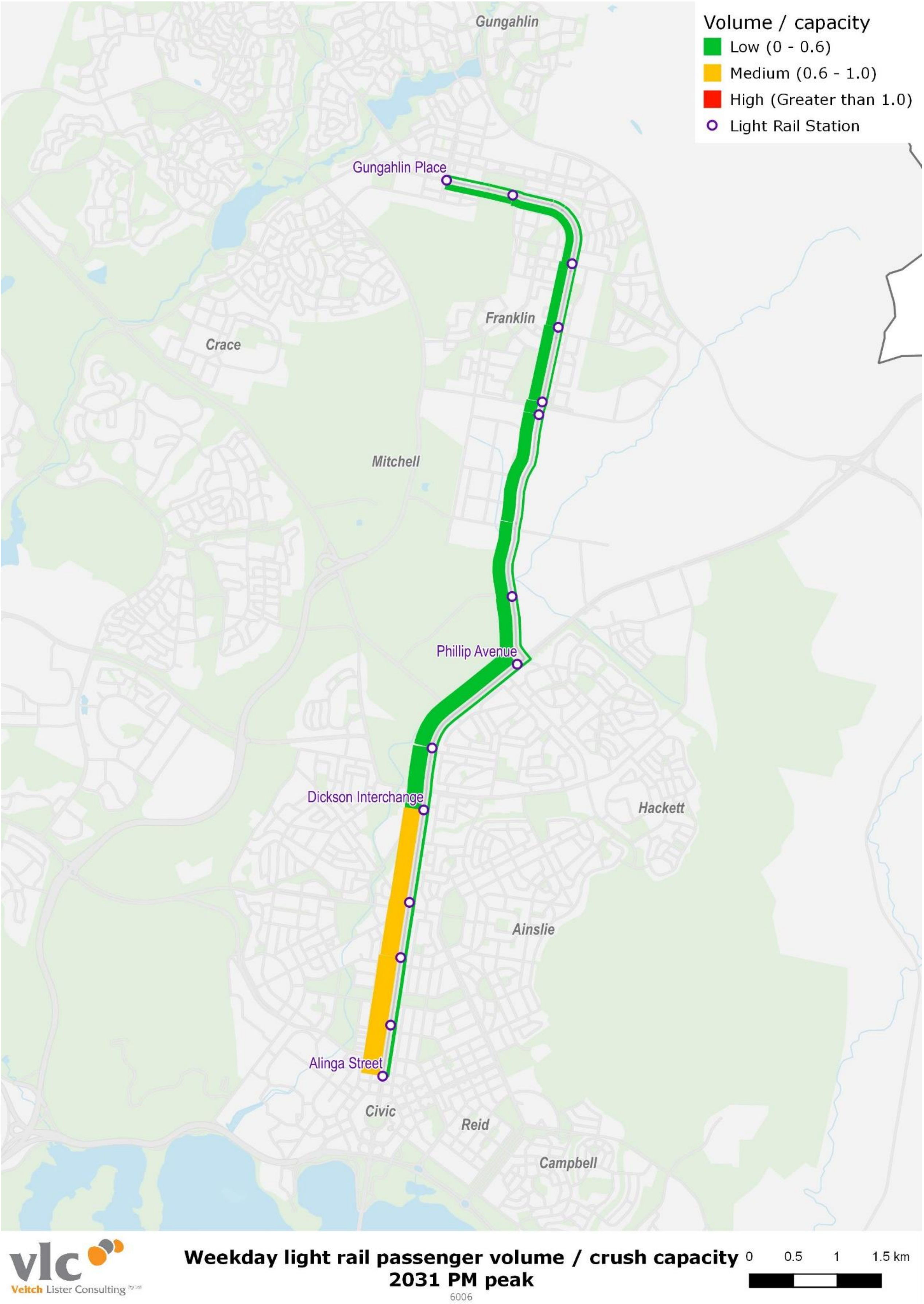


**Figure 5-8 – ACT weekday light rail passenger volume / crush capacity - 2031 1-hour PM peak**



# 6. Accessibility and social inclusion

The ability to participate in society is greatly affected by access to services and opportunities. Hospitals, schools, child care services and green space are all vital types of social infrastructure that can enhance the wellbeing of individuals and the community generally. Conversely, poor transport connections and lack of access to these kinds of services can lead to social isolation and exclusion.

This section of the report examines the extent to which areas across the ACT and Queanbeyan have adequate access to key services and opportunities both now and in the future. Services have been considered at two levels of geography – local and regional (Table 6-1). Shorter travel times would be expected for services in the former group, while longer travel times are more acceptable for regional social infrastructure.

Two factors affect a person's accessibility to services. The first is the travel times across the transport network. For example, increased congestion on the road network causes longer travel times, resulting in lower accessibility. New road connections, on the other hand, may reduce travel times, resulting in higher accessibility. Accessibility is measured by both car and public transport travel times.

The second factor is the spatial distribution of services. The addition of more jobs, a new hospital, or a new park would result in an improvement to accessibility for adjacent areas, even without apparent changes to travel times. The locations of child care services, hospitals, schools and green space are assumed to remain static between 2016 and 2031. In reality this is unlikely to be the case, and new services will almost certainly be developed over the coming years. While to some extent this is a limitation of these measures, it also provides an opportunity to highlight where new social infrastructure development should be focused if it is not already in planning.

***Limitations of strategic accessibility modelling:***

*All travel times represent journeys between travel zones – one zone is at the home end of the trip and the other at the destination. Demand produced from each travel zone is fed onto the transport network from a single point (the 'centroid') via a notional link known as a 'centroid connector'. The precision of modelled travel times is therefore highly dependent on the granularity of travel zones at either end of the journey. Geographically larger travel zones (generally at the fringes of the urban area) have a greater imprecision associated with the location of the centroid versus the actual locations of households. Larger zones also have longer centroid connectors, so the travel time on these connectors to reach the realistic transport network becomes a proportionally longer component of the overall trip. The model is not able to estimate travel times for trips made by public transport entirely within a travel zone – 'intrazonal trips'. Travel times for these trips are therefore based on walk times. Finally, the model does not consider all factors that can affect end-to-end car travel time, such as locating a car park.*

*To aid interpretation, two adjustments are made to the maps of PT accessibility: large and low population density zones are not mapped, and remaining zones containing the relevant social infrastructure are capped at 30 minute access time.*

**Table 6-1 – Accessibility to social infrastructure services**

| Service | Accessibility metric | Rationale | Spatial data source |
|---|---|---|---|
| | | ***Local*** | |
| *Child care services* | Average travel time to the nearest five child care centres | The availability of child care services is an important driver for participation in social activities for parents and children alike. Having a choice of more than one service increases the likelihood that parents and children will find a centre to meet their specific needs, for example in terms of opening hours or style of care. | Approved education and care services in 2018 from the Australian Children's Education & Care Quality Authority. |
| *Public schools (primary/ secondary)* | Travel time to the nearest school | School is generally the most significant social activity for school age children and teenagers. This metric has been limited to public schools to cover all residents. | Schools in 2016 from the Australian Curriculum, Assessment and Reporting Authority |
| *Green space* | % of the residential population in an SA3 within a 10-minute walk of green space | Green space is a vital component of liveable cities and provides an opportunity for recreation and socialising for residents. | Parkland classified meshblocks in the 2016 Census. This includes nature reserves, conserved/protected areas, and public open space. It may also include sporting facilities not open to the public. Minor alterations have been made based on satellite data. |
| | | ***Regional*** | |
| *Jobs* | Number of jobs that can be reached within 30 minutes by car and public transport | Access to jobs is a critical indicator of social inclusion. The more employment opportunities within a reasonable travel time from a person's home, the higher the likelihood of that person finding a job that appropriately matches their skills and experience. | 2016 and 2031 employment data from Zenith, which is adapted from the 2016 ABS Census and 2031 ACT Government projections |
| *Hospitals (public/ emergency)* | Travel time to the nearest public/emergency hospital | Limited access to healthcare can negatively impact health outcomes and overall quality of life. This metric has been limited to public hospitals and/or hospitals with an emergency department to ensure that the service is usable by all residents. | Hospitals in 2018 from the MyHospital database (Australian Institute of Health and Welfare) |

## 6.1 Accessibility in 2016 and 2031

Local infrastructure should be accessible within short travel times. Ideally, residents should also have options to choose motorised or active modes of transport for these journeys.

The modelling indicates that for the average ACT or Queanbeyan resident with access to a car, child care and public schools are within a four-minute trip in 2016 and a five-minute trip in 2031 (Table 6-2). For residents dependent on public transport, travel times are much longer – generally 15 to 25 minutes for child care services and public primary schools in 2016, and travel time to public secondary schools approaching 30 minutes. The modelling suggests that public transport travel times will increase slightly to 2031.

***Table 6-2 – ACT and Queanbeyan population-weighted average travel times to child care and public schools - AM peak (7-9AM)***

| Service | Car (mins) | | PT (mins) | |
|---|---|---|---|---|
| | *2016* | *2031* | *2016* | *2031* |
| **Child care services** | 2.7 | 3.3 | 17.3 | 20.7 |
| **Public primary school** | 2.5 | 3.2 | 16.8 | 20.3 |
| **Public secondary school** | 3.7 | 4.6 | 23.7 | 27.4 |

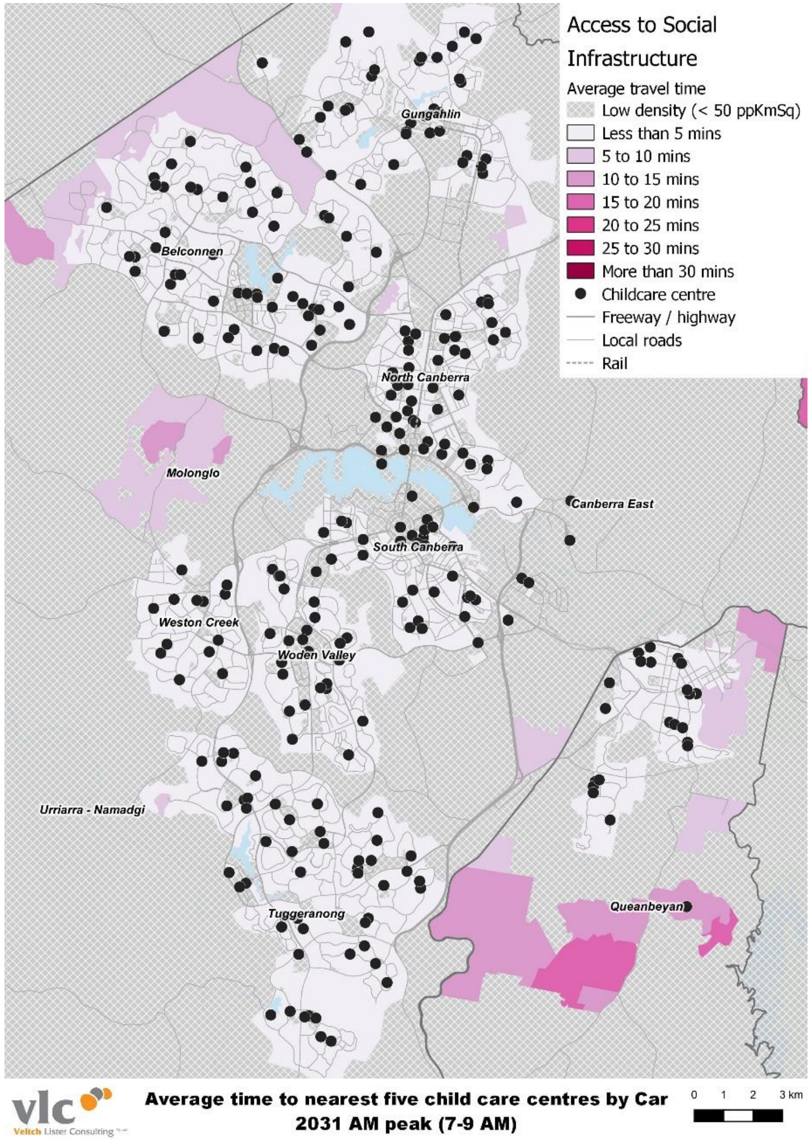
Most parts of the ACT and Queanbeyan are expected to be able to reach a range of child care centres within a four-minute drive from home in 2031, which is consistent with the city-wide average travel time of about three minutes (Figure 6-1). The main exceptions are for residents in areas with greenfield development, in Queanbeyan and Molonglo, as well as peri-urban SA3s such as Canberra East and Urriarra – Namadgi (Table 6-3). Queanbeyan and Molonglo are expected to experience the greatest reductions in accessibility across services and transport modes from 2016 to 2031 (Figure 6-1 to Figure 6-6). This reduction in accessibility is a function of significant population growth projected in outer parts of these SA3s coupled with the limited existing supply of both transport and social infrastructure. The large model travel zones in these areas also mechanically boosts estimated travel times to and from newly populated areas, so results should be interpreted with a degree of caution (see 'Limitations of strategic accessibility modelling' box above).

Access to education infrastructure is likely to be more difficult without access to a car. Public transport may still offer a realistic alternative to car as a means of accessing childcare services (Figure 6-2), public primary schools (Figure 6-4) and public secondary schools (Figure 6-6) in the 2031 AM peak for much of the ACT, with travel times under 25 minutes.

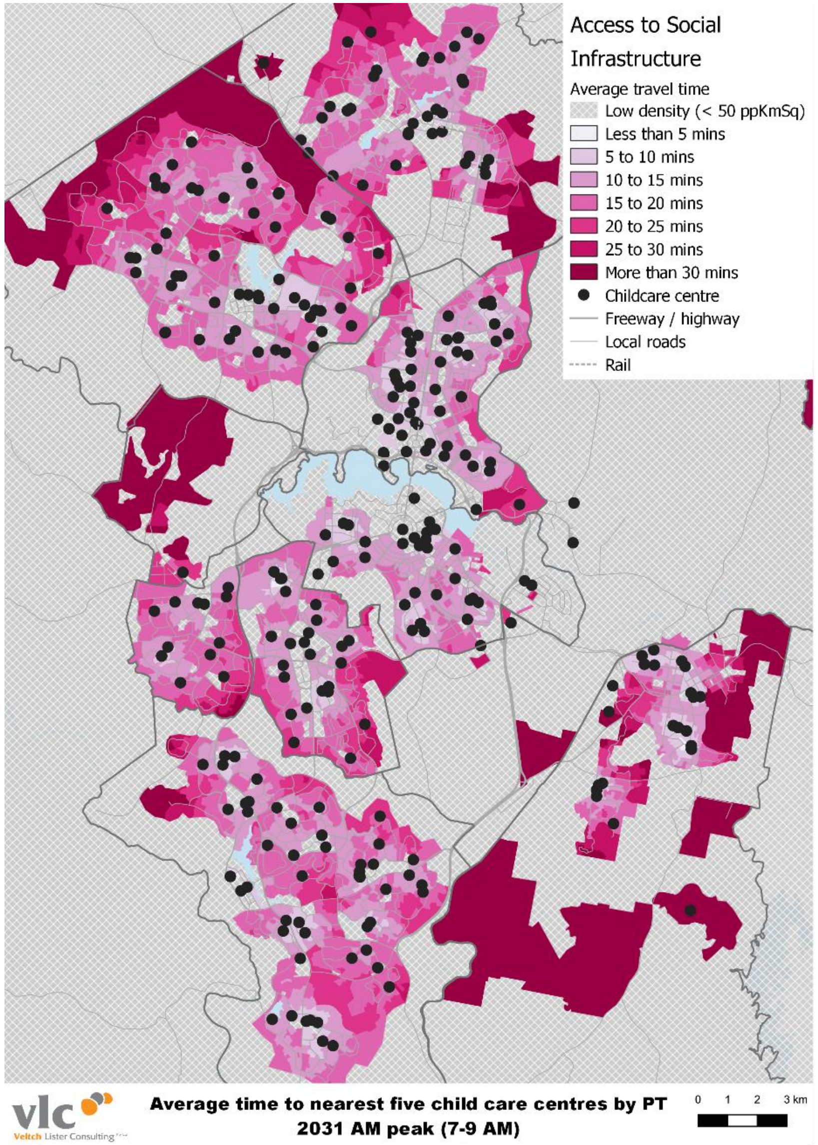
Travel times between 30 to 60 minutes are expected for residents of Canberra East, Queanbeyan and Molonglo, reflecting limited public transport service improvements assumed in these regions. However, transport accessibility of local social infrastructure in North and South Canberra, Canberra East, Tuggeranong, and Woden Valley is forecast to improve slightly to 2031, reflecting improved bus frequencies from the integrated public transport network.

To a large extent, the relatively poor accessibility offered by public transport is a function of the way in which the network serves large activity centres (Section 5). The public transport system is not as effective at catering for local travel needs as it is at transporting large numbers of people between urban centres.

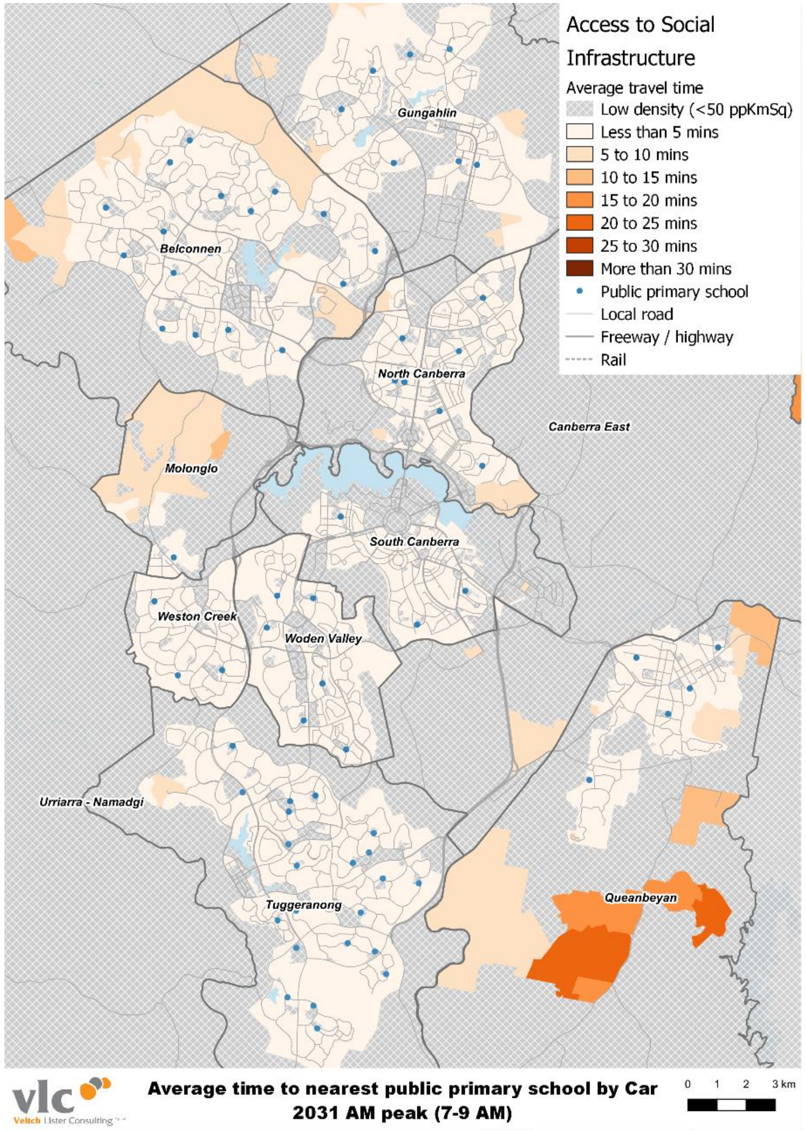
## *Figure 6-1 – ACT and Queanbeyan average time to nearest five child care centres by Car - 2031 AM peak (7-9AM)*



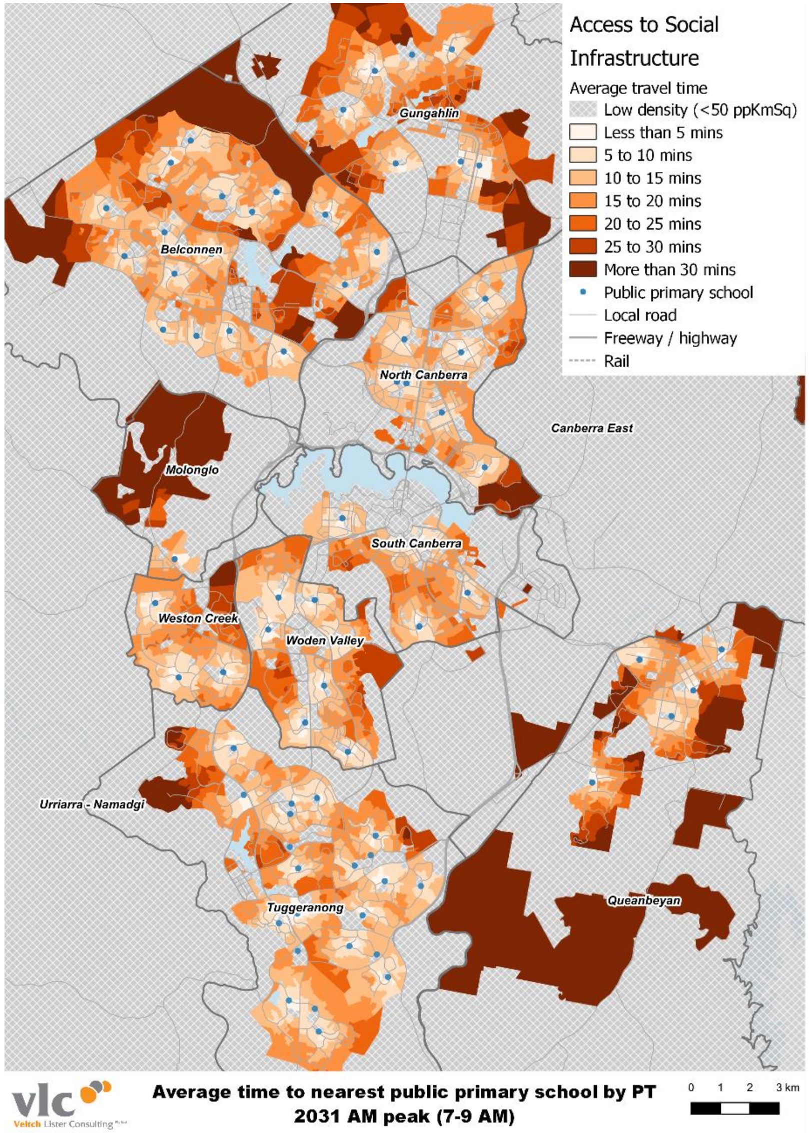

## *Figure 6-2 – ACT and Queanbeyan average time to nearest five child care centres by PT - 2031 AM peak (7-9AM)*



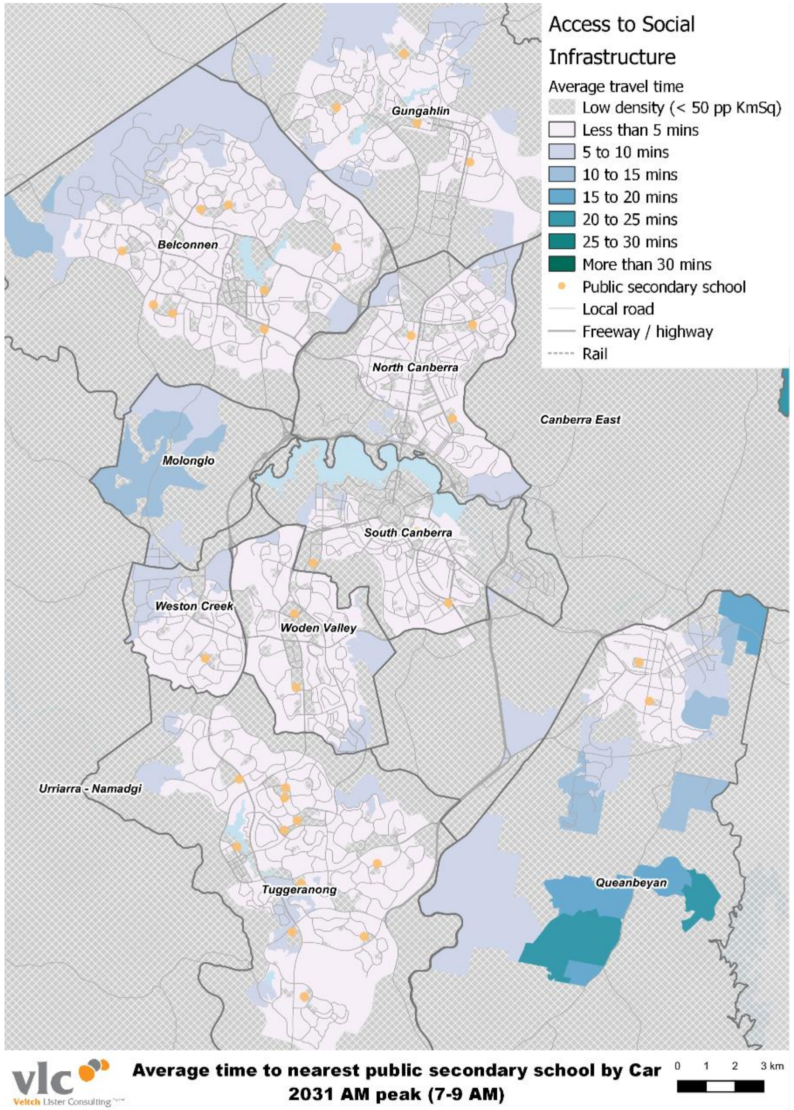
## *Figure 6-3 – ACT and Queanbeyan average time to nearest public primary school by Car - 2031 AM peak (7-9AM)*



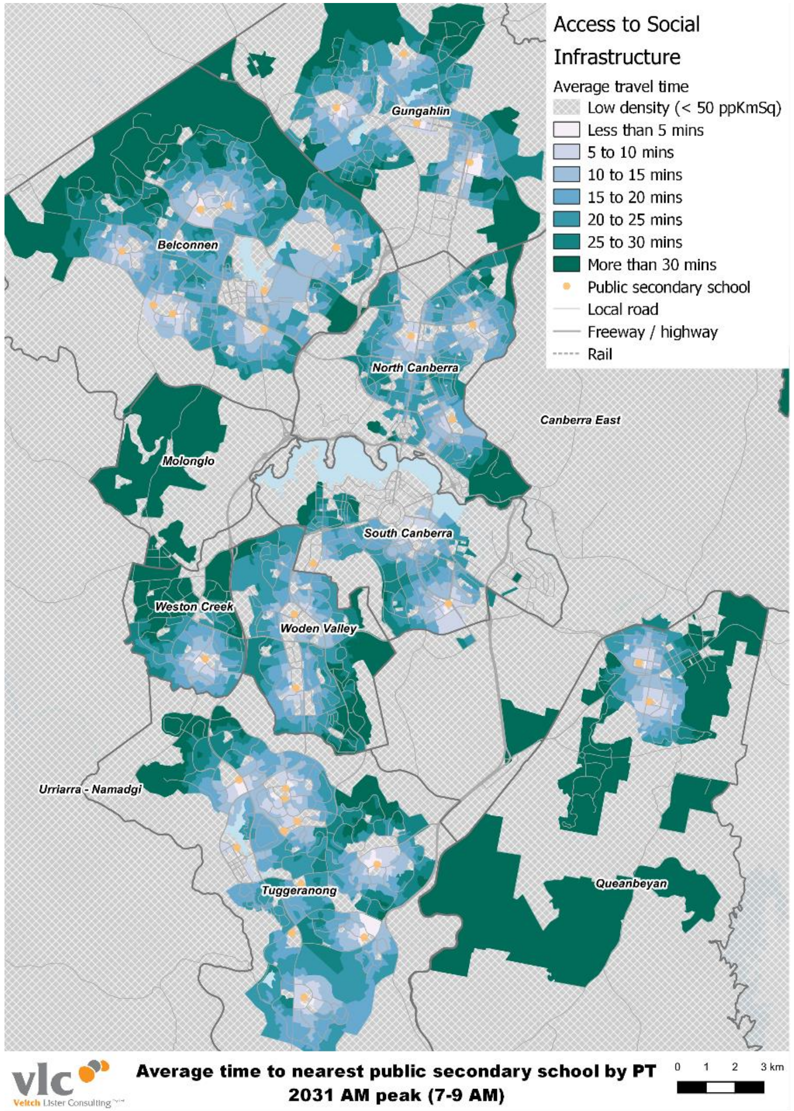

## *Figure 6-4 – ACT and Queanbeyan average time to nearest public primary school by PT - 2031 AM peak (7-9AM)*



## *Figure 6-5 – ACT and Queanbeyan average time to nearest public secondary school by Car - 2031 AM peak (7-9AM)*




## *Figure 6-6 – ACT and Queanbeyan average time to nearest public secondary school by PT - 2031 AM peak (7-9AM)*



### *Table 6-3 – ACT and Queanbeyan population-weighted average travel times* to child care and public schools by SA3 - AM peak (7-9AM)*

| SA3 | Child care centres (nearest five, mins) | | | | | | Nearest public primary school (mins) | | | | | | Nearest public secondary school (mins) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Car | | | PT | | | Car | | | PT | | | Car | | | PT | | |
| | *2016* | *2031* | *Diff* | *2016* | *2031* | *Diff* | *2016* | *2031* | *Diff* | *2016* | *2031* | *Diff* | *2016* | *2031* | *Diff* | *2016* | *2031* | *Diff* |
| Belconnen | 2.9 | 3.7 | *+0.8* | 18.3 | 21.2 | *+2.9* | 2.7 | 3.4 | *+0.7* | 16.7 | 19.2 | *+2.6* | 3.7 | 4.5 | *+0.8* | 22.2 | 24.5 | *+2.3* |
| Canberra East | 5.5 | 5.3 | *-0.3* | 43.2 | 41.7 | *-1.5* | 6.0 | 5.8 | *-0.2* | 43.5 | 43.0 | *-0.5* | 6.4 | 6.4 | *-0.0* | 50.6 | 48.9 | *-1.7* |
| Gungahlin | 2.7 | 2.9 | *+0.2* | 17.1 | 19.3 | *+2.2* | 2.7 | 3.0 | *+0.3* | 17.4 | 19.9 | *+2.6* | 3.7 | 4.0 | *+0.3* | 22.3 | 24.6 | *+2.3* |
| Molonglo | 3.6 | 6.9 | *+3.3* | 24.7 | 44.9 | *+20.2* | 2.0 | 5.7 | *+3.6* | 14.4 | 39.1 | *+24.7* | 7.7 | 10.3 | *+2.6* | 41.9 | 60.5 | *+18.6* |
| North Canberra | 2.0 | 2.0 | *+0.0* | 12.6 | 12.5 | *-0.1* | 2.2 | 2.3 | *+0.1* | 14.4 | 14.6 | *+0.2* | 3.5 | 3.7 | *+0.1* | 20.2 | 21.1 | *+0.9* |
| South Canberra | 1.9 | 1.9 | *+0.0* | 12.5 | 12.4 | *-0.1* | 2.1 | 2.1 | *+0.1* | 14.5 | 14.3 | *-0.2* | 2.8 | 2.9 | *+0.1* | 18.2 | 17.9 | *-0.3* |
| Tuggeranong | 2.6 | 2.6 | *-0.0* | 16.7 | 16.1 | *-0.5* | 2.1 | 2.1 | *-0.0* | 14.4 | 14.1 | *-0.3* | 3.3 | 3.3 | *-0.0* | 21.0 | 20.3 | *-0.7* |
| Urriarra - Namadgi | 20.3 | 16.7 | *-3.5* | 226.8 | 178.7 | *-48.1* | 19.9 | 16.5 | *-3.5* | 226.4 | 180.3 | *-46.1* | 23.5 | 19.9 | *-3.6* | 245.6 | 196.4 | *-49.2* |
| Weston Creek | 2.7 | 2.8 | *+0.0* | 17.5 | 17.6 | *+0.1* | 2.4 | 2.4 | *+0.0* | 15.5 | 15.5 | *+0.0* | 3.8 | 3.8 | *+0.0* | 25.8 | 25.9 | *+0.1* |
| Woden Valley | 2.4 | 2.4 | *+0.1* | 15.8 | 15.7 | *-0.1* | 2.1 | 2.1 | *+0.0* | 13.9 | 13.9 | *-0.0* | 3.2 | 3.3 | *+0.1* | 21.5 | 21.4 | *-0.1* |
| Queanbeyan^ | 3.1 | 5.5 | *+2.3* | 22.5 | 35.3 | *+12.8* | 3.5 | 6.8 | *+3.3* | 25.0 | 39.0 | *+13.9* | 5.3 | 8.1 | *+2.9* | 37.9 | 48.1 | *+10.2* |
| **Total ACT and Queanbeyan** | **2.7** | **3.3** | ***+0.6*** | **17.3** | **20.7** | ***+3.4*** | **2.5** | **3.2** | ***+0.7*** | **16.8** | **20.3** | ***+3.5*** | **3.7** | **4.6** | ***+0.9*** | **23.7** | **27.4** | ***+3.7*** |

*The travel times reflect all modelled zones and so does not reflect adjustments made in Figures 6-2, 6-4 and 6-6 (see 'Limitations of strategic accessibility modelling' box above).

^ Urban and peri-urban portions of the SA3 only

Most ACT and Queanbeyan residents have good access to green space. Overall, 85 per cent of the ACT and Queanbeyan population could reach green space within 10 minutes in 2016, decreasing to 77 per cent in 2031. This measure excludes population in large travel zones (mostly on the urban fringe or rural areas). Applying a similar filter at an SA3 level constrains the analysis largely to established areas – North and South Canberra, Weston Creek and Woden Valley – that are assessed as having very good walking access to green space of some kind. Tuggeranong, Belconnen, Gungahlin and Queanbeyan have below average access to green space (Figure 6-7).

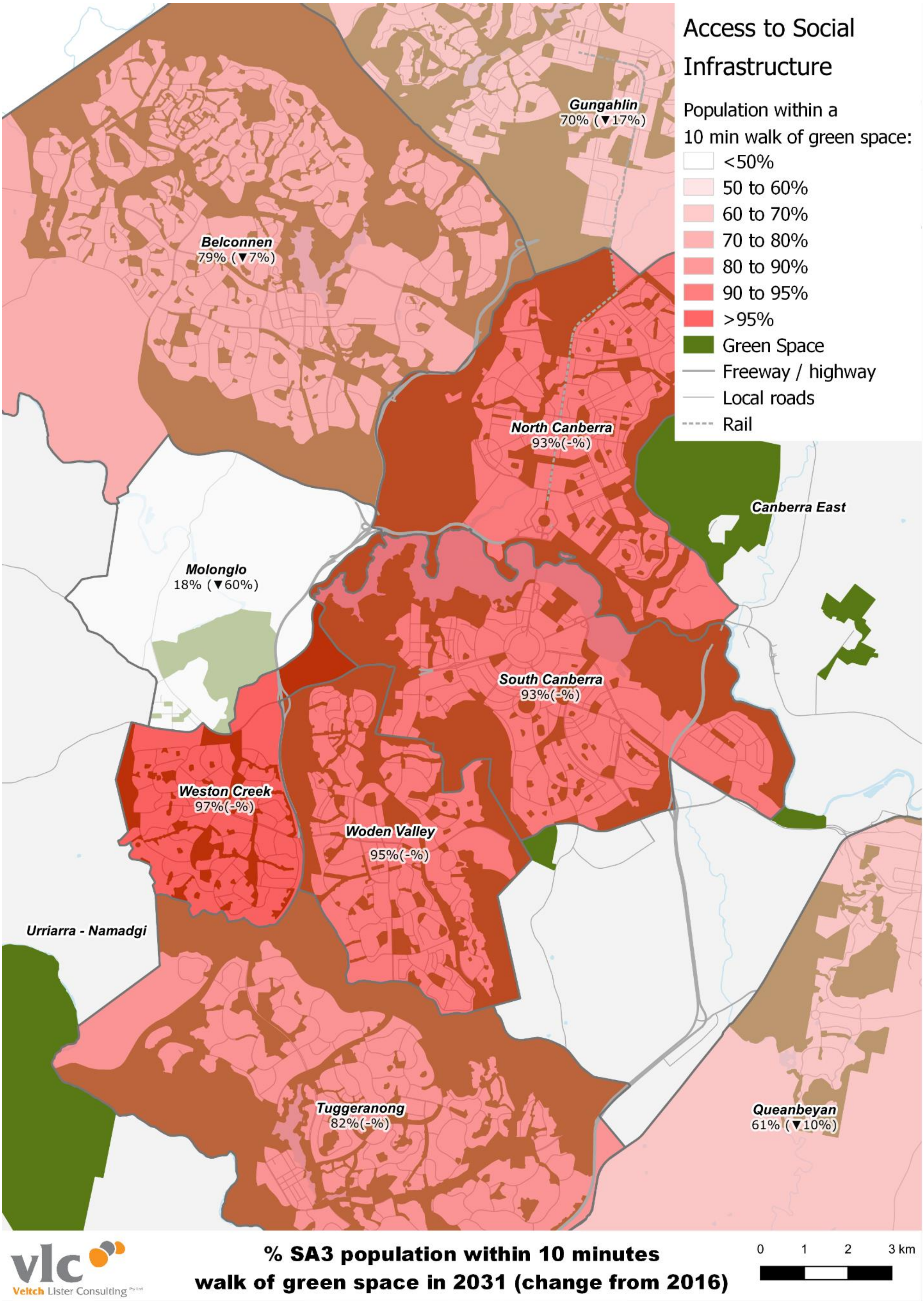
Molonglo is expected to experience a large reduction in green space accessibility to 2031. As with the issue highlighted for social accessibility, this is likely to be partly attributed to a combination of the spatial distribution of projected population growth and a lack of resolution in modelling of the future land uses in this growth area (travel zones, pedestrian and local road infrastructure, as well as future parklands themselves). Plans for these areas are at an early stage which limits the level of detail that can be input to the model and, in turn, the realism of accessibility outcomes for such a localised metric.

***Limitations to measuring green space access:***

*Green areas defined in Figure 6-7 overleaf are used to estimate the green space accessibility metric. This interpretation of green space is quite broad, and does not account for the quality or quantity of the area. All residents in a travel zone are measured as having the same access to green space in one of two ways. The first is if the travel zone itself includes green space, it is assumed that walking time for everyone is 10 minutes or less. The second is if the walking time to nearby travel zones with green space is 10 minutes or less.*

*Both of these cases for estimation of metrics have issues on the urban fringe where travel zones are large. To overcome these issues, large and low-population-density travel zones have been excluded from the SA3 metrics mapped in Figure 6-7. Similarly, SA3s with more than 80 per cent of its population in large travel zones are not mapped.*

## Figure 6-7 – ACT and Queanbeyan percentage of population within a 10-minute walk of green space in 2031



Access to employment opportunities across the ACT and Queanbeyan differs dramatically depending on where a person lives and what mode of travel they take, in both 2016 and 2031. As jobs represent a 'regional' level category of social infrastructure, travel times are generally expected to be longer than for child care, schools and green space. Employment accessibility is measured here as the percentage of total jobs that can be reached within 30 minutes.

Given the ACT's smaller geographical area compared to other Australian cities, and well-developed road infrastructure, most jobs can be reached within a 30-minute drive from all urban areas, with exceptions towards the outskirts of Tuggeranong, Gungahlin and Belconnen. Job accessibility by car reduces slightly from 2016 to 2031, particularly in the north of Gungahlin and Belconnen, and east of Queanbeyan (Figure 6-8 and Figure 6-9). This suggests that congestion on arterials will have a material impact on travel times to job opportunities for residents in these areas.

Job accessibility by public transport is relatively stable between 2016 and 2031, with many residents unable to reach a high proportion of the region's jobs within a 30-minute commute (Figure 6-10 and Figure 6-11). Residents who live closer to town centres, particularly in inner areas such as North and South Canberra, Woden Valley and Belconnen, have better access via public transport, while again those that live in outer ACT and Queanbeyan are less supported by public transport infrastructure. This indicates that the public transport infrastructure included in the 'do minimum' 2031 scenario is likely to severely limit the proportion of job opportunities available to residents of these areas.

Access to critical healthcare is measured by the travel time to the nearest public hospital/hospital with an emergency department by car and public transport (Figure 6-12 and Figure 6-13). Car accessibility to hospitals is far superior to public transport. In 2031, the shortest average travel time to the nearest public hospital via public transport is around 23 minutes, for residents in Woden Valley, while North and South Canberra residents are expected to travel for over 30 minutes. In other areas residents are predicted to need to travel for more than 40 minutes, with exceptions for those who live very close to a hospital (Table 6-4).

**Figure 6-8 – ACT and Queanbeyan access to jobs by Car - 2016 AM peak (7-9AM)**

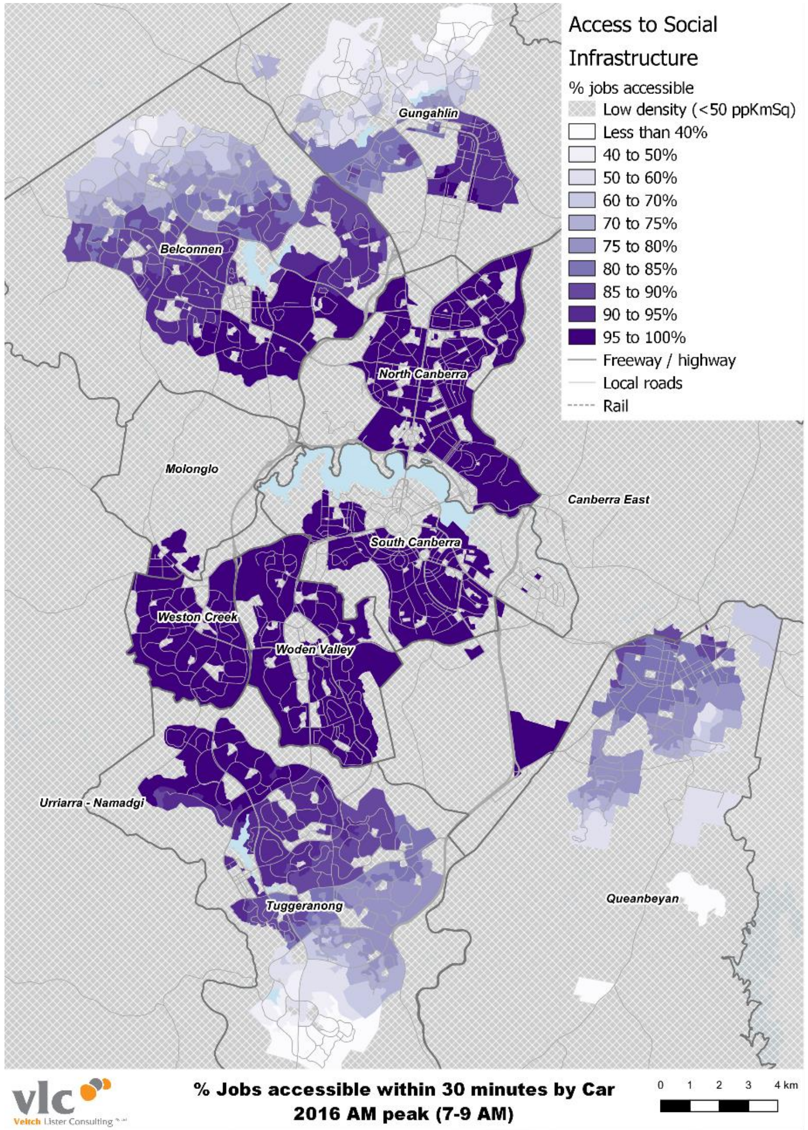
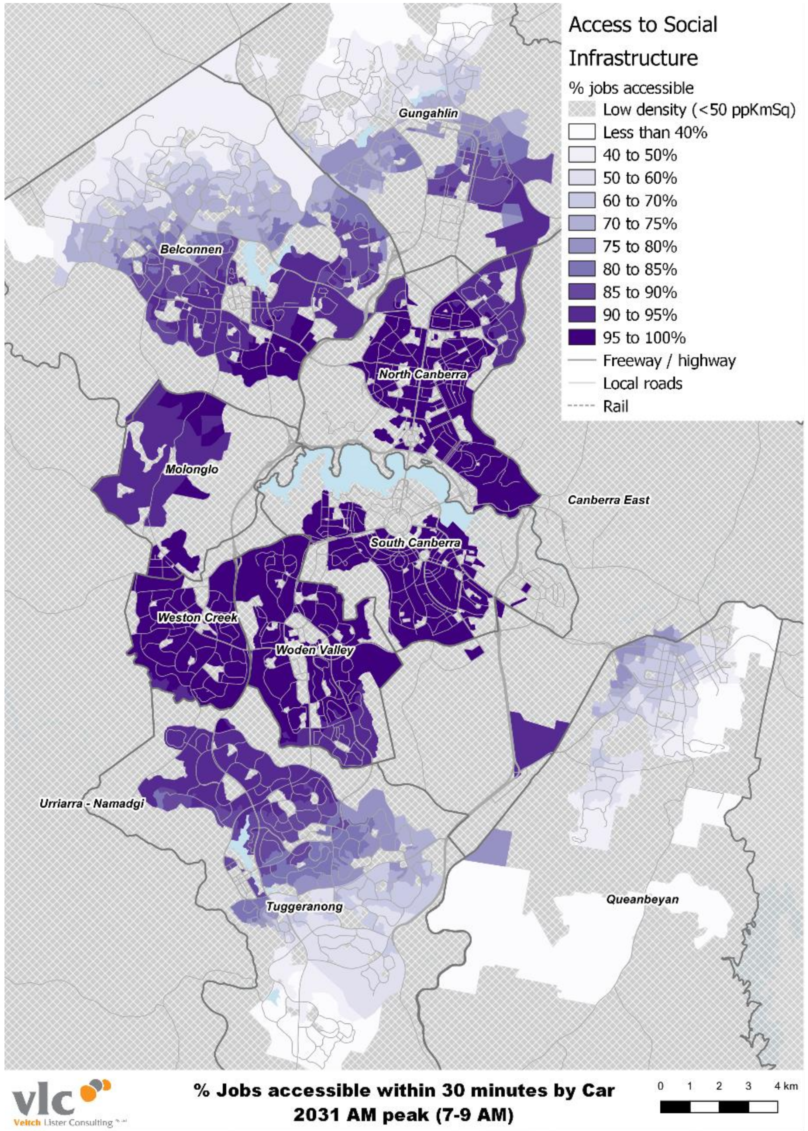
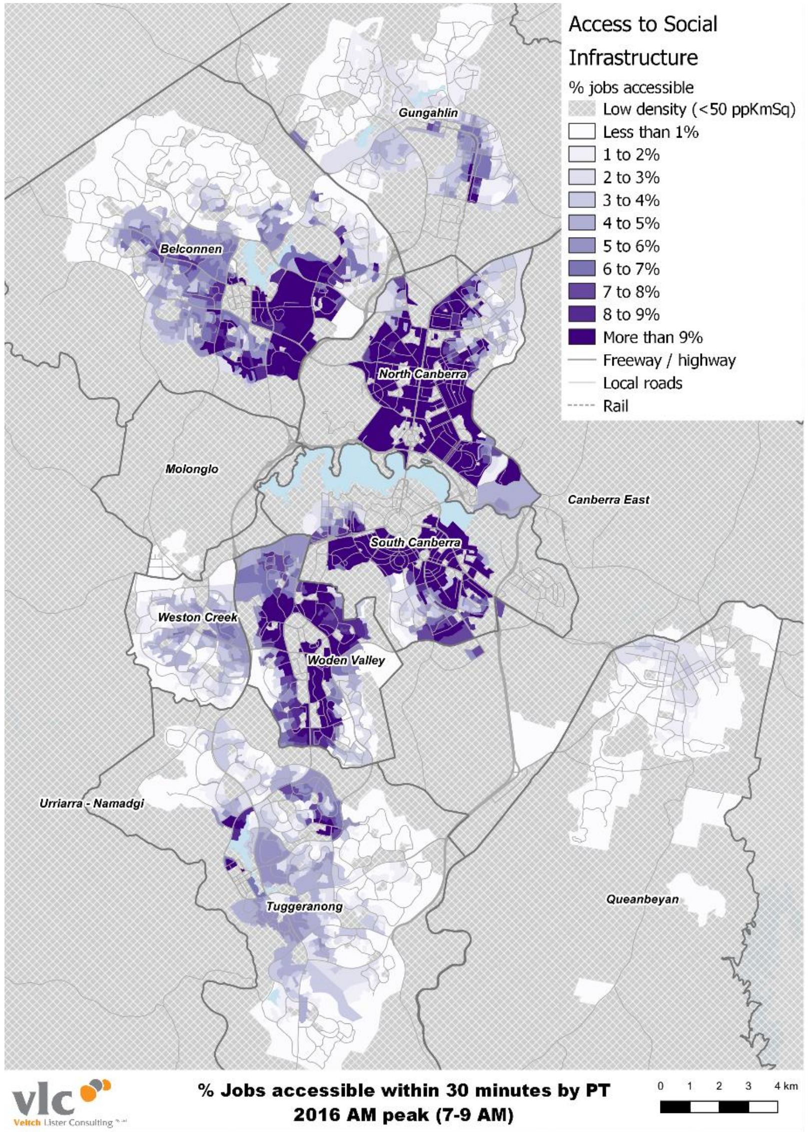


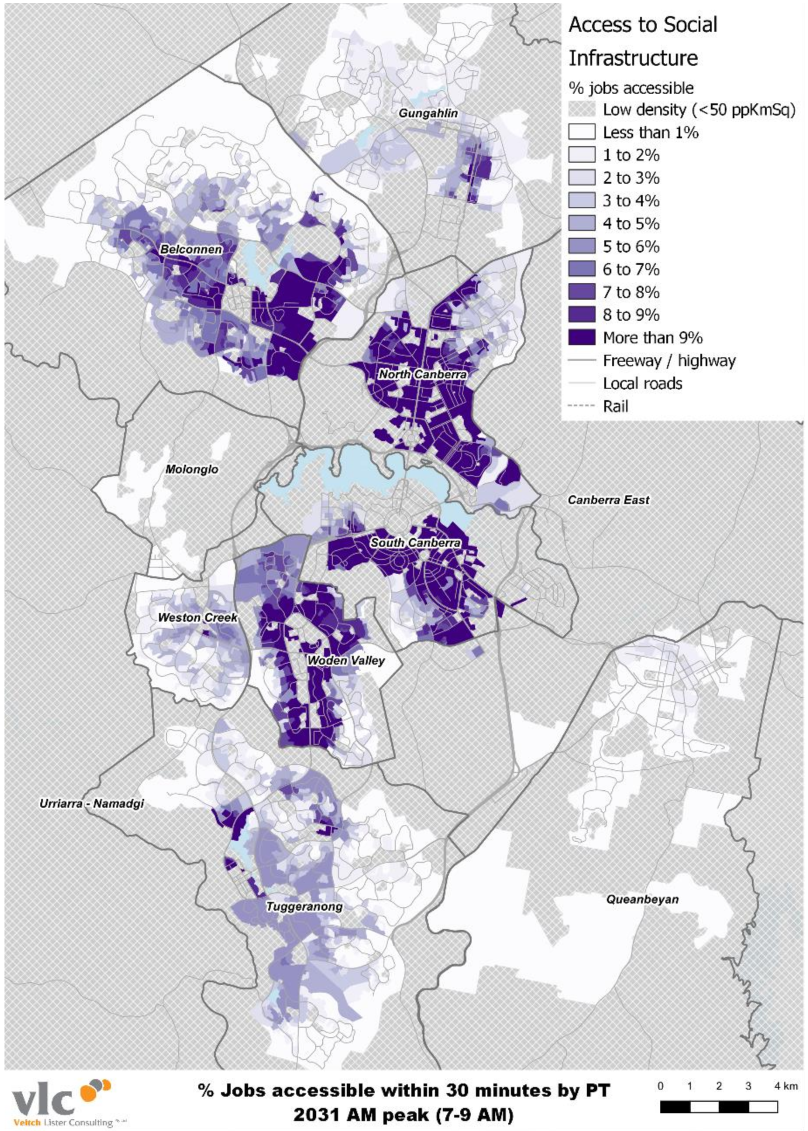

**Figure 6-9 – ACT and Queanbeyan access to jobs by Car - 2031 AM peak (7-9AM)**



## *Figure 6-10 – ACT and Queanbeyan access to jobs by PT - 2016 AM peak (7-9AM)*




## *Figure 6-11 – ACT and Queanbeyan access to jobs by PT - 2031 AM peak (7-9AM)*



### *Table 6-4 – ACT and Queanbeyan population-weighted average travel time* to the nearest public hospital by SA3 - AM peak (7-9AM)*

| SA3 | Car | | | PT | | |
|---|---|---|---|---|---|---|
| | 2016 | 2031 | *Change* | 2016 | 2031 | *Change* |
| Belconnen | 9.2 | 10.7 | *+1.5* | 40.8 | 41.8 | *+1.0* |
| Canberra East | 9.2 | 8.5 | *-0.7* | 56.9 | 53.9 | *-3.0* |
| Gungahlin | 19.1 | 18.8 | *-0.3* | 58.3 | 60.7 | *+2.4* |
| Molonglo | 8.6 | 12.2 | *+3.7* | 54.2 | 70.7 | *+16.5* |
| North Canberra | 8.7 | 9.2 | *+0.5* | 35.1 | 35.2 | *+0.1* |
| South Canberra | 7.7 | 8.6 | *+0.9* | 33.9 | 33.9 | *-0.0* |
| Tuggeranong | 17.0 | 17.3 | *+0.4* | 50.9 | 51.3 | *+0.4* |
| Urriarra - Namadgi | 30.1 | 29.7 | *-0.4* | 272.1 | 221.7 | *-50.4* |
| Weston Creek | 9.1 | 10.1 | *+1.0* | 41.5 | 41.6 | *+0.1* |
| Woden Valley | 4.2 | 4.5 | *+0.3* | 23.0 | 23.1 | *+0.1* |
| Queanbeyan^ | 6.6 | 10.1 | *+3.5* | 42.4 | 57.1 | *+14.7* |
| **Total ACT and Queanbeyan** | **11.5** | **12.2** | ***+0.7*** | **43.8** | **46.8** | ***+3.0*** |

*The travel times reflect all modelled zones and so does not reflect adjustments made in Figure 6-13 (see 'Limitations of strategic accessibility modelling' box above).

^ Urban and peri-urban portions of the SA3 only

**Figure 6-12 – ACT and Queanbeyan average time to nearest public/emergency hospital by Car - 2031 AM peak (7-9AM)**

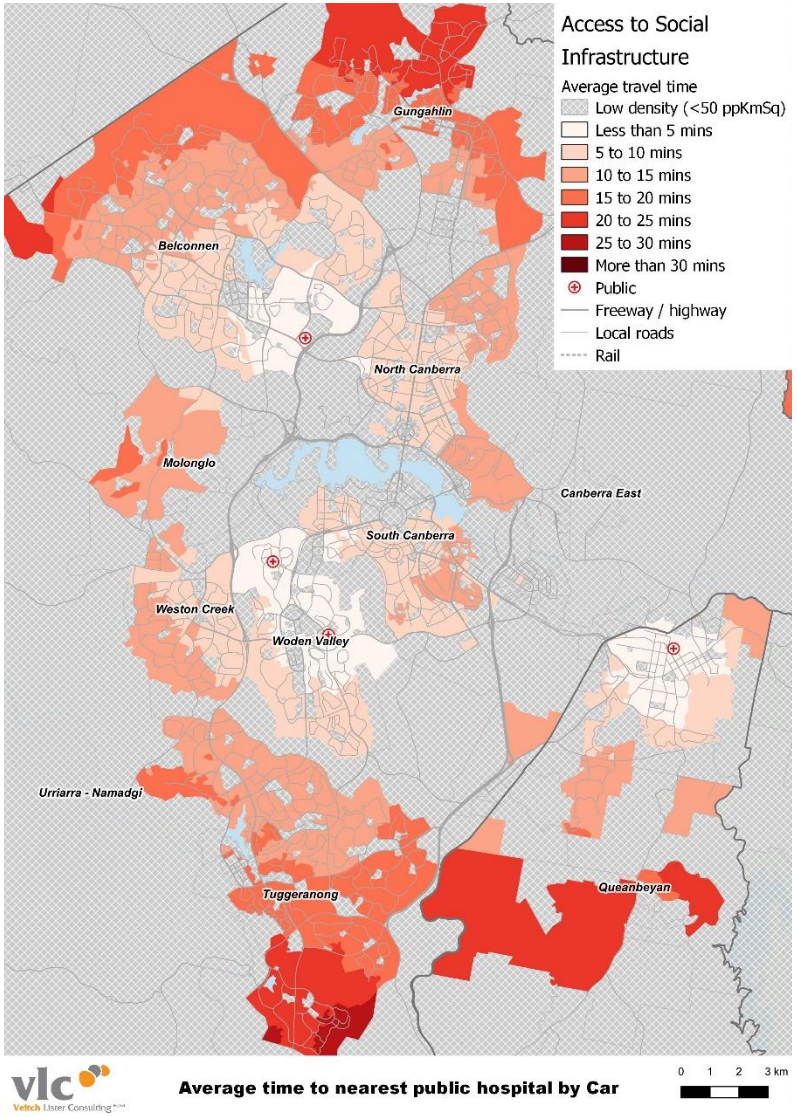
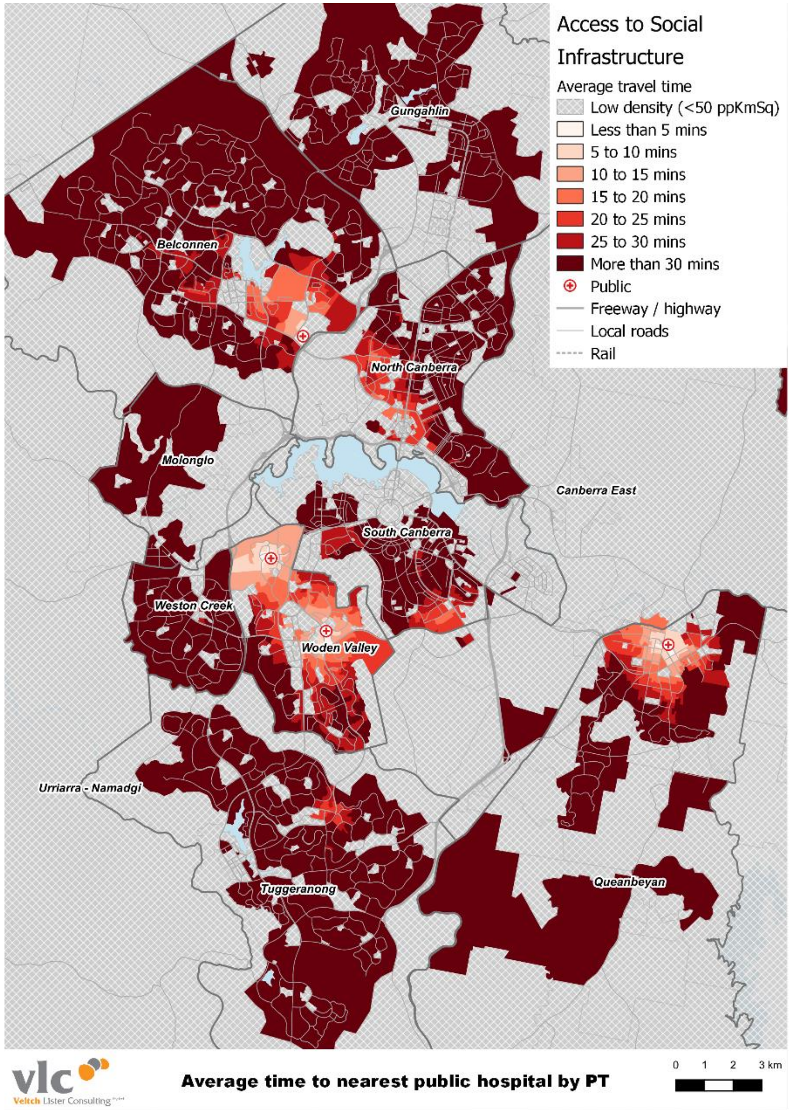



**Figure 6-13 – ACT and Queanbeyan average time to nearest public/emergency hospital by PT - 2031 AM peak (7-9AM)**



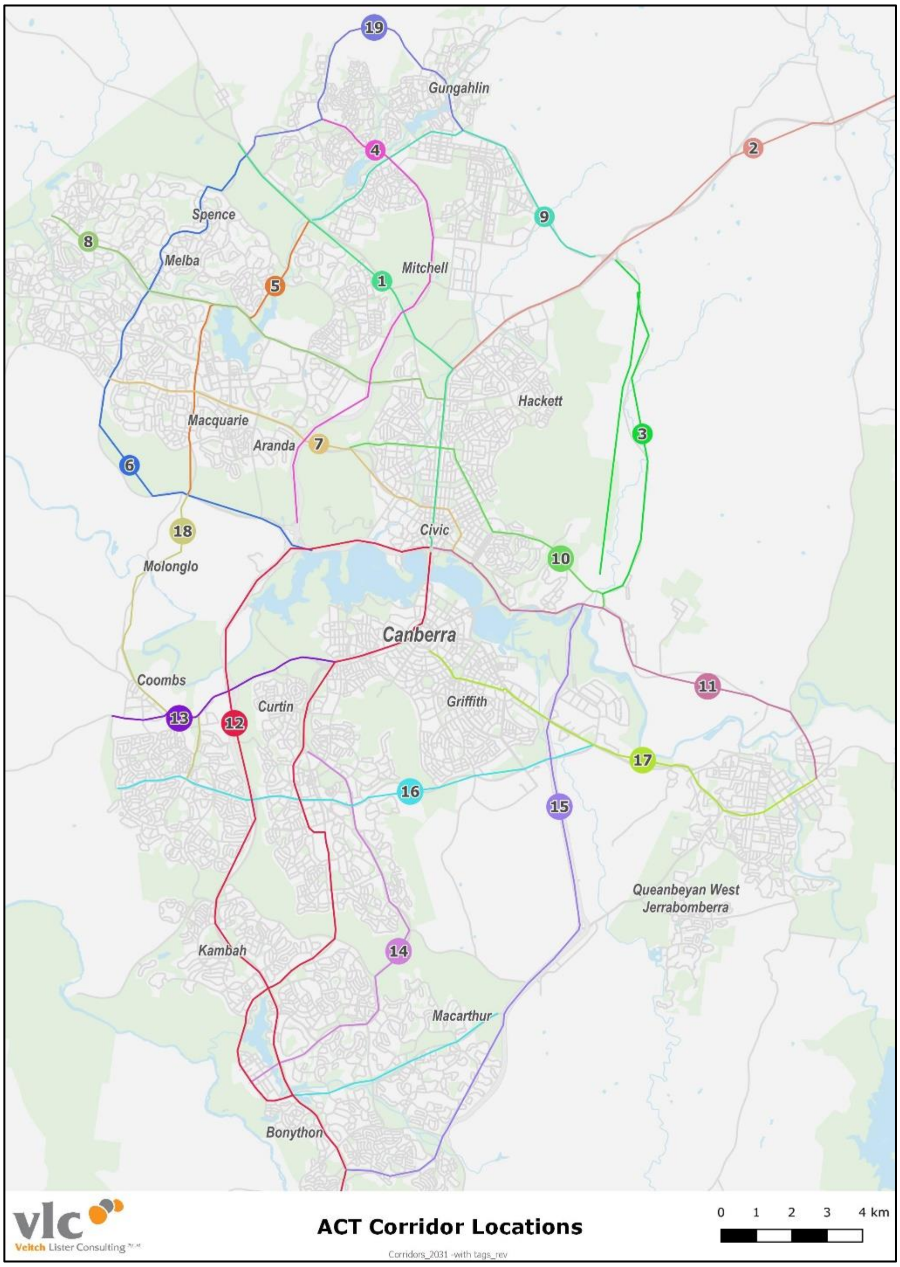
# 7. Assessment

This section draws together the analysis of the preceding chapters and assesses transport network performance along two dimensions: corridors and regions. It also discusses some of the economic impacts of the deteriorating network performance.

## 7.1 Corridor deficiencies

The ACT and Queanbeyan's key corridors are expected to come under increased pressure by 2031, causing delays for motorists and, to an extent, users of buses. Increasing demand can also increase crowding on public transport services if service frequencies do not keep pace. In this section we measure network performance for road and bus corridors in 2016 and 2031 using key multi-modal corridors that were identified with Infrastructure Australia (Figure 7-1 and Appendix Table C-1).

*Figure 7-1 – ACT and Queanbeyan transport corridors*



Performance of road corridors is measured in two ways: delay hours (an aggregate measure) and percentage of journey time accounted for by congestion (a measure of individual road user experience).

The Drakeford Drive/Tuggeranong Pky/Parkes Way corridor, Gungahlin Drive and Monaro Highway have the longest total delays in 2016 (Table 7-1). The performance of Drakeford Drive and Monaro Highway corridors are expected to worsen, and continue to be the worst performing road corridors in 2031, with peak period delay hours increasing to around 700 to 1,000 respectively (Table 7-2). The Canberra Avenue corridor is also forecast to worsen significantly, with delay hours almost doubling to approximately 800 to 900 delay hours in each peak period in 2031. Substantial employment growth in Tuggeranong is a likely driver of the increase on Drakeford Drive and Monaro Highway corridors, while the increased delay on Canberra Avenue is likely due to increased demand from the Tralee and Googong growth areas in the Queanbeyan region. In contrast, Gungahlin Drive is not forecast to experience an increase in delay hours despite significant population and employment growth to 2031. This is likely due to stage one of the Canberra Metro, which connects Gungahlin to Canberra's CBD.

***Table 7-1 – ACT and Queanbeyan 2016 ten most delayed road corridors (ranked by total delay)***

| | Corridor name | Number | Direction | Delay Hours |
|---|---|---|---|---|
| | ***AM peak (7-9AM)*** | | | |
| **1** | Drakeford Dve/Tuggeranong Pky/Parkes Way Corridor | 12 | NB | 800 |
| **2** | Gungahlin Dve Corridor | 4 | SB | 500 |
| **3** | Barton Hwy/Northbourne Ave Corridor | 1 | SB | 500 |
| **4** | Canberra Avenue Corridor | 17 | WB | 500 |
| **5** | Monaro Hwy Corridor | 15 | NB | 500 |
| **6** | Athllon Dve/Commonwealth Ave Corridor | 12 | NB | 400 |
| **7** | Kingsford Smith Dve/William Hovell Dve Corridor | 6 | SB | 300 |
| **8** | Belconnen Way/Barry Dve Corridor | 7 | EB | 300 |
| **9** | Canberra Airport to Civic Corridor | 11 | WB | 300 |
| **10** | Ginninderra Dve Corridor | 8 | EB | 200 |
| | ***PM peak (4-6PM)*** | | | |
| **1** | Drakeford Dve/Tuggeranong Pky/Parkes Way Corridor | 12 | SB | 700 |
| **2** | Monaro Hwy Corridor | 15 | SB | 500 |
| **3** | Canberra Avenue Corridor | 17 | EB | 400 |
| **4** | Barton Hwy/Northbourne Ave Corridor | 1 | NB | 400 |
| **5** | Gungahlin Dve Corridor | 4 | NB | 400 |
| **6** | Athllon Dve/Commonwealth Ave Corridor | 12 | SB | 300 |
| **7** | Canberra Airport to Civic Corridor | 11 | EB | 300 |
| **8** | Kingsford Smith Dve/William Hovell Dve Corridor | 6 | NB | 200 |
| **9** | Belconnen Way/Barry Dve Corridor | 7 | WB | 200 |
| **10** | Gundaroo Dve/Horse Park Dve Corridor | 9 | WB | 200 |

### Table 7-2 – ACT and Queanbeyan 2031 ten most delayed road corridors (ranked by total delay)

| | Corridor Name | Number | Direction | Delay Hours |
|---|---|---|---|---|
| | ***AM peak (7-9AM)*** | | | |
| **1** | Drakeford Dve/Tuggeranong Pky/Parkes Way Corridor | 12 | NB | 1,000 |
| **2** | Canberra Avenue Corridor | 17 | WB | 900 |
| **3** | Monaro Hwy Corridor | 15 | NB | 700 |
| **4** | Barton Hwy/Northbourne Ave Corridor | 1 | SB | 600 |
| **5** | Canberra Airport to Civic Corridor | 11 | WB | 600 |
| **6** | Athllon Dve/Commonwealth Ave Corridor | 12 | NB | 600 |
| **7** | Gungahlin Dve Corridor | 4 | SB | 500 |
| **8** | Kingsford Smith Dve/William Hovell Dve Corridor | 6 | SB | 500 |
| **9** | Belconnen Way/Barry Dve Corridor | 7 | EB | 400 |
| **10** | East-West Corridors (Hindmarsh Dve) | 16 | EB | 300 |
| | ***PM peak (4-6PM)*** | | | |
| **1** | Drakeford Dve/Tuggeranong Pky/Parkes Way Corridor | 12 | SB | 800 |
| **2** | Canberra Avenue Corridor | 17 | EB | 800 |
| **3** | Monaro Hwy Corridor | 15 | SB | 800 |
| **4** | Canberra Airport to Civic Corridor | 11 | EB | 600 |
| **5** | Athllon Dve/Commonwealth Ave Corridor | 12 | SB | 500 |
| **6** | Barton Hwy/Northbourne Ave Corridor | 1 | NB | 500 |
| **7** | Gungahlin Dve Corridor | 4 | NB | 400 |
| **8** | Kingsford Smith Dve/William Hovell Dve Corridor | 6 | NB | 400 |
| **9** | East-West Corridors (Hindmarsh Dve) | 16 | WB | 300 |
| **10** | Belconnen Way/Barry Dve Corridor | 7 | WB | 300 |

By 2031, motorists in the ACT and Queanbeyan can expect slightly longer traffic delays, where users can expect to spend approximately half of their travel time stuck in traffic along the worst corridors, compared to 40 per cent in 2016 (Table 7-3 and Table 7-4). The worst performers in the 2016 peak periods include William Slim Drive / Coulter Drive, Barton Hwy / Northbourne Ave, and Gundaroo Drive / Horse Park Drive corridors. These corridors are important arterials connecting people to Belconnen and across Gungahlin, as well as to Gungahlin Drive and Tuggeranong Parkway, which provides a significant north-south connection through the ACT. Notably, Gundaroo Drive worsens despite plans for its duplication, which reflects high nearby population growth, and suggests that the increased capacity may also attract some road users from alternative routes (and possibly from alternative modes).

By 2031, increased delays on the Canberra Airport to Civic and Canberra Avenue corridors push these to the top of the list, due in part to growth in the Queanbeyan region. The William Slim Drive / Coulter Drive corridor is forecast to experience an improvement in traffic delays, with almost a 10 to 20 per cent decrease in user delay, and dropping out of the ten most delayed corridors in 2031.

Duplication of the section of Gungahlin Drive parallel to this north-south corridor encourages motorists to shift routes.

*Table 7-3 – ACT and Queanbeyan 2016 top ten most delayed road corridors (ranked by user delay)*

| | Corridor name | Number | Direction | Length (km) | % of journey time accounted for by congestion | Delay per vehicle (mins) | Congested travel time for corridor (mins) |
|---|---|---|---|---|---|---|---|
| | ***AM peak (7-9AM)*** | | | | | | |
| **1** | William Slim Dve/Coulter Dve Corridor | 5 | SB | 10 | 40% | 6 | 15 |
| **2** | Barton Hwy/Northbourne Ave Corridor | 1 | SB | 14 | 39% | 9 | 22 |
| **3** | Canberra Airport to Civic Corridor | 11 | WB | 15 | 39% | 8 | 21 |
| **4** | Canberra Avenue Corridor | 17 | WB | 13 | 39% | 8 | 21 |
| **5** | Gundaroo Dve/Horse Park Dve Corridor | 9 | EB | 11 | 39% | 6 | 16 |
| **6** | Gungahlin Dve Corridor | 4 | SB | 15 | 38% | 7 | 20 |
| **7** | Kingsford Smith Dve/William Hovell Dve Corridor | 6 | SB | 18 | 38% | 9 | 23 |
| **8** | Drakeford Dve/Tuggeranong Pky/Parkes Way Corridor | 12 | NB | 33 | 33% | 12 | 37 |
| **9** | Ginninderra Dve Corridor | 8 | EB | 13 | 32% | 5 | 16 |
| **10** | Gundaroo Dve/Horse Park Dve Corridor | 9 | WB | 11 | 29% | 4 | 13 |
| | ***PM peak (4-6PM)*** | | | | | | |
| **1** | William Slim Dve/Coulter Dve Corridor | 5 | NB | 10 | 39% | 6 | 14 |
| **2** | Gundaroo Dve/Horse Park Dve Corridor | 9 | WB | 11 | 37% | 6 | 15 |
| **3** | Canberra Avenue Corridor | 17 | EB | 13 | 35% | 7 | 20 |
| **4** | Barton Hwy/Northbourne Ave Corridor | 1 | NB | 14 | 35% | 7 | 21 |
| **5** | Canberra Airport to Civic Corridor | 11 | EB | 15 | 34% | 7 | 19 |
| **6** | Gungahlin Dve Corridor | 4 | NB | 15 | 33% | 6 | 18 |
| **7** | Kingsford Smith Dve/William Hovell Dve Corridor | 6 | NB | 18 | 33% | 7 | 21 |
| **8** | Drakeford Dve/Tuggeranong Pky/Parkes Way Corridor | 12 | SB | 32 | 30% | 11 | 36 |
| **9** | Monaro Hwy Corridor | 15 | SB | 21 | 29% | 6 | 21 |
| **10** | Ginninderra Dve Corridor | 8 | WB | 13 | 27% | 4 | 15 |

## Table 7-4 – ACT and Queanbeyan 2031 top ten most delayed road corridors (ranked by user delay)

| | Corridor name | Number | Direction | Length (km) | % of journey time accounted for by congestion | Delay per vehicle (mins) | Congested travel time for corridor (mins) |
|---|---|---|---|---|---|---|---|
| | **AM peak (7-9AM)** | | | | | | |
| **1** | Canberra Airport to Civic Corridor | 11 | WB | 15 | 54% | 15 | 28 |
| **2** | Canberra Avenue Corridor | 17 | WB | 13 | 51% | 13 | 26 |
| **3** | Barton Hwy/Northbourne Ave Corridor | 1 | SB | 14 | 45% | 11 | 24 |
| **4** | Gungahlin Dve Corridor | 4 | SB | 15 | 38% | 7 | 20 |
| **5** | Ginninderra Dve Corridor | 8 | EB | 13 | 38% | 7 | 18 |
| **6** | Kingsford Smith Dve/William Hovell Dve Corridor | 6 | SB | 18 | 35% | 8 | 22 |
| **7** | Drakeford Dve/Tuggeranong Pky/Parkes Way Corridor | 12 | NB | 33 | 35% | 13 | 38 |
| **8** | Cotter Road Corridor | 13 | EB | 7 | 35% | 3 | 9 |
| **9** | Monaro Hwy Corridor | 15 | NB | 20 | 34% | 8 | 24 |
| **10** | Belconnen Way/Barry Dve Corridor | 7 | EB | 12 | 34% | 6 | 18 |
| | **PM peak (4-6PM)** | | | | | | |
| **1** | Canberra Airport to Civic Corridor | 11 | EB | 15 | 50% | 13 | 26 |
| **2** | Canberra Avenue Corridor | 17 | EB | 13 | 46% | 11 | 24 |
| **3** | Barton Hwy/Northbourne Ave Corridor | 1 | NB | 14 | 39% | 9 | 22 |
| **4** | Monaro Hwy Corridor | 15 | SB | 21 | 35% | 8 | 23 |
| **5** | Cotter Road Corridor | 13 | WB | 7 | 34% | 3 | 9 |
| **6** | East-West Corridors (Hindmarsh Dve) | 16 | WB | 14 | 33% | 6 | 18 |
| **7** | Ginninderra Dve Corridor | 8 | WB | 13 | 33% | 5 | 16 |
| **8** | Gungahlin Dve Corridor | 4 | NB | 15 | 32% | 6 | 18 |
| **9** | East-West Corridors (Isabella Dve) | 16 | EB | 6 | 31% | 2 | 7 |
| **10** | Drakeford Dve/Tuggeranong Pky/Parkes Way Corridor | 12 | SB | 32 | 31% | 11 | 36 |

The additional demand placed on the ACT and Queanbeyan's public transport system to 2031 is expected to result in some deterioration in network performance. In this study, high levels of crowding are taken as an indicator of poor network performance. (In reality, other adverse network performance outcomes not modelled by VLC are likely to result from high loadings of services, such as increased dwell times at stations, reduced reliability and passengers being unable to board their preferred service.)

Crowding on the worst corridors of the bus network are expected to exceed seated capacity by 2031, with the Barton Hwy/Northbourne Ave, Cotter Road and Weston to Molonglo corridors also exceeding crush capacity during the peaks (Table 7-5 and Table 7-6). This is likely due to increased passenger demand, particularly from the Molonglo Valley growth area, which is not matched by increases in service frequencies.

The modelling indicates that users will also experience uncomfortable levels of crowding particularly on corridors that connect commuters to Canberra's CBD; bus loadings on these sections are forecast to be above vehicle seated capacities.

*Table 7-5 – ACT and Queanbeyan crowded sections of 2016 bus network*

| Corridor | Direction | Indicative volume / seated capacity | Indicative volume / crush capacity |
|---|---|---|---|
| | | ***AM peak (7-9AM)*** | |
| Belconnen Way/Barry Dve Corridor | EB | 0.8 | 0.5 |
| Barton Hwy/Northbourne Ave Corridor | SB | 0.8 | 0.5 |
| Cotter Road Corridor | EB | 0.8 | 0.5 |
| Canberra Avenue Corridor | WB | 0.8 | 0.5 |
| Federal Hwy Corridor | WB | 0.8 | 0.5 |
| | | ***PM peak (4-6PM)*** | |
| Cotter Road Corridor | WB | 0.9 | 0.5 |
| Federal Hwy Corridor | EB | 0.8 | 0.5 |
| Belconnen Way/Barry Dve Corridor | WB | 0.8 | 0.5 |
| Drakeford Dve/Tuggeranong Pky/Parkes Way Corridor | SB | 0.8 | 0.5 |
| Barton Hwy/Northbourne Ave Corridor | NB | 0.7 | 0.5 |

*Table 7-6 – ACT and Queanbeyan crowded sections of 2031 bus network*

| Corridor | Direction | Indicative volume / seated capacity | Indicative volume / crush capacity |
|---|---|---|---|
| | | ***AM peak (7-9AM)*** | |
| Barton Hwy/Northbourne Ave Corridor | SB | 2.1 | 1.4 |
| Weston to Molonglo Corridor | SB | 1.7 | 1.1 |
| Cotter Road Corridor | EB | 1.4 | 0.9 |
| Belconnen Way/Barry Dve Corridor | EB | 1.3 | 0.8 |
| Canberra Avenue Corridor | WB | 1.2 | 0.8 |
| | | ***PM peak (4-6PM)*** | |
| Cotter Road Corridor | WB | 1.9 | 1.2 |
| Weston to Molonglo Corridor | NB | 1.8 | 1.1 |
| Canberra Avenue Corridor | EB | 1.4 | 0.9 |
| East-West Corridors (Isabella Dve) | WB | 1.2 | 0.7 |
| Monaro Hwy Corridor | SB | 1.1 | 0.7 |

## 7.2 Regional deficiencies

Despite growth in road congestion to 2031, residents across the ACT are well-served by local social infrastructure, providing they have access to a car. In 2031, the average resident in SA3s in the ACT and Queanbeyan can reach the nearest five child care centres, nearest public primary school and nearest public secondary school within a five-minute drive in the morning peak, except for Molonglo and Queanbeyan. This is a result of modelled growth in congestion around these SA3s, that partly reflects limitations in the knowledge of the future networks in their growth areas (Section 6.1). The future congestion forecast by the model is therefore likely to be overstated. However, the modelling highlights what could happen if public transport services, local road networks and social infrastructure investment does not keep pace with projected increases in population.

Accessibility for the ACT and Queanbeyan residents without access to a car is lower, however, public transport is still a feasible alternative particularly those living in denser areas of the region. The average resident would need to spend 10 to 20 minutes on public transport to accompany their young child to care or primary school, or travel to high school, while residents in Canberra East, Queanbeyan or Molonglo would need to spend 35 to 45 minutes. The low accessibility in growth areas is largely due to the limited knowledge of future social and physical infrastructure in these areas, coupled with the limited bus services that cater for localised travel needs.

Increased congestion on roads in the ACT and Queanbeyan will affect access to jobs, but the magnitude of the congestion and its impact is fairly limited, compared to other Australian cities. Residents in Queanbeyan are forecast to experience the greatest decrease in job accessibility. Queanbeyan's population growth outpaces local employment growth and the future population faces challenges in connecting to jobs in the ACT.

## 7.3 Economic impacts

Congestion, traffic delays and poor travel time reliability result in widespread negative impacts on the community and economy. Delays (particularly where they are unexpected) can result in missed appointments, wasted time and frustration for users of the transport system.

VLC has estimated the dollar value of the cost of congestion in the ACT and Queanbeyan in 2016 and 2031 based on the way people are prepared to trade off money for reductions in the time spent travelling (see Appendix D.4 for a detailed calculation methodology). The daily cost of congestion is estimated to rise from $837,000 in 2016 to $1.5 million in 2031 (Figure 7-2). This is consistent with the deteriorating network performance described in the preceding chapters.

Each modelled time-period contributes a different amount to the total daily congestion cost. The highest costs are accrued in the AM peak (36.9% in 2016, growing to 37.7% in 2031). The hourly cost of congestion incurred is also highest in the AM peak in both years ($0.15 million in 2016, almost doubling to $0.28 million in 2031). This is closely followed by the PM peak, while the inter-peak period has a much lower cost (Figure 7-3).

Annually, the estimated cost of congestion in the ACT and Queanbeyan is $289 million in 2016, growing to $504 million in 2031.

**Figure 7-2 – ACT and Queanbeyan average weekday cost of congestion, 2016 and 2031**

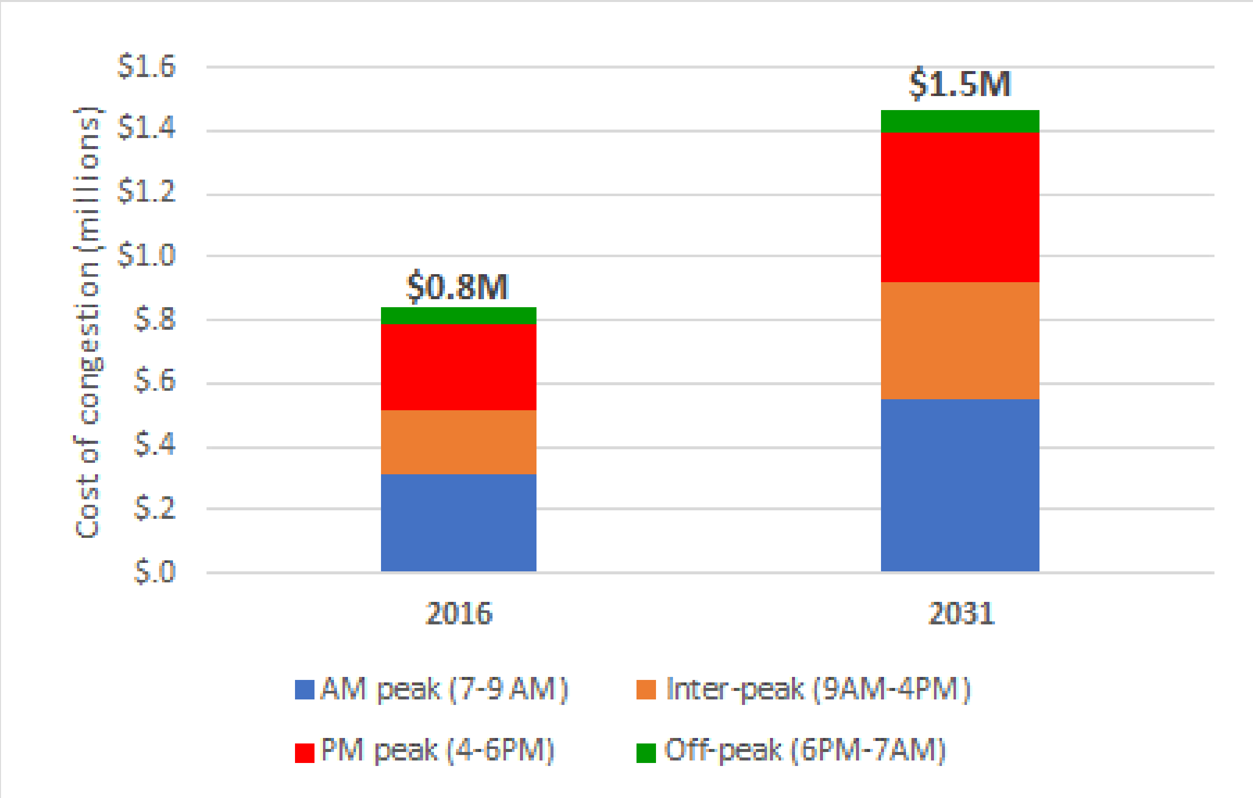
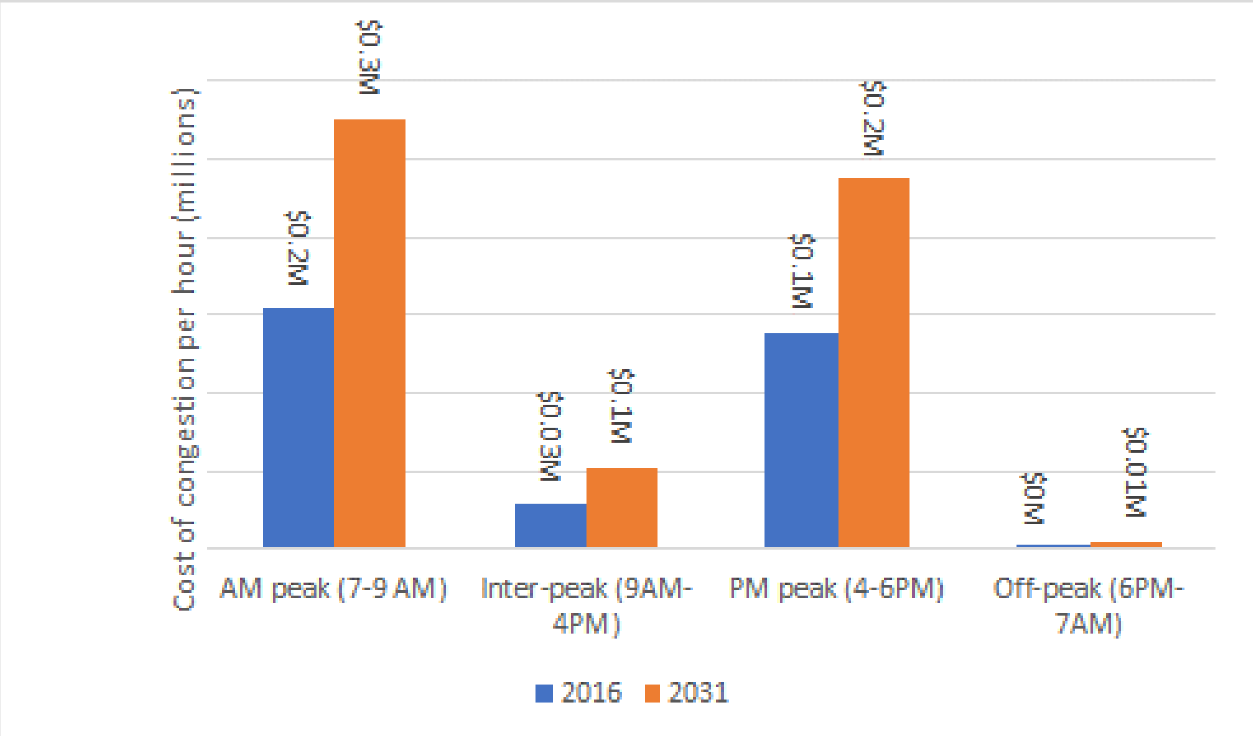



**Figure 7-3 – ACT and Queanbeyan average weekday hourly cost of congestion by time-period, 2016 and 2031**




An economic cost can also be estimated for the crowding experienced by passengers on the public transport network, this reflects the aversion people have to standing on a service, and particularly where vehicles are very full (again, see Appendix D.4 for a detailed calculation methodology).

Crowding costs are based on the average crowding of services in each two-hour peak period (similar to chapter 5). As such, the cost of crowding would underestimate costs where there is high variability in crowding levels across services within this peak period.

Estimated costs of public transport crowding are immaterial compared to the road congestion costs (Table 7-7). Though still small in magnitude, peak period crowding costs increase considerably for bus users between 2016 and 2031. This is the result of the increase in passenger kilometres outpacing the increase in in-service kilometres. The light rail line in 2031 does incur some crowding costs, broadly in line with its share of passenger kilometres on the network (Table 3-6). Annually, the estimated cost of crowding in the ACT and Queanbeyan is $600,000 in 2016, growing to $7.8 million in 2031.

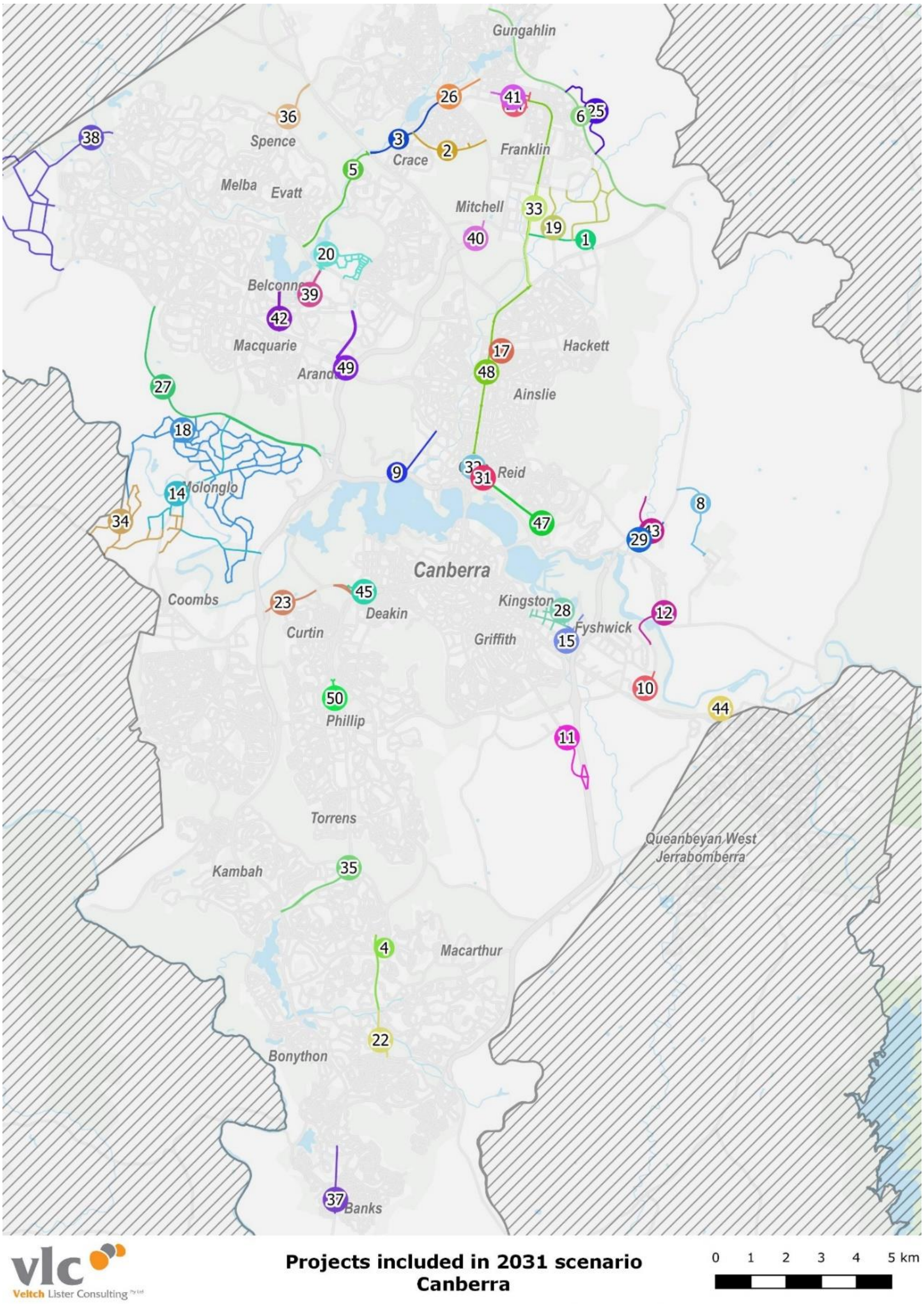
***Table 7-7 – ACT and Queanbeyan average weekday cost of public transport crowding, 2016 and 2031***

| Mode | Time period | 2016 | 2031 | Change | % change |
|---|---|---|---|---|---|
| **Bus** | AM peak (7-9AM) | $1,400 | $15,000 | $13,600 | 971% |
| | PM peak (4-6PM) | $700 | $9,600 | $8,900 | 1271% |
| **Light Rail** | AM peak (7-9AM) | $0 | $1,600 | $1,600 | - |
| | PM peak (4-6PM) | $0 | $1,200 | $1,200 | - |

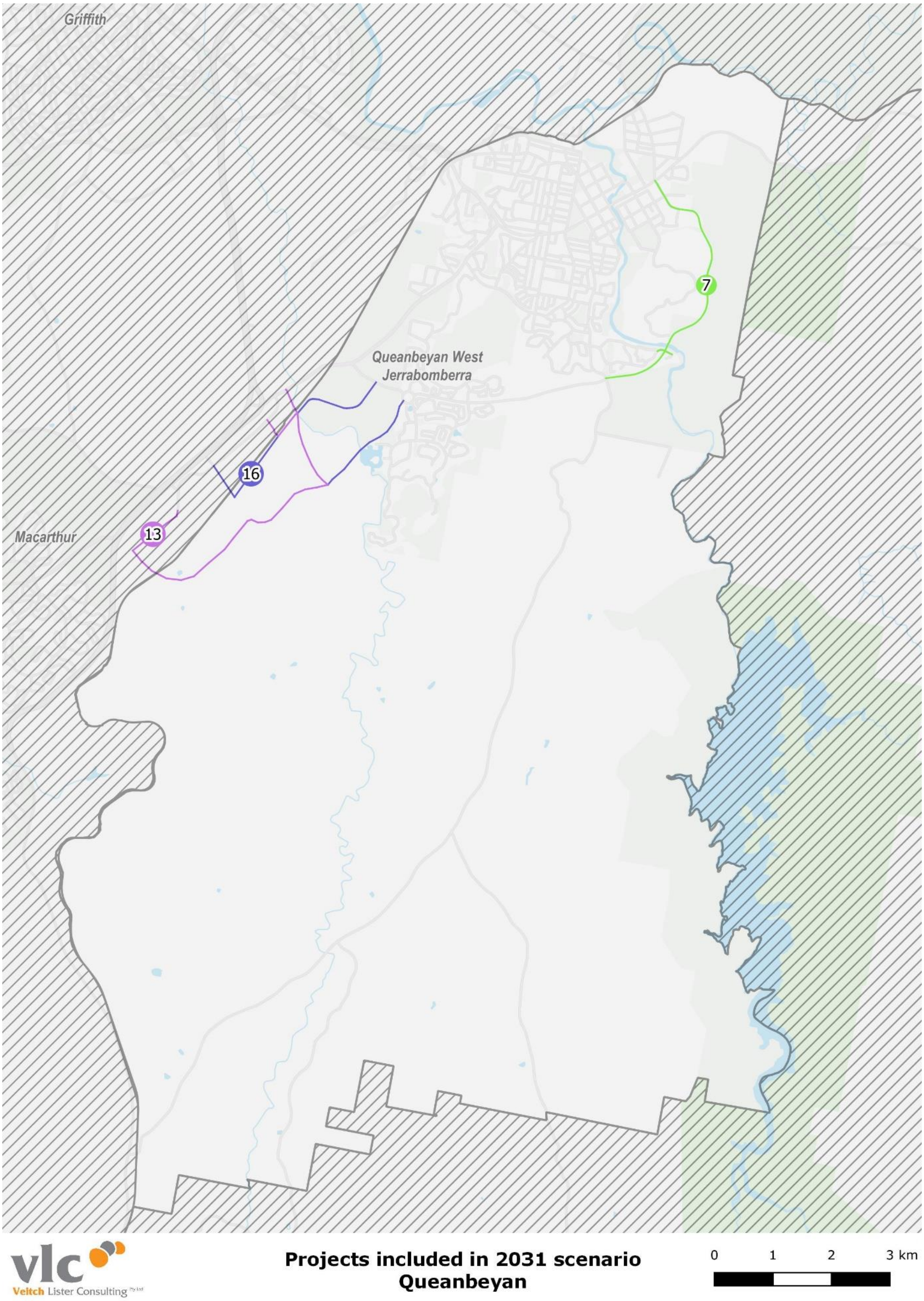
# Appendix A: Projects included in modelling

This section details the projects included in the modelling. Maps for ACT and the Queanbeyan sub-region have been included. The numbers in maps relate to project names in Appendix Table A-1.

***Appendix Figure A-1– Projects included in the 2031 forecast SA4: ACT - Canberra***



## Appendix Figure A-2– Projects included in the 2031 forecast - Queanbeyan



## Appendix Table A-1 – ACT and Queanbeyan projects included in the 2031 forecast

| Project no. | Name |
|---|---|
| 1 | Sandford Street Extension. |
| 2 | Nudurr Drive Extension. |
| 3 | Gundaroo Drive Duplication - Stage 2. |
| 4 | Ashley Drive Upgrade - Stage 1. |
| 5 | William Slim Drive Upgrade. |
| 6 | Horse Park Drive Duplication. |
| 7 | Ellerton Drive Extension. New route. |
| 8 | Airport Northern Access Road. New route. |
| 9 | Clunies Ross Street Upgrade. |
| 10 | Tennant Street Extension. New route. |
| 11 | Jerrabomberra Avenue Extension. New route. |
| 12 | Fyshwick to Pialligo Link. New route. |
| 13 | Googong/Tralee Link. New route. |
| 14 | Molonglo Roads Stage 2.5. New route. |
| 15 | East Lake Bridges. New route. |
| 16 | Googong/Tralee Additional Infrastructure. New route. |
| 17 | Cape Street extension. New route. |
| 18 | Molonglo Roads Stage 3. New route. |
| 19 | Kenny Collector Roads. New route. |
| 20 | Lawson South Development. New route. |
| 21 | Jacka Collector Roads. New route. |
| 22 | Ashley Drive Upgrade - Stage 2. New route. |
| 23 | Cotter Road Duplication Stage 2. |
| 24 | Gungahlin Town Centre Additional Network. New route. |
| 25 | Bettong Avenue. New route. |
| 26 | Gundaroo Drive Duplication - Stage 1. |
| 27 | William Hovell Drive duplication. |
| 28 | East Lake Internal Roads - attempt to restore of proj 001. New |
| 29 | Majura Rd Widening - Between Fairbairn Av and Mustang Av. |
| 30 | Taylor Estate. New route. |
| 31 | Constitution Road Extension. New route. |
| 32 | Edinburgh Avenue Extension . New route. |
| 33 | Reduction in Flemington Road Capacity. |
| 34 | Additional Molonglo roads. New route. |
| 35 | Athllon Drive Duplication . |
| 36 | Kuringa Drive. Planned upgrade. |
| 37 | Tharwa Drive. Planned upgrade. |
| 38 | Belconnen west growth area. New route. |
| 39 | Aikman Drive Duplication. |
| 40 | Gungahlin Drive Upgrade. |
| 41 | Hibberson Street pedestrian zone. |
| 42 | Benjamin Way Bike Lane. |
| 43 | Majura link road. New route. |

| Project no. | Name |
|---|---|
| **44** | Abattoir redevelopment access roads. New route. |
| **45** | Dudley St upgrade. |
| **46** | Flemington Road Bus Priority. New route. |
| **47** | Constitution Avenue Upgrade. New route. |
| **48** | Light Rail- Gungahlin to Civic. New route. |
| **49** | Belconnen to City Transitway. New route. |
| **50** | Callum Street extension. New route. |

# Appendix B: Public Transport Network Assumptions

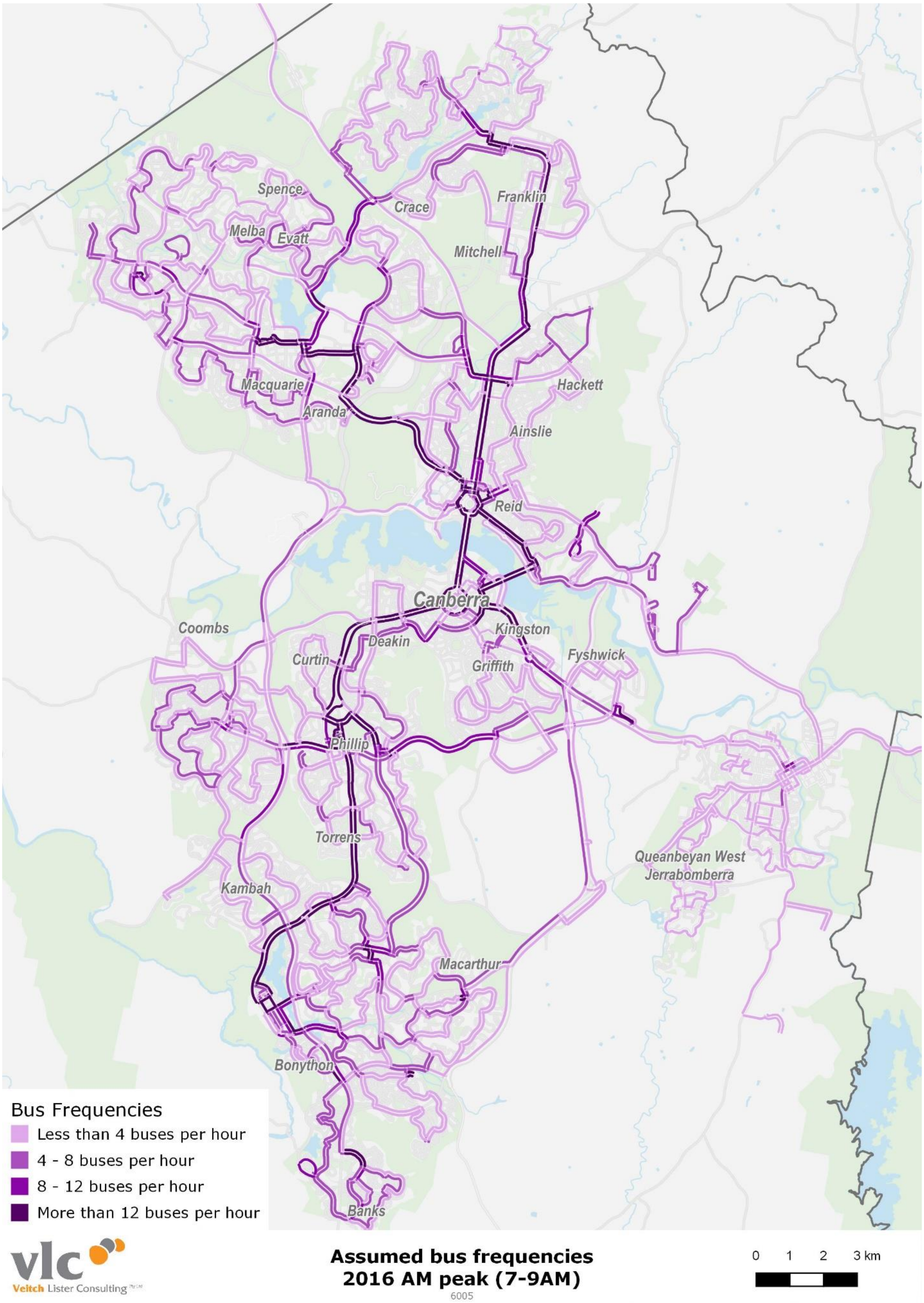
This section provides a high-level overview of the public transport networks used in the modelling.

Appendix Figure B-1 through to Appendix Figure B-4 illustrate the frequencies assumed on the ACT and Queanbeyan's bus network.

Appendix Figure B-5 and Appendix Figure B-6 illustrate the frequencies assumed on the ACT's light rail network in 2031.

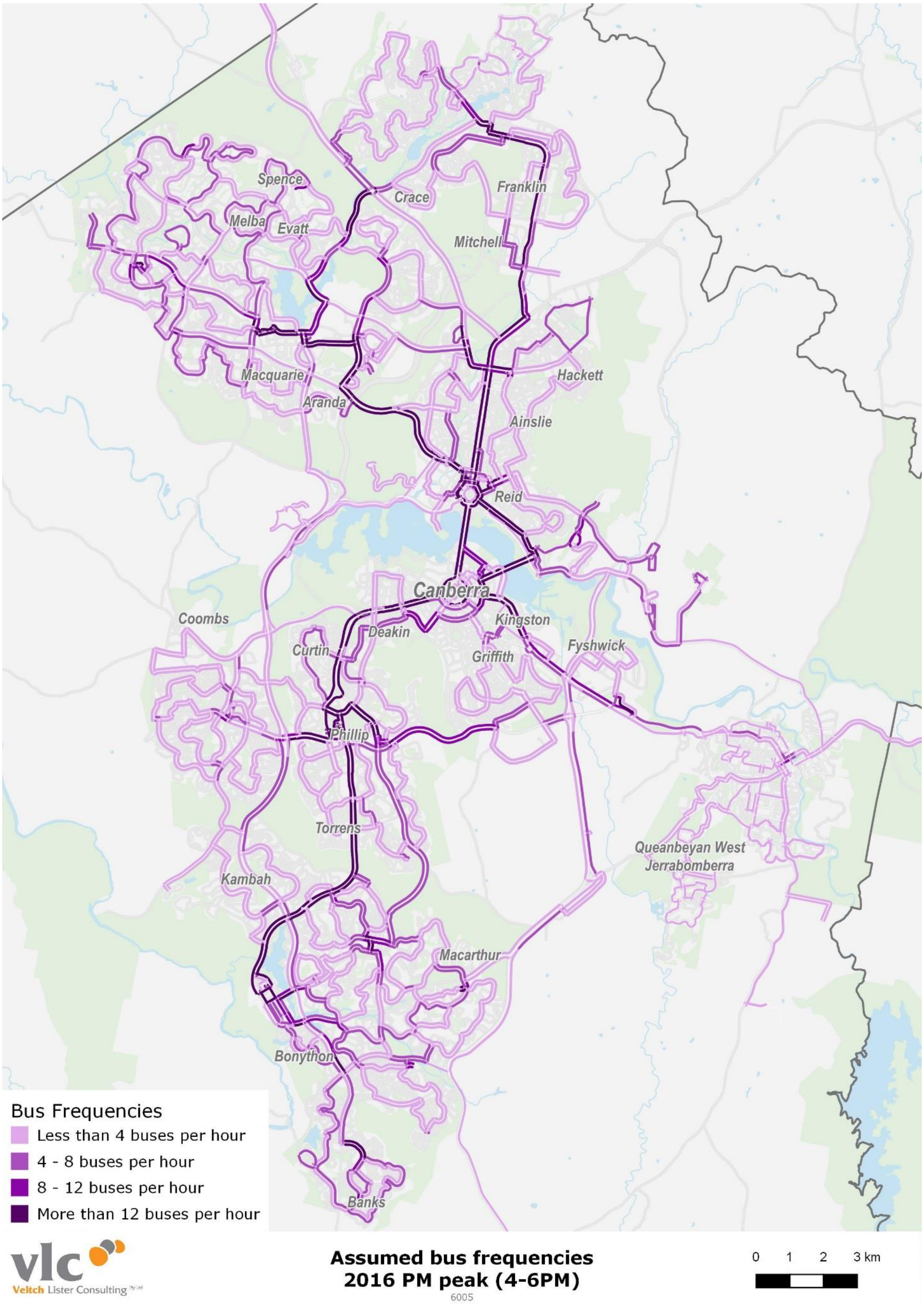
The 2016 routes and frequencies used in modelling were obtained from Transport Canberra. Details of how the 2031 network was developed can be found in Appendix D.

## Appendix Figure B-1 – ACT and Queanbeyan assumed bus frequencies, 2016 AM peak (7-9AM)



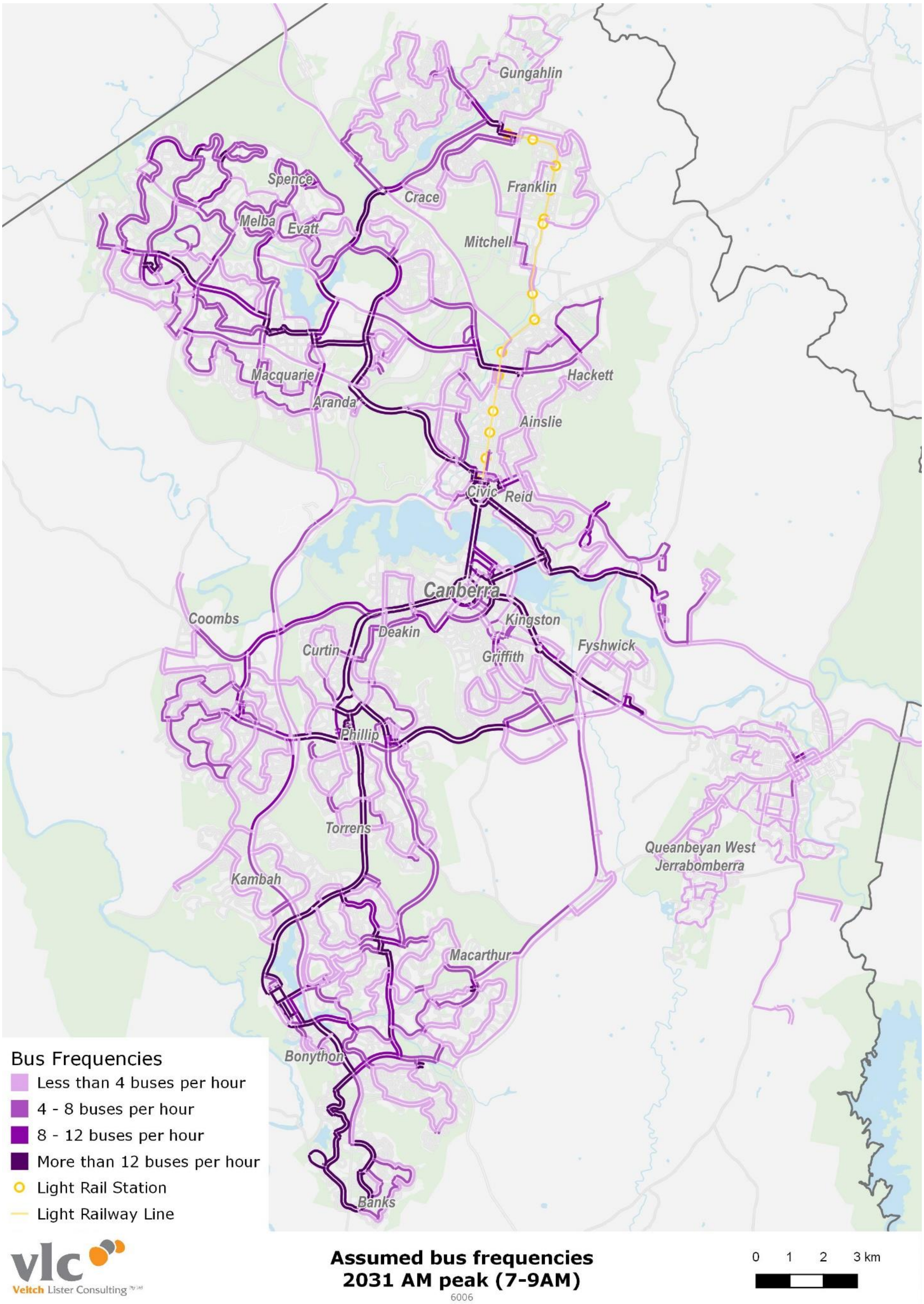

Source: Transport Canberra

## Appendix Figure B-2 – ACT and Queanbeyan assumed bus frequencies, 2016 PM peak (4-6PM)

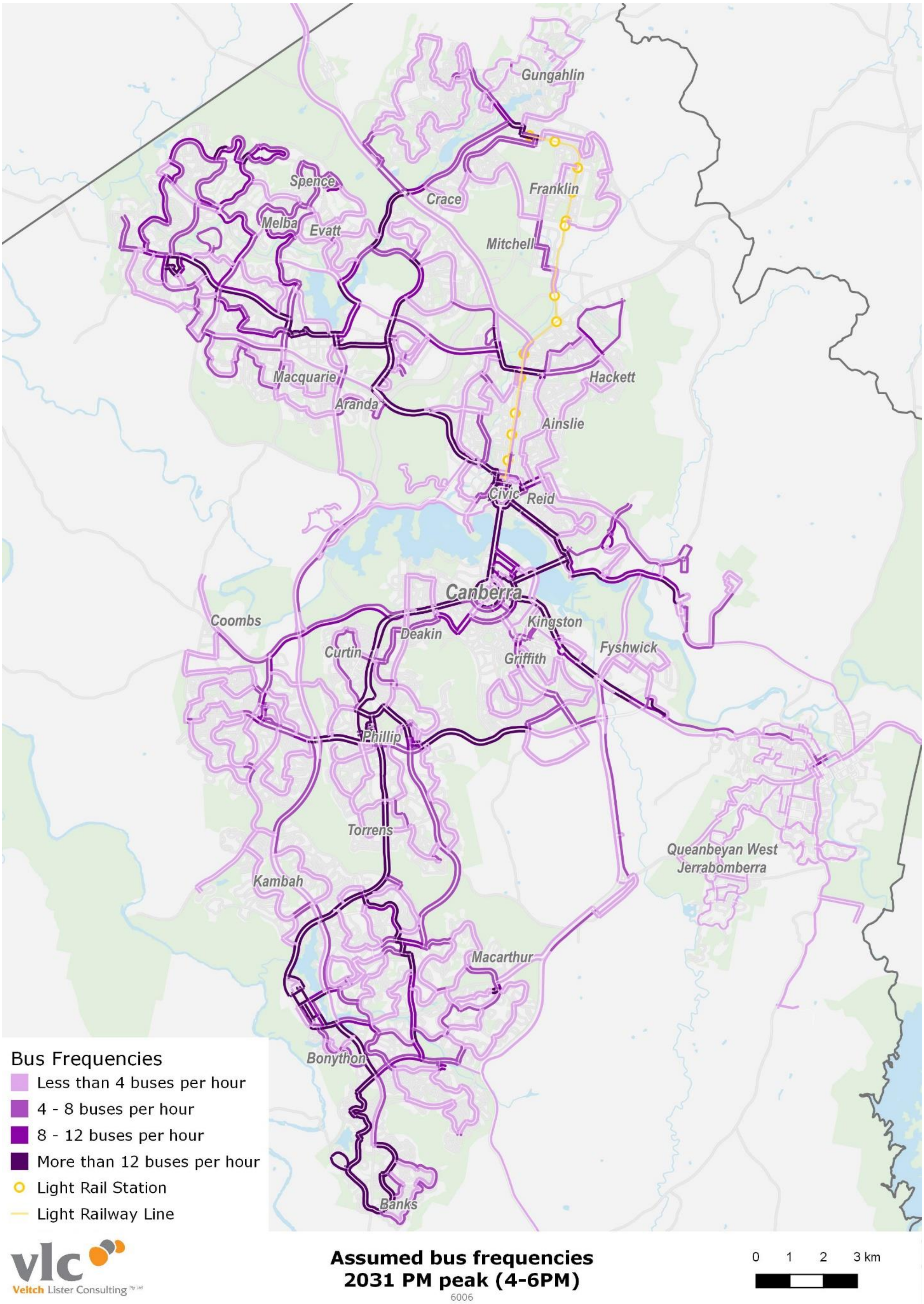



Source: Transport Canberra

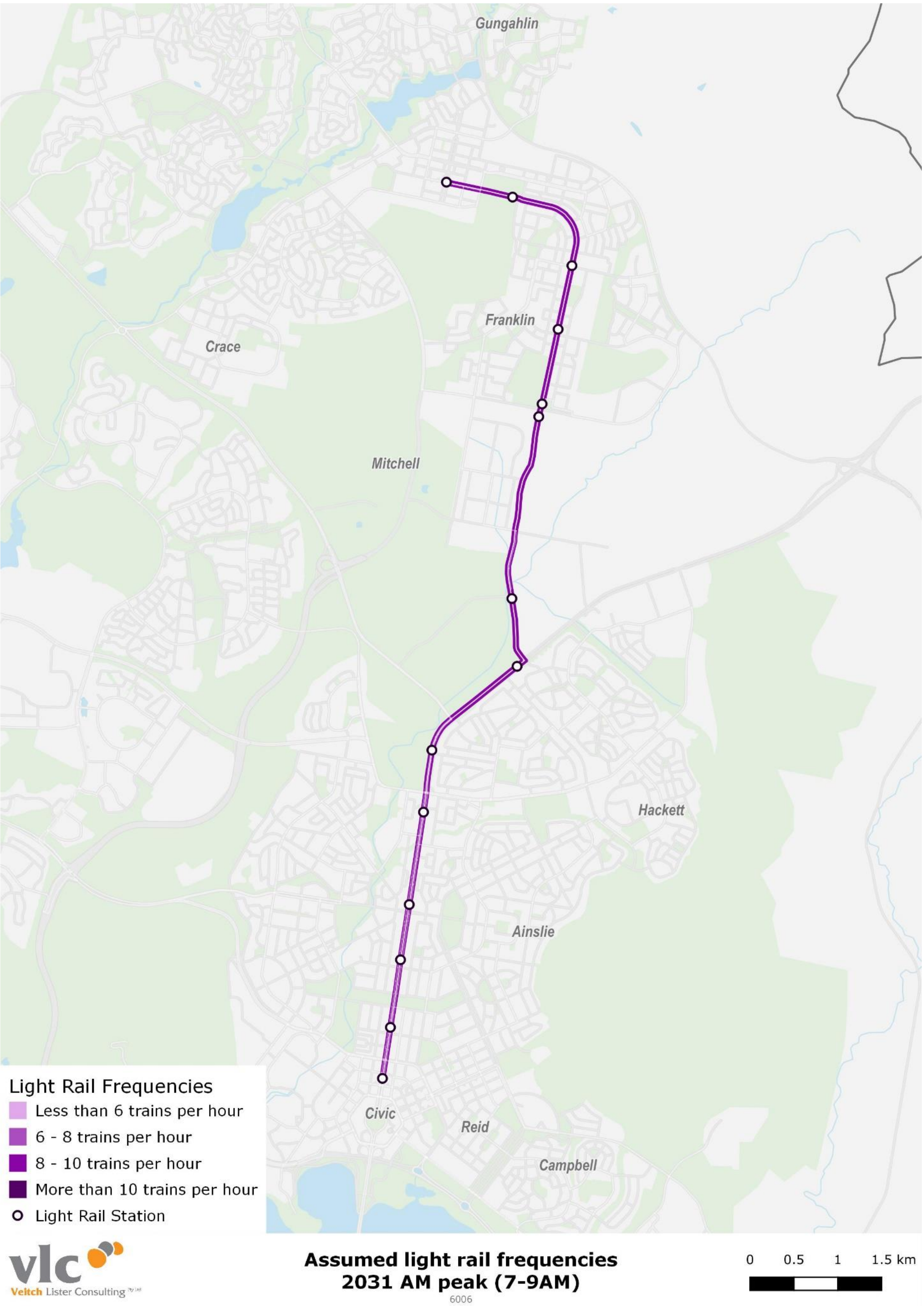
## Appendix Figure B-3 – ACT and Queanbeyan assumed bus frequencies, 2031 AM peak (7-9AM)



**Appendix Figure B-4 – ACT and Queanbeyan assumed bus frequencies, 2031 PM peak (4-6PM)**

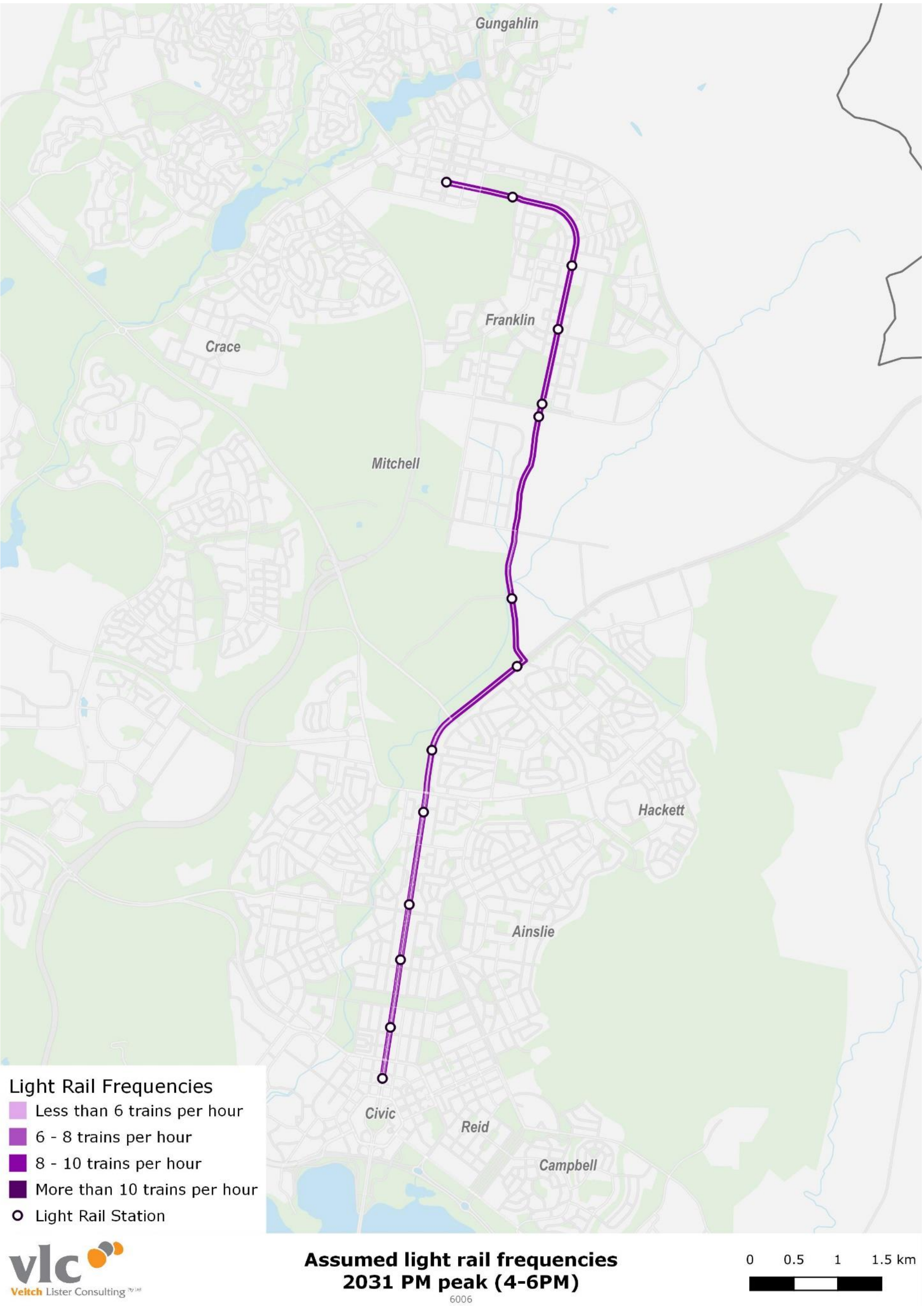


## Appendix Figure B-5 – ACT assumed light rail frequencies, 2031 AM peak (7-9AM)




Source: Transport Canberra

## Appendix Figure B-6 – ACT assumed light rail frequencies, 2031 PM peak (4-6PM)




Source: Transport Canberra

# Appendix C: ACT and Queanbeyan Road Corridors

### *Appendix Table C-1 – ACT and Queanbeyan road corridors*

| Number | Corridor name |
|---|---|
| **1** | Barton Hwy/Northbourne Ave Corridor |
| **2** | Federal Hwy Corridor |
| **3** | Majura Parkway Corridor |
| **3** | Majura Road Corridor |
| **4** | Gungahlin Drive Corridor |
| **5** | William Slim Drive/Coulter Drive Corridor |
| **6** | Kingsford Smith Drive/William Hovell Drive Corridor |
| **7** | Belconnen Way/Barry Drive Corridor |
| **8** | Ginninderra Drive Corridor |
| **9** | Gundaroo Drive/Horse Park Drive Corridor |
| **10** | Macarthur Ave/Limestone Ave/Fairbairn Ave Corridor |
| **11** | Canberra Airport to Civic Corridor |
| **12** | Drakeford Drive/Tuggeranong Pky/Parkes Way Corridor |
| **12** | Athllon Drive/Commonwealth Ave Corridor |
| **13** | Cotter Road Corridor |
| **14** | Erindale Drive/Yamba Drive Corridor |
| **15** | Monaro Hwy Corridor |
| **16** | East-West Corridors (Isabella Drive) |
| **16** | East-West Corridors (Hindmarsh Drive) |
| **17** | Canberra Avenue Corridor |
| **18** | Weston to Molonglo Corridor |
| **19** | Horse Park Drive Corridor |

# Appendix D: Model Assumptions

## D.1 Purpose

This appendix sets out the overarching assumptions and methodology applied in our modelling. It also documents some of the city specific assumptions such as parking charges and public transport fares.

## D.2 Modelling methodology

This section briefly describes the Zenith Travel Models developed by VLC and used to undertake all modelling for the Audit.

### D.2.1 Development of the Zenith Travel Models

The Zenith models have been established through applying behavioural relationships calibrated from household travel surveys and validating these against traffic counts and public transport passenger surveys. These relationships have been updated on several occasions over the past 18 years. Zenith models operate using OmniTRANS, offering a versatile and interactive platform for multimodal transport planning. The platform also adds value in the presentation and discussion of patronage forecasts.

The models simulate all travel undertaken by households and firms, and visitors to the region during an average weekday in each forecast year. Given a scenario of land use and demographic change, the models reflect the level of participation in a range of activities across the region and the frequency of travel to them, as well as the choice of destination, mode and route.

The models are unique in their ability to reflect access to public transport, which is a key influence on accessibility in Australian cities, and in reflecting the travel choices made by their residents and visitors.

Many of the parameters of the multimodal model have their genesis in the calibration of the Zenith model of Melbourne in 1995, which made extensive use of the Victorian Activity and Travel Survey (VATS) database. When household travel surveys later became available in other regions, this provided the opportunity to revalidate the regional models against local data and to recalibrate selected sub-models and market segments where appropriate to better reflect behaviour specific to each region.

VLC is continually undertaking research and development to ensure the Zenith models remain at the forefront of transport planning practice and incorporates evolving state-of-the-art techniques when it is appropriate to do so. All of the data sets underpinning the models are reviewed frequently and maintained to be consistent with the latest information available.

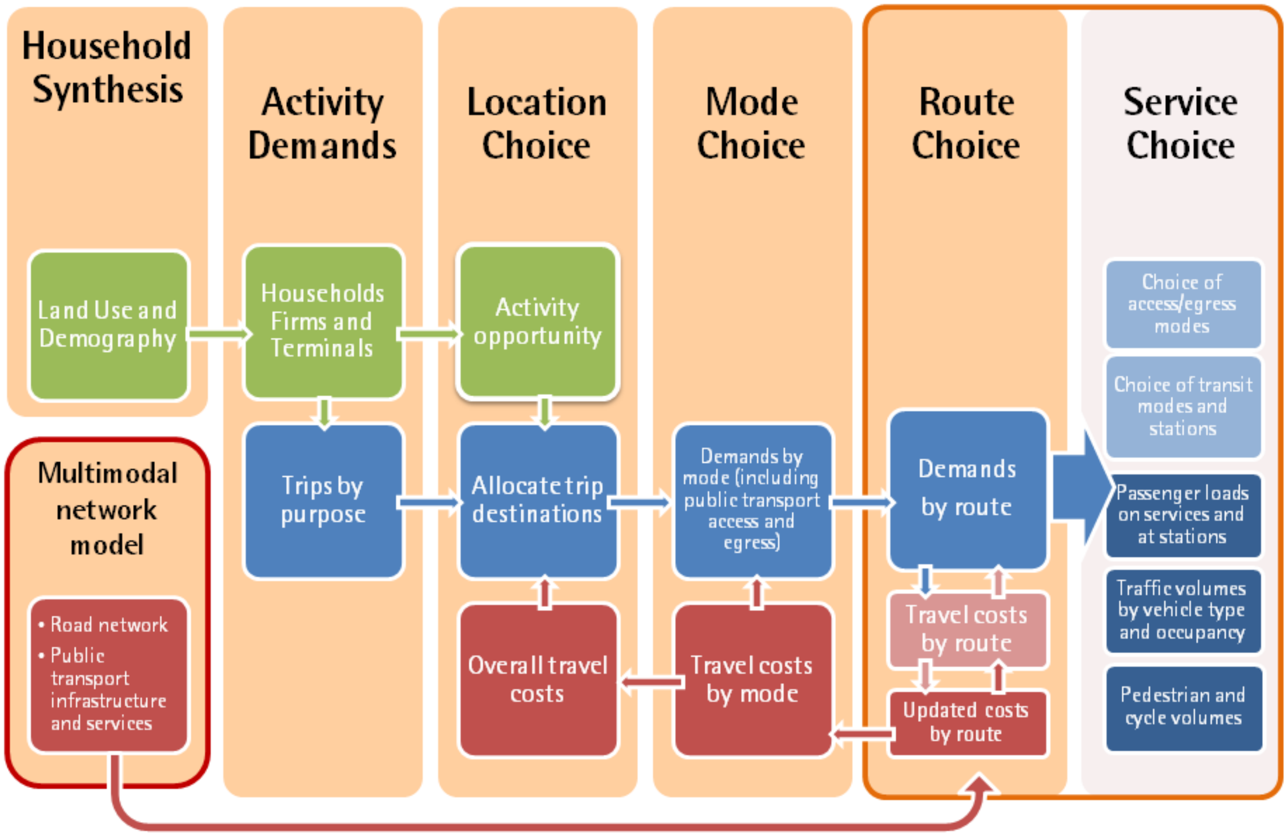
### D.2.2 Model Architecture

The prime objective of Zenith is to provide a planning tool to support the evolving policy issues of relevance to planners and government. This is accomplished through replicating the demand for travel by residents and visitors in the modelled region, which is derived from the demand for participation in activities. Travel choices may differ depending on the activity for which the travel is undertaken. The nature of the activity may influence the frequency, timing and duration of participation, the location, as well as the mode of travel and in some cases, the route chosen.

The Zenith travel demand model simulates the travel behaviour of households, firms and visitors within the modelled region associated with their participation in the range of activities described above. The model makes use of information that is available to describe the potential demands for these activities in each location, such as statistics on employment in various industries, enrolments at educational facilities, and demographic variables such as population and households.

The key stages of the Zenith model process are illustrated in Appendix Figure D-1.

***Appendix Figure D-1 – Key Stages of the Zenith Models***




Each region is divided into several thousand travel zones, providing a high degree of resolution for forecasting movements between suburbs and across the city. A large range of demographic, socioeconomic and land use variables are used to identify the types of households and range of activities in each zone.

The model forecasts the number of trips made for work, education, shopping, personal business, recreation, social and “other” journey purposes (why travel?). It simulates the decisions made by households regarding the time period (when?), destination (where?) and mode of travel (how?) for each trip, with models developed from surveys of travel behaviour undertaken in each region.

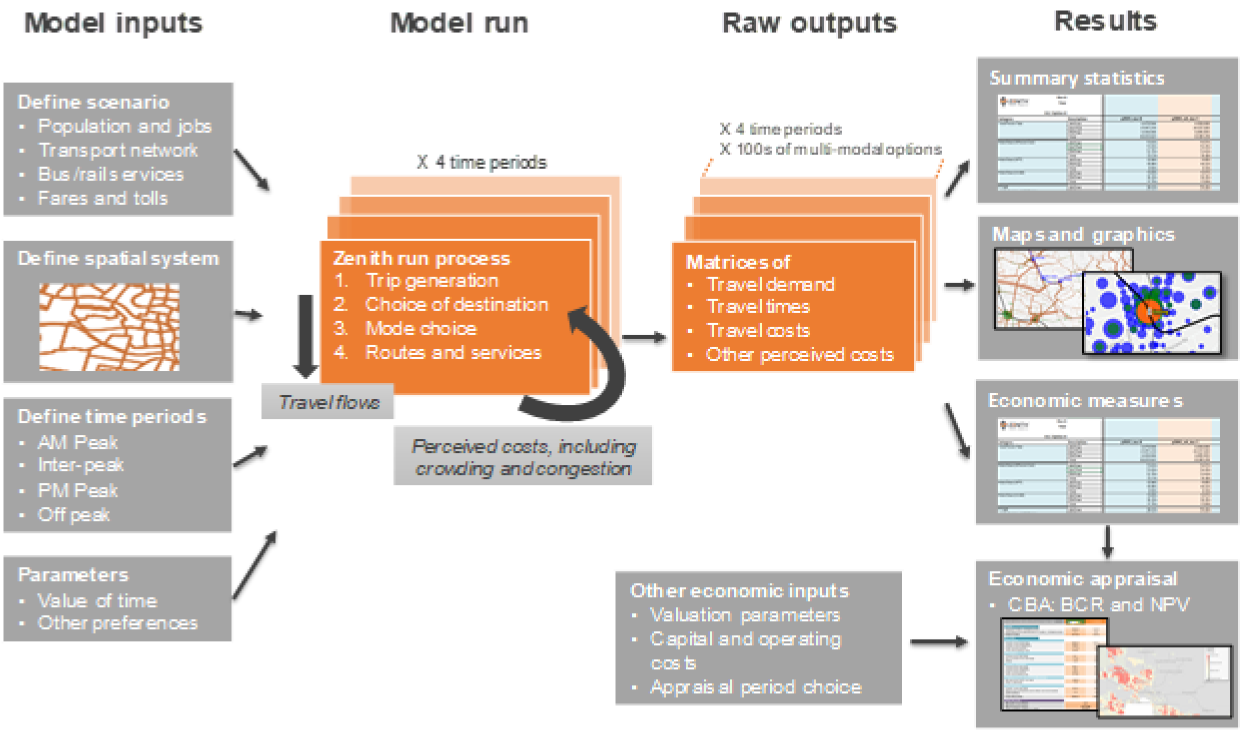
Having determined the destination and mode of travel, the model then reflects the choice of route for trips by private or commercial vehicle, public transport and active travel modes such as cycling and walking.

The more fine-grained the travel zone system, the more accurate travel forecasts have the potential to be. This is particularly the case on parts of the road network with lower traffic volumes, and on public transport services, as smaller zones capture vehicle movements on lower-order roads used to reach major arterials, and more closely reflect walking distances to the public transport stops.

### D.2.3 Model process

The practicalities of establishing and running a given forecast year scenario are described in Appendix Figure D-2. For a given set of infrastructure and services assumptions, inputs are devised and entered into the Zenith user interface, the model is run, raw outputs are produced, and finally a range of detailed results are prepared.

*Appendix Figure D-2 – Scenario testing with the Zenith model*




#### Model inputs

- Define scenario – the distribution of population and employment in the forecast year, the nature of the transport network (including any upgrades assumed) as well as all of the service attributes (such as tolls, fares and service frequencies) must each be set.
- Define spatial system – the zone system determines how wide the model's coverage will be (generally the greater metropolitan area), how disaggregated the representation of the area will be in the model (number of zones), and which areas have more or less detailed representation (e.g. disaggregated zones in the corridor under consideration). In general, major capital cities are modelled In Zenith with between around 2000 and 4500 zones. More zones gives greater detail (for example for people choosing whether or not to walk to train stations), but requires longer model running times.
- Define time periods – some models only consider a single period of a weekday. Zenith applies a four-period breakdown of the weekday, with the actual hours distinguishing the AM and PM peaks potentially varying depending on local travel conditions.
- Input parameters – a range of behavioural parameters define the trade-offs people in the model are assumed to make, for example the trade-off between travel time and out-of-pocket spending is represented by the value of time. These parameters are estimated to best reflect existing travel behaviour.

**Model run**

The process of the Zenith model's operation is described in some detail in the remainder of this document. From the perspective of running a single model scenario, the most important feature is the iterative nature of the estimation of travel costs and travel demand. The model attempts to find an 'equilibrium' set of costs and demands for a wide range of travel modes, routes and services. Through making increasingly small adjustments to variables it converges towards the most consistent set of costs and demands for each period of the day.

**Raw outputs**

The key outputs of the model run are the equilibrium travel costs and travel demands for each origin-destination pair across each period of the day and each travel mode. Given the number of alternative travel options (e.g. walk to rail station 1, bus to rail station 2, car driver, car passenger, etc.) and the number of origin and destination zones, the resulting data is a very large number of matrices ('trip tables' and 'cost skims').

**Results**

The raw outputs can be adapted to any range of output formats to understand the implications of the modelled scenario, including tables, graphs, static maps and interactive maps. Common measures are total travel time, total vehicle kilometres (by road and vehicle type) and travel time spent in crowded public transport vehicles. Transport network performance measures can be estimated on a stand-alone basis or comparing scenarios across time (time series), across options (comparative), and between with and without-project (incrementally). Outputs can also be further processed to understand the incremental economic benefits of a 'with project' scenario compared to a 'without project' scenario for use in cost-benefit analysis, either within Zenith's economics module or with third-party economics spreadsheets.

## D.3 Model inputs

Many of the model inputs described in Section D.2.3 above are specific to each modelled city and will be dealt with in the respective Technical Appendixes. However, there are a number of inputs that have been agreed with Infrastructure Australia and harmonised across all six major city Zenith models. These are assumptions to do with travel costs, technology and the approach to the value of travel time.

### D.3.1 Travel costs

**Fuel price**

There is a range of influences on the unit cost of fuel consumed in urban transport, which can be affected by global and local conditions. The most significant influences on the costs of fuel include:

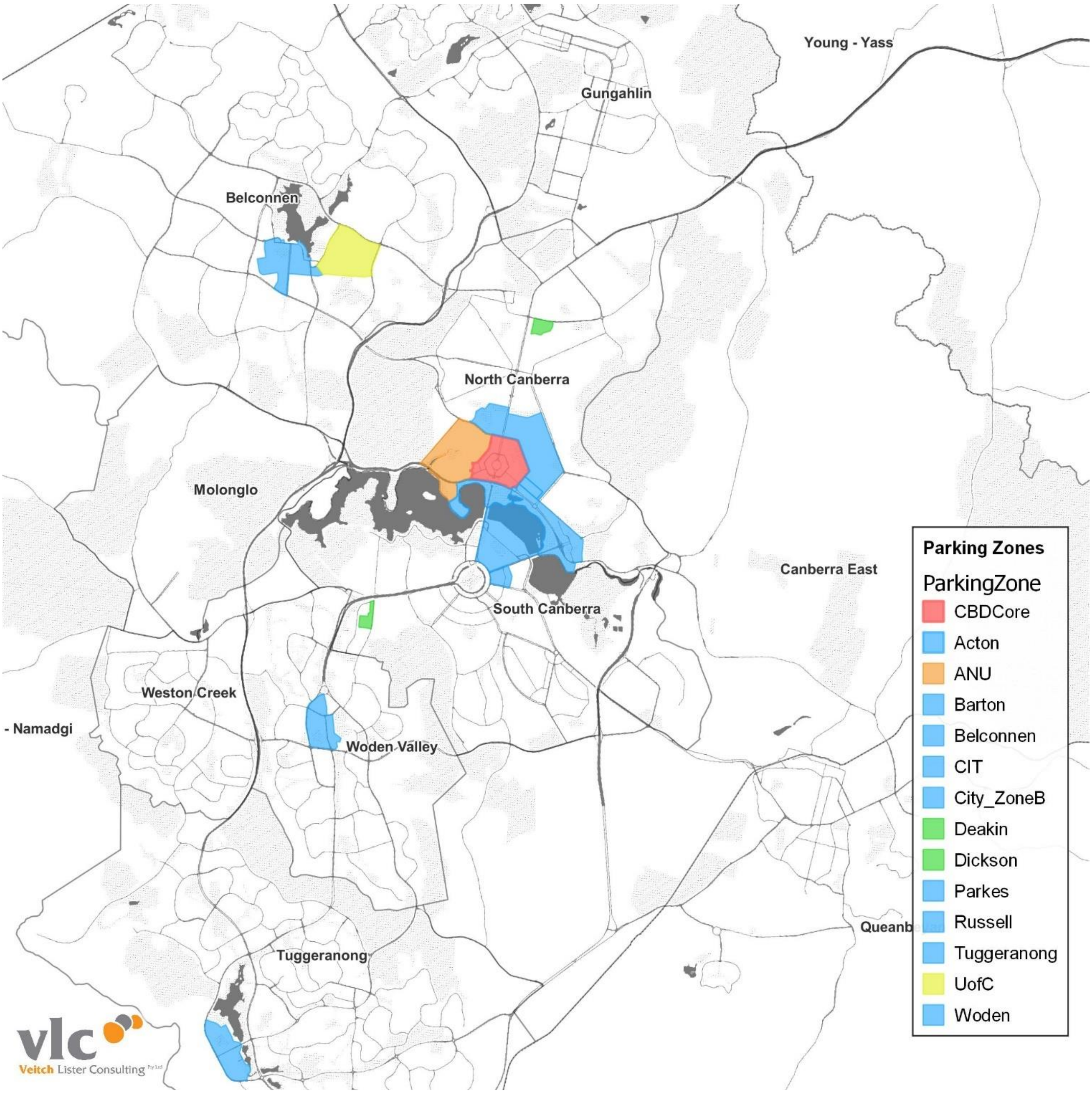
- real increases in the price of transport fuels; and
- reduction in the rate of fuel consumption due to improved vehicle efficiency and increased use of more efficient fuels within the vehicle fleet.

These two factors act to counter each other, and with insufficient evidence to indicate which will dominate in future, may well result in no real change in the average unit costs of fuel. For this work, it has therefore been assumed no real change in the unit of costs of fuel in future (i.e. fuel prices change in line with the Consumer Price Index - CPI).

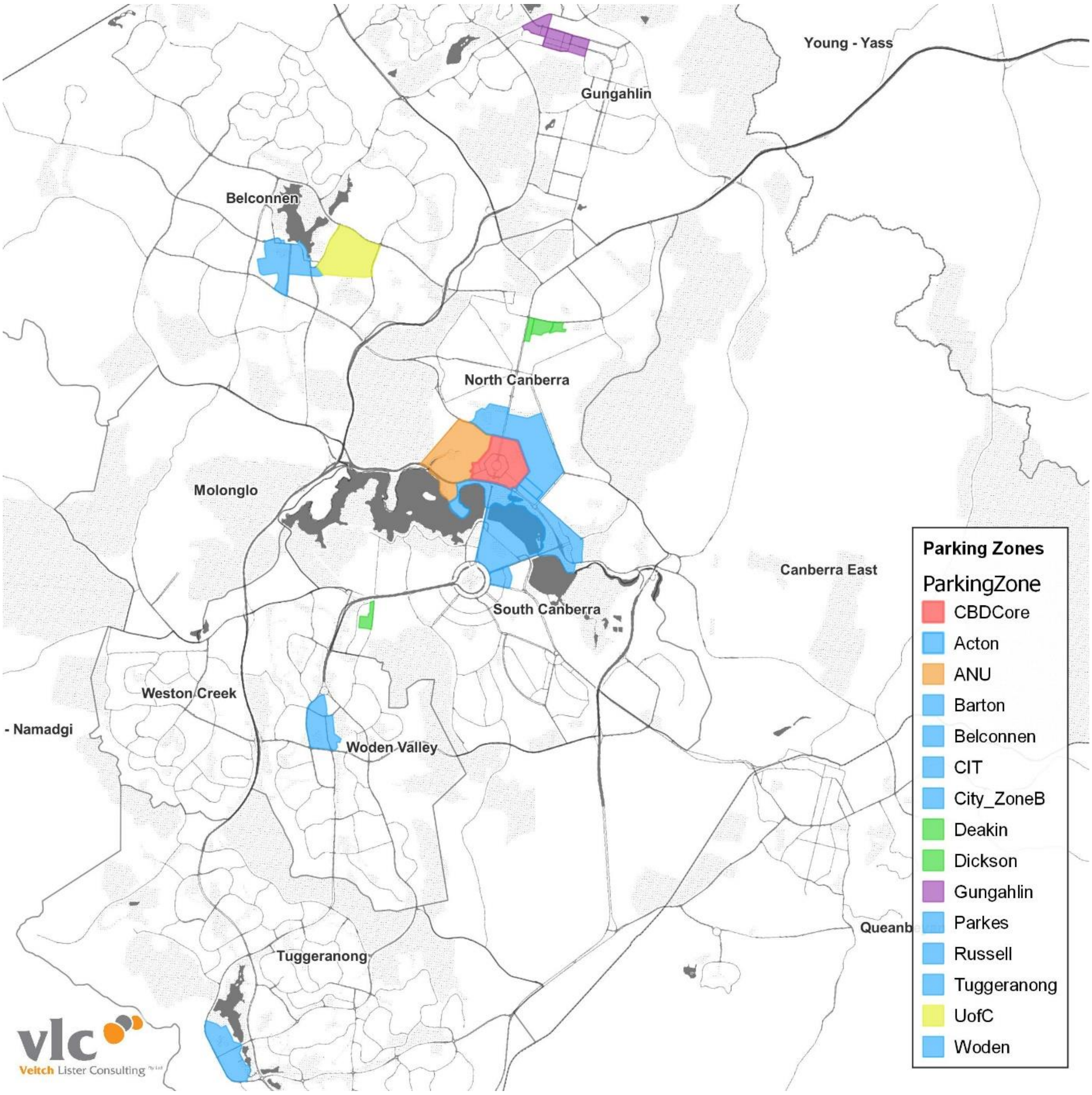
## Parking costs

A real annual increase of 1.5 per cent (i.e. above CPI) in parking charges is assumed. The intention is to represent the strong pressures on price arising from increasing demand and constrained supply of parking in the CBD and major activity centres, as well as the non-linear increase in price associated with moving towards more parking structures rather than surface parking. This is consistent with the assumption applied for the modelling in the first Infrastructure Audit. The parking zones used in the modelling are illustrated in Appendix Figure D-3 and Appendix Figure D-4.

***Appendix Figure D-3 – ACT and Queanbeyan parking zones - 2016***



### *Appendix Figure D-4 – ACT and Queanbeyan parking zones - 2031*




## Tolls

The ACT and Queanbeyan do not have any existing or planned toll roads.

## Public transport fares

While any observed increases in the cost of public transport fares between 2011 and the time of modelling in 2018 have been factored into all future scenarios, beyond 2018 fares have been assumed to grow in line with CPI. The public transport fares and costs have been documented in Appendix Table D-1.

### *Appendix Table D-1 – ACT and Queanbeyan public transport costs and fares*

| Public Transport Cost Parameters | | Zenith |
|---|---|---|
| Public Transport VOT, 2011 (AUD 2008) | | $12 / hour |
| Public Transport Fares, 2011 | Flat | 2.67 |
| Public Transport Fare change | | CPI |

### D.3.2 Technology uptake

While transport models are useful planning tools, they are also limited in that they are estimated and calibrated based on historical survey data. There are numerous exogenous factors, particularly changes in technology, that are difficult to predict and quantify. These changes include:

- Electric vehicles;
- Shared mobility business models
- Driverless vehicles;
- Home deliveries; and
- Telecommuting.

Due to uncertainty around how these technologies might change how people travel, the current uptake of each is assumed to continue into the future modelled years.

### D.3.3 Value of travel time

There are two approaches to the value of travel time: a 'behavioural' value that is relevant in trying to accurately predict how different market segments will respond to travel options, and an 'economic' value that is relevant for measuring community impacts of travel time. This section relates to the behavioural values used in modelling. Section D.4.1 discusses the relevant values for estimating economic costs of crowding – these values reflect equity values (ensuring infrastructure investment is not focused on areas with high incomes) and resource values (where travel time has real economic opportunity costs, e.g. due to people travelling during the course of their paid work).

The behavioural value of time spent travelling and its influence on travel behaviour depends on a range of factors, such as the reason for travel, and the use to which the time might otherwise be put. The modelling of travel choices reflects preferences that imply different values of travel time for each trip purpose and for each mode of travel, including walking and waiting associated with using public transport and the use of toll roads.

These behavioural values of time are indirectly estimated for each journey purpose and city travel market through the model estimation process (i.e. statistically estimating the model parameters that best describe traveller choices from household travel surveys). Consequently these parameter values are not drawn directly from guidelines.

The values of time are estimated more or less for the current day, but an assumption is needed for modelling the way that travellers will trade off time and money in the forecast years. There is a significant volume of behavioural research that suggests values of travel time increase with growing average income. For the purposes of the modelling on this project VLC has assumed that values of travel time remain at current levels in the future.

The exception to this assumption is that people are assumed to have an increased willingness to pay tolls in the future. This is reflected in the application of an elasticity of 0.8 between value of time and increases in real average weekly earnings. This assumption is consistent with that applied in the previous Infrastructure Audit modelling.

### D.3.4 Public transport frequencies

While public transport frequencies are partly driven by the completion of infrastructure projects, additional services are regularly added to the network. This includes more regular services along established public transport corridors, as well as new routes to growth areas. In both cases, this is generally in response to population growth.

Determining appropriate future public transport frequencies is based on a combination of the following approaches:

- Increasing service kilometres according to planning and policy documents (as documented in the project list for each market);
- Adding new bus routes to growth areas not serviced by other infrastructure proposals; and
- Increasing service kilometres on remaining bus services to bring overall network frequencies to growth rate of 1.5% per annum. This assumption was applied uniformly across jurisdictions based on actual growth in major-city scheduled bus kilometres documented in jurisdictions' budget papers where available over the past five years.

### D.3.5 Commercial vehicle definitions

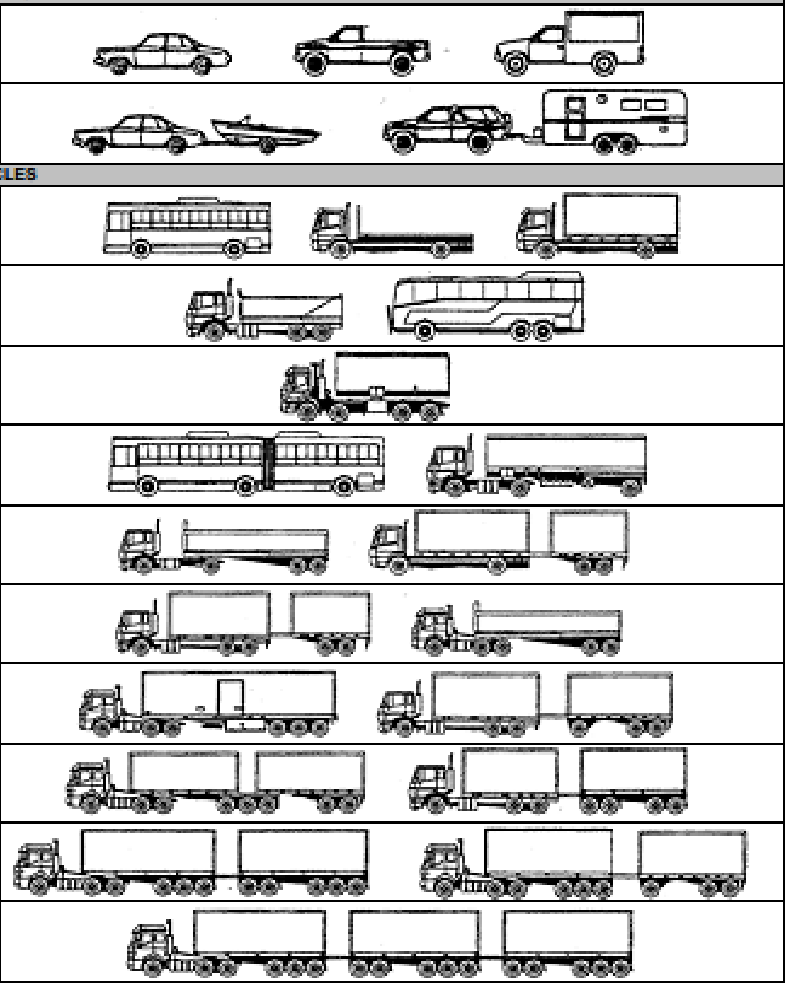
In the Zenith model private vehicle traffic is split into cars and commercial vehicles. Commercial vehicles are further split into sub-categories of light commercial vehicles and heavy commercial vehicles.

Vehicles are classified according to the Austroads Vehicle Classification System (Appendix Figure D-5). Appendix Table D-2 details how the VLC vehicle types equate to Austroads vehicle classes.

***Appendix Table D-2 – VLC vehicle types with Austroads classes***

| VLC vehicle type | Sub type | Austroads vehicle class |
|---|---|---|
| **Car** | NA | 1 & 2 |
| **Commercial vehicles** | Light commercial vehicles | 3 |
| | Heavy commercial vehicles | 3 to 12 |

## *Appendix Figure D-5 – Austroads Vehicle Classification System*



| Class | Parameters | Typical Configuration |
|---|---|---|
| | **LIGHT VEHICLES** | |
| 1 | d(1) ≤ 3.2m and axles = 2 | |
| 2 | groups = 3<br>d(1) ≥ 2.1m, d(1) ≤ 3.2m,<br>d(2) ≥ 2.1m and axles = 3, 4 or 5 | |
| | **HEAVY VEHICLES** | |
| 3 | d(1) > 3.2m and axles = 2 | |
| 4 | axles = 3 and groups = 2 | |
| 5 | axles > 3 and groups = 2 | |
| 6 | d(1) > 3.2m, axles = 3<br>and groups = 3 | |
| 7 | d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m<br>axles = 4 and groups > 2 | |
| 8 | d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m<br>axles = 5 and groups > 2 | |
| 9 | axles = 6 and groups > 2 or<br>axles > 6 and groups = 3 | |
| 10 | groups = 4 and axles > 6 | |
| 11 | groups = 5 or 6<br>and axles > 6 | |
| 12 | groups > 6<br>and axles > 6 | |

Source: Austroads

## D.4 Economic cost methodology

VLC provides two measures of economic costs associated with the performance of the transport network: cost of road congestion and cost of public transport crowding. This section briefly outlines the methodology and input assumptions applied in all models.

### D.4.1 Cost of road congestion

**Modelling approach to estimate impacts**

Congested travel times are calculated by comparing the total travel time for a road link under congested conditions, with the travel time of the same link under free-flow conditions.

The amount of time spent travelling under congested conditions is then aggregated to the desired geography in order to understand which parts of the network are most heavily affected by excess travel demand. Weekday forecasts of congested travel times are annualised by a factor of 345 in all cities, reflecting the relatively high traffic volumes on weekends (TfNSW 2016).[3]

**Method to quantify**

A monetary value of travel time factor is applied to the congested hours, distinguishing between business and non-business travel, as well as an additional freight value of time for commercial vehicles, which are separately identified in the model outputs. The values of time applied are estimated relative to average hourly earnings of the traveller or vehicle to reflect the differing economic costs associated with time lost for each type of trip.

The valuation parameters used are consistent with ATAP (2016) guidelines, updated to December 2017 values:

- Value of time per occupant (excluding freight vehicles):
  - Business-related travel (129.8% of hourly earnings = **$53.78/hr**). Applied using an average vehicle occupancy of 1.3 people per car.
  - Non-business travel (40% of hourly earnings = **$16.57/hr**). Applied using an average vehicle occupancy of 1.7 people per car.
- Freight value of time per vehicle (including occupants):
  - Light commercial vehicles = **$38.23/hr** (Austroads class 3 vehicle, two-axle truck)
  - Heavy commercial vehicles = **$71.36/hr** (Austroads classes 4-10, weighted average according to typical urban conditions Australia-wide, with the majority assumed to be within classes 4, 5, 9 and 10).

### D.4.2 Cost of public transport crowding

**Modelling approach to estimate impacts**

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[3] Transport for NSW (2016), *Principles and Guidelines for Economic Appraisal of Transport Investment and Initiatives - Transport Economic Appraisal Guidelines”*, Sydney, Australia.

The modelling approach to estimating crowding includes three components. These are:

- Measures of service capacity
- Crowding cost function, and
- Linking of outward and return journeys.

Measures of service capacity

Measures of service capacity are provided as a model input, detailing the number of passengers that can be accommodated on each individual service in the modelled public transport network. Seated and standing passenger capacities are specified separately, as passenger comfort levels tend to differ considerably under crowded conditions depending on whether they are travelling in a seat or are standing in passages and doorways.

Appropriate capacities are determined for each city individually. Factors that are considered in specifying service capacities include:

- The rolling stock deployed on particular routes/lines
- The percentage of services run with higher or lower capacity rolling stock to determine ‘average’ seated and standing capacities (where that level of detail is available)

Appendix Table D-3 sets out the public transport vehicle seated and crush capacities used in the modelling (it is assumed that bus capacities remain the same in 2031 as they were in 2016).

***Appendix Table D-3 – ACT and Queanbeyan public transport vehicle capacities***

| Vehicle | Seated Capacity | Crush capacity |
|---|---|---|
| **Bus** | 46 | 72 |
| **Light rail** | 66 | 207 |

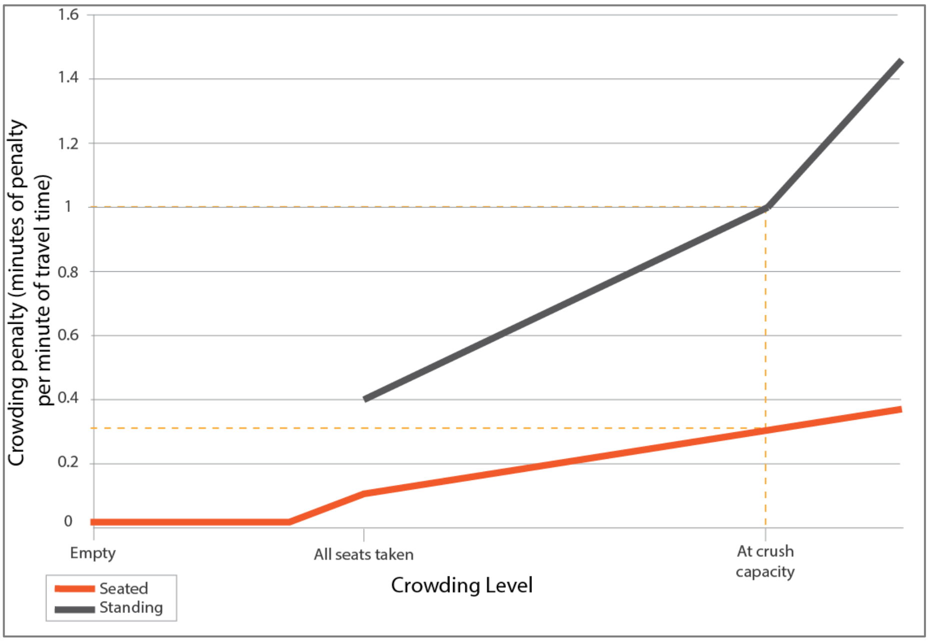
Source: Bus capacities are the weighted average of ACT Transport fleet information. November 2018. www.transport.act.gov.au/about-us/public-transport-options/bus/about-the-fleet

Crowding cost function

The crowding cost function is an estimate of the level of discomfort experienced by passengers at different levels of crowding, depending on whether passengers are seated or standing. The function is based on parameters provided in Australian Transport Council (ATC) guidelines and is shown in Appendix Figure D-6.[4] These broadly align with the latest guidance from ATAP, though the ATAP guidelines do not provide adequate detail to quantify impacts for seated and standing travellers.

[4] Australian Transport Council. 2006. *Volume 4: Urban Transport*. Canberra: ATC.

**Appendix Figure D-6 – Crowding cost function**




The crowding cost function works by applying a penalty to journeys that are made under crowded conditions. Based on the function, a 10-minute journey at crush capacity would incur a three-minute penalty for seated passengers and a 10 minute penalty for standing passengers.

Beyond crush capacity, the penalty increases at a rapid rate in order to further deter passengers from boarding extremely crowded services. While loads in excess of crush capacity may seem to contradict the definition of crush capacity, passenger load surveys have observed services operating with passenger volumes significantly higher than their theoretical service capacity.

Linking of outward and return journeys

Zenith links outward and return journeys, ensuring that additional travel costs associated with crowded travel conditions impact on the mode of travel for both inbound and outbound trips. This ensures that the model produces balanced travel demands depending on the time period or direction of travel. This is an important feature, because passenger crowding experiences may be inconsistent depending on the time of day.

For example, in the morning peak passengers living at the end of a train line will generally be able to get a seat. Even if the train gets very crowded as it approaches the inner city, they will have a lower perceived cost of crowding than if they were forced to stand. Returning home in the afternoon, the same passengers may be required to stand for significant lengths of their journey, which is associated with a higher perceived cost of crowding. Using linked outward and return journeys, the likelihood of standing on the return journey will be factored into mode and destination choice decisions made for the outward journey as well. This not only ensures that the model has suitably consistent inbound / outbound passenger demands, but also that it is appropriately responsive to infrastructure and policies aimed at reducing crowding.

**Method to quantify**

Quantifying the cost of public transport crowding involves estimating traveller outcomes in a capacity constrained model run for current (2016) and future (2031) crowding levels.

The number of daily 'disbenefit' or 'penalty' hours experienced by public transport users due to crowding is first calculated. The number of seating and standing hours at different levels of crowded conditions are combined with the disutilities at each crowding level (Appendix Figure D-6).

For example, in the example in the previous subsection, passengers standing at crowded capacity (e.g. a loading factor (LF) of 200% of seated capacity, where LF is passengers / provided seats on services on a link) for a 10-minute journey would experience a crowding disutility of:

*Journey time x crowding penalty (at the relevant load factor) = 10 x 1 = 10 minutes*

Seated passengers would experience a crowding disutility of 3 minutes during the same journey in addition to their ordinary (uncrowded) travel time disutility of 10 minutes.

Generalising this calculation for a given link (potentially serving multiple lines) yields:

| Link average crowding | Crowding disutility for seated passengers | Crowding disutility for standing passengers |
|---|---|---|
| **Uncrowded**<br>LF < 0.7 | 0 | 0 |
| **Nearing seated capacity**<br>0.7 < LF < 1.0 | JT * Pax * (LF - 0.7) * 1 / 3 | 0 (or if people stand it is by choice with disutility as per seating passengers) |
| **Crowded**<br>1.0 < LF < Crush | JT * Seats * [0.1 + (Pax – Seats) * 0.2 / (Crush – Seats)] | JT * (Pax – Seats) * [0.4 + (Pax – Seats) * 0.6 / (Crush – Seats)] |
| **Crushed**<br>LF > Crush | JT * Seats * [0.1 + (Pax – Seats) * 0.2 / (Crush – Seats)] | JT * (Pax – Seats) * [1 + (Pax – Crush) * 1.2 / (Crush – Seats)] |

Notes: 1) Total crowding costs sum the two columns for any given load factor (LF)
2) LF is defined at a link level capturing all services operating on that link and all passengers travelling on the link (Pax) during a time period, such as the 2-hour AM peak
3) JT is the journey time across the link, including travel time and dwell time at stops
4) 'Seats' is the total seated capacity for vehicles operating services on the link during the time period
5) 'Crush' is the total crush capacity for vehicles operating services on the link during the time period.

For national consistency we follow ATAP (2018) guidelines by applying an annualisation factor of 286 to scale up the weekday average estimates, reflecting the perspective that crowding is primarily a weekday phenomenon.[5] Annualised disbenefit hours are multiplied by the value of time for non-business travellers ($16.57/hour from section D.4.1 above) to determine the annual cost.

[5] Australian Transport Assessment and Planning Guidelines (2018), *"M1 – Public Transport"*, ATAP, Canberra, Australia.

# Appendix E: Differences between 2015 and current modelling

Modelling undertaken for the ACT in the 2018-19 Audit differs slightly from work undertaken in 2014-15. Changes have been made to the model inputs and assumptions. This section compares the 2018-19 Audit to the 2014-15 Audit, using the 2014-15 inputs / outputs as a base.

## E.1 Changes to the models

Significant changes have been made to the Zenith models across all markets since 2014-15.

***Appendix Table E-1 – Changes to the Zenith models since the 2014-15 Audit***

| Change | Detail | Affected markets |
|---|---|---|
| **Demand model re-estimation** | This is the process of using a household travel survey to estimate parameters used to model the behaviour of trips for different purposes, particularly for mode and destination choice steps.<br>This affects the balance between trip lengths and trip numbers. While trip numbers decrease, network volumes remain broadly unchanged. | • SEQ and Sydney models have both undergone full re-estimation.<br>• Adelaide and Perth models use parameters adapted from the SEQ re-estimation.<br>• Melbourne and ACT models have not been re-estimated |
| **Incorporation of crowding** | Additional components were added into the four-step models to capture the perceived cost of travelling under heavily crowded conditions on public transport services. All models were run in 2018 on the basis of crowding levels influencing travel choices; none used this feature in 2014. | • SEQ, Sydney, Perth and Adelaide have undergone software upgrades to include public transport crowding<br>• Melbourne and ACT models were previously public transport crowding-capable, but for consistency reasons this option was not used in 2014-15. |
| **Changing to a 2016 base year** | Population and employment inputs were updated to reflect the 2016 Census. Travel costs and transport networks were also updated.<br>Of particular significance was the reduction in fuel price between 2011 and 2016. This was based on a structural decrease observed in fuel retail prices collected by the Australian Competition and Consumer Commission. | • All markets have updated base years<br>• All markets have undergone re-calibration and validation to ensure that changes made to the models are both robust and appropriate. |
| **Model calibration** | After model parameters have been estimated (see above) model calibration is the process of adjusting these parameters. The aim is to improve the level of correlation between the model's outputs and observed measures of travel demand (traffic counts, public transport patronage, origin-destination surveys etc.) | |

## E.2 Changes to model inputs and assumptions

### E.2.1 Population and land use

In the 2014-15 Audit, 2031 population projections for all six markets were derived from ABS Series B projections. In the latest work, projections have been provided by each state government. For the ACT, the impact is as follows:

***Appendix Table E-2 – Comparison of ACT and Queanbeyan 2031 forecast population***

| | 2014-15 Audit | 2018-19 Audit | Difference |
|---|---|---|---|
| **ACT and Queanbeyan** | 610,000 | 560,000 | -8% |

The 2031 population forecast used in this audit expects fewer people to live in ACT and Queanbeyan than the forecast used in the 2014-15 Audit. Population is also distributed slightly differently. A map showing this change spatially by SA3 is shown in Appendix Figure E-1. Forecast population is higher in areas such as the Woden Valley (an extra 7,600) and Weston Creek (an extra 2,600). It is much lower in Queanbeyan (-25,500 residents) and Gunghalin (-20,500 residents). Of particular note is Molonglo, which had zero population in 2031 in the 2014-15 Audit but has 32,000 residents in the 2018-19 Audit.

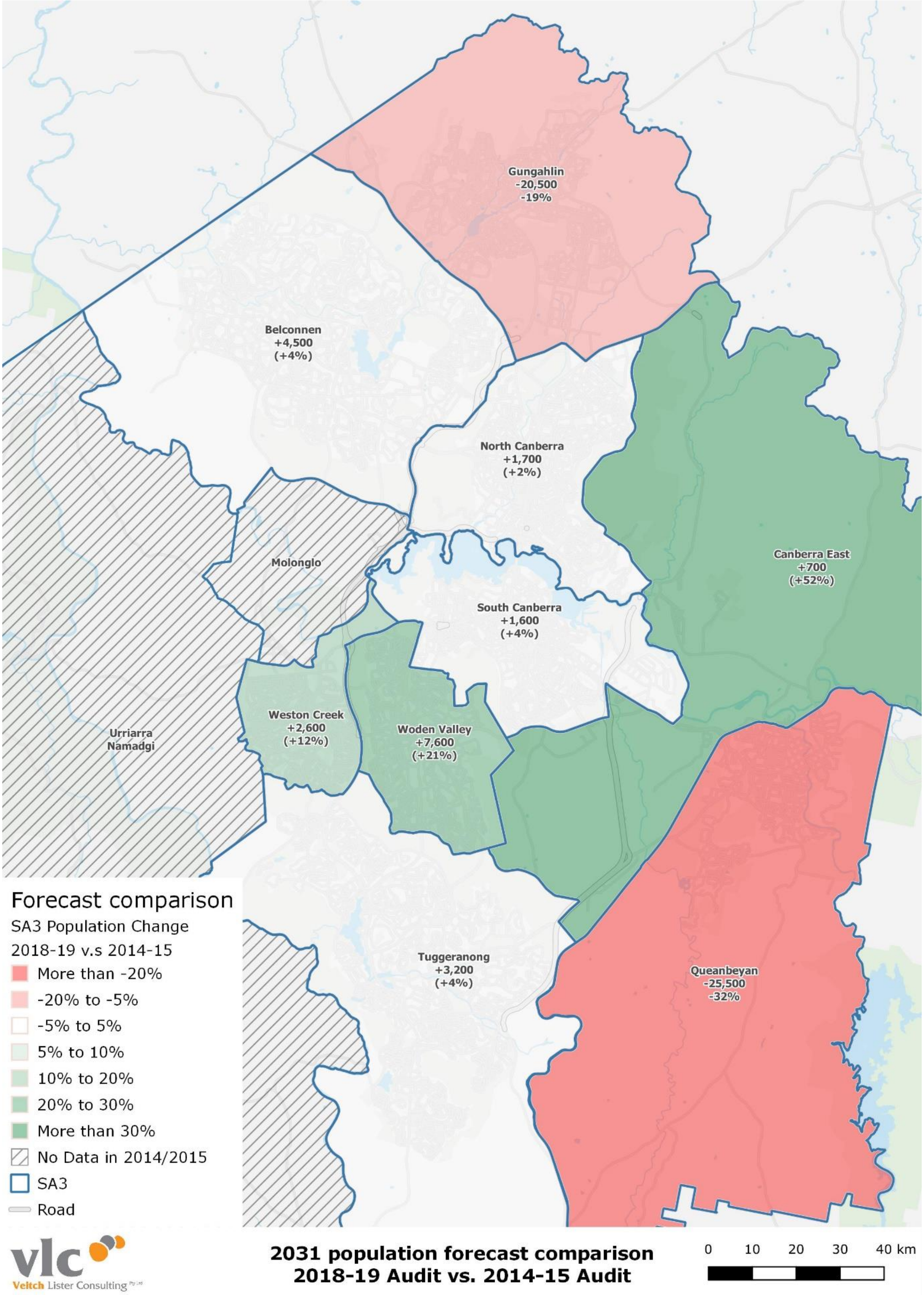
In the 2014-15 Audit, VLC prepared forecasts for employment, consistent with the population projections constrained to the ABS B series forecast. The employment forecasts are based on projected levels of employment self-containment within each LGA, which recognise the structure planning of local authorities and the longer-term infrastructure and development planning by each state government. In the latest work, projections have been provided by each state government. For ACT, the impact is as follows:

***Appendix Table E-3 – Comparison of ACT and Queanbeyan 2031 forecast employment and centralisation***

| | 2014-15 Audit | 2018-19 Audit | Difference |
|---|---|---|---|
| **Employment in ACT and Queanbeyan** | 340,000 | 320,000 | -6% |
| **Proportion of employment North and South Canberra** | 49% | 51% | +2% |

The way in which jobs are distributed across a city is a key determinant of trip destination, and as such mode choice (more jobs in the CBD encourages more PT travel). In strategic modelling, a gravity model is used to distribute trip destinations, with features such as jobs attracting trips. As such the attractiveness of an area is determined by its **share** of total employment rather than the actual **number** of jobs it contains. Given that the distribution of employment remains relatively similar in the 2018-19 Audit, there is little impact on the balance between car and PT travel (employment centralisation has been used as a proxy for the overall distribution of trip destinations) (Appendix Table E-3).

## Appendix Figure E-1 – 2031 Population forecast - 2018-19 Audit compared to 2014-15 Audit base



### E.2.2 Network assumptions

Both Audits use a similar approach to developing network assumptions – i.e. a 'minimal intervention' approach, that assumes only projects with funding or significant levels of political commitment will be completed by 2031. In the ACT and Queanbeyan major project assumptions are largely consistent between the Audits. However, incremental impacts of more minor projects have results in higher in-service kilometres on the public transport and more lane kilometres on the road network in the 2018-19 Audit compared with the 2014-15 Audit.

### E.2.3 Cost assumptions

Cost assumptions in the ACT (public transport fares and parking charges) and are consistent between 2014-15 Audit and 2018-19 Audit.

## E.3 Impacts on model metrics and outputs

Model metrics and outputs are impacted by the changes made to the model inputs and model calibration.

Appendix Table E-4 compares the following high-level outputs:

- Total trips
- Car trips
- Car vehicle kilometres travelled
- Public transport trips.

Total trips and car trips forecast in this study are slightly lower than those forecast in the 2014-15 Audit (Appendix Table E-4). This is largely due to the lower population growth forecast for ACT and Queanbeyan. Public transport trips increase marginally (+1%). The likely reason for this is the incremental improvements to the public transport network that results in in-service kilometres being 31 per cent higher in the 2018-19 Audit relative to the 2014-15 Audit.

Relative to the previous audit car vehicle kilometres travelled are slightly lower. Correspondingly, forecast traffic volumes on the Canberra's major roads are slightly lower in this audit (Appendix Table E-5), as are AM peak vehicle delays. Results for the PM peak showed a similar outcome.

***Appendix Table E-4 – Changes in model inputs and key outputs between the 2014-15 and 2018-19 Audit modelling***

| | | Demographic assumptions | | Network assumptions | | Travel cost assumptions | | | | Model Parameters |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ***Population*** | ***Jobs*** | ***Road investment*** | ***Public transport investment*** | ***Fuel*** | ***PT Fares*** | ***Parking*** | ***Tolls*** | |
| **Change in inputs** | | ⇩ **Population forecasts have reduced (-8%)** | ⇧ **Employment forecasts have reduced (-6%), however the proportion of jobs in North and South Canberra SA3s remains stable** | ⇧ **More investment in the road network (+12% network lane km)** | ⇧ **More investment in the PT network (+31% service kms)** | ⇩ **Reduction in fuel price (140 c/L to 104 c/L AUD 2011)** | **- No change in other transport costs** | | | • **The 2016 base models have lower fuel prices (per observed reduction in fuel prices between 2011 and 2016)**<br>• **The 2016 base models include capacity-constrained public transport networks** |
| **Impact on output (AM peak)** | Total trips (-6%) | ⇩ Lower total population reduces total modelled trips | - Total trips are generated by population assumptions and model parameters only. | | | | | | | • The ACT model has not been recalibrated (only updated to a 2016 base year). As a result, it is not affected by re-calibrated parameters. |
| | Car trips (-10%) | ⇩ Lower total population reduces total modelled car trips. | - The distribution of employment is similar between the audits, as such a decline in overall employment does not substantially alter the balance between car and PT travel | ⇧ Better roads encourage car travel | ⇩ Better PT can encourage more PT travel and fewer car trips | ⇧ Lower fuel prices encourage car travel | - No change = no impact | | - Negligible impact | • The ACT model has not been recalibrated (only updated to a 2016 base year). As a result, it is not affected by re-calibrated parameters. |
| | Car vehicle kms travelled (-4%) | ⇩ An overall reduction in population reduces car kilometres. | - The distribution of employment is similar between the audits, as such a decline in overall employment does not substantially alter the balance between car and PT travel | ⇧ Better roads encourage car travel | ⇩ Better PT can encourage more PT travel and fewer car kms | ⇧ Lower fuel prices encourage car travel | - No change = no impact | | - Negligible impact | • The ACT model has not been recalibrated (only updated to a 2016 base year). As a result, it is not affected by re-calibrated parameters. |
| | Public transport trips (+1%) | ⇩ Lower total population should reduce total PT trips, but there appears to have been a slight mode shift away from car in favour of PT. | - The distribution of employment is similar between the audits, as such a decline in overall employment does not substantially alter the balance between car and PT travel | ⇩ Better roads encourage car travel and fewer PT trips | ⇧ Better PT can encourage more PT travel | ⇩ Lower fuel prices encourage car travel and reduce PT travel | - No change = no impact | | - Negligible impact | • Capacity constraining public transport networks would reduce demand for services where crowding occurs.<br>• The ACT model has not been recalibrated (only updated to a 2016 base year). As a result, it is not affected by re-calibrated parameters. |

**Appendix Table E-5 – ACT and Queanbeyan 2031 top ten most delayed road corridors AM peak (ranked by total delay)**

| Rank IA Audit 2018-19 | Direction | Corridor Name | Corridor | Average Peak Hour Traffic for 2031 forecasts | | | Total Delay Hours for 2031 forecasts | | | Rank IA Audit 2014-15 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | IA Audit 2014-15 | IA Audit 2018-19 | % Diff | IA Audit 2014-15 | IA Audit 2018-19 | % Diff | |
| 1 | NB | Drakeford Dve/Tuggeranong Pky/Parkes Way Corridor | 12 | 2,400 | 2,200 | -7% | 1,700 | 1,000 | -43% | 1 |
| 2 | WB | Canberra Avenue Corridor | 17 | 2,000 | 1,900 | -8% | 1,300 | 900 | -27% | 5 |
| 3 | NB | Monaro Hwy Corridor | 15 | 3,000 | 2,600 | -15% | 900 | 700 | -18% | 9 |
| 4 | SB | Barton Hwy/Northbourne Ave Corridor | 1 | 2,200 | 1,900 | -14% | 1,400 | 600 | -54% | 3 |
| 5 | WB | Canberra Airport to Civic Corridor | 11 | 2,000 | 1,400 | -26% | 1,300 | 600 | -51% | 4 |
| 6 | NB | Athllon Dve/Commonwealth Ave Corridor | 12 | 1,900 | 1,600 | -13% | 1,100 | 600 | -51% | 7 |
| 7 | SB | Gungahlin Dve Corridor | 4 | 2,600 | 2,300 | -10% | 1,300 | 500 | -59% | 6 |
| 8 | SB | Kingsford Smith Dve/William Hovell Dve Corridor | 6 | 1,500 | 1,800 | 23% | 900 | 500 | -46% | 8 |
| 9 | EB | Belconnen Way/Barry Dve Corridor | 7 | 2,500 | 1,900 | -27% | 1,400 | 400 | -70% | 2 |
| 10 | EB | East-West Corridors (Hindmarsh Dve) | 16 | 800 | 1,700 | 128% | 0 | 300 | 985% | 34 |
| 11 | WB | Federal Hwy Corridor | 2 | 1,900 | 1,800 | -4% | 500 | 300 | -27% | 12 |
| 12 | NB | Erindale Dve/Yamba Dve Corridor | 14 | 1,600 | 1,400 | -8% | 500 | 300 | -32% | 13 |
| 13 | EB | Ginninderra Dve Corridor | 8 | 1,800 | 1,400 | -25% | 600 | 300 | -52% | 10 |
| 14 | SB | Drakeford Dve/Tuggeranong Pky/Parkes Way Corridor | 12 | 1,300 | 1,300 | 0% | 300 | 300 | 2% | 17 |
| 15 | SB | Majura Road Corridor | 3 | 1,100 | 1,200 | 17% | 100 | 200 | 68% | 24 |

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