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Report

District Traffic Study 2023

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9 January 2025

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1. Introduction

SMEC was appointed by the City of Cockburn in 2023 to prepare a District Traffic Study (DTS). The City conducts this study every five years to evaluate the existing road network performance and to assist in decision-making for future road network improvements and upgrades within the City boundary. It also helps to better incorporate future transport needs based on anticipated expansion in land use, employment, population, as well as traffic journeys predicted by the Main Roads Regional Operations Model (ROM24). Please refer to the Appendices for the detailed technical work for this District Traffic Study.

1.1 Background and Objectives

The previous DTS was prepared in 2018. Since then, the City has experienced considerable growth and land development. The plan for the local and state road network improvement has had changes, which necessitates a review and replacement of the existing 2018 DTS.

The 2023 DTS considers road upgrades identified or planned in the City of Cockburn Regional & Major Roadworks 2018-2031. The outputs from the study will provide guidance on the road upgrades required in the medium and long-term future. The contents from this DTS report act as an informing document and form part of the City's Integrated Transport Strategy.

The study used the Aimsun traffic modelling software as the analytical basis for the review. The analysis was conducted for three horizon years: the base year (2021), a medium-term horizon year (2031), and a longer-term horizon year (2041). The intent of the study was also to feed information to the City's Integrated Transport Strategy and the Four-Year Capital Works Programme.

The objectives of this District Traffic Study were as follows:

- Identify existing/ base year (2021) traffic volumes in the study area;
- Develop a regional and district-level traffic model for the study area;
- Identify deficiencies in the road network for future years 2031 and 2041 and provide advice on timing for road network improvements; and
- Test additional scenarios to understand the impacts of alternate major road upgrades in the network.

1.2 Abbreviations

Table 1: List of abbreviations

Abbreviation	Meaning
CDTM	Cockburn District Traffic Model
c/w	Carriageway
DTS	District Traffic Study
NB, SB, EB, WB	Northbound, Southbound, Eastbound, Westbound
ROM24	Regional Operations Model
V/C	Volume/Capacity

2. Study Area

The red dotted line in Figure 1 below shows the boundaries of the study area. It covers the entire City of Cockburn with an extension in the north to South Street. Please refer to the technical memos provided for further details.

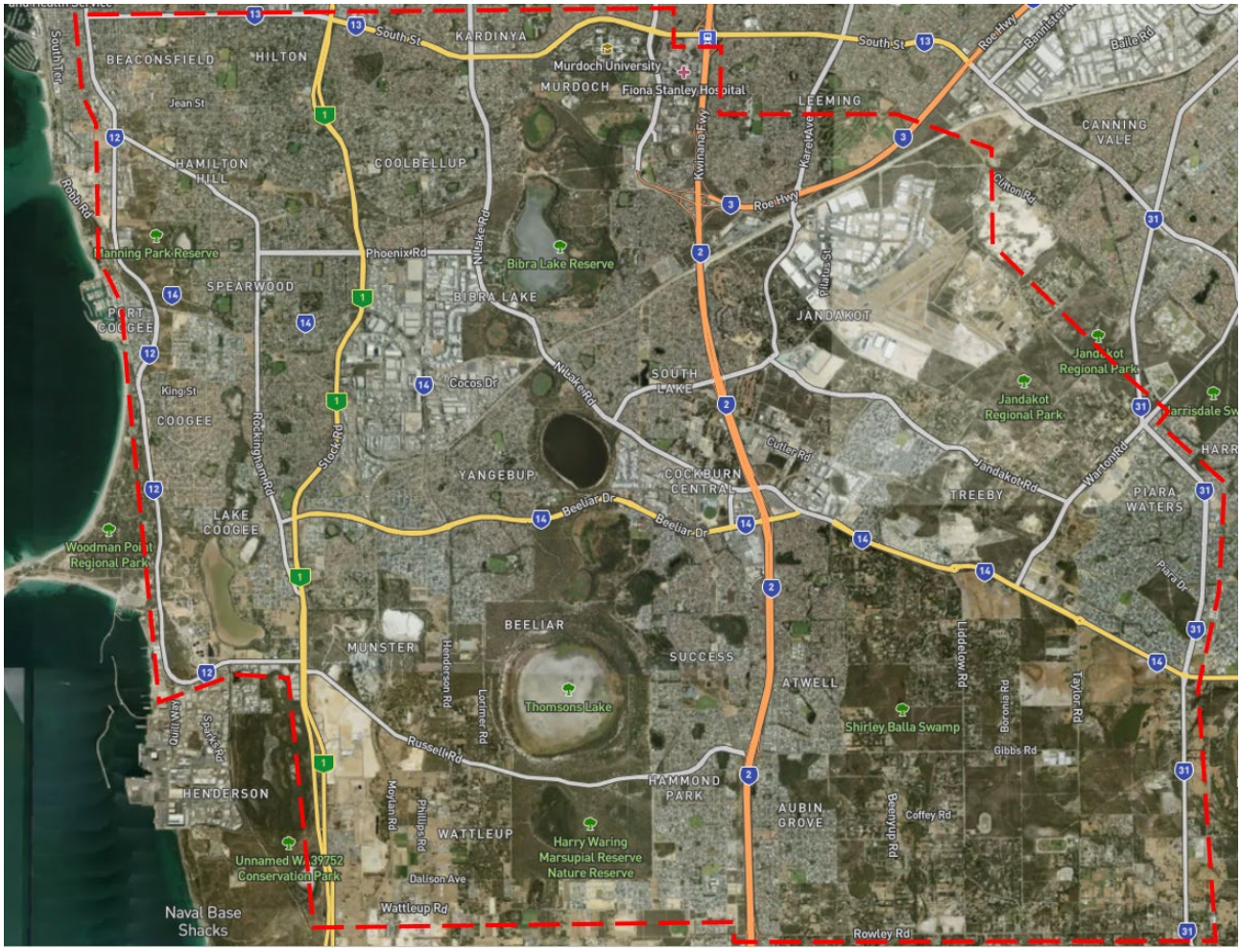

Figure 1: Aimsun modelling study area (Source: Metromap 2024)

3. Base Year Network review

The AM and PM peak periods in the base year (2021) were determined by analysing hourly traffic volumes for major road sections within the network. The AM and PM peak periods were determined to be 7:00 am – 9:00 am and 3:00 pm – 5:00 pm respectively. Refer to *Appendix A – Technical Memo Inputs* for further details on the existing peak period traffic estimation. The study and tests conducted focus only on these peak periods.

The model results were interpreted based on the Volume/Capacity Ratio (V/C). V/C is a measure of the level of saturation and is used to identify areas where the demand exceeds the supply within a road network. For our study purposes, the V/C ratio has been multiplied by 100 – so a V/C of 100 represents a link where demand equals the supply (in the peak period). We have classified the V/C Ratio into 4 groups above 100. Assigned volume plots are outputs obtained from the strategic model which show the peak hour traffic volumes across the network and are attached in Appendix A.

Note that in theoretical terms, the volume can't exceed the capacity. However, the AIMSUN model gives us an indication of where demand exists so that we can see where additional capacity may be required in the future. Figure 2 and Figure 3 below show the links where the V/C exceeded 100%. These links are likely to be highly congested with no changes to the anticipated demand or road network capacity during the AM and PM peaks.

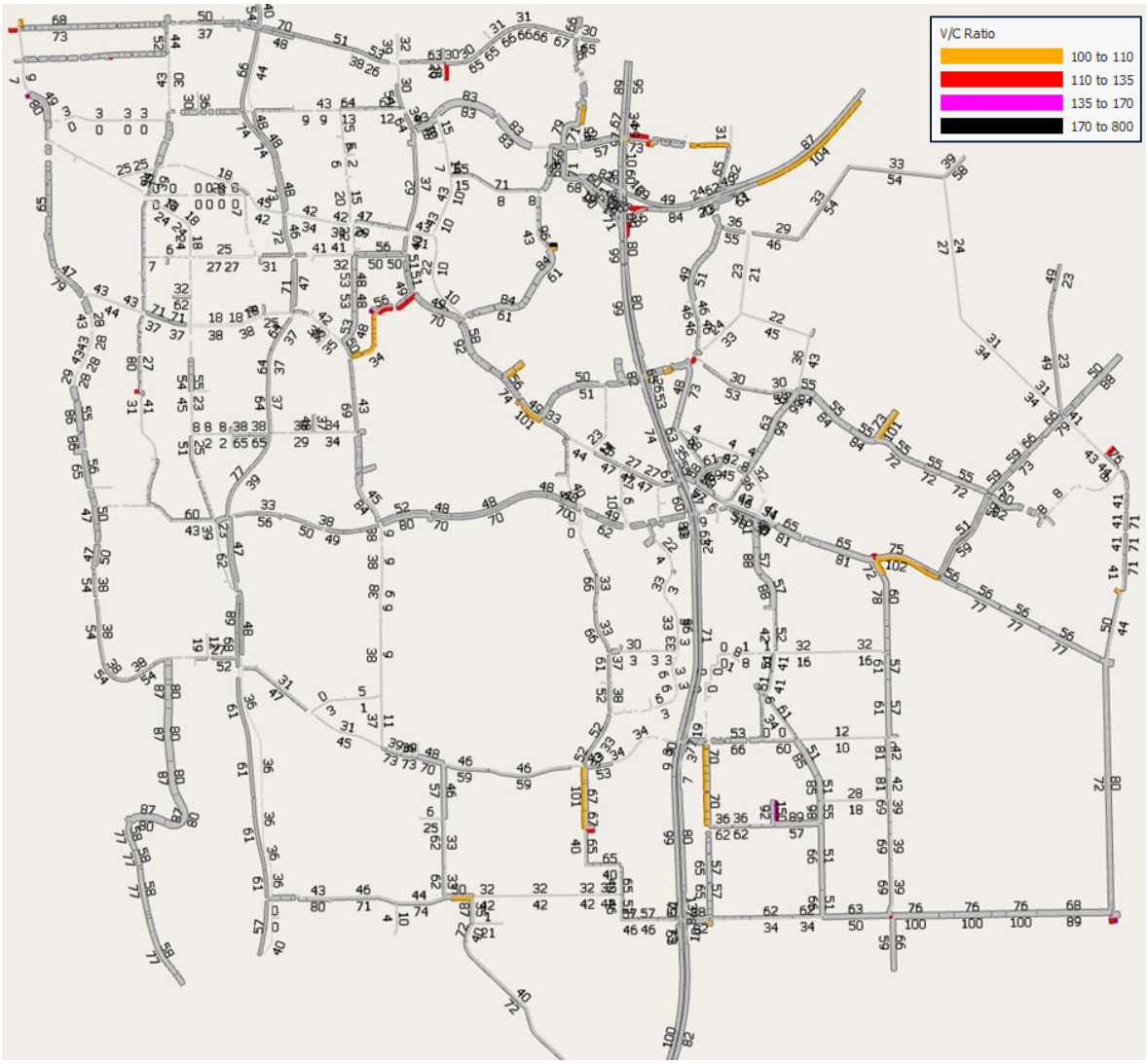

Figure 2: Road sections highlighted exceed 100% V/C Ratio during AM peak – 2021

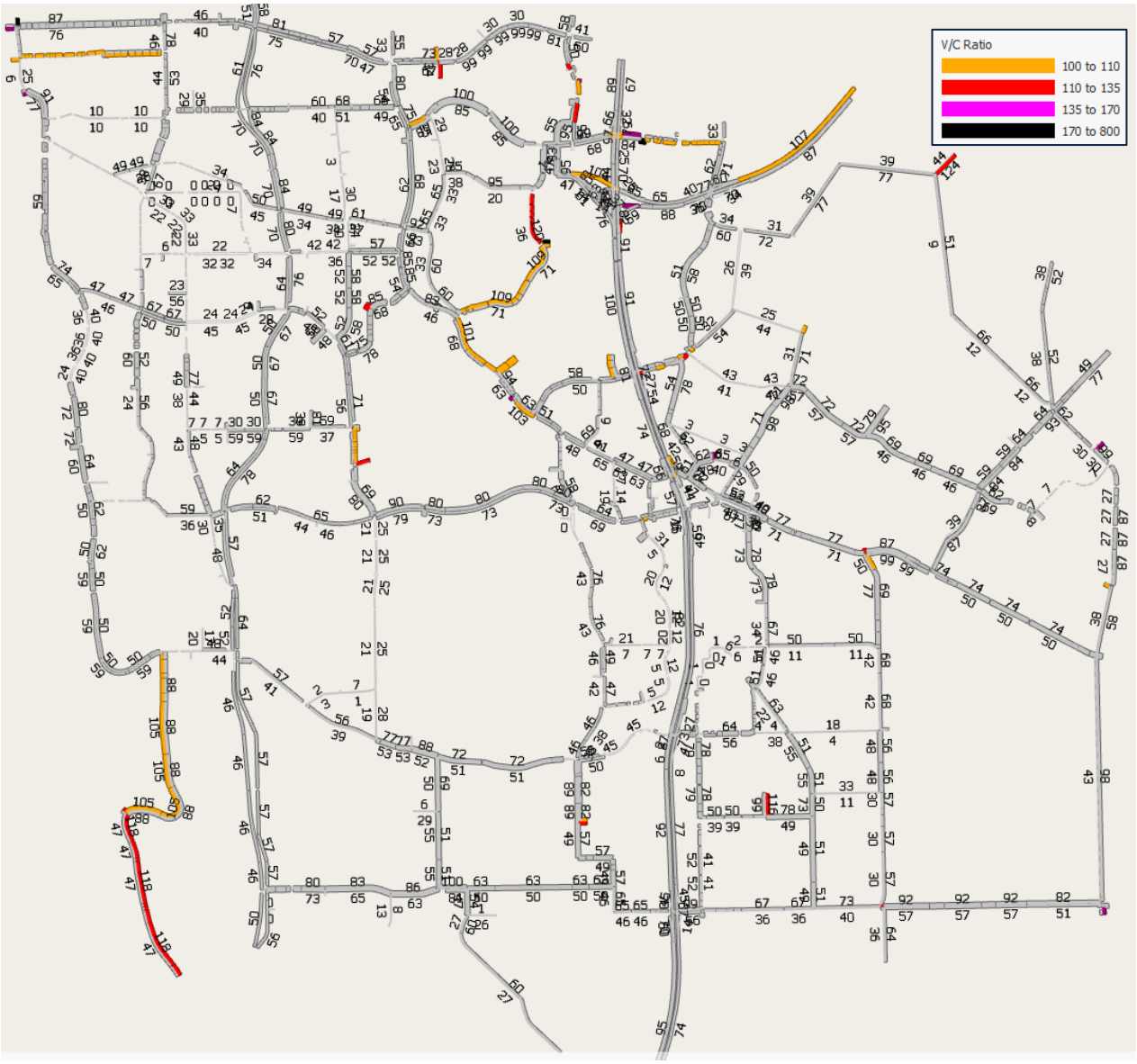

Figure 3: Road sections highlighted exceed 100% V/C Ratio during PM peak – 2021

The results for V/C ratio plots for the base year (2021) revealed that the network operated satisfactorily in both the AM and PM peak periods with only a few congestion hotspots occurring mainly on the northern section of the City adjacent to Kwinana Freeway.

Given that the model examines the network on a strategic level, there are model limitations in terms of predicting the disruptions to traffic due to activities such as roadworks and road incidents.

4. Future Year Network Review

4.1 Forecast Scenarios

Two future horizon years were modelled: 2031 and 2041. Each of these has two scenarios as shown below in Table 2:

- "Do Nothing" – The road network remains as per year 2021; and
- "Do Something" – City of Cockburn + Main Roads WA improvements as identified in the list of upgrades in City's Regional & Major Roadworks plan.

Table 2: Scenario Matrix

Scenario	Existing (2021)	Short Term (2031)	Long Term (2041)
"Do Nothing" - Existing network	Existing network	No improvements	No improvements
"Do Something"		List of agreed road network upgrade	List of agreed road network upgrade

The '"Do Nothing"' scenario is predominantly tested to demonstrate the traffic conditions in the future if there are no upgrades in the current road network. This will also help to identify priority areas where significant congestion may occur and the subsequent requirement for upgrades.

The "Do Something" scenario shows the traffic network performance if the proposed upgrades (City of Cockburn + Main Roads WA) are built in the future. The effect of these road upgrades will be evaluated in this study.

Model Assumptions:

It should be noted that the upgrades in the "Do Something" scenario do not include road safety projects such as intersection upgrades, traffic signal upgrades, traffic calming, road safety improvements, turn bans, LATM measures, intersection upgrades and operational improvements **-** many of which may be required to achieve suitable road safety and community amenity outcomes. This is due to the strategic nature of the methodology which focuses on major upgrades such as new links, additional carriageways, and removal of existing carriageway/s. Public Transport usage has not been modelled. Main Roads ROM data does not consider the traffic generation from Jandakot Treeby PIA area as it was announced in late 2023. As such, there may be areas within the local government boundary where significant traffic growth may occur as a result of new development which this report does not account for. The currently planned road upgrades and the test for alternative scenarios have been formulated based on consultation with the City.

The list of planned road upgrades extracted from City of Cockburn's Regional and Major Roadworks and those applicable for strategic modelling is shown below.

Table 3: List of planned road upgrades applicable for strategic modelling

Implementation Plan	City of Cockburn		Main Roads WA	
Road Network Upgrade	2031	2041	2031	2041
Rockingham Road – Phoenix Road to Spearwood Avenue reconstruction (reduce to 1 lane each way)	✓			
Jandakot Road Upgrade - Skotsch Road to Warton Road (increase to 2 carriageways)	✓			
Russell Road Upgrade - Hammond Road to Rockingham Road - Stage 1 - Hammond Road to Henderson Road (increase to 2 carriageways)	✓			
Russell Road – Henderson Road to Rockingham Road (increase to 2 carriageways) - Stage 2	✓			
Elderberry Drive Realignment - Jindabyne Heights to Berrigan Drive to connect to Ngort Drive	✓			
Hammond Road Upgrade - Beeliar Drive to North Lake Road (increase to 2 carriageways)	✓			
Hammond Road Upgrade and Widening - Branch Circus to Bartram (increase to 2 carriageways)	✓			
Spearwood Avenue Upgrade - Beeliar Drive to Fancote Avenue (increase to 2 carriageways)	✓			
Ngort Drive Upgrade & Extension - North Lake Road to Berrigan Drive		✓		
Hammond Road Upgrade & Extension - Gaebler Road to Rowley Road - Stage 1 - Russell Road to Frankland Avenue (construct 1 carriageway both NB and SB)		✓		
Rowley Road Upgrade - Rockingham Road to Hammond Road - Stage 1 - Kwinana Freeway to Hammond Road (construct 2 carriageways)		✓		
Mayor Road Downgrade / Removal - Apium Mews to Atwell Close (link removal)		✓		
Midgegooroo Avenue Downgrade - Beeliar Drive to North Lake Road (reduce to 2 lanes in both directions)		✓		
Hammond Road Extension - Russell Road to Rowley Road - Stage 2 - Frankland Avenue to Wattleup Road (link extension)		✓		
Hammond Road Extension - Russell Road to Rowley Road - Stage 3 - Wattleup Road to Rowley Road (link extension)		✓		
Poletti Road Upgrade - Beeliar Drive to North Lake Road (increase to 2 carriageways)		✓		
Pilatus Street Upgrade - Berrigan Drive to Jandakot Airport boundary (increase to 2 carriageways)		✓		
Kwinana Freeway - Rowley Road to Russell Road (northbound additional lane) State Planned Project				✓

4.2 Results for 2031 road network

Figure 4 and Figure 5 show the differences between the “Do Nothing” and “Do Something” scenarios for 2031 during the AM peak period. The figures display links with V/C X 100 exceeding 100.

AM Peak Do Nothing:

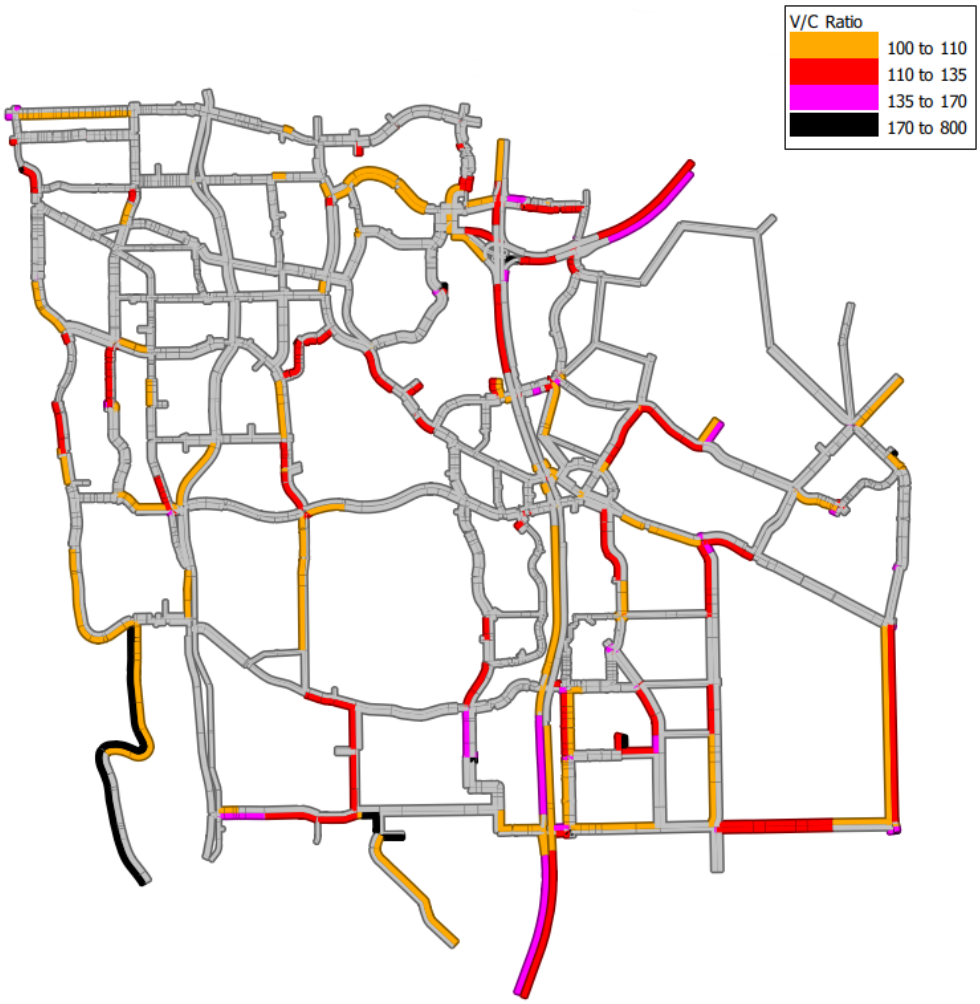

Figure 4: Road sections highlighted exceed 100% V/C ratio during AM Peak – 2031 “Do Nothing” scenario

AM Peak Do Something:

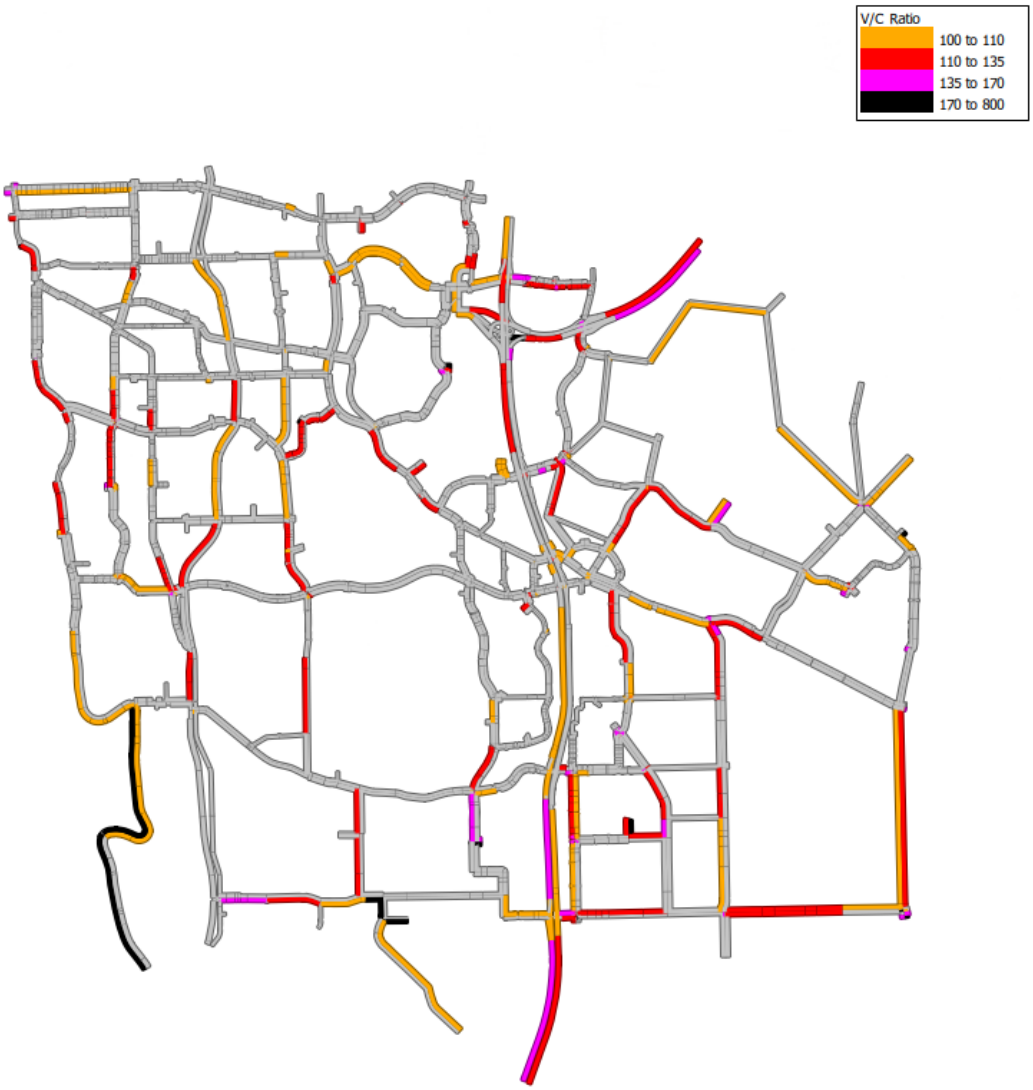

Figure 5: Road sections highlighted exceed 100% V/C ratio during AM Peak – 2031 "Do Something" scenario

The figures show a marginal improvement in the road network in the "Do Something" scenario. The Rockingham Road downgrade from two lanes to one lane results in increased congestion on Rockingham Road. The purpose of the capacity downgrade is to improve road safety and pedestrian amenity in the area.

Vehicle-hours travelled (VHT) across the Cockburn road network was used to estimate the benefits of the upgrades. In the 2031 "Do Nothing" AM peak scenario, the VHT was 645,007 vehicle-hours which reduced to 642,338 vehicle-hours for the "Do Something" AM peak. This represents a travel time savings of 2,669 vehicle-hours during the AM peak.

Figure 6 and Figure 7 show the difference in the “Do Nothing” and “Do Something” scenarios for 2031 during the PM peak.

PM Peak Do Nothing:

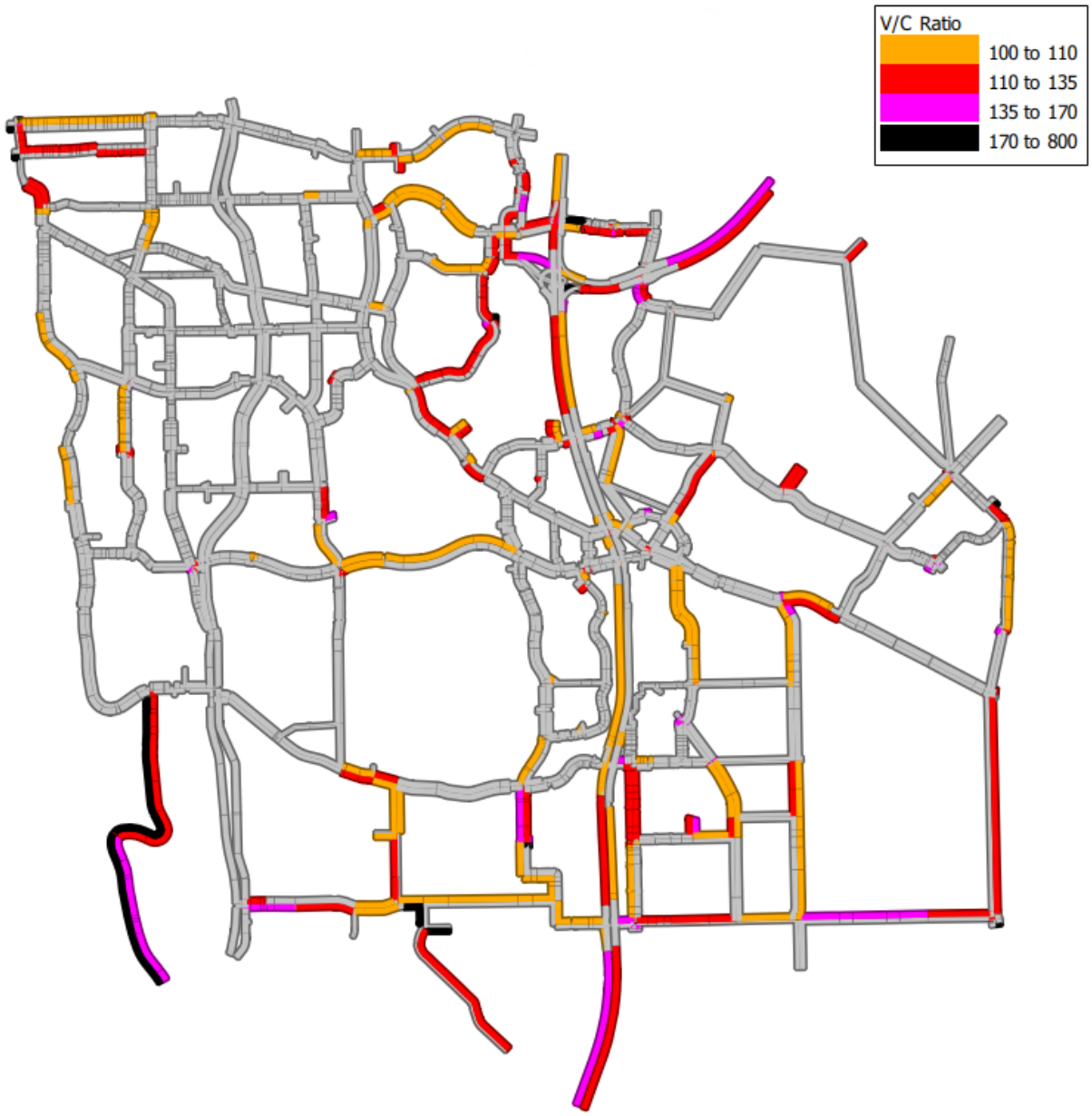

Figure 6: Road sections highlighted exceed 100% V/C ratio during PM Peak – 2031 “Do Nothing” scenario

PM Peak Do Something case:

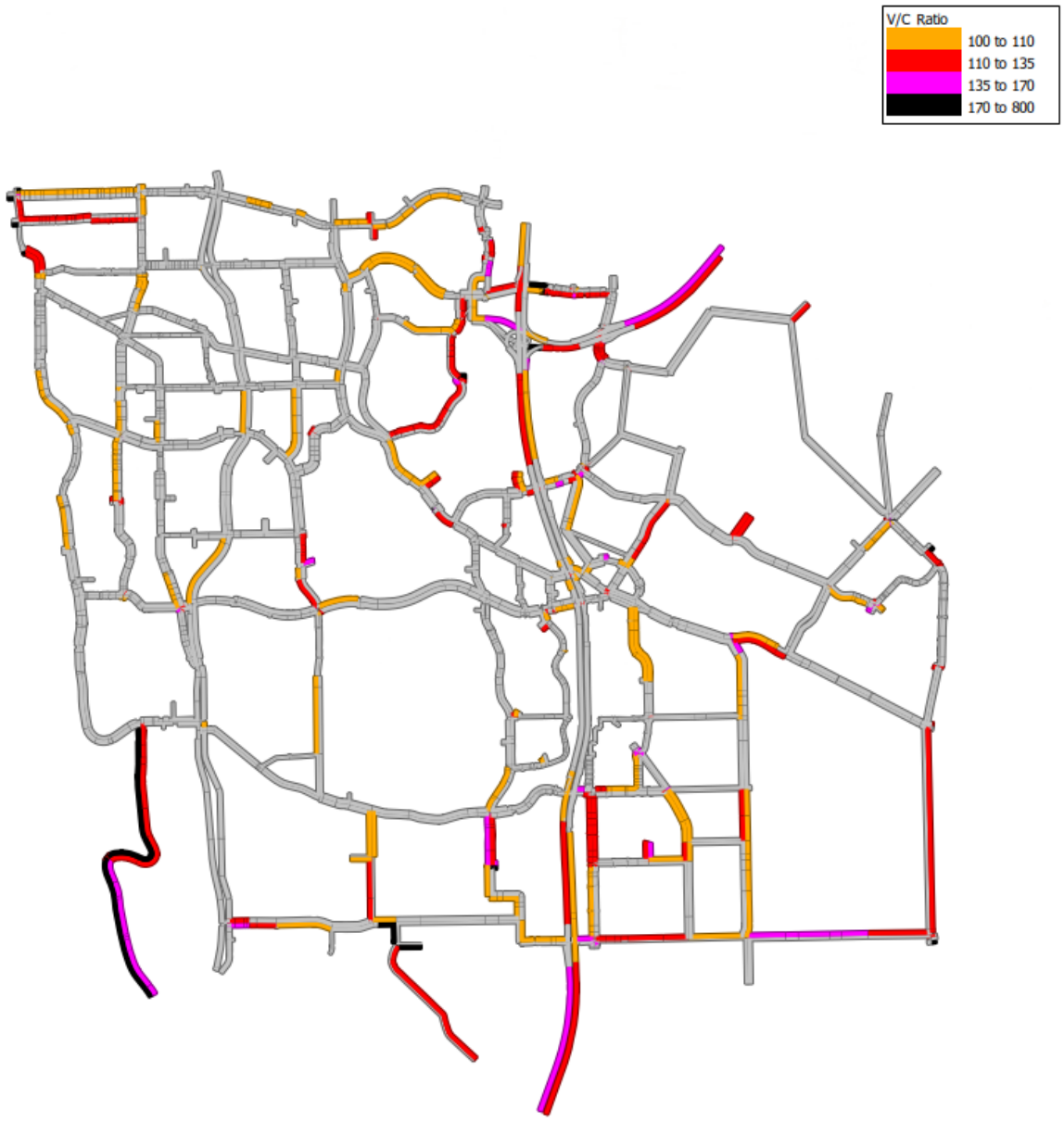

Figure 7: Road sections highlighted exceed 100% V/C ratio during PM Peak – 2031 "Do Something" scenario

The results show a marginal improvement in the PM peak period road network in the "Do Something" scenario. The PM peak congestion in the "Do Nothing" scenario is spread out throughout the road network in contrast to the "Do Something" scenario where it is concentrated towards the extreme north and south regions of the network and adjacent to the freeway. Local roads seem to have benefitted in travel times by the road upgrades in the "Do Something" scenario. In the 2031 "Do Nothing" PM peak period scenario, the VHT was 658,543 whereas it was 652,988 for the "Do Something" PM peak. The results indicated a travel time savings of 5,555 vehicle-hours during the PM peak period.

4.3 Results for 2041 planned road network

The results for the 2041 “Do Nothing” and “Do Something” scenarios show that peak period congestion is spread out throughout the road network in both scenarios. A comparison of VHT indicates a marginal improvement in the road network in the “Do Something” scenario.

Figure 8 and Figure 9 show the difference in the 2041 AM peak period “Do Nothing” and “Do Something” scenarios.

AM Peak Do Nothing:

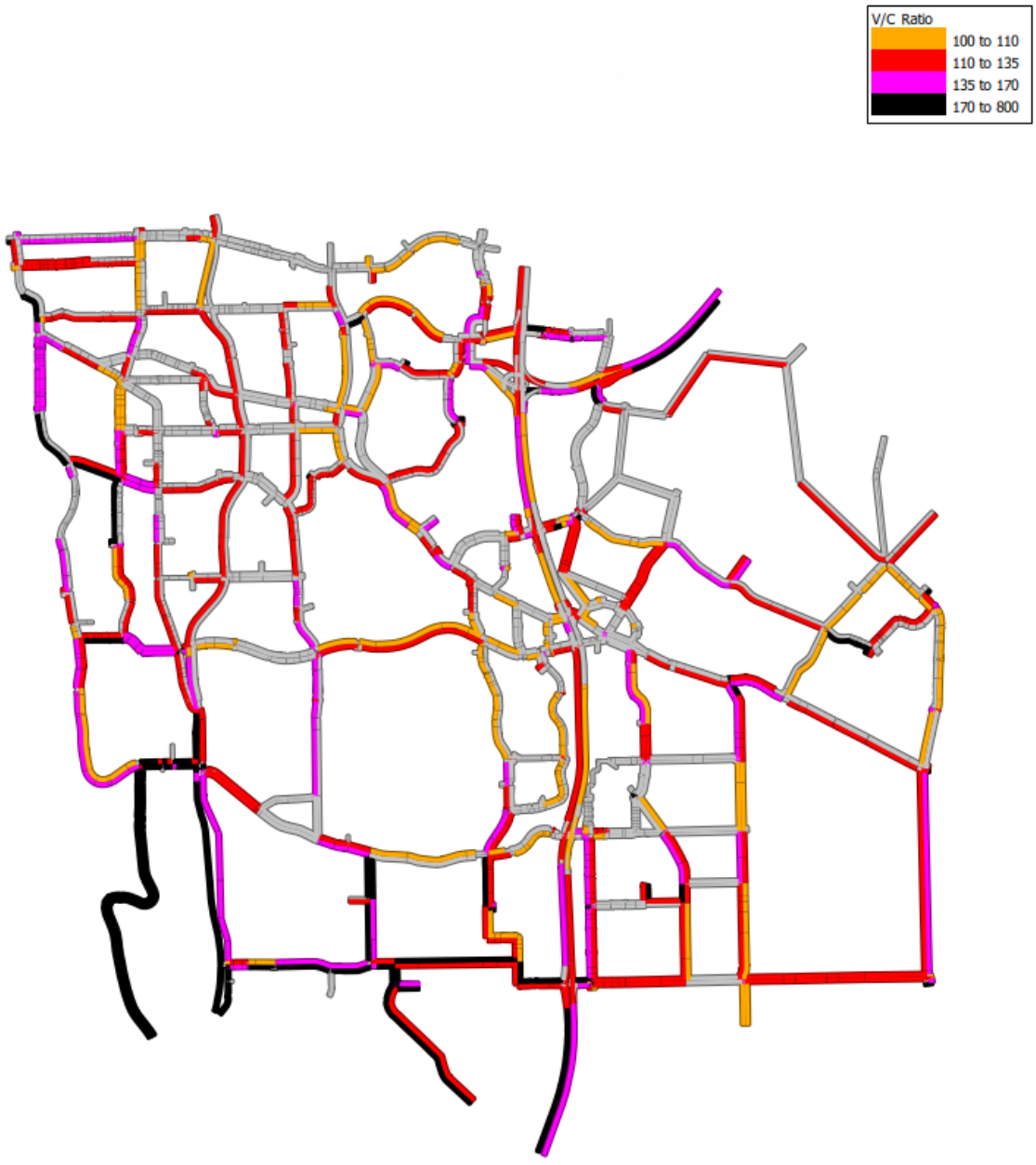

Figure 8: Road sections highlighted exceed 100% V/C ratio during AM Peak – 2041 “Do Nothing” scenario

AM Peak Do Something case:

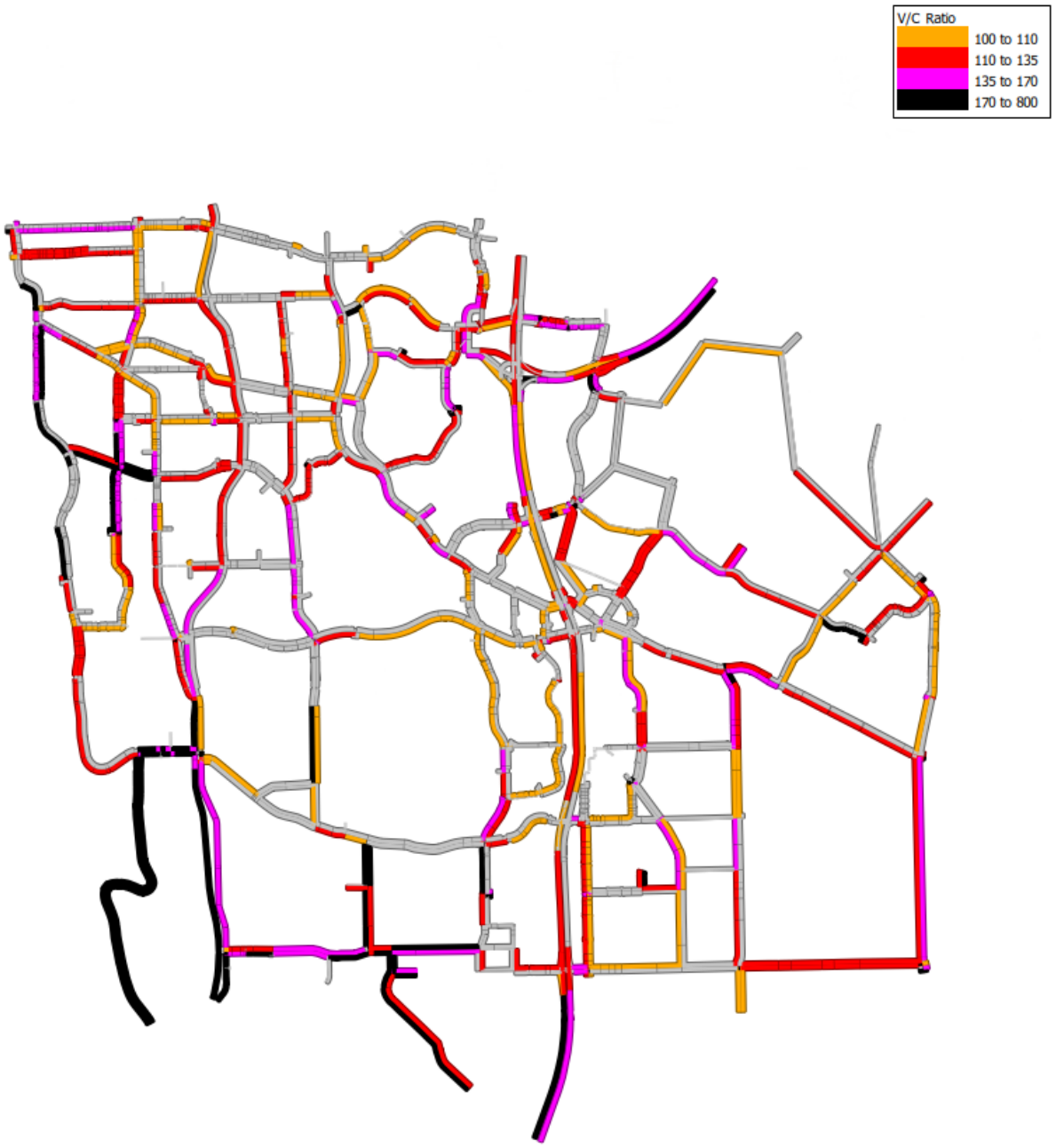

Figure 9: Road sections highlighted exceed 100% V/C ratio during AM Peak – 2041 "Do Something" scenario

Figure 10 and Figure 11 show the difference in the 2041 PM peak period "Do Nothing" and "Do Something" scenarios.

PM Peak Do Nothing:

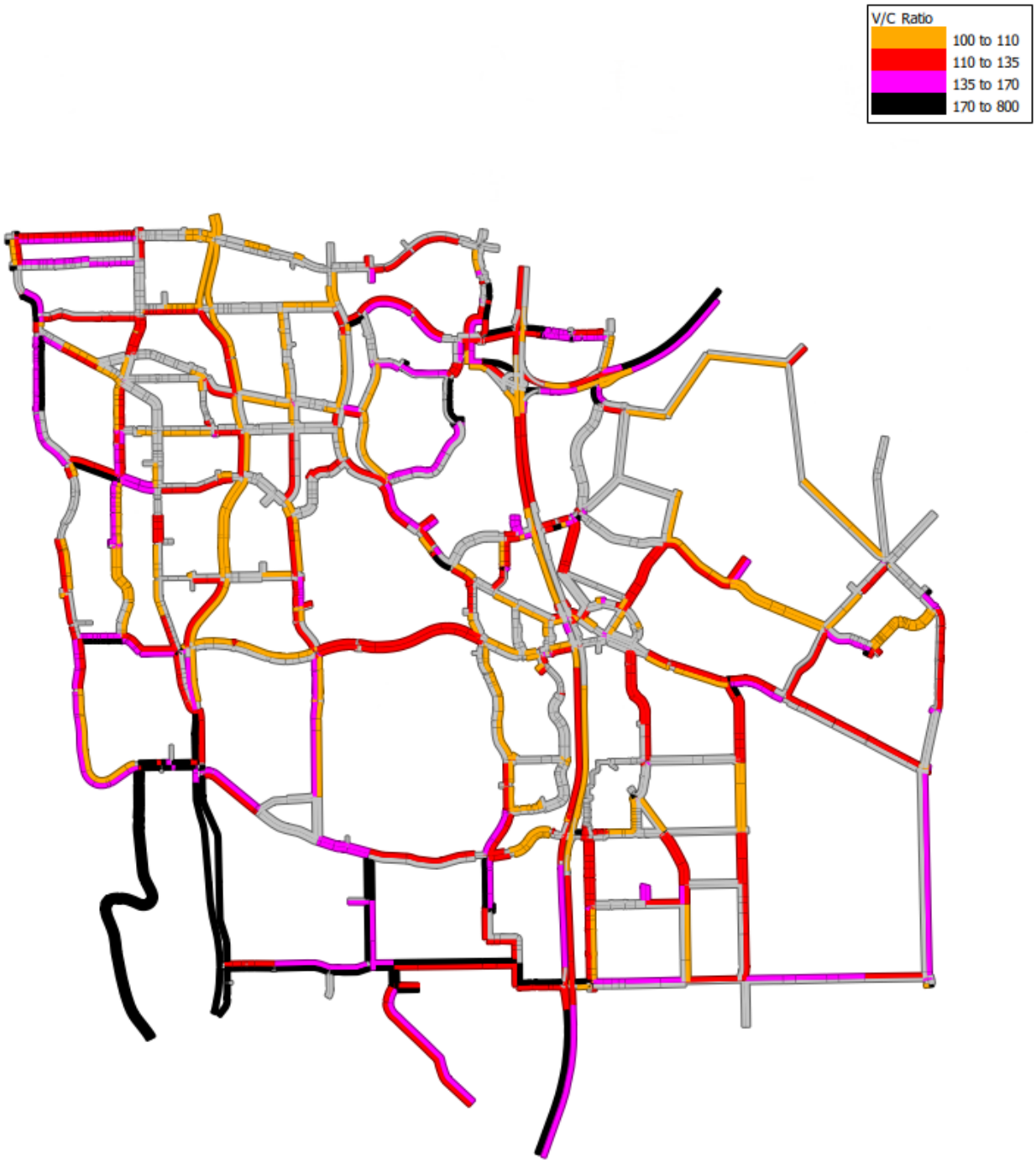

Figure 10: Road sections highlighted exceed 100% V/C ratio during PM Peak – 2041 "Do Nothing" scenario

PM Peak Do Something:

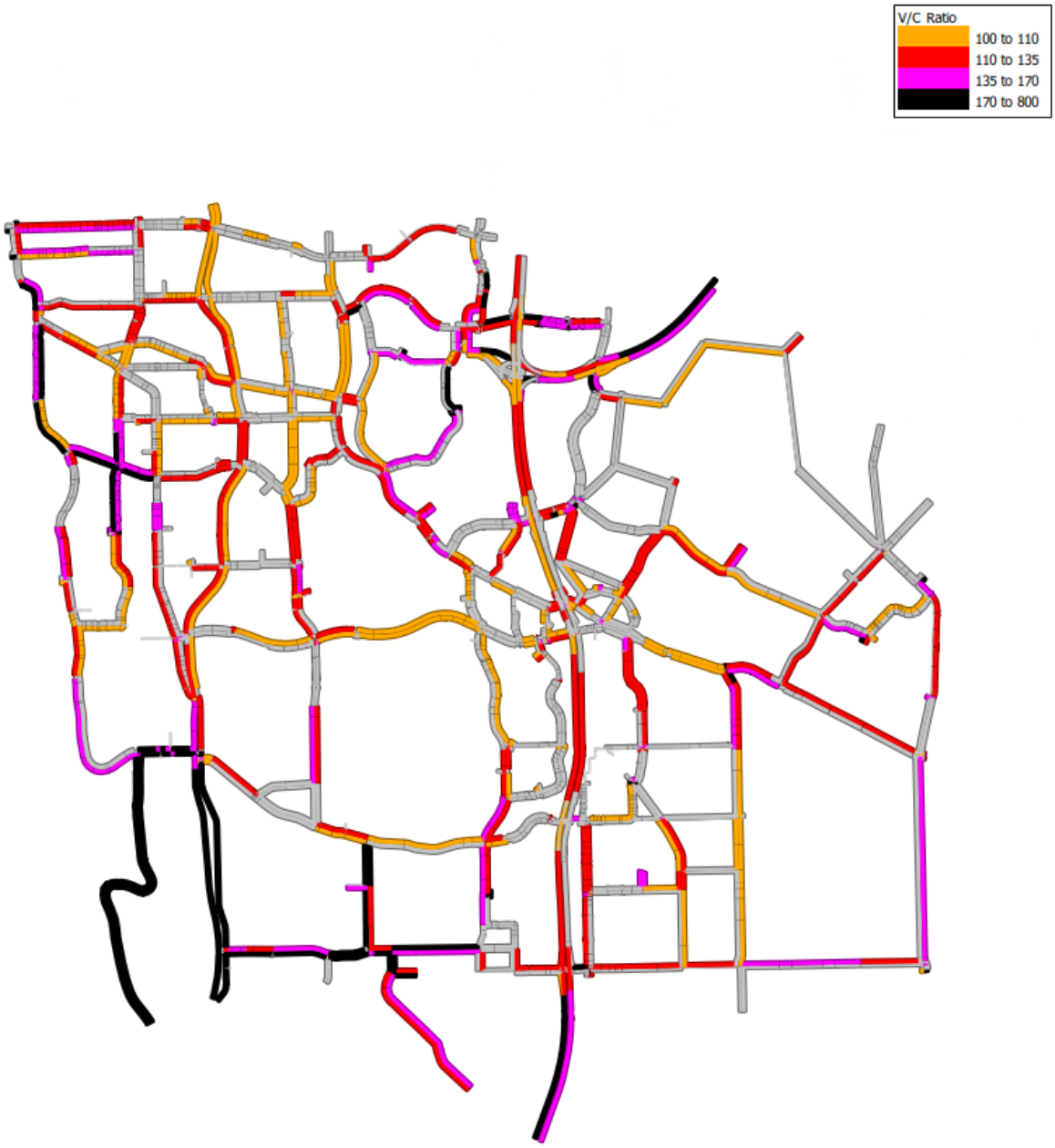

Figure 11: Road sections highlighted exceed 100% V/C ratio during PM Peak – 2041 "Do Something" scenario

The 2041 "Do Nothing" AM peak VHT was 4,216,083 veh-hrs which reduced to 4,115,750 veh-hrs for the "Do Something" scenario. The results indicated a travel time savings of 100,333 veh-hrs during the AM peak period in 2041.

Similarly, for the PM peak, the results indicated a reduction in VHT by 99,667 veh-hrs. Refer to Appendix A for further details.

Since this is a high level strategic modelling exercise, there are some limitations. The assessment of finer grained operational components such as individual intersection or corridor performance would enable a better understanding of the congestion hotspots. The strategic model uses link-based delays whereas an operational model would assess congestion at intersections.

4.4 Network Statistics

Table 4 shows a summary of network statistics for base and future years for the "Do Nothing" and the "Do Something" scenarios. These help to identify impacts of the upgrades on the overall travel time and travel distance in the network during peak periods.

The planned road upgrades reduce vehicle-hours but add to vehicle-kms during peak periods. New roads will reduce veh-hours and increase traffic speeds but also encourage longer trip lengths – hence, the increase in vehicle-kms.

Table 4: Forecast scenario assignment summary statistics

Network Variable	Base	Do Nothing		Do Something	
	2021	2031	2041	2031	2041
Vehicle-hours (AM Peak)	60,349	645,007	4,216,083	642,338	4,115,750
Vehicle-kms (AM Peak)	1,008,230	1,440,000	1,940,530	1,444,030	1,960,200
Vehicle-hours (PM Peak)	105,414	658,543	4,584,700	652,988	4,485,033
Vehicle-kms (PM Peak)	1,009,980	1,489,930	1,991,070	1,498,750	2,011,710

4.5 High Demand zones

The southwest section of the road network will experience a high growth in traffic due to the presence of AMC, Latitude 32 and Westport. Zones 21-26, 61, 62, 77,79 and 112 are the zones in question which can be seen in Figure 12.

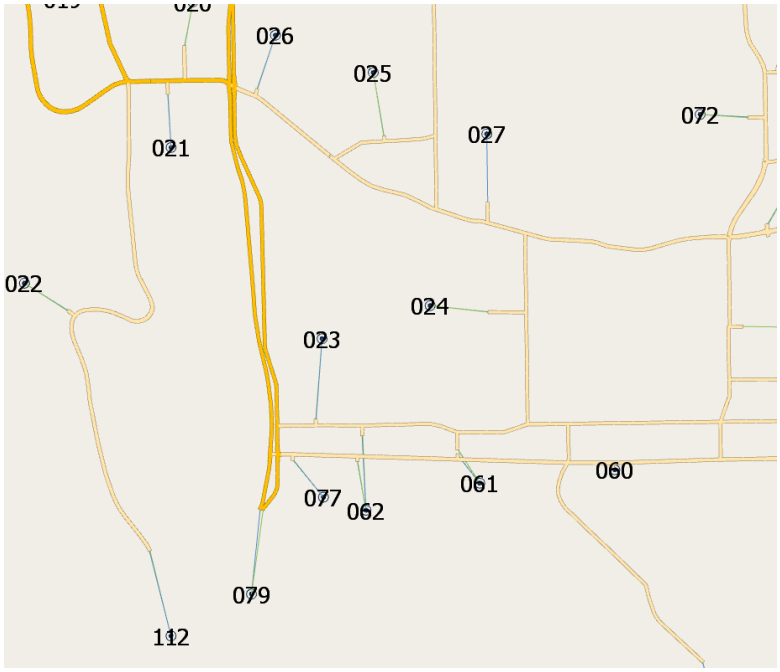

Figure 12: High Demand SW Zones in 2041 road network

There is a significant increase in vehicular demand to and from these zones. Table 5 and Table 6 summarise the demands.

Table 5 shows traffic demand to the zones in question. The Westport zones attract about 4,000 vehicles in 2031 and 10,000 vehicles in 2041. This demand increase along with the surrounding zones for AMC and Latitude 32 causes the total trips into these zones to increase significantly. This increase causes congestion issues particularly in 2041 which is visible in the V/C ratio results in all the scenarios tested.

Table 5: Comparison of demands to the zones corresponding to the southwest of the network

To	Zone ID	AM (7 am – 9 am)			PM (3 pm – 5 pm)		
		2021	2031	2041	2021	2031	2041
Westport	79,112	3227	7078	13994	2917	6196	12975
AMC	21,22	968	980	3734	2488	2532	5000
Lat 32	23-26, 61,62,77	525	1740	3138	657	1922	2670
Total		**4720**	**9798**	**20866**	**6062**	**10649**	**21303**

Table 6 shows the demands generated from the zones that correspond to Westport, AMC and Latitude 32. Similar level of increase in demands can be seen for the future years 2031 and 2041.

Table 6: Comparison of demands from the zones corresponding to the southwest of the network

From	Zone ID	AM(7 am – 9 am)			PM(3 pm – 5 pm)		
		2021	2031	2041	2021	2031	2041
Westport	79,112	2569	4018	9641	4227	6273	12179
AMC	21,22	1474	2904	5908	1083	2028	5128
Lat 32	23-26, 61,62,77	710	2372	4284	767	2496	4270
Total		**4753**	**9294**	**19833**	**6076**	**10797**	**21577**

The congestion issues experienced in the south west section of the network causes a flow-on effect on the northern sections of the network.

5. Additional scenario testing

Further scenario testing of alternative options was undertaken. These scenarios were tested to quantify the V/C ratio, Veh-hrs and Veh-kms travelled during peak periods. They were then used to make comparisons amongst different scenarios to understand the most beneficial upgrades. There were six additional scenarios tested which are described below.

5.1 Scenario 1 – City upgrades:

This scenario was tested on the base year 2021 road network. In this scenario, the upgrades highlighted below were assumed to be undertaken by the City in years 2031 and 2041 as shown. Figure 13 shows planned upgrades in this scenario with 2031 and 2041 upgrades highlighted.

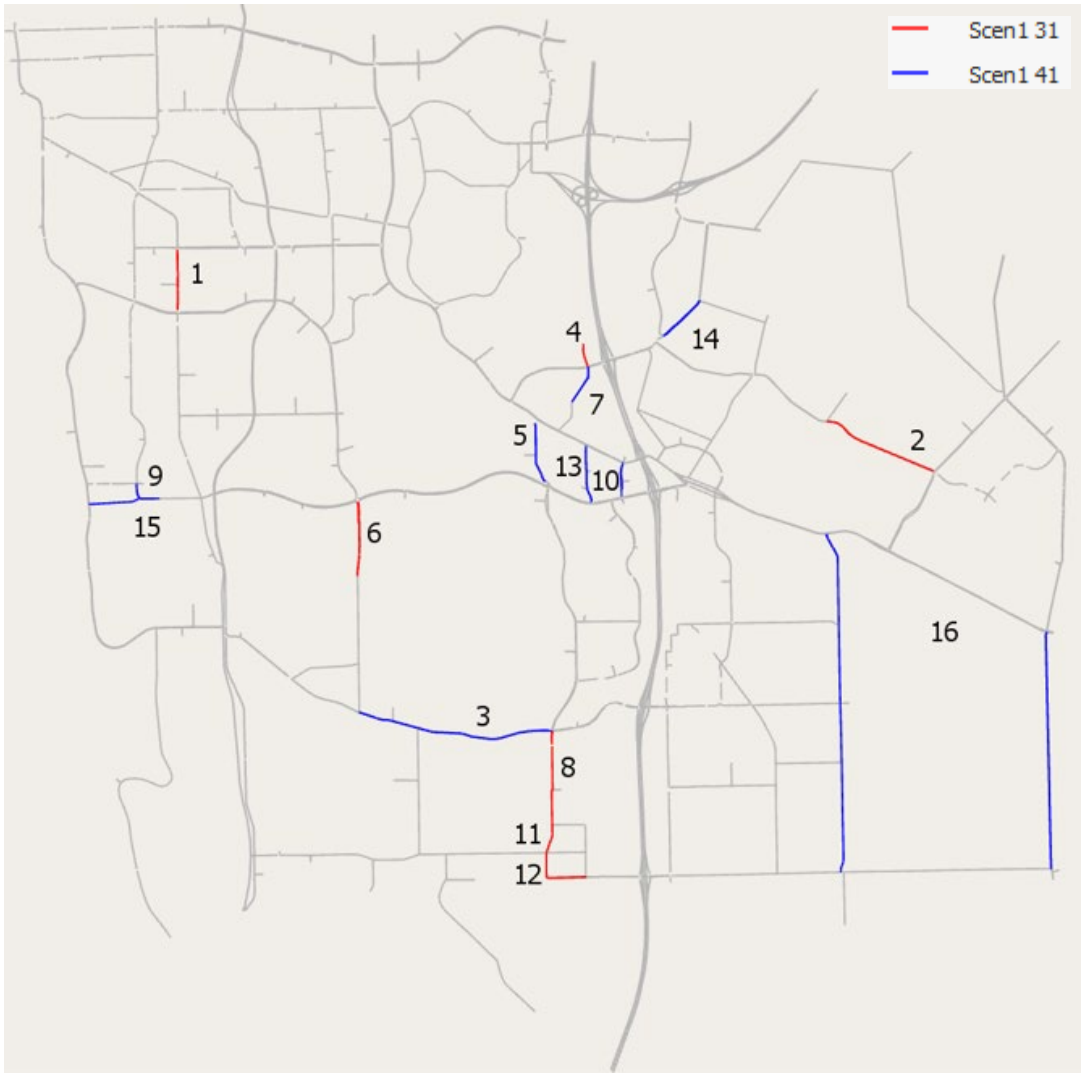

Figure 13: Map showing the 2031 City of Cockburn road network under Scenario 1

Table 7: Scenario 1 – City upgrades

Upgrade number	Road	Type of upgrade	Year of upgrade
1	Rockingham Road – Phoenix Road to Spearwood Avenue	reduce to 1 lane each way	2031
2	Jandakot Road Upgrade – Fraser Road to Warton Road	Additional lane both directions	2031
3	Russell Road Upgrade - Hammond Road to Rockingham Road - Stage 1 - Hammond Road to Henderson Road	Additional lane both directions	2041
4	Elderberry Drive Realignment	Jindabyne Heights to Berrigan Drive to connect to Ngort Drive	2031
5	Hammond Road Upgrade - Beeliar Drive to North Lake Road	Additional lane both directions	2041
6	Spearwood Avenue Upgrade - Beeliar Drive to Fancote Avenue	Additional lane both directions	2031
7	Ngort Drive Upgrade & Extension	North Lake Road to Berrigan Drive	2041
8	Hammond Road Upgrade & Extension - Gaebler Road to Rowley Road - Stage 1 -	Construct 1 carriageway both NB and SB	2031
9	Mayor Road Downgrade / Removal	Apium Mews to Atwell Close	2041
10	Midgegooroo Avenue Downgrade between Beeliar Drive to North Lake Road	reduce to 2 lanes both directions	2041
11	Hammond Road Upgrade & Extension - Russell Road to Rowley Road - Stage 2	link extension from Frankland Avenue to Wattleup Road	2031
12	Hammond Road Upgrade & Extension - Russell Road to Rowley Road - Stage 3	link extension from Wattleup Road to Rowley Road	2031
13	Poletti Road Upgrade - Beeliar Drive to North Lake Road	Additional lane both directions	2041
14	Pilatus Street Upgrade - Berrigan Drive to Jandakot Airport boundary	Additional lane both directions	2041
15	Beeliar Drive extension	link extension from west of Stock Road up to Cockburn Road	2041

The modelling results indicate a marginal increase in veh-hrs and veh-kms in the AM peak period and a marginal reduction in the PM peak period.

V/C Ratio results for this scenario are similar to the “Do Something” scenario with minor variations in the AM and PM peak periods and do not suggest major improvements. Plots for the V/C Ratio are shown below.

2031 Results:

V/C - AM Peak Period - Scenario 1:

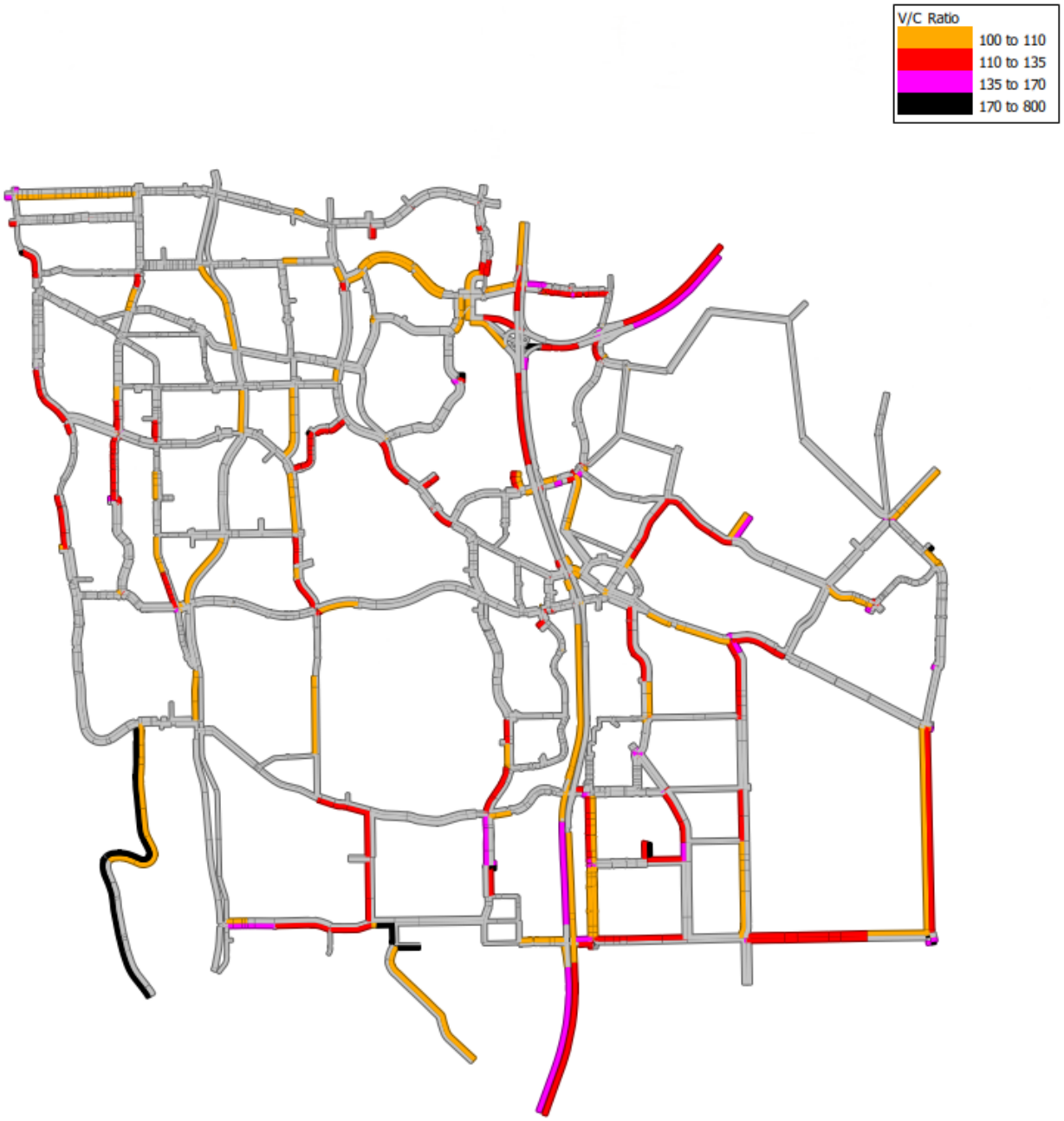

Figure 14: V/C Ratio exceeding 100 in Scenario 1 – AM Peak – 2031

V/C PM Peak Period – Scenario 1:

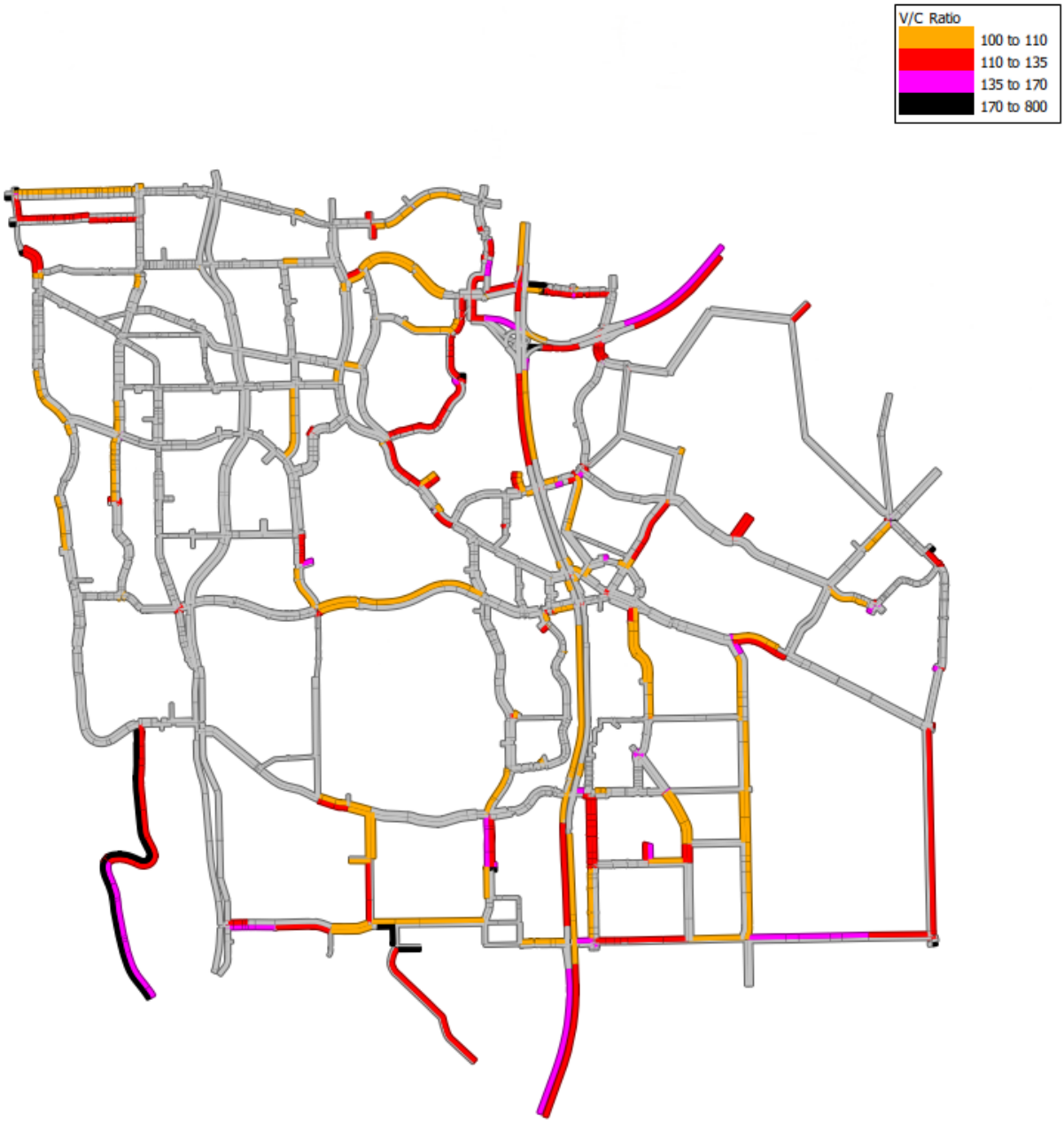

Figure 15: V/C Ratio exceeding 100 in Scenario 1 – PM Peak - 2031

2041 Results:

V/C AM Peak Period – Scenario 1:

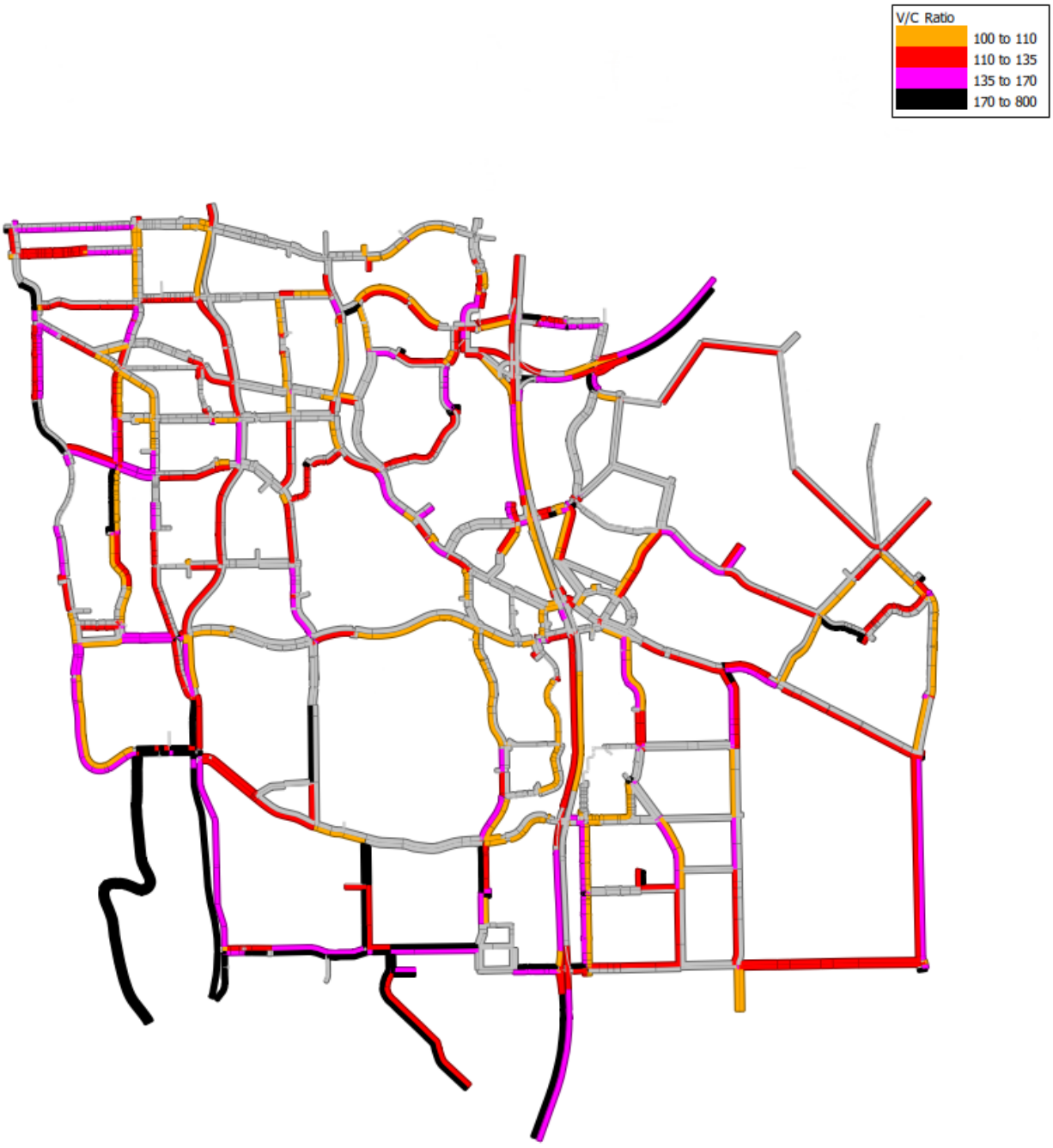

Figure 16: V/C Ratio exceeding 100 in Scenario 1 – AM Peak – 2041

V/C PM Peak Period – Scenario 1:

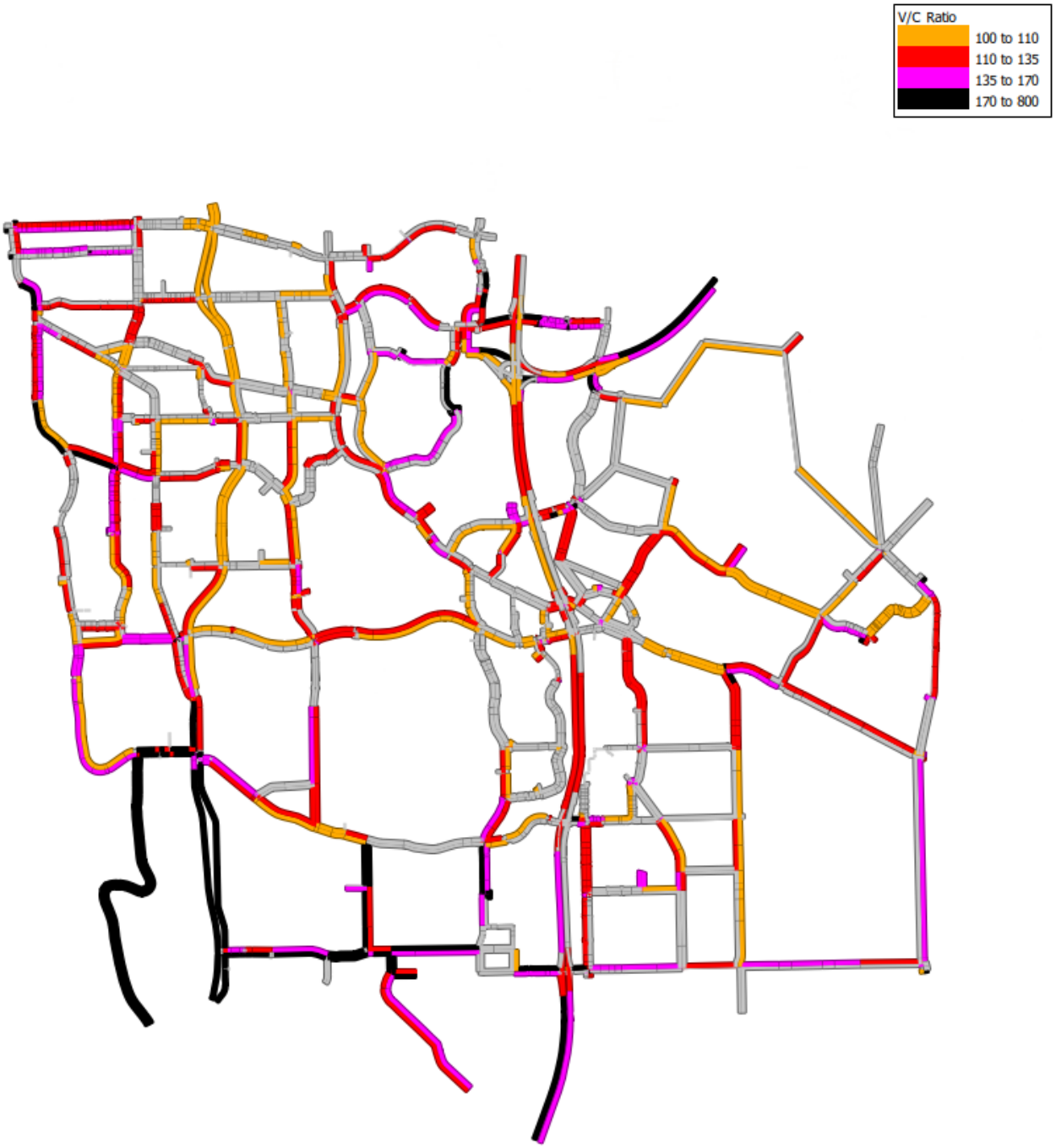

Figure 17: V/C Ratio exceeding 100 in Scenario 1 – PM Peak - 2041

V/C results for Scenario 1 are almost identical to the “Do Something” scenario. There are no major reductions in the V/C ratio in the road network. The benefits from this scenario are marginal when compared to the “Do Something” scenario.

5.2 Scenario 2 – State Upgrades with Fremantle Port

Scenario 2 was a test to observe the impacts of upgrades undertaken by Main Roads WA in 2031. The upgrades are shown in the figure below.

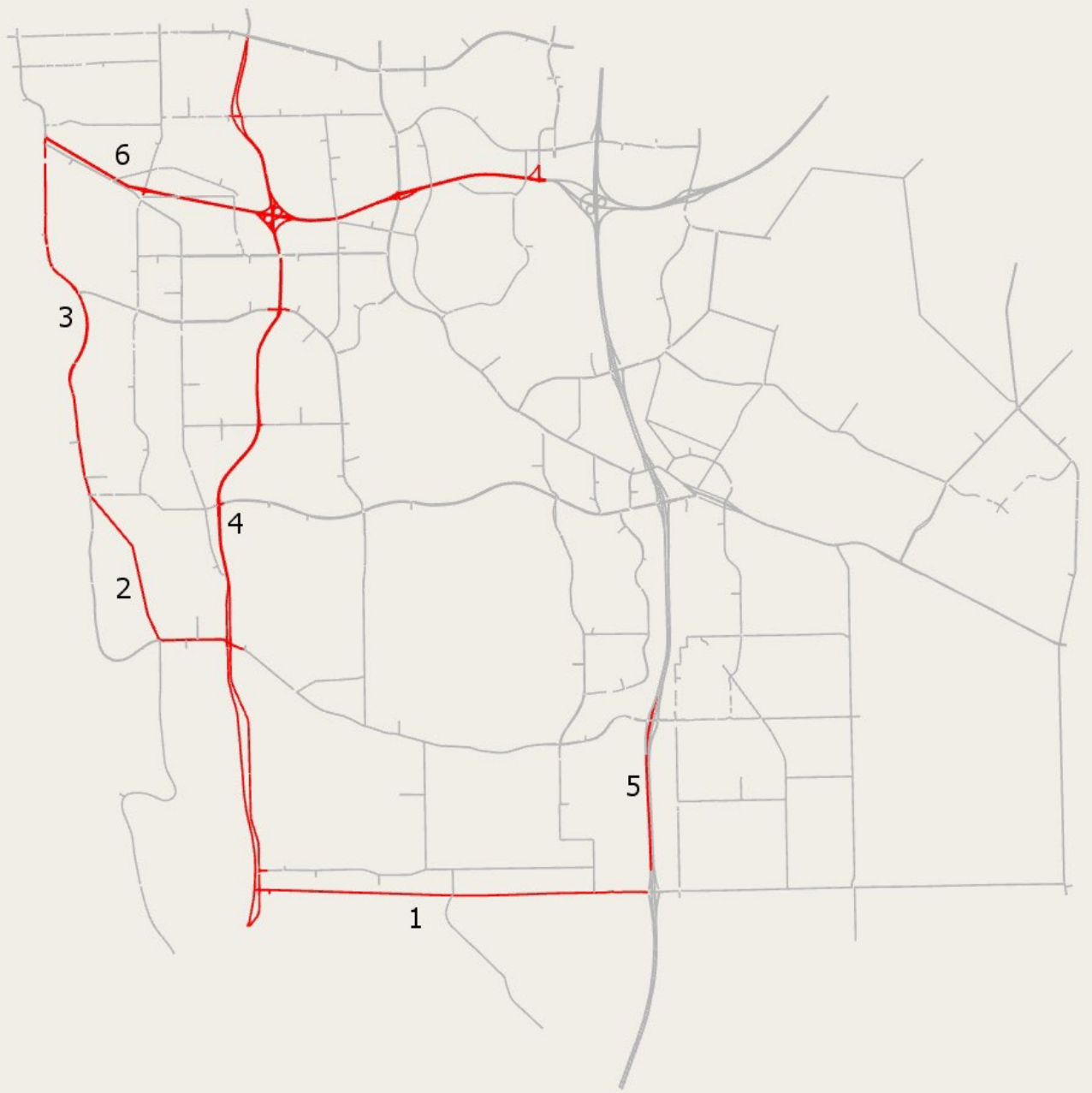

Figure 18: Map showing upgrades in City of Cockburn road network in Scenario 2

The assumed improvements included:

1. Rowley Road West – Provision of divided dual carriageway – between Kwinana Freeway and Rockingham Road - Construct 2 carriageways operating at 80kph
2. Russell Road/Cockburn Road – Rockingham Road to Beeliar Drive extension (future connection) operating as a dual carriageway in both directions at 80km/hr (2031);
3. Cockburn Road to Beeliar Drive extension to Roe Highway – Operating as a Dual Carriageway 70km/hr (2031);
4. Stock Road – Control of access highway upgrade. Divided dual carriageway 100 km/hr (2031);
5. Freeway as noted in Do Something scenario (see Table 3) i.e. Northbound lane addition between Rowley Road and Russell Road; and
6. Roe 9 - Control of access highway upgrade. Divided dual carriageway 100km/hr (2031).

The veh-hrs results in Scenario 2 showed that there were significant travel time savings compared to the "Do Something" scenario. In the 2031 AM and PM Peak periods, there was a saving of 124,271 veh-hrs and 124,006 veh-hrs respectively.

The veh-kms results showed an increase in distance travelled during the AM and PM peak periods for Scenario 2. The Roe Highway extension seemed to contribute to the majority of the increase in distance travelled. Being a high-speed route (100 km/hr), road users were more likely to use the route to save travel time for the east west movements. This added distance to some journeys but saved time.

The results for V/C Ratios are shown below:

2031 Results:

V/C AM Peak Period – Scenario 2:

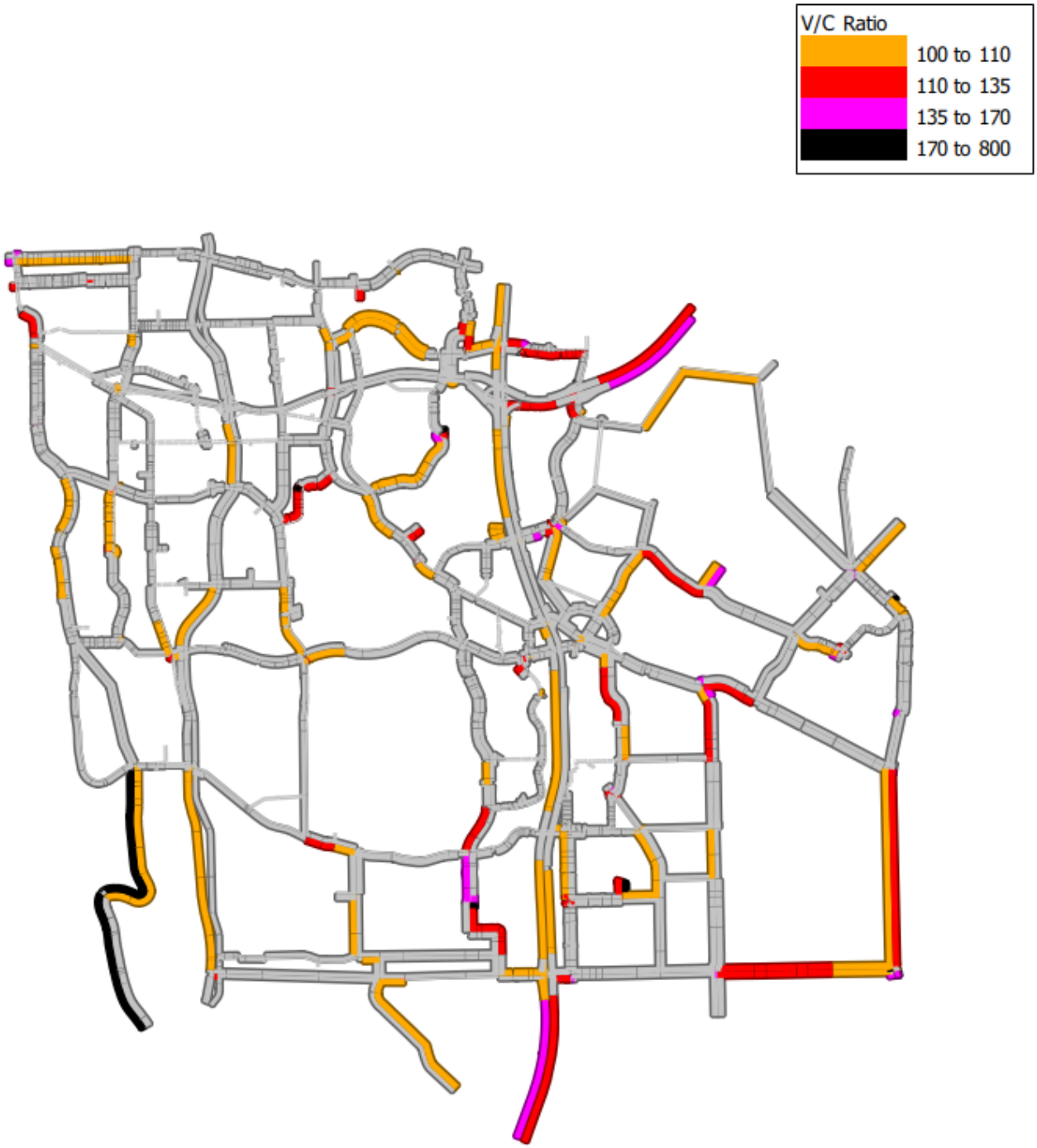

Figure 19: V/C Ratio exceeding 100 in Scenario 2 – AM Peak – 2031

V/C PM Peak Period – Scenario 2:

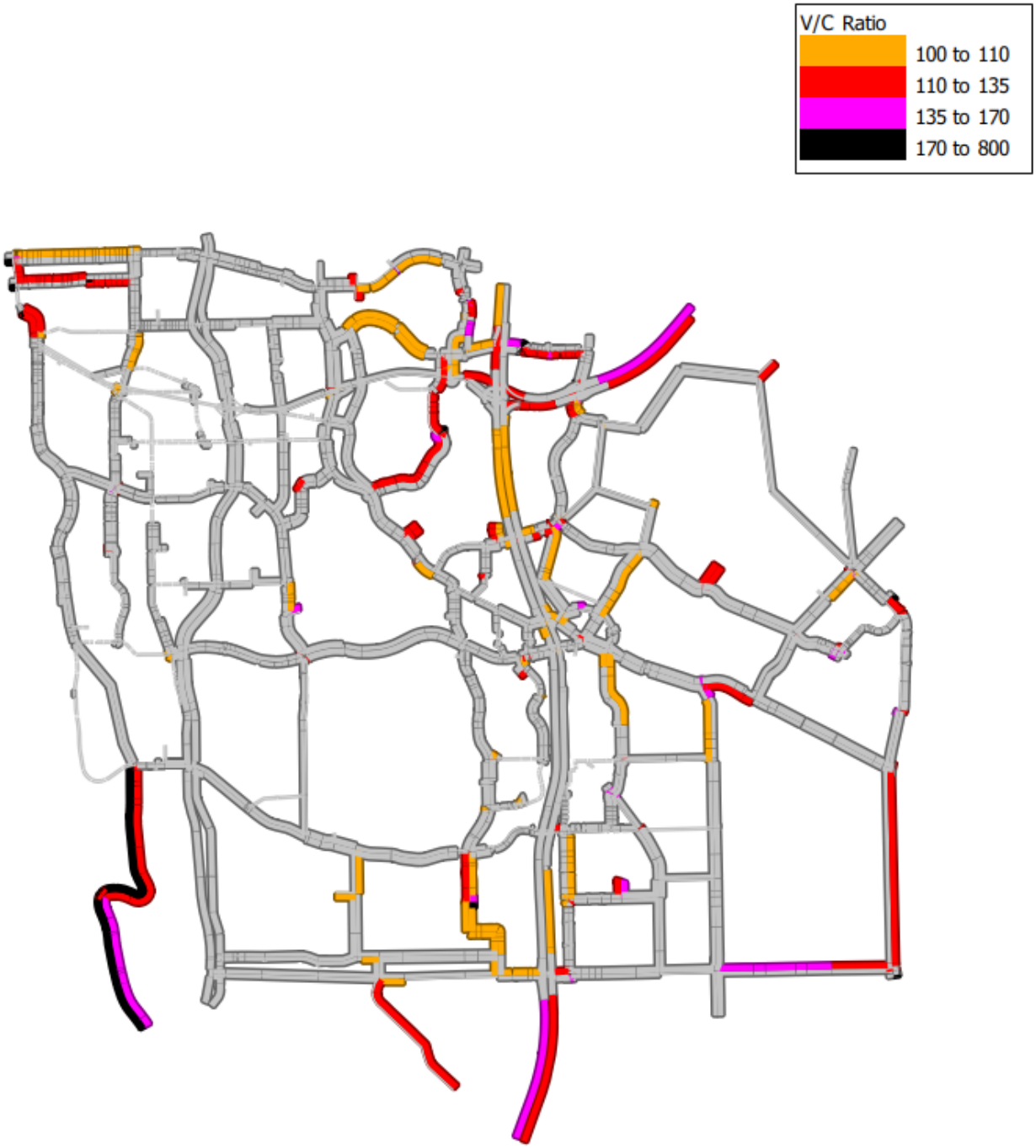

Figure 20: V/C Ratio exceeding 100 in Scenario 2 – PM Peak – 2031

The V/C ratios for the 2031 AM and PM peak periods show that the upgrades in Scenario 2 improved the network performance compared to the "Do Something" results. The benefits were concentrated on the western sections of the network with some noticeable improvements visible in the southern end of the network close to the freeway.

2041 Results:

V/C AM Peak Period – Scenario 2:

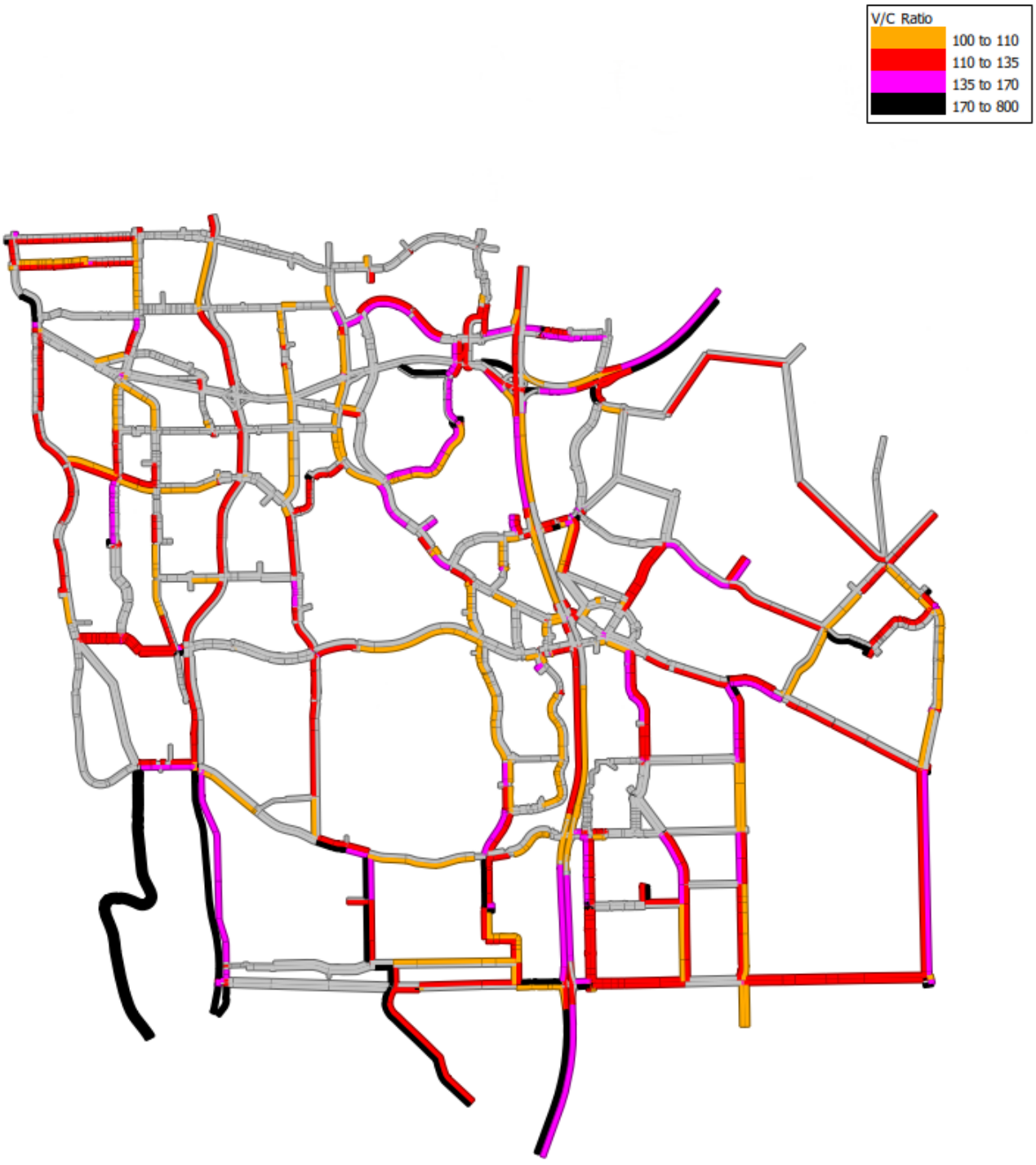

Figure 21: V/C Ratio exceeding 100 in Scenario 2 – AM Peak – 2041

V/C PM Peak Period – Scenario 2:

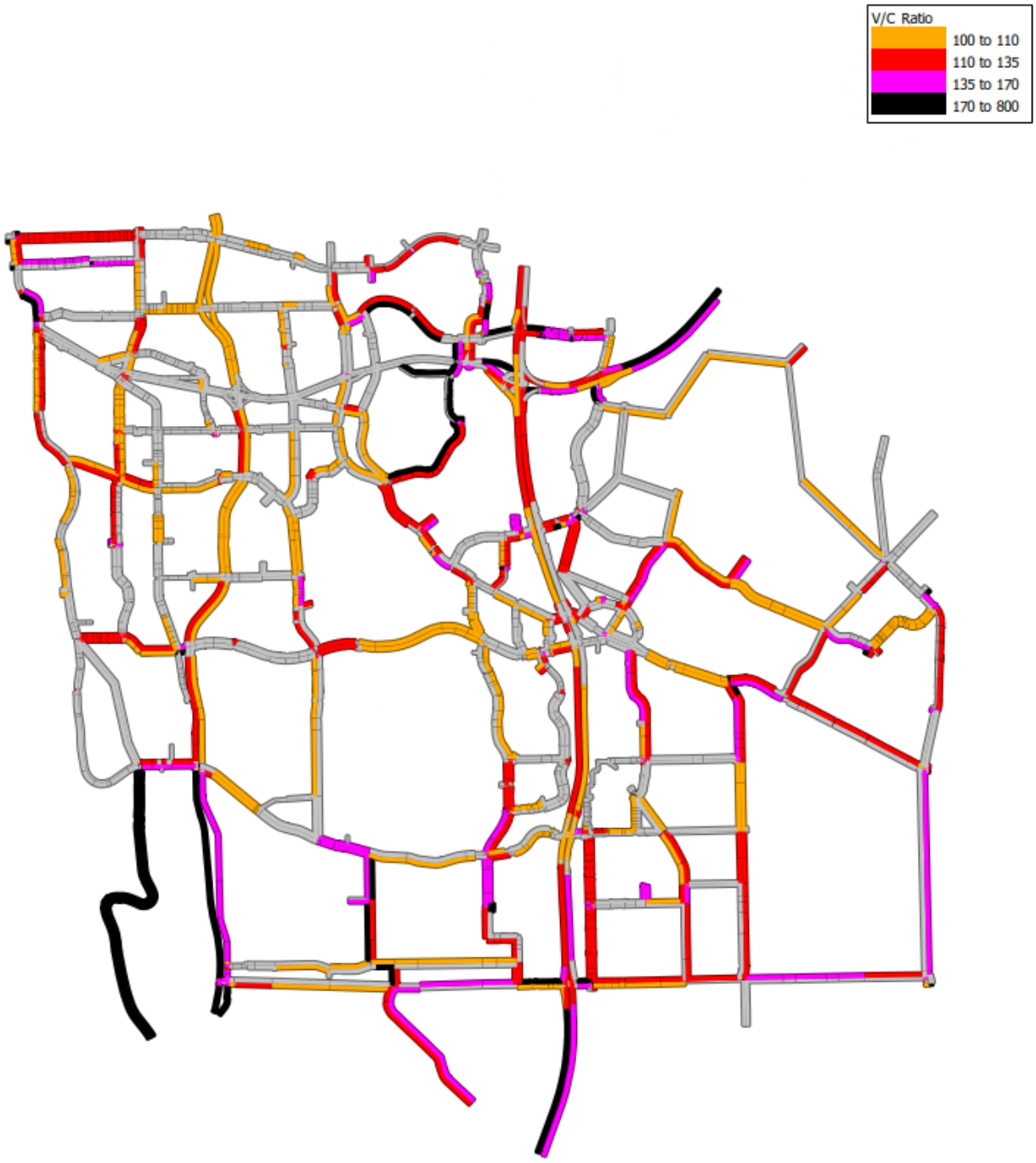

Figure 22: V/C Ratio exceeding 100 in Scenario 2 – PM Peak – 2041

V/C ratio results for 2041 showed similar improvements to 2031 with the north-west section showing most of the improvement.

The results for the Veh-Hrs in Scenario 2 showed that there was significant travel time savings compared to the "Do Something" scenario. In the 2041 AM and PM Peak periods, veh-hrs reduced by 560,317 veh-hrs and 715,983 veh-hrs respectively.

Veh-kms across the network increased during the AM and PM peak periods for Scenario 2 due to improved East-West accessibility provided by the Roe Highway.

5.3 Scenario 3 – State upgrades with Westport

This scenario was tested with the base year 2021 road network. In this scenario, the upgrades highlighted below were assumed to be undertaken by Main Roads in 2031. Figure 23 below shows the planned upgrades in this scenario.

Figure 23: Map showing the 2031 City of Cockburn road network in Scenario 3

The following upgrades were assumed in this scenario:

1. Rowley Road West – Provision of divided dual carriageway – between Kwinana Freeway and Rockingham Road - Construct 2 carriageways operating at 80kph
2. Russell Road/Cockburn Road – Rockingham Road to Beeliar Drive extension (future connection) as divided dual carriageway, 80km/hr (2031);
3. Cockburn Road – dual carriageway from Beeliar Drive extension to Rockingham Road/Hampton Road intersection – dual carriageway 70km/hr (2031);
4. Stock Road – Controlled access highway upgrade with 3 lanes each direction at 100km/hr (2031);
5. Kwinana Freeway widening (2031) i.e. additional lane both directions between Anketell Road and Russell Road;
6. Cockburn Road (South), upgrade to dual carriageway 70 kph (2031);
7. Rowley Road East - divided dual carriageway 80 kph between Kwinana Freeway and Tonkin Highway (2041);
8. Nicholson Road upgrade to dual carriageway 80 kph and Liddelow Road speed reduction to 60 kph; and
9. Russell Road – Henderson Road to Rockingham Road – dual carriageway.

The V/C ratio results from the assumed upgrades are shown below:

2031 Results:

V/C AM Peak Period – Scenario 3:

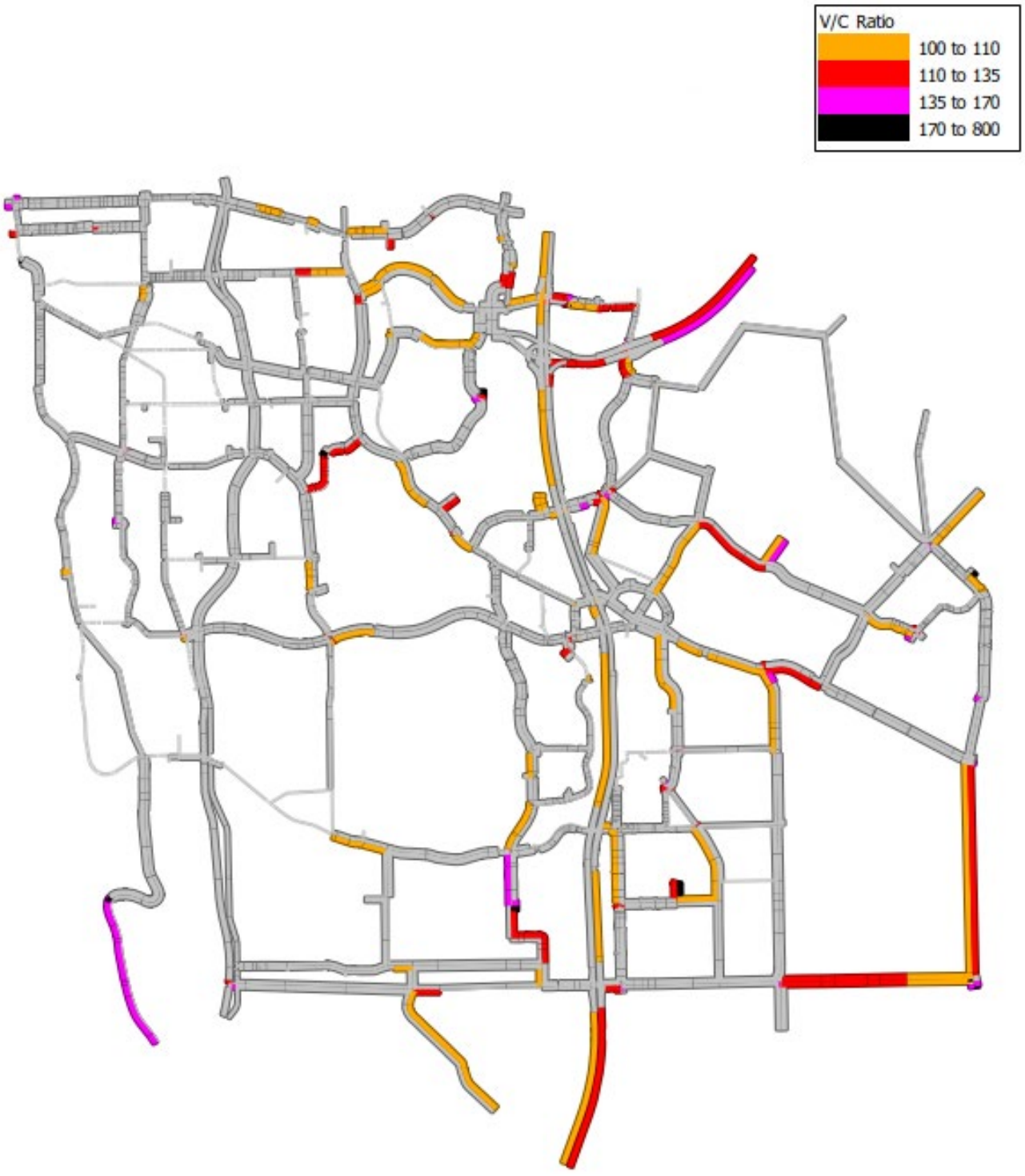

Figure 24: V/C Ratio exceeding 100 in Scenario 3 – AM Peak – 2031

V/C PM Peak Period – Scenario 3:

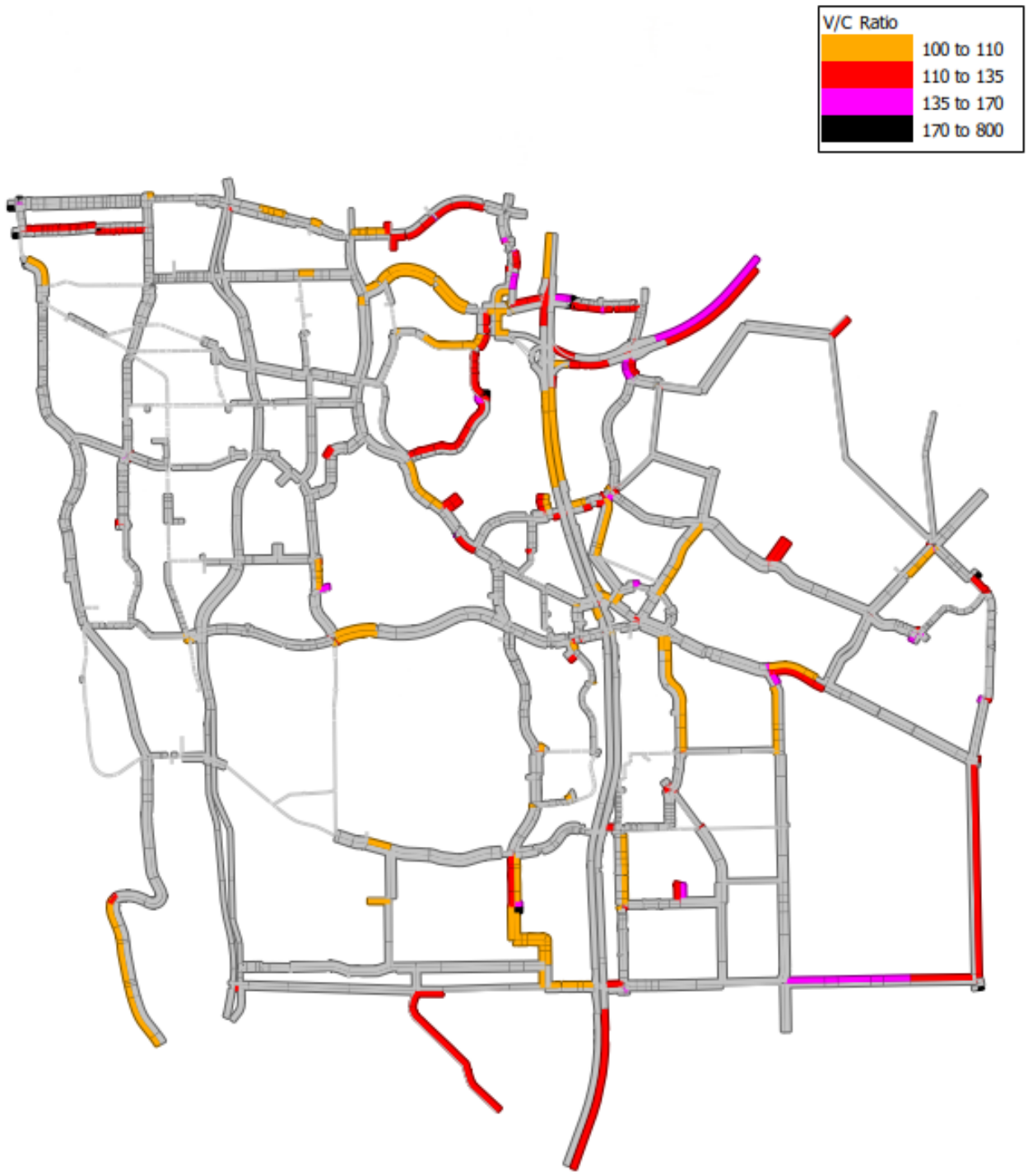

Figure 25: V/C Ratio exceeding 100 in Scenario 3 – PM Peak – 2031

The V/C Ratio plots for 2031 (AM and PM peak periods) show a significant improvement compared to the "Do Something" scenario. The Cockburn Road and Rowley Road east upgrades have reduced congestion levels on the surrounding roads and most sections west of Kwinana Freeway.

2041 Results:

V/C AM Peak Period – Scenario 3:

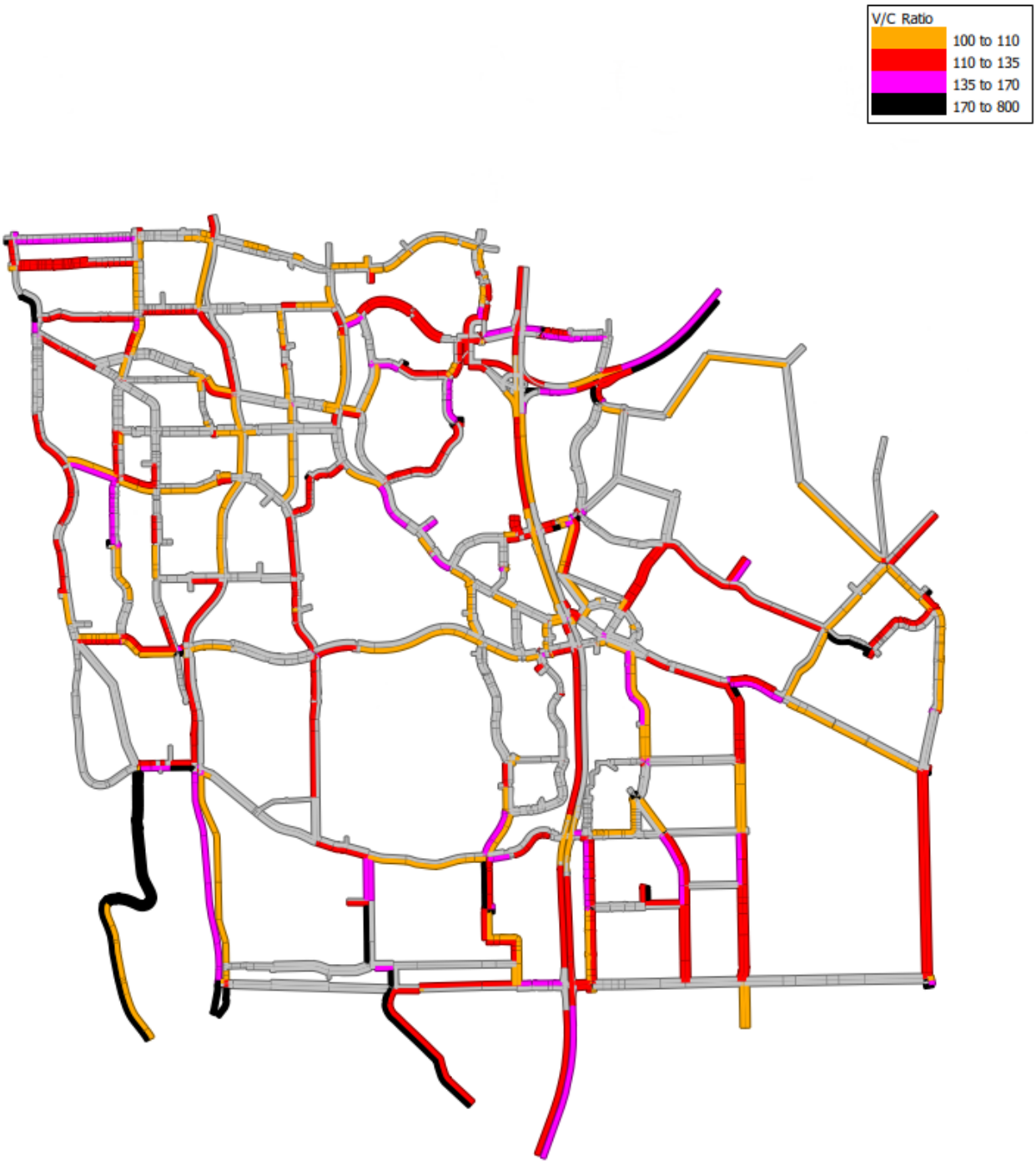

Figure 26: V/C Ratio exceeding 100 in Scenario 3 – AM Peak – 2041

V/C PM Peak Period – Scenario 3:

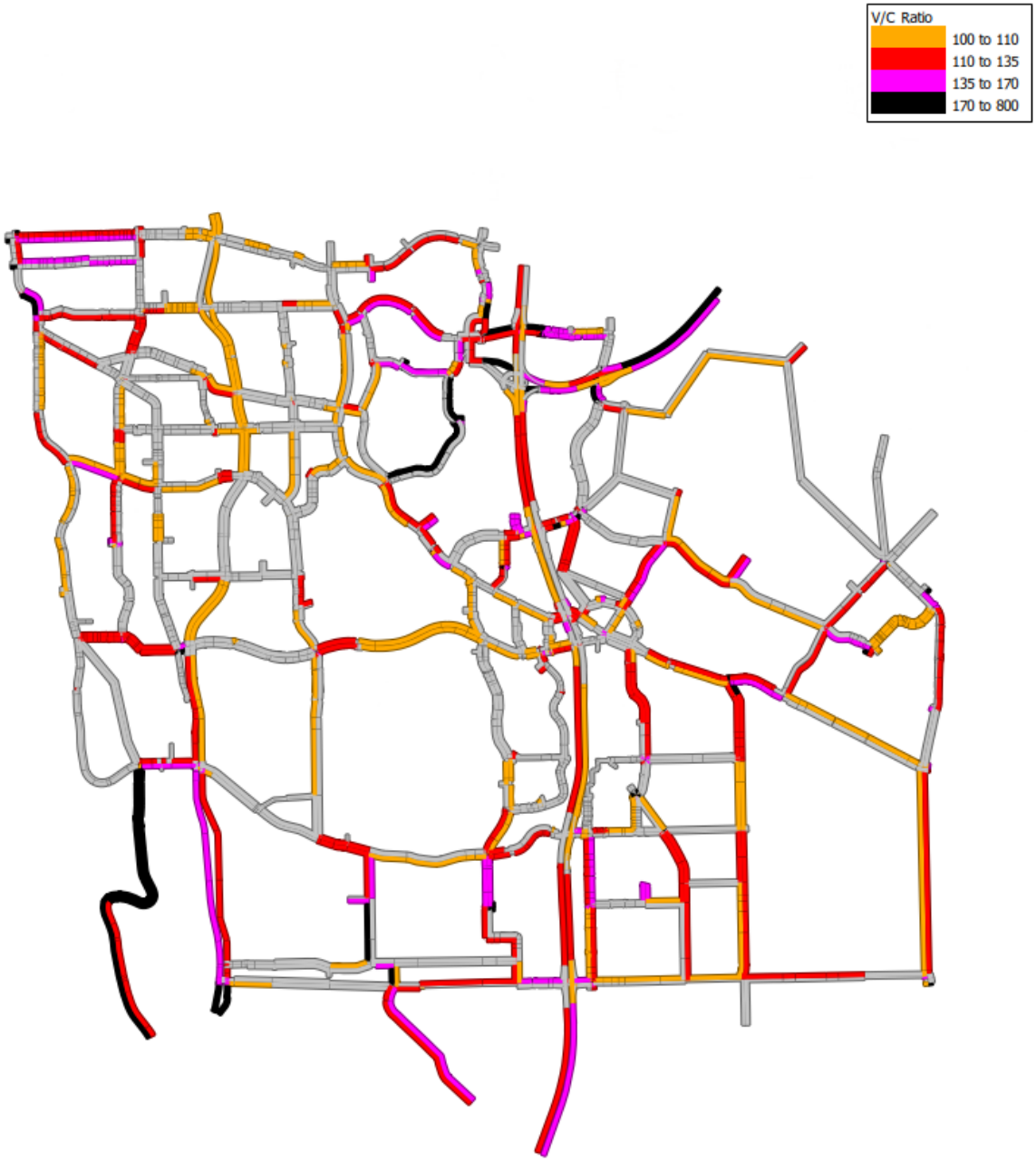

Figure 27: V/C Ratio exceeding 100 in Scenario 3 – PM Peak – 2041

The scenario 3 results show a further reduction in veh-hrs during the AM and PM peak periods. When the "Do Something" scenario is compared with Scenario 3, the veh-hrs fall by nearly 50% which indicates a significant reduction in congestion. Given that Scenario 3 includes most of Scenario 2 (except for Roe Highway), the addition of the Cockburn Road South upgrade, the Rowley Road east upgrades and the added capacity on Stock Road have been the primary reasons for the improvements. Roe Highway removal from the prior scenario resulted in increased congestion on parallel roads and to the northern sections of the network.

Similar to the 2031 results, the V/C Ratio plots for the 2041 AM and PM peak periods show similar improvements when compared to the "Do Something" results. The veh-hrs results in Scenario 3 (2041) show a significant reduction (i.e. approximately 1.85m and 2m vehicle-hours for AM and PM peak periods respectively).

5.4 Scenario 4 – Combination of City and State Upgrades with Westport

Scenario 4 includes a combination of upgrades featured in Scenarios 1 + 3. The upgrades in this scenario are:

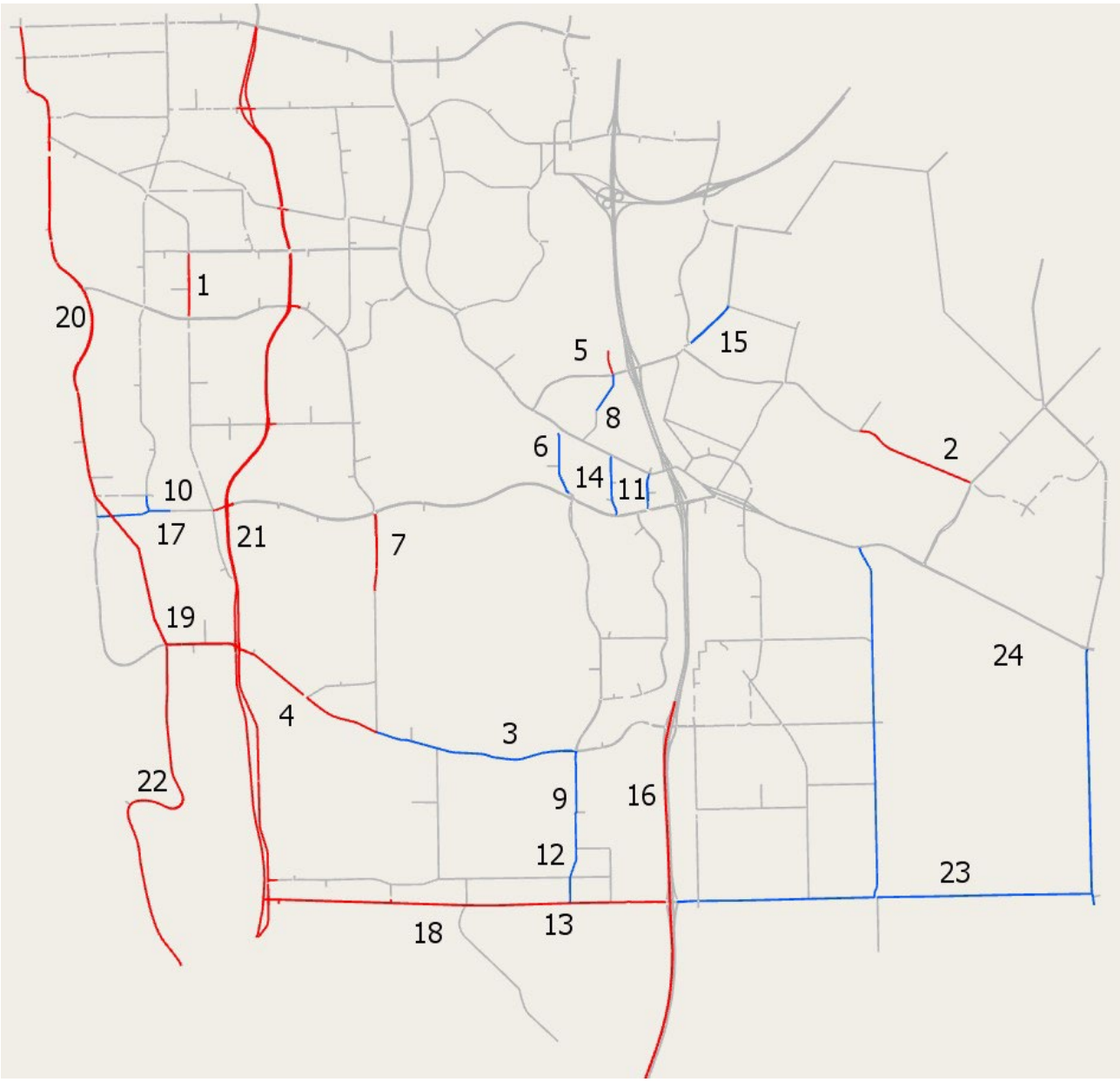

Figure 28: Map showing the 2041 City of Cockburn road network in Scenario 4

The changes to the network are listed in Table 8 as shown below:

Table 8: Scenario 4 – Assumptions

Upgrade number	Road	Type of upgrade	Year of upgrade
1	Rockingham Road – Phoenix Road to Spearwood Avenue reconstruction	reduce to 1 lane each way	2031
2	Jandakot Road Upgrade - Skotsch Road to Warton Road	Additional lane	2031
3	Russell Road Upgrade - Hammond Road to Rockingham Road - Stage 1 - Hammond Road to Henderson Road	Additional lane	2041
4	Russell Road – Henderson Road to Rockingham Road - Stage 2	Additional lane	2041
5	Elderberry Drive Realignment - Jindabyne Heights to Berrigan Drive to connect to Ngort Drive	Jindabyne Heights to Berrigan Drive to connect to Ngort Drive	2031
6	Hammond Road Upgrade - Beeliar Drive to North Lake Road	Additional lane	2041
7	Spearwood Avenue Upgrade - Beeliar Drive to Fancote Avenue	Additional lane	2031
8	Ngort Drive Upgrade & Extension	Extension - North Lake Road to Berrigan Drive	2041
9	Hammond Road Upgrade & Extension - Gaebler Road to Rowley Road - Stage 1 -	construct 1 carriageway in both directions i.e. NB and SB	2031
10	Mayor Road Downgrade / Removal	Removal from Apium Mews to Atwell Close	2041
11	Midgegooroo Avenue Downgrade	Beeliar Drive to North Lake Road reduce to 2 lanes	2041
12	Hammond Road Upgrade & Extension - Russell Road to Rowley Road - Stage 2 -	Link extension from Frankland Avenue to Wattleup Road	2031
13	Hammond Road Upgrade & Extension - Russell Road to Rowley Road - Stage 3	Link extension from Wattleup Road to Rowley Road	2031
14	Poletti Road Upgrade - Beeliar Drive to North Lake Road	Additional lane	2041
15	Pilatus Street Upgrade - Berrigan Drive to Jandakot Airport boundary	Additional lane	2041
16	Kwinana Freeway widening i.e. between Anketell Road and Russell Road	Additional lane in both NB and SB direction	2031
17	Beeliar Drive extension	Link extension from west of Stock Road up to Cockburn Road	2041
18	Rowley Road west between Kwinana Freeway to Rockingham Road	Construct 2 carriageways operating at 80kph	2031
19	Russell Road / Cockburn Road from Rockingham Road to Beeliar Drive extension	Construct 2 carriageways	2031
20	Cockburn Road from Beeliar Drive extension to Rockingham Road/Hampton Road intersection	Additional lane	2031
21	Stock Road upgrade – South Street to Rowley Road	3 lanes each direction with 100 kph	2031
22	Cockburn Road south	Additional lane	2031
23	Rowley Road East upgrade	Divided dual carriageway 70 kph	2041
24	Nicholson Road upgrade and Liddelow Road downgrade	Upgrade Nicholson Road to dual carriageway 80 kph and reduce speed limit along Liddelow Road to 60 kph	2041

Results 2031:

V/C AM Peak Period – Scenario 4:

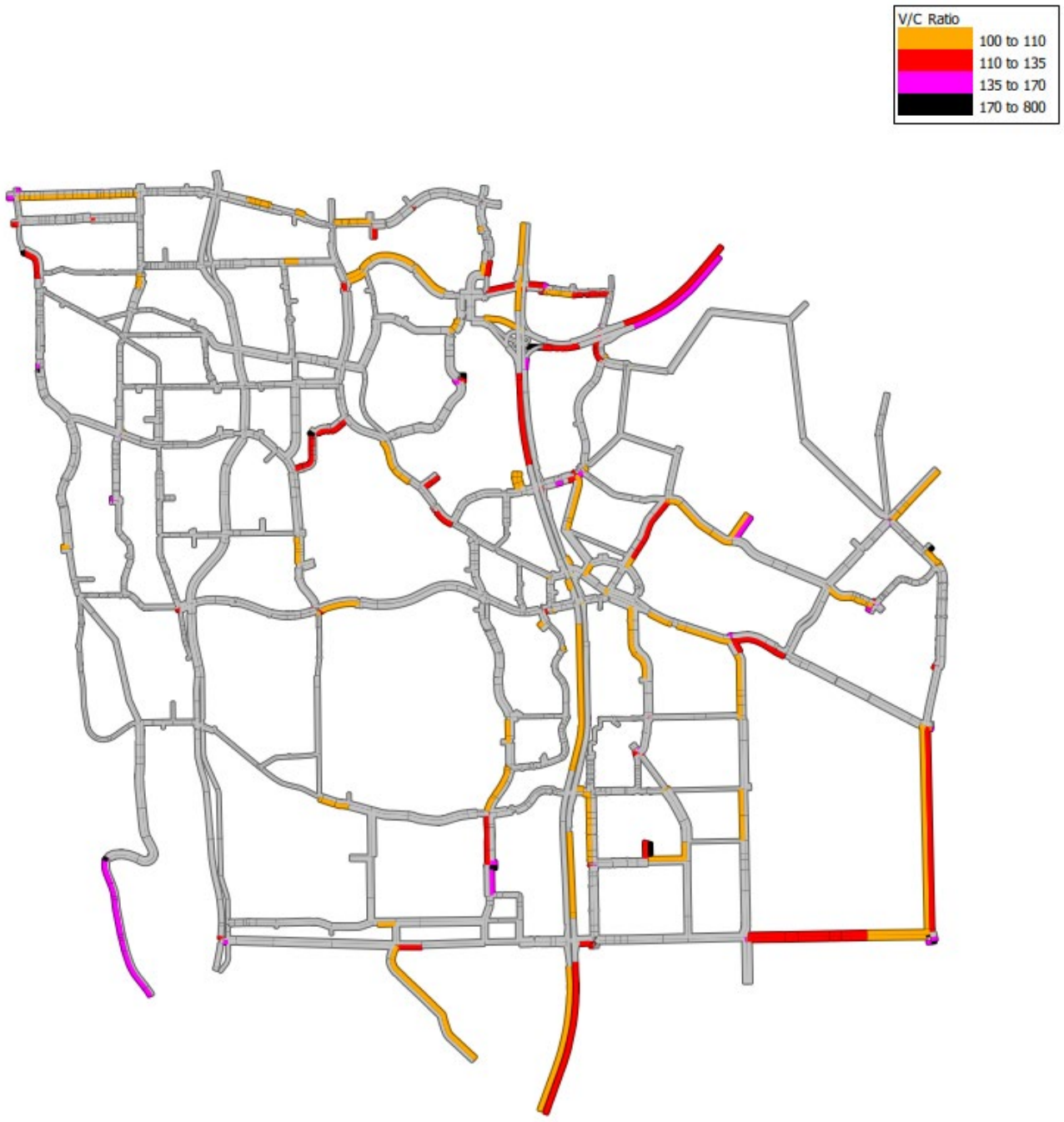

Figure 29: V/C Ratio exceeding 100 in Scenario 4 – AM Peak – 2031

V/C PM Peak Period – Scenario 4:

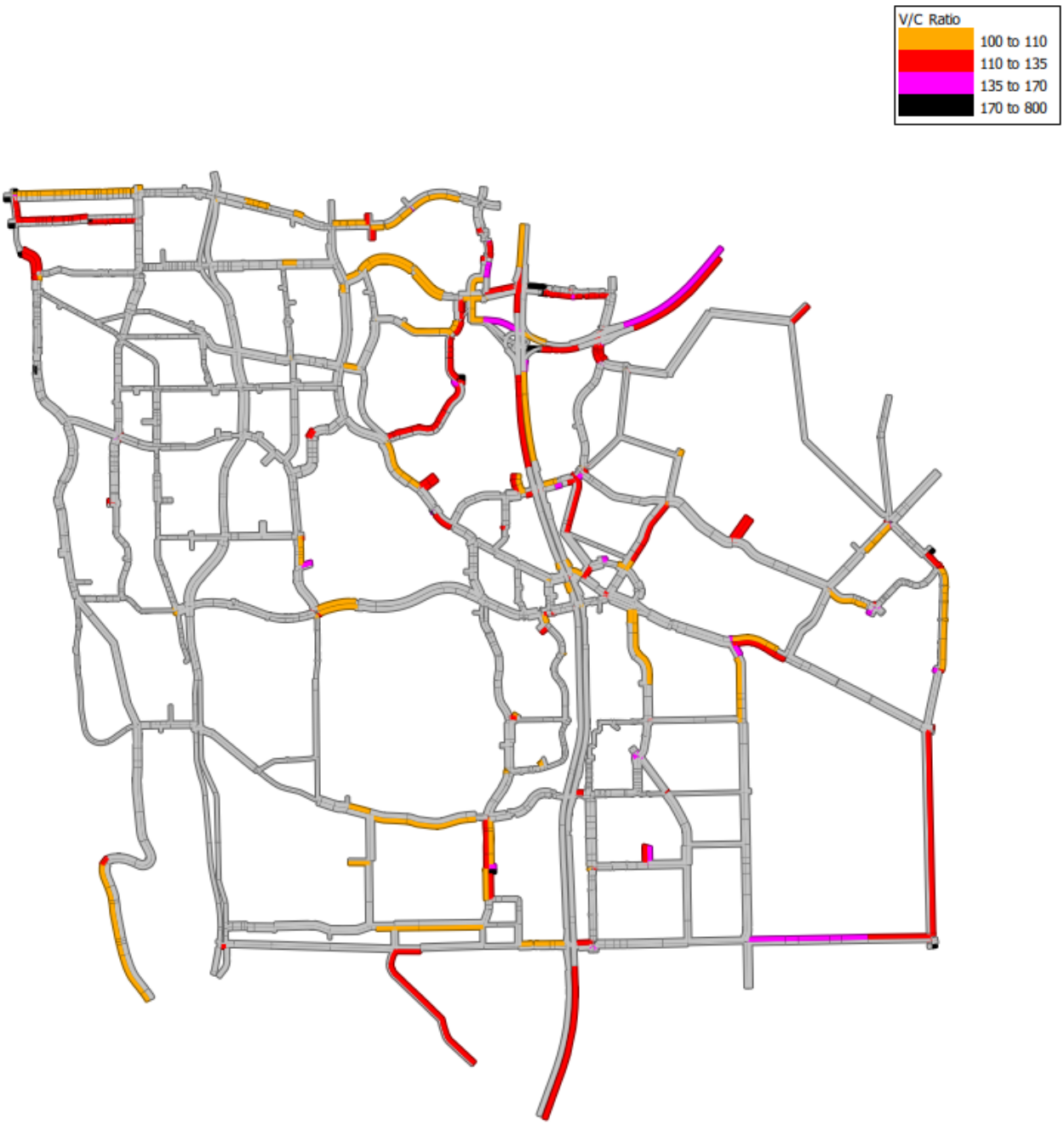

Figure 30: V/C Ratio exceeding 100 in Scenario 4 – PM Peak – 2031

Results 2041:

V/C AM Peak Period – Scenario 4:

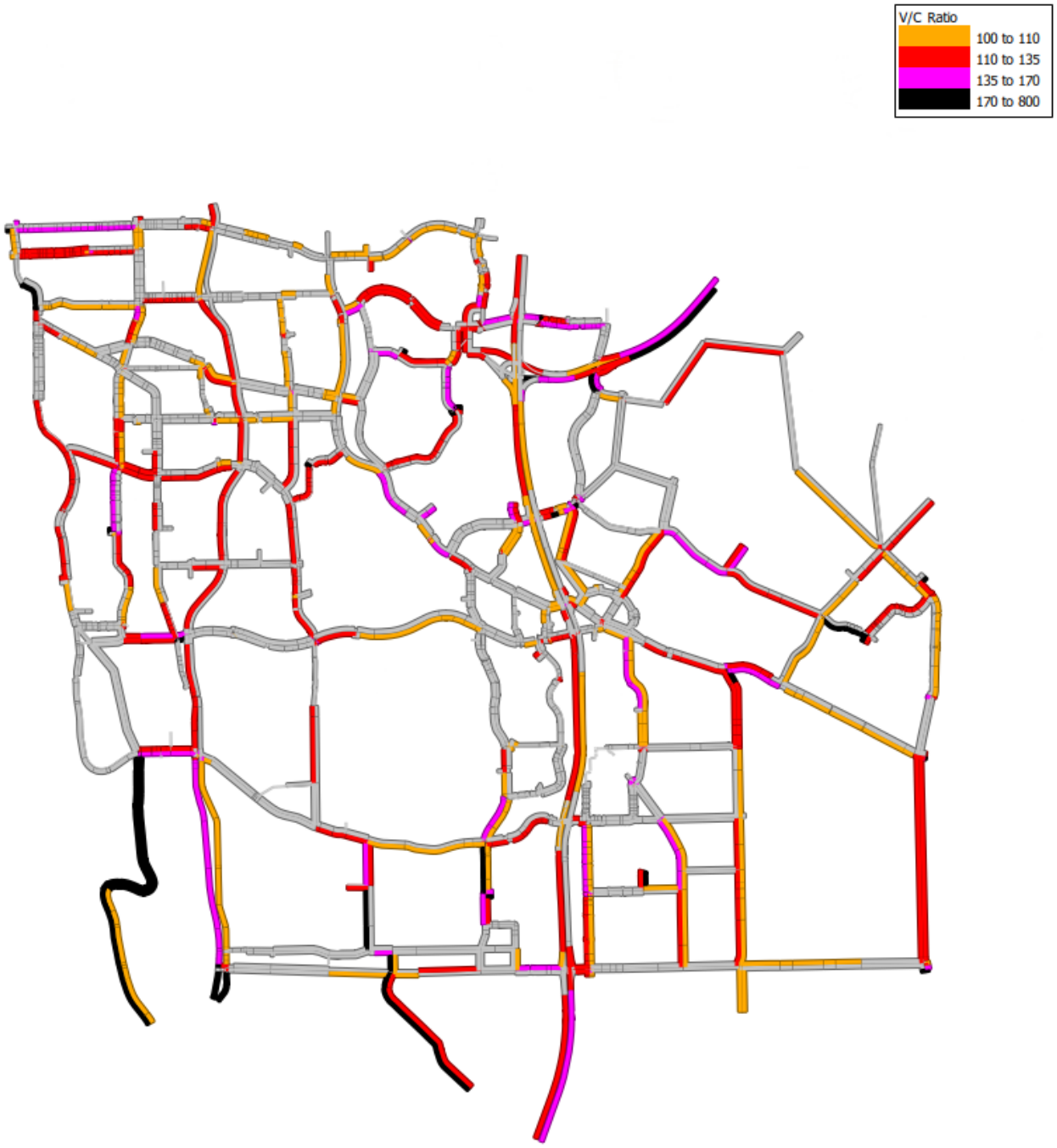

Figure 31: V/C Ratio exceeding 100 in Scenario 4 – AM Peak – 2041

V/C PM Peak Period – Scenario 4:

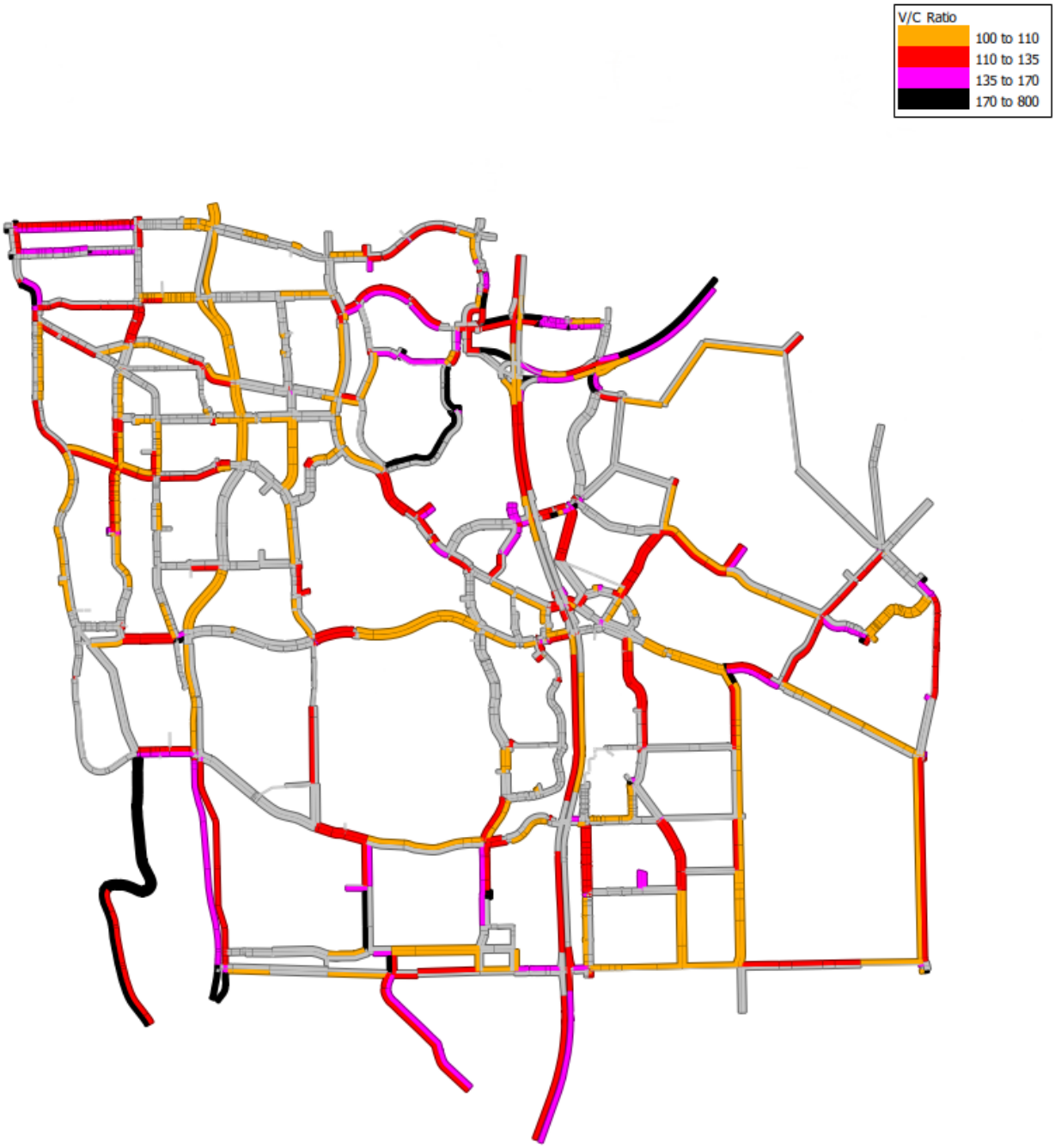

Figure 32: V/C Ratio exceeding 100 in Scenario 4 – PM Peak – 2041

Scenario 4 includes the improvements in Scenarios 1 & 3. When comparing the results of Scenario 4 against Scenario 3, there have been minimal changes to veh-hrs and veh-kms. There was, however, an increase of 6,972 veh-hrs and 26,505 veh-hrs for the 2031 AM and PM peak periods. In 2041, there was a reduction in veh-hrs by about 50,000 in both peak periods when compared to Scenario 3. Therefore, the benefits of Scenario 4 are seen largely in 2041.

5.5 Scenario 5 – Mode Share Shift – Active Transport + Public Transport

Scenario 5 represents an alternative to all the previous scenarios as it does not focus on planned road upgrades for capacity increases. It rather focuses on improving and investing on infrastructure for sustainable modes of transport i.e. walking, cycling and public transport usage for demand decreases. Scenario 5 considers the impact of mode change throughout the entirety of the City of Cockburn area, and specifically a 1% (in 2031) and 2% (in 2041) reduction in car vehicle mode choice towards choices of sustainable transport modes such as public transport and walking. It is considered that such a global mode share change could be achieved through a range of measures consisting of:

- General improvements to public transport services such as increased bus frequencies and improved travel times (such as can be achieved via bus priority measures); whilst the City of Cockburn has a dispersed bus network, frequencies on some routes are significantly low which is unattractive for those considering using public transport – these improvements are within the jurisdiction of the PTA;
- Improved network connectivity and safety for cyclists and pedestrians. In particular, infrastructure improvements to safe crossing points at intersections and mid-block, as well as segregated paths for cyclists and pedestrians such as PSPs along major road corridors can result in people being more willing to choose this as an option. Another key improvement to the attractiveness of these model area mode share impacts, particularly for pedestrians, is the provision of shade. Major paths are within the jurisdiction of DoT and Main Roads WA.
- Travel Behaviour Change programmes (Your Move) – a travel behaviour programme either at individual activity groups such as Schools or offices that actively seek to inform and persuade people to consider change in primary travel mode from private vehicle to more sustainable modes.

In general, each of the above are significantly influenced by investment and organisation by the Transport Portfolio as such the City should continue to lobby the State Government to these considerations.

Results for this scenario suggest that this would have a major role in the reduction of vehicle hours travelled and thereby provide relief in some congestion hotspots.

The V/C ratio diagrams for this scenario are shown in the figures below:

2031 Results:

V/C AM Peak Period – Scenario 5:

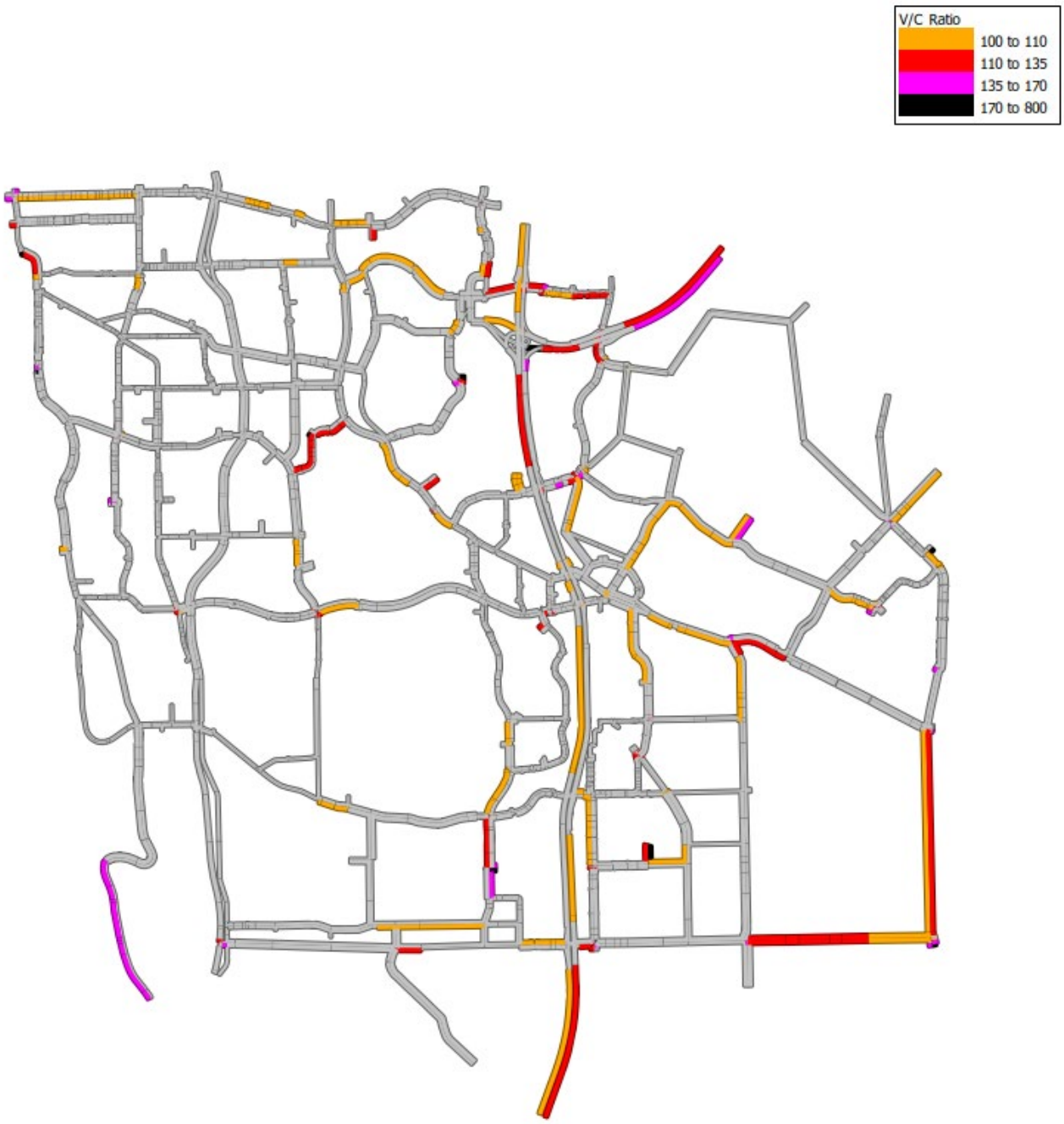

Figure 33: V/C Ratio exceeding 100 in Scenario 5 – AM Peak – 2031

V/C PM Peak Period – Scenario 5:

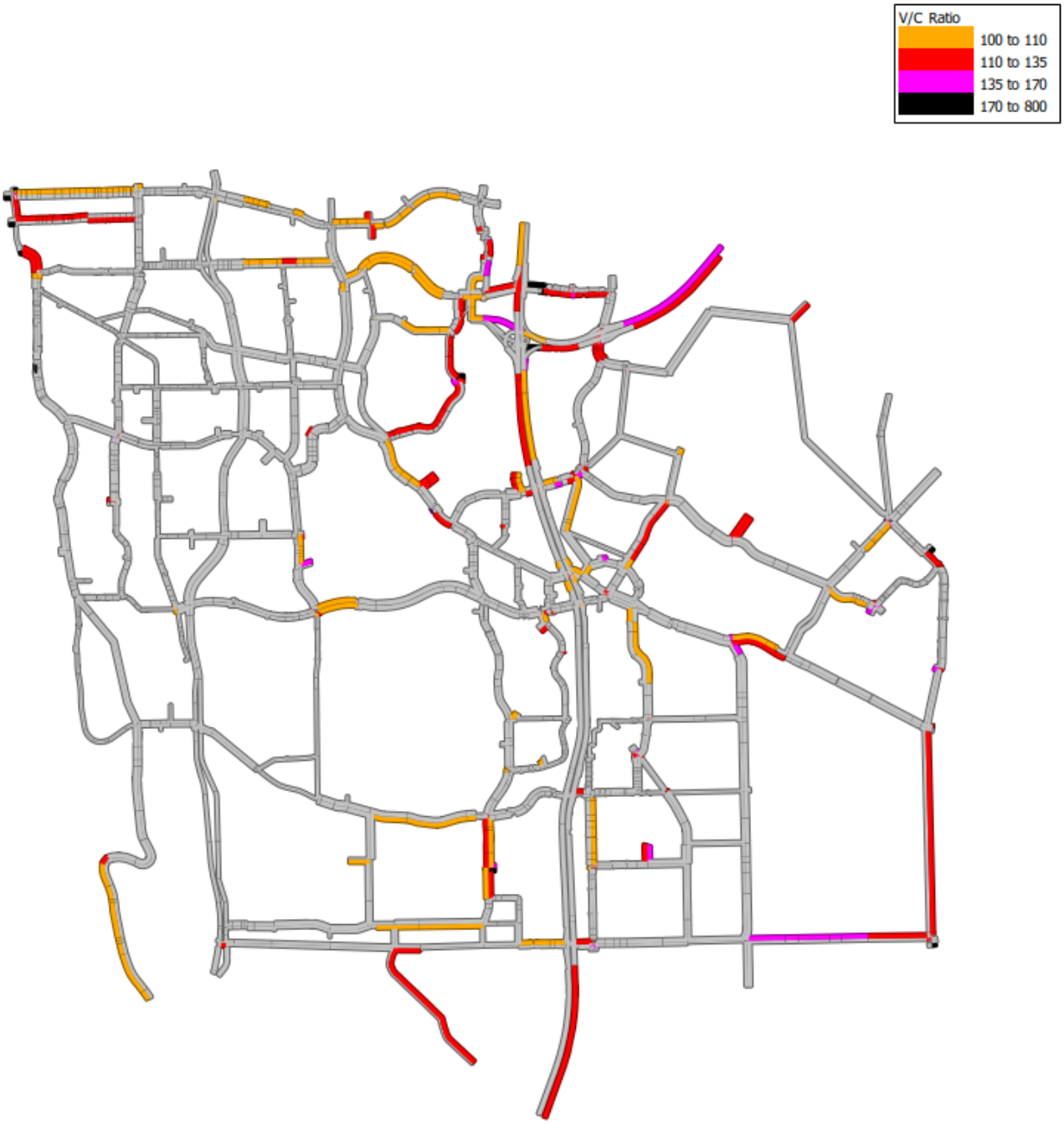

Figure 34: V/C Ratio exceeding 100 in Scenario 5 – PM Peak – 2031

2041 Results:

V/C AM Peak Period – Scenario 5:

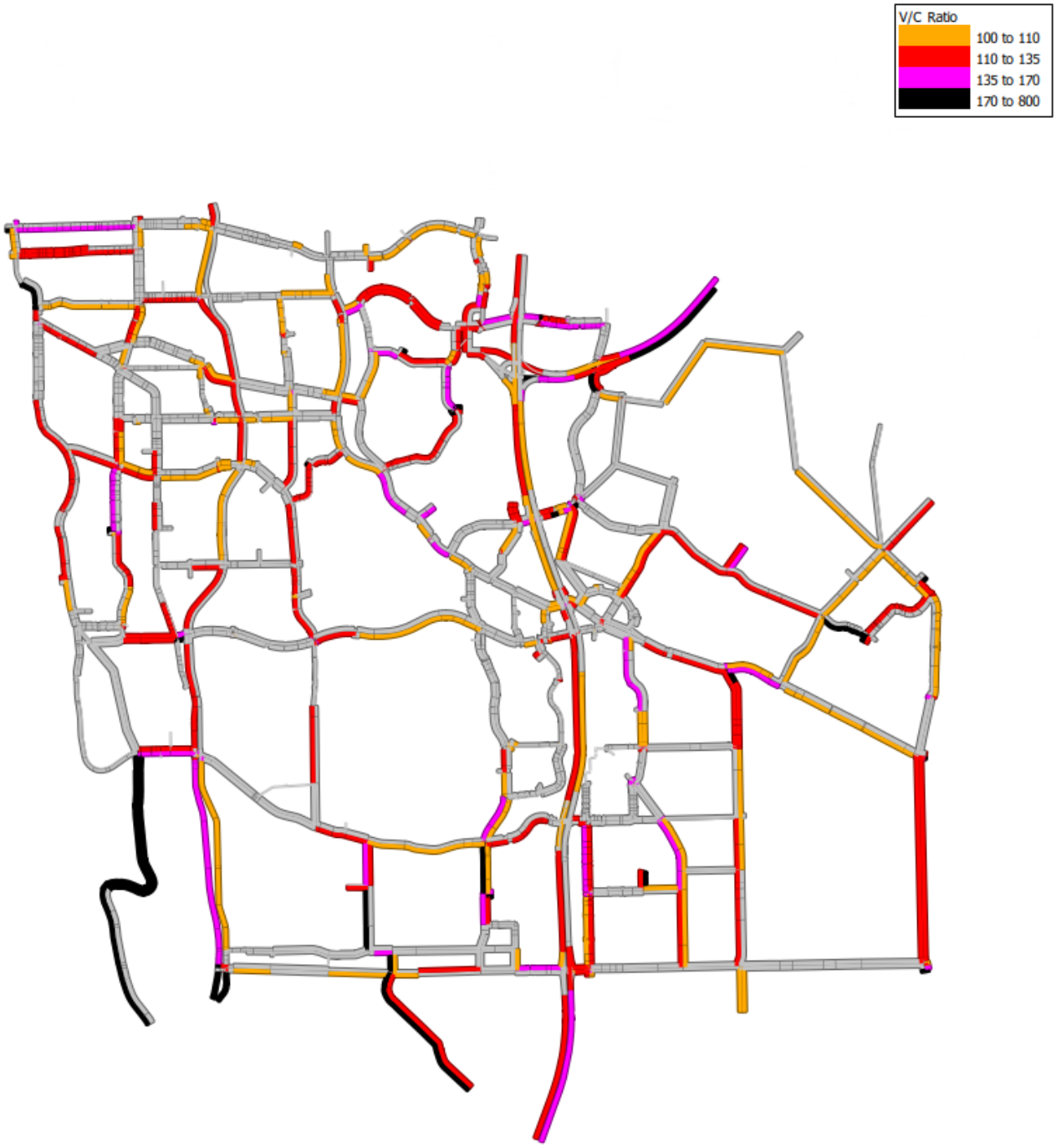

Figure 35: V/C Ratio exceeding 100 in Scenario 5 – AM Peak – 2041

V/C PM Peak Period – Scenario 5:

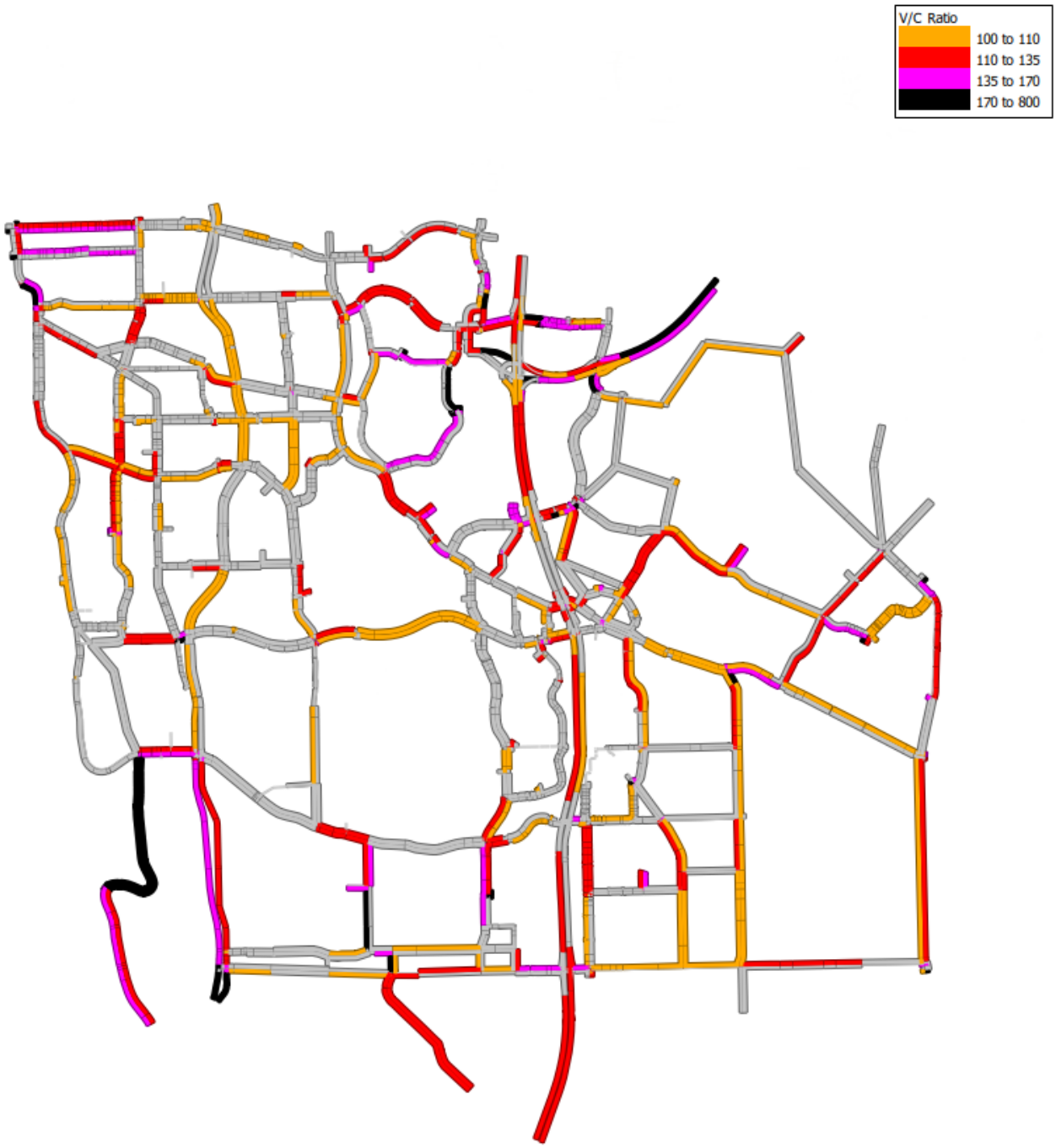

Figure 36: V/C Ratio exceeding 100 in Scenario 5 – PM Peak – 2041

The results indicate that the VHT is the lowest of all scenarios tested. This shows how significant the 1% mode shift (reduction in vehicular traffic) across all zones can be to the overall network performance. The VKT also had some reductions as there was no capacity increase on links and a greater reliance on utilising other modes of transport.

5.6 Scenario 6 – City Upgrades + State Upgrades + Active Transport + Public Transport

Scenario 6 tested a combination of Scenario 4 (City + State upgrades with Westport) + Scenario 5 (Mode Share Shift – Active Transport + Public Transport). The results show that a combination of these provides the best outcomes in terms of reducing the VHT and VKT throughout the network.

The diagrams below show the V/C Ratio plots for the 2031 and 2041 peak periods.

2031 Results:

V/C AM Peak Period– Scenario 6:

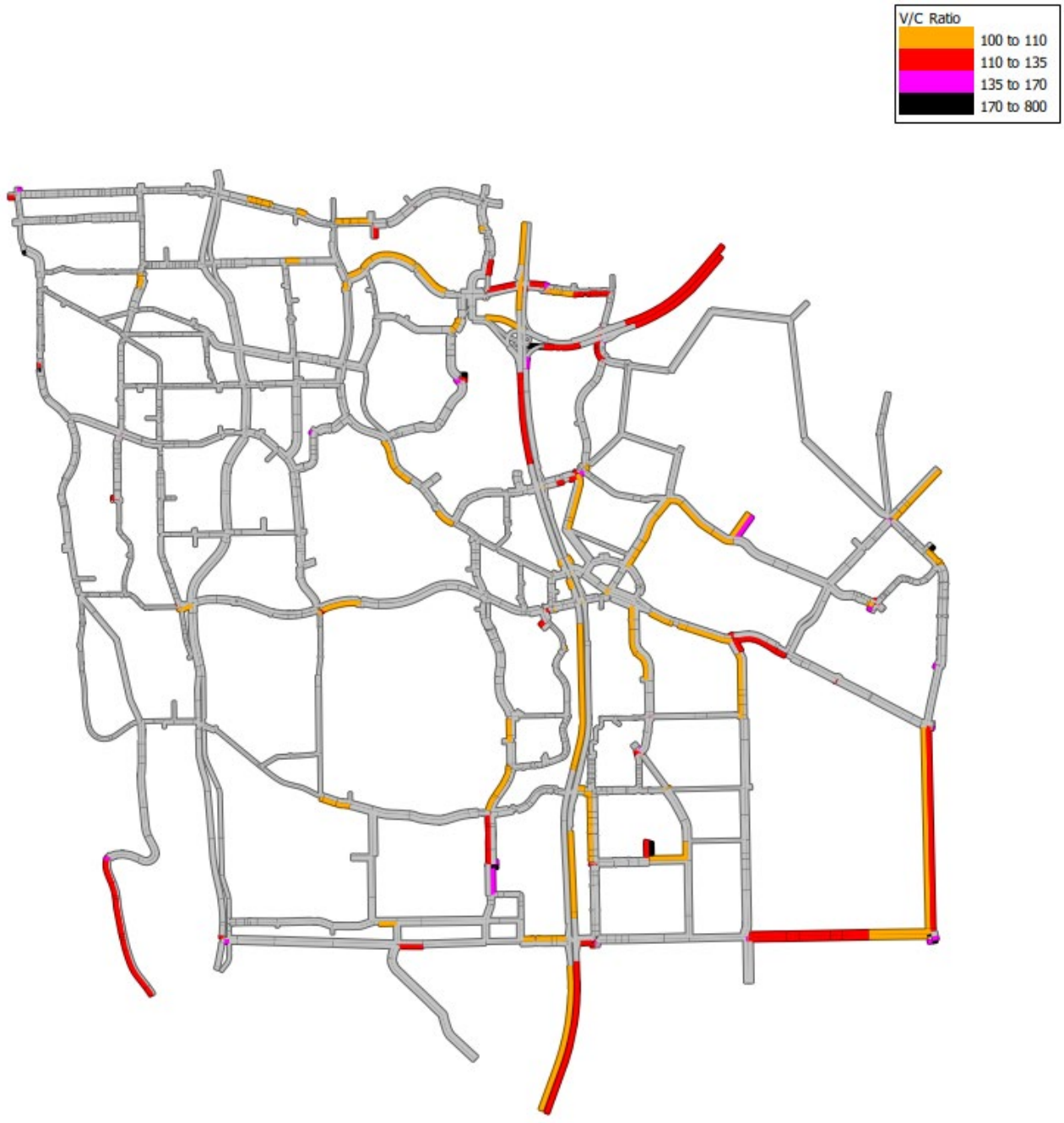

Figure 37: V/C Ratio exceeding 100 in Scenario 6 – AM Peak – 2031

V/C PM Peak Period – Scenario 6:

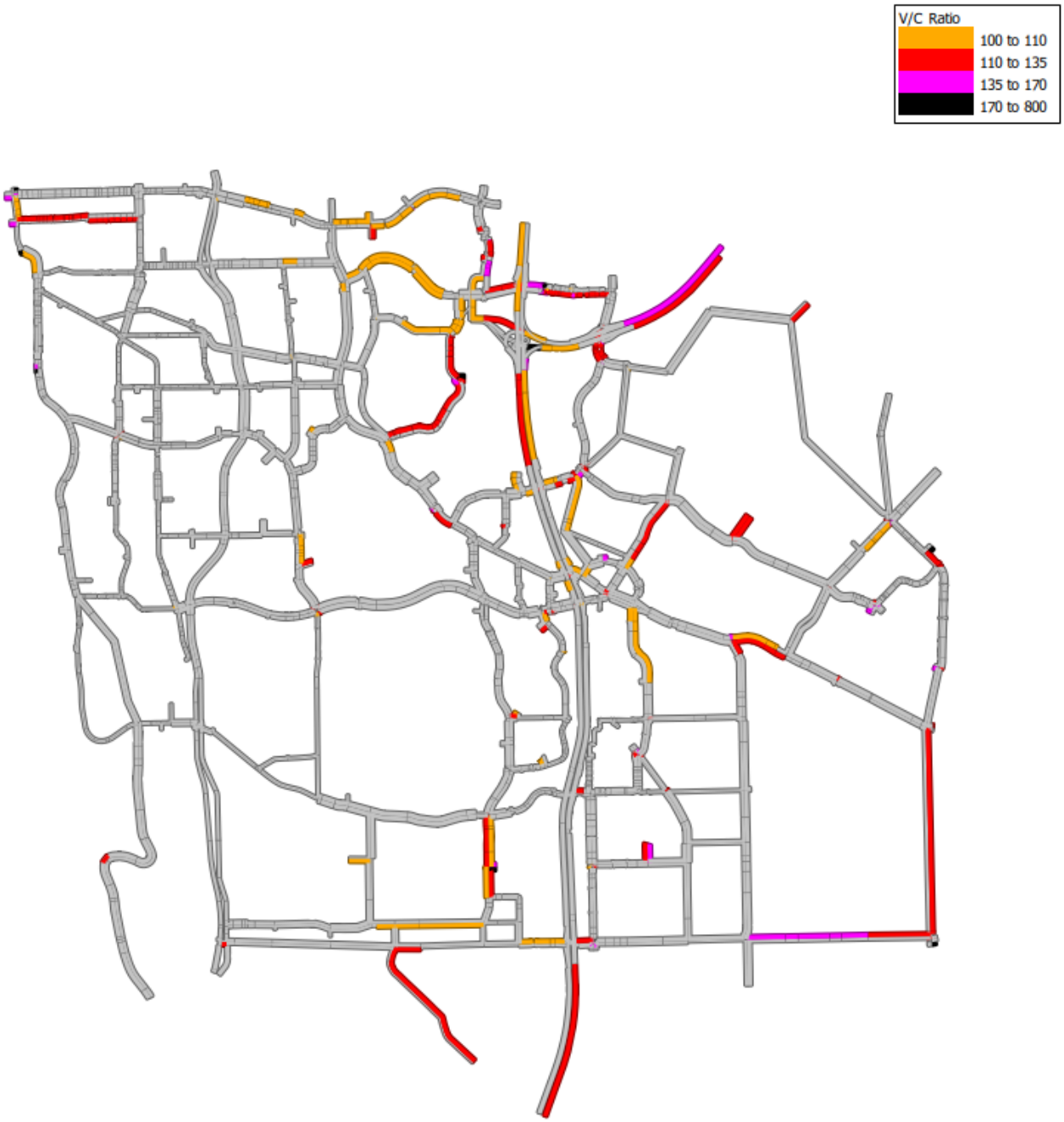

Figure 38: V/C Ratio exceeding 100 in Scenario 6 – PM Peak – 2031

2041 Results:

V/C AM Peak Period – Scenario 6:

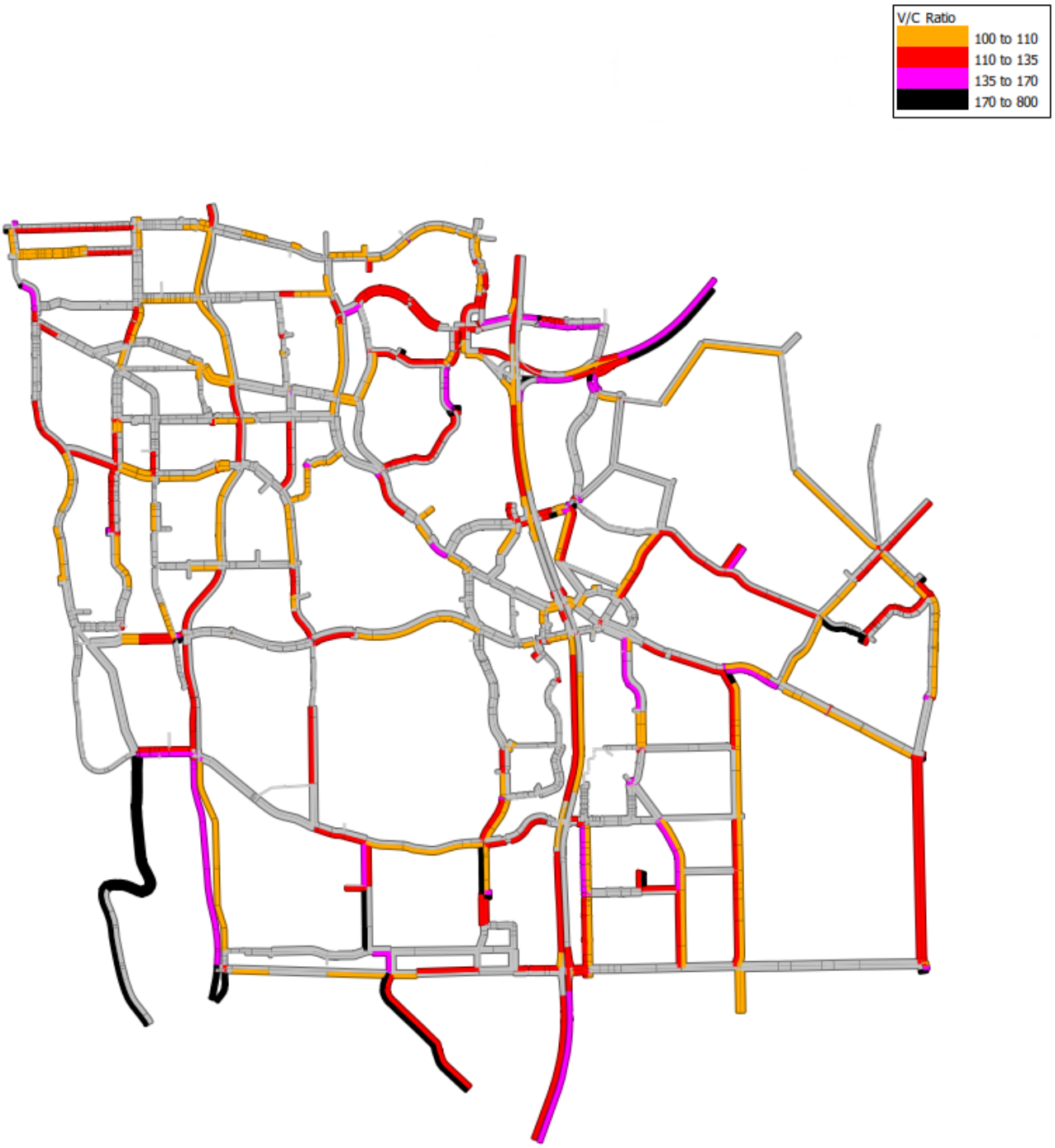

Figure 39: V/C Ratio exceeding 100 in Scenario 6 – AM Peak – 2041

V/C PM Peak Period – Scenario 6:

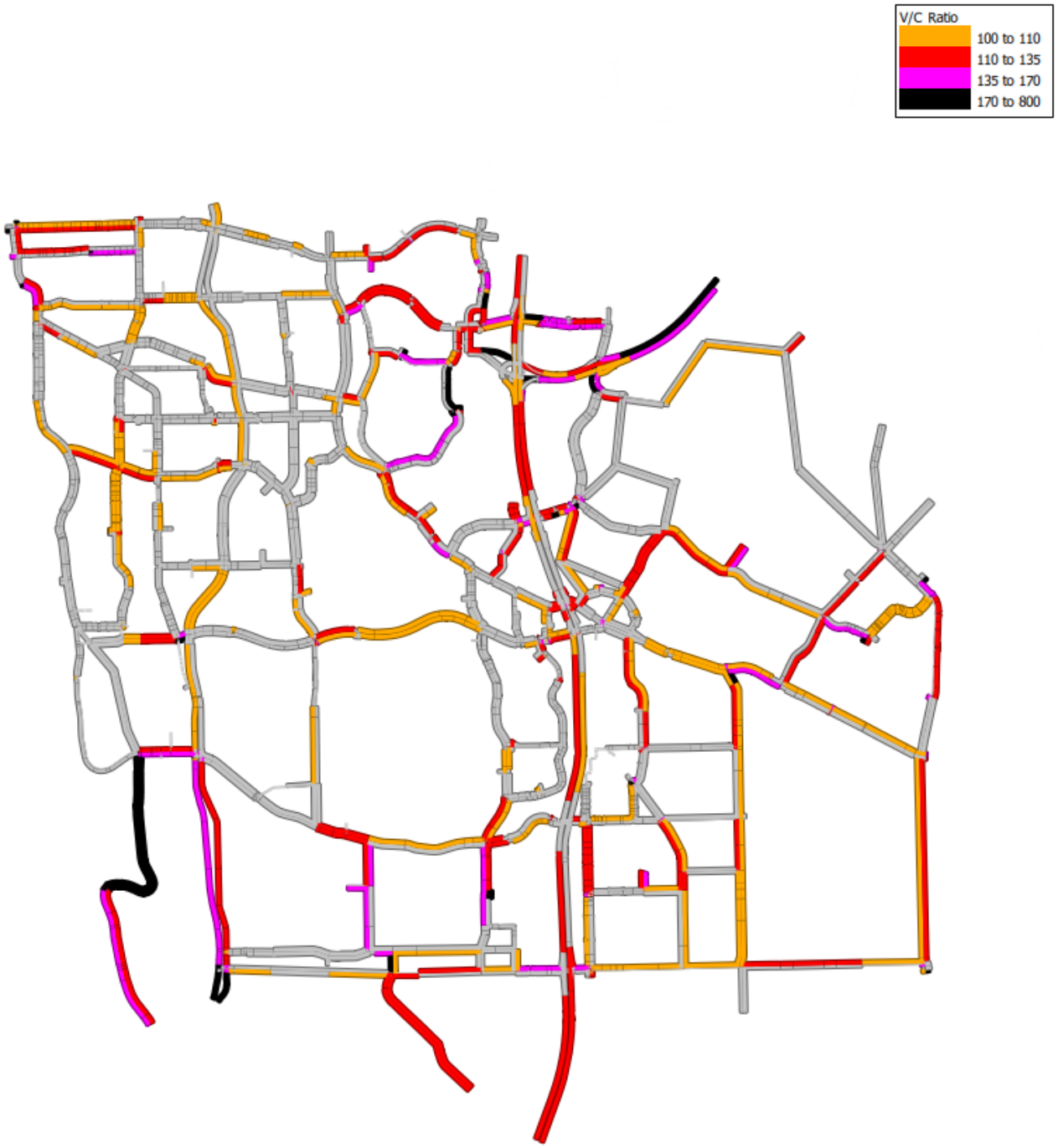

Figure 40: V/C Ratio exceeding 100 in Scenario 6 – PM Peak – 2041

The VHT results in this scenario indicate that a combination of all the upgrades and mode shift reduces both the VHT and VKT during peak periods considerably thereby reducing congestion levels throughout the network.

Comparison of results for all the scenarios:

VHT comparison:

2031:

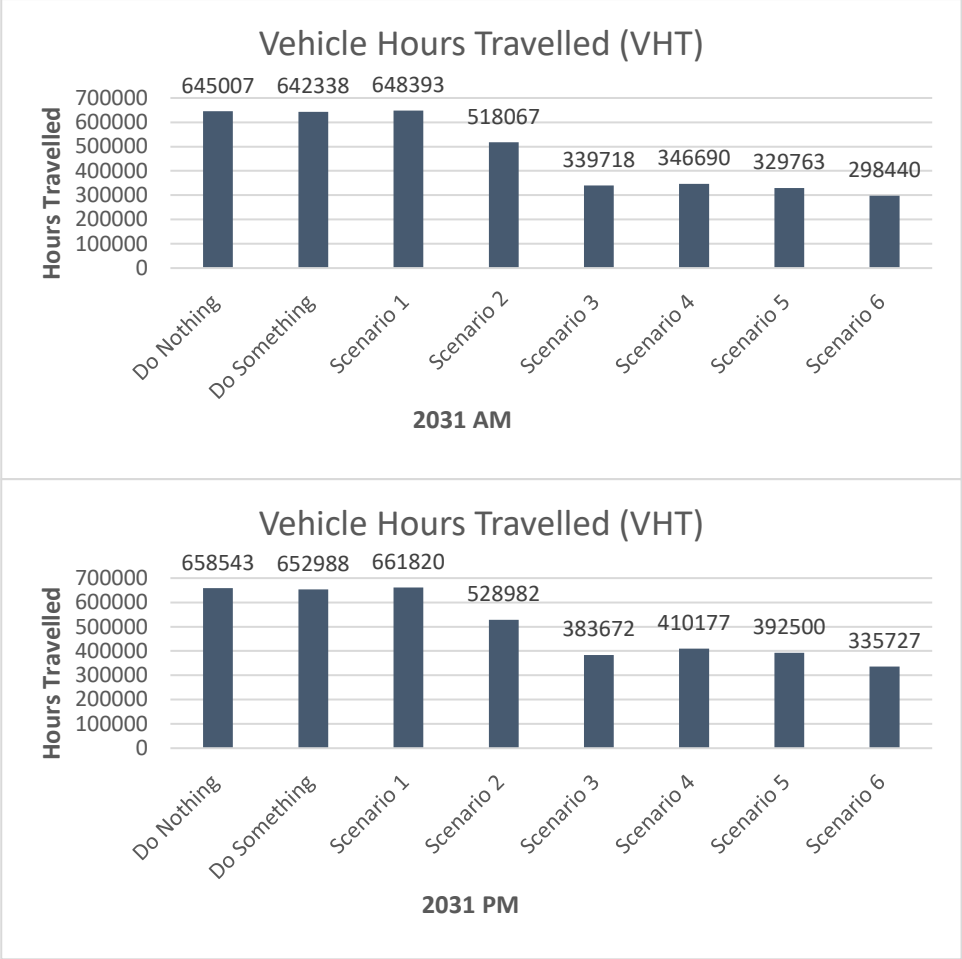

Figure 41: Vehicle Hours Travelled (VHT) across the network for 2031 peak periods

The VHT comparison for all scenarios tested shows that Scenario 6 accounts for the least number of vehicle-hours travelled on the City's road network during the 2031 AM and PM peaks. It also highlights how a combination of road upgrades, investment in public transport and active transport infrastructure can result in a significant reduction in VHT throughout the network.

2041:

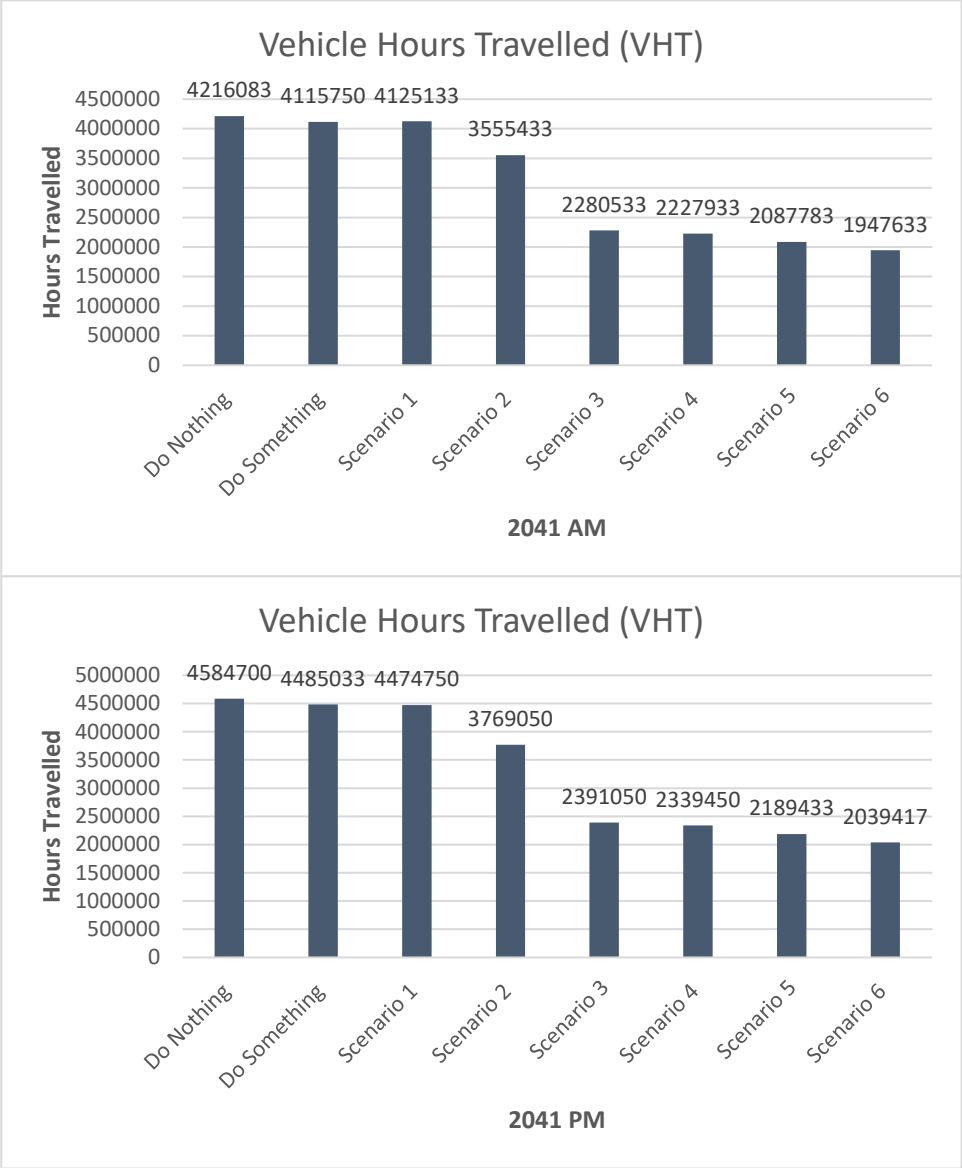

Figure 42: Vehicle Hours Travelled (VHT) across the network for 2041 peak periods

Similar to 2031, the 2041 VHT comparison for all scenarios show that Scenario 6 accounts for the least number of veh-hrs travelled on the City's road network. The addition of new links and capacity in this scenario further to Scenario 5 helps reduce travel duration and time spent in travel across the whole road network.

VKT comparison:

2031:

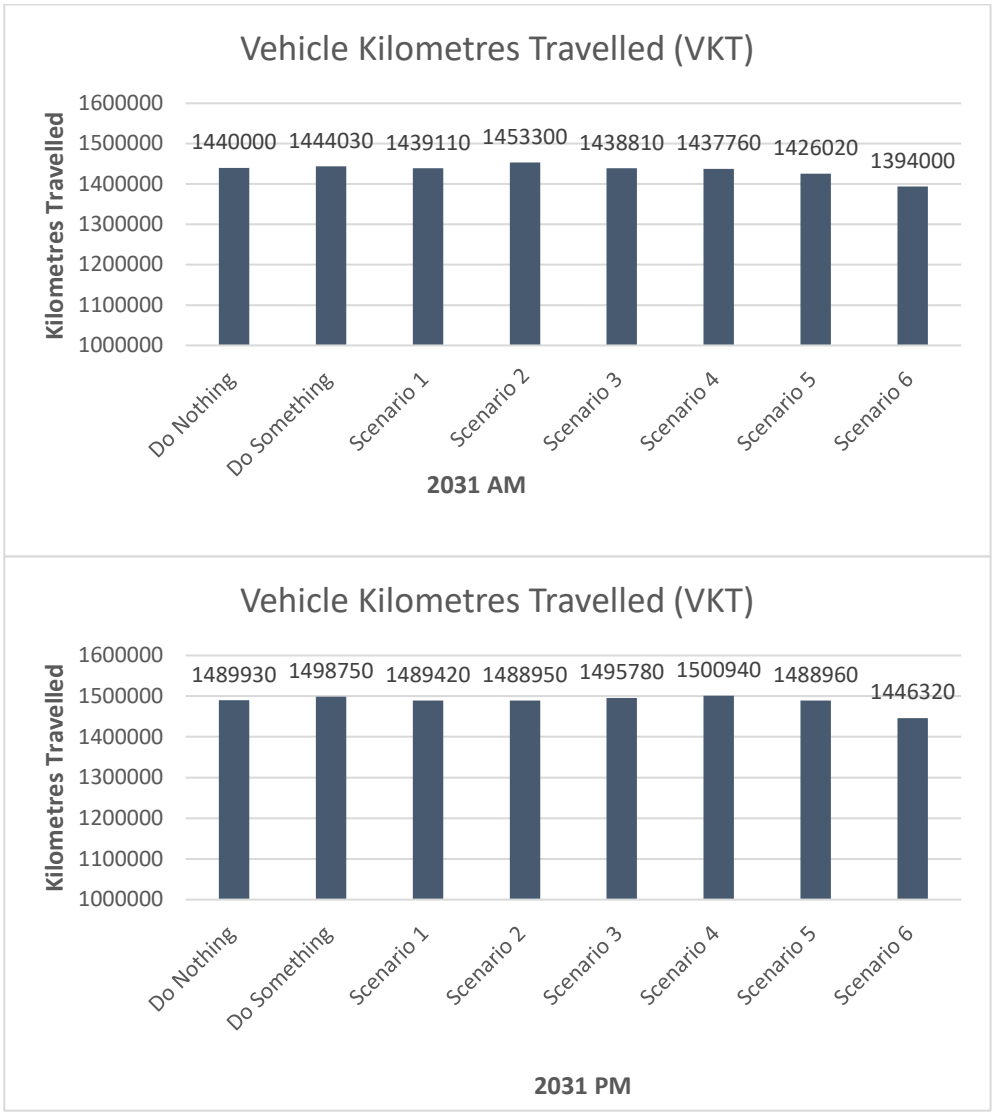

Figure 43: Vehicle Kilometres Travelled (VKT) across the network for 2031 peak periods

The results for the VKT during the 2031 peak periods indicate a similar level of distance travelled for most scenarios. Scenario 6 has the lowest VKT for both AM and PM peak periods. This suggests that in addition to road upgrades (capacity increment) , improvements in active transport and public transport infrastructure has reduced the overall kilometres travelled.

2041:

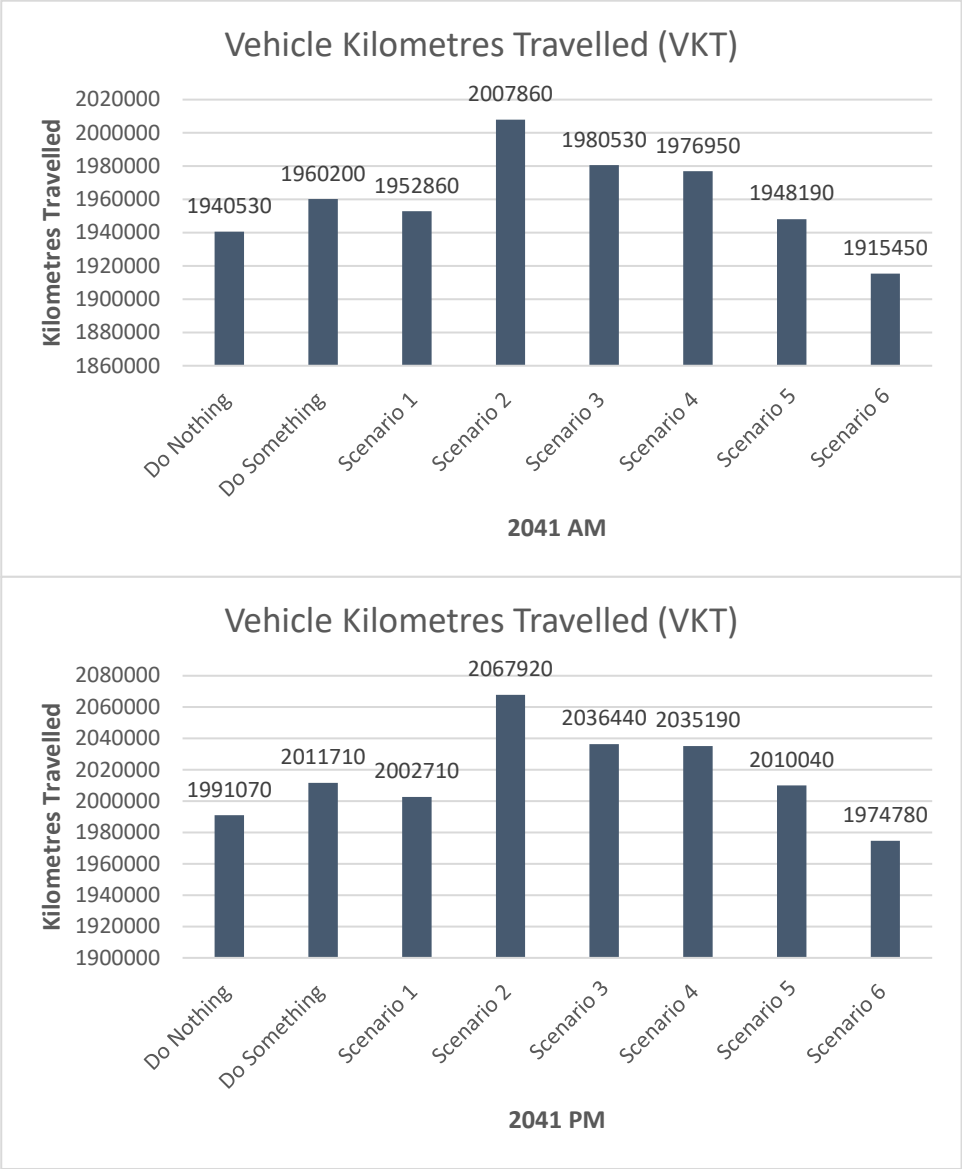

Figure 44: Vehicle Kilometres Travelled (VKT) across the network for 2041 peak periods

The VKT results during the 2041 peak periods indicate that Scenario 6 has the least VKT for both AM and PM peak periods. The results from the 2% mode shift in 2041 combined with the network upgrades show that the VKT in the entire network is the lowest in Scenario 6 amongst all scenarios.

6. Implementation Plan

Road Section	Planned Upgrades based upon Modelling Results		Direction	2031								2041							
				"Do Nothing" AM		"Do Nothing" PM		Scenario 6 AM		Scenario 6 PM		"Do Nothing" AM		"Do Nothing" PM		Scenario 6 AM		Scenario 6 PM	
	by 2031	by 2041		Volume	VCR	Volume	VCR	Volume	VCR	Volume	VCR	Volume	VCR	Volume	VCR	Volume	VCR	Volume	VCR
2031																			
Rockingham Road – Phoenix Road to Spearwood Avenue (reduce to 1 lane)	x	x	NB	3,497	97	2,537	70	1,401	78	1,219	68	4,208	117	3,878	108	2,104	117	1,892	105
	x	x	SB	1,667	46	2,126	59	769	43	984	55	2,553	71	3,157	88	1,429	79	1,776	99
Jandakot Road Upgrade - Skotsch Road to Warton Road (Additional lane)	upgrade	upgrade	NB	3,325	104	2,574	80	3,046	95	2,391	75	3,908	122	3,352	105	3,737	117	3,319	104
	x	x	SB	2,353	74	2,925	91	2,357	74	2,705	85	2,338	73	3,255	102	2,170	68	3,072	96
Russell Road Upgrade - Hammond Road to Rockingham Road - Stage 1 - Hammond Road to Henderson Road (Additional lane)	upgrade	upgrade	EB	1,263	70	1,792	100	899	50	1,493	83	1,940	108	2,166	120	2,493	69	3,605	100
	upgrade	upgrade	WB	1,685	94	1,645	91	1,739	97	1,737	96	1,642	91	1,515	84	3,607	100	3,550	99
Russell Road – Henderson Road to Rockingham Road (Additional lane) - Stage 2	upgrade	upgrade	EB	1,307	73	1,524	85	907	25	1,591	44	2,259	126	2,530	141	2,404	67	3,414	95
	upgrade	upgrade	WB	1,523	85	1,441	80	1,524	42	1,625	45	2,139	119	2,214	123	3,192	89	3,084	84
Elderberry Drive Realignment - Jindabyne Heights to Berrigan Drive to connect to Ngort Drive			NB					1,331	95	1,479	106					1,598	114	1,754	125
			SB					1,042	74	1,135	81					1,332	95	1,633	117
Hammond Road Upgrade - Beeliar Drive to North Lake Road (Additional lane)	upgrade	upgrade	NB	1,439	90	1,469	92	1,366	106	1,320	113	1,748	109	1,791	112	2,899	91	2,997	94
	upgrade	upgrade	SB	974	61	969	61	950	48	910	63	1,229	77	926	58	1,970	62	2,432	76
Hammond Road Upgrade and Widening - Branch Circus to Bartram Road (Additional lane)	upgrade	upgrade	NB	1,832	115	1,672	104	2,635	82	2,071	65	2,311	144	1,921	120	3,024	87	2,542	89
	upgrade	upgrade	SB	1,308	82	1,697	106	1,548	48	2,217	69	1,628	102	1,918	120	2,112	66	2,998	88
Spearwood Avenue Upgrade - Beeliar Drive to Fancote Avenue (Additional lane)	upgrade	upgrade	NB	1,409	101	1,136	81	703	25	544	19	2,027	145	1,871	134	1,607	57	1,470	52
	upgrade	upgrade	SB	491	35	603	43	265	9	249	9	934	67	1,439	103	650	23	1,049	37
2041																			
Ngort Drive Upgrade & Extension - North Lake Road to Berrigan Drive	x	x	NB	817	58	838	60	662	47	767	55	1,399	100	1,449	103	1,413	101	1,315	94
	x	x	SB	686	49	867	62	611	44	848	61	929	66	1,676	120	1,392	99	1,849	132
Hammond Road Upgrade & Extension - Gaebler Road to Rowley Road - Stage 1 - Russell Road to Frankland Avenue (construct 1 carriageway)	x	x	NB	1,129	81	1,404	100	1,287	92	1,495	107	1,760	126	1,846	132	1,878	134	1,941	139
	x	x	SB	1,397	100	1,259	90	1,909	136	1,654	118	1,417	101	1,153	82	1,570	112	1,380	99
Rowley Road Upgrade - Rockingham Road to Hammond Road - Stage 1 - Kwinana Freeway to Hammond Road (construct 2 carriageways at 80	x	upgrade	EB	1,649	103	1,607	100	1,223	101	1,309	103	2,819	176	2,816	176	4,792	133	5,154	143
	x	upgrade	WB	1,261	79	1,225	77	2,576	81	2,015	63	1,943	121	1,904	119	3,285	91	3,138	87
Mayor Road Downgrade / Removal - Apium Mews to Atwell Close	x	x	EB	1,568	98	1,191	74	730	46	635	40	2,309	144	2,068	129				
	x	x	WB	946	59	1,031	64	631	39	620	39	2,471	154	2,510	157				
Midgegooroo Avenue Downgrade - Beeliar Drive to North Lake Road (reduce to 2 lanes)	x	x	NB	2,783	77	2,982	83	2,584	72	2,687	75	3,569	99	3,258	91	1,775	99	1,498	83
	x	x	SB	2,025	56	2,777	77	2,084	58	2,403	67	2,641	73	3,648	101	1,699	94	1,877	104
Hammond Road Upgrade & Extension - Russell Road to Rowley Road - Stage 2 - Frankland Avenue to Wattleup Road			NB													1,090	78	1,168	83
			SB													885	63	831	59
Hammond Road Upgrade & Extension - Russell Road to Rowley Road - Stage 3 - Wattleup Road to Rowley Road			NB													1,355	85	1,580	99
			SB													553	35	857	54
Poletti Road Upgrade - Beeliar Drive to North Lake Road (Additional lane)	upgrade	upgrade	NB	752	54	756	54	629	45	628	45	1,304	93	1,240	89	1,791	64	1,817	65
	upgrade	upgrade	SB	336	24	522	37	242	17	483	34	733	52	902	64	997	36	1,516	54
Pilatus Street Upgrade - Berrigan Drive to Jandakot Airport boundary (Additional lane)	x	upgrade	EB	1,528	42	1,456	40	1,242	35	1,340	37	2,394	67	1,835	51	1,847	51	2,083	58
	x	upgrade	WB	1,980	55	2,254	63	1,816	50	2,074	58	2,922	81	3,123	87	2,653	74	3,029	84
Kwinana Freeway - Rowley Road to Russell Road (Additional lane) State Planned Project	x	upgrade	NB	11,312	135	10,473	125	12,280	97	12,073	96	13,863	165	12,720	151	16,185	128	14,765	117
	x	upgrade	SB	8,742	104	8,725	104	8,614	103	8,388	100	10,486	125	10,348	123	12,206	97	12,476	99
Additional Scenario Upgrades																			
Rowley Rd West – Divided Dual Carriageway between Kwinana Freeway and Rockingham Rd – acting as a future highway	upgrade	upgrade	EB					1,757	49	2,265	63					2,571	71	2,541	71
	upgrade	upgrade	WB					3,038	84	2,563	71					3,650	101	3,685	102
Russell Rd/Cockburn Rd between Rockingham Rd to Beeliar Drive extension (Construct 2 carriageways)	upgrade	upgrade	NB					2,819	59	2,824	59					3,896	81	4,074	85
	upgrade	upgrade	SB					1,762	37	2,233	47					3,188	66	3,240	68
Cockburn Rd from Beeliar Dr extension to Rockingham Rd Hampton Rd intersection (Additional lane)	upgrade	upgrade	NB	2,831	59	2,436	51	4,036	84	3,460	72	3,820	80	3,098	65	5,262	110	4,749	99
	upgrade	upgrade	SB	1,635	34	2,375	49	1,960	41	2,821	59	1,909	40	2,422	50	2,429	51	3,140	65
Stock Rd – South St to Rowley Rd - Control of access highway upgrade. 3 lanes 100km/hr (2031)	upgrade	upgrade	NB	4,669	97	4,016	84	5,876	82	4,831	67	5,703	119	5,139	107	7,586	105	6,849	95
	upgrade	upgrade	SB	2,602	54	4,206	88	3,472	48	4,922	68	3,441	72	4,815	100	4,608	64	6,880	96
Kwinana Freeway between Anketell Road and Russell Road - Additional Lane	upgrade	upgrade	NB	12,897	154	12,298	146	12,866	102	12,262	97	15,106	180	14,418	172	15,064	120	14,376	114
	upgrade	upgrade	SB	10,364	123	9,417	112	10,334	123	9,380	112	12,294	146	11,380	135	12,256	146	11,333	135
Cockburn Road (South of Beeliar Ave) upgrade to dual carriageway 70 kph (2031)	upgrade	upgrade	NB	2,886	180	3,029	189	2,524	79	2,685	84	9,122	570	9,536	596	8,804	275	9,208	288
	upgrade	upgrade	SB	1,716	107	1,949	122	1,548	48	1,717	54	8,454	528	8,458	529	8,355	261	8,332	260
Rowley Road East between Kwinana Freeway and Tonkin Highway- Additional Lane	x	upgrade	EB	1,746	109	1,813	113	1,334	83	1,505	94	2,090	131	2,278	142	3,016	94	3,320	104
	x	upgrade	WB	1,118	70	692	43	1,073	67	886	55	1,810	113	1,410	88	2,514	79	999	31
Nicholson Road upgrade - Additional Lane	x	upgrade	NB	1,942	106	1,059	58	1,839	102	962	53	2,195	122	1,516	84	2,160	120	1,848	103
	x	upgrade	SB	2,127	118	2,363	131	2,107	117	2,311	128	2,530	141	2,661	148	2,296	128	2,202	122
Liddelow Road speed reduction to 60 kph			NB	1,577	99	1,546	97	1,235	77	1,038	65	1,625	102	1,626	102	1,585	99	1,488	93
			SB	1,528	95	1,587	99	1,291	81	1,331	83	1,629	102	1,677	105	1,607	100	1,620	101
Russell Road – Henderson Road to Rockingham Road Additional Lane	upgrade	upgrade	EB	1,268	70	1,544	86	907	77	1,591	65	2,256	126	2,556	142	2,404	67	3,414	95
	upgrade	upgrade	WB	1,447	80	1,381	77	1,524	81	1,625	83	2,158	120	2,213	123	3,192	89	3,084	84

V/C Ratio
- 0 to 29
- 29 to 46
- 46 to 60
- 60 to 80
- 80 to 100
- 100 to 110
- 110 to 135
- 135 to 170
- 170 to 800

Figure 45: Implementation Plan for Scenario 6

The road network action plan shown in Figure 50 lists the roads that could be upgraded based on the outcomes of the modelling analysis. The list is prepared by applying a logic of 10% improvement in V/C ratio in the “Do Something“ compared to the “Do Nothing” scenario. A 10% improvement in the V/C ratio resulted in a decision to recommend the upgrade.

Table 9 provides a summarised list of road upgrades recommended based upon the modelling results. Upgrades suggested for the 2031 time horizon are considered the priority upgrades.

Figure 45: Implementation Plan for Scenario 6

Table 9: List of future road upgrades based on Scenario 6 modelling results

Road Section	Upgrade Required	Direction	Time of upgrade	
			2031	2041
Jandakot Road Upgrade – Skotsch Road to Warton Road	Additional lane	NB	Upgrade	
Russell Road Upgrade - Hammond Road to Rockingham Road - Stage 1 - Hammond Road to Henderson Road	Additional lane	NB	Upgrade	
	Additional lane	SB	Upgrade	
Russell Road – Henderson Road to Rockingham Road - Stage 2	Additional lane	EB	Upgrade	
	Additional lane	WB	Upgrade	
Hammond Road Upgrade - Beeliar Drive to North Lake Road	Additional lane	EB	Upgrade	
	Additional lane	WB	Upgrade	
Hammond Road Upgrade and Widening - Branch Circus to Bartram Road	Additional lane	NB	Upgrade	
	Additional lane	SB	Upgrade	
Spearwood Avenue Upgrade - Beeliar Drive to Fancote Avenue	Additional lane	NB	Upgrade	
	Additional lane	SB	Upgrade	
Rowley Road Upgrade - Rockingham Road to Hammond Road - Stage 1 - Kwinana Freeway to Hammond Rd	Construct 2 carriageways operating at 80kph	EB		Upgrade
	Construct 2 carriageways operating at 80 kph	WB		Upgrade
Poletti Road Upgrade - Beeliar Drive to North Lake Road	Additional lane	NB	Upgrade	
	Additional lane	SB	Upgrade	
Pilatus Street Upgrade - Berrigan Drive to Jandakot Airport boundary	Additional lane	EB		Upgrade
	Additional lane	WB		Upgrade
Kwinana Freeway - Rowley Road to Russell Road - State Planned Project	Additional lane	NB		Upgrade
	Additional lane	SB		Upgrade
Rowley Road West – Provision of divided dual carriageway – between Kwinana Freeway and Rockingham Road	Construct 2 carriageways operating at 80kph	EB		Upgrade
	Construct 2 carriageways operating at 80 kph	WB		Upgrade
Russell Road / Cockburn Road between Rockingham Road to Beeliar Drive extension	Construct 2 carriageways	NB	Upgrade	
	Construct 2 carriageways	SB	Upgrade	
Cockburn Road from Beeliar Drive extension to Rockingham Road/Hampton Road intersection	Additional lane	NB	Upgrade	
	Additional lane	SB	Upgrade	
Cockburn Road south of Beeliar Drive extension	Additional lane	NB	Upgrade	
	Additional lane	SB	Upgrade	
Stock Road	Control of access highway upgrade to 3 lanes operating at 100 kph	NB	Upgrade	
	Control of access highway upgrade to 3 lanes operating at 100 kph	SB	Upgrade	
Kwinana Freeway widening between Anketell Road and Russell Road	Additional lane	NB	Upgrade	
	Additional lane	SB	Upgrade	
Rowley Road East between Kwinana Freeway and Tonkin Highway	Divided dual carriageways	EB		Upgrade
	Divided dual carriageways	WB		Upgrade
Nicholson Road between Armadale Road and Thomas Road	Additional lane	NB		Upgrade
	Additional lane	SB		Upgrade

7. Recommended Pedestrian Facilities

An additional component tested as part of this study was the assessment of pedestrian crossing infrastructure throughout the City's road network. The Western Australian Planning Commission (WAPC) Transport Impact Assessment Guidelines (Volume 2 – Planning Schemes, Structure Plans and Activity Centre Plans) has a table showing recommended criteria to assess the need for pedestrian crossing infrastructure. The below table was extracted from the document and was applied to the recommended scenario (Scenario 6) to determine the areas where pedestrian crossing facilities were recommended.

Table 10: Traffic volumes affecting pedestrian crossing amenity (Source: WAPC TIA Guidelines Vol. 2)

Road cross-section	Traffic volumes affecting ability of pedestrians to cross * (vehicles per hour – two way)
2 lane undivided	1,100 vph
2 lane undivided (or with pedestrian refuge islands)	2,800 vph
4 lane undivided (without pedestrian refuge islands)	700 vph
4 lane divided (or with pedestrian refuge islands)	1,600 vph

A heat map was developed for the future years 2031 and 2041. The heat map shows deficiency of pedestrian crossing infrastructure in red. Road segments with speed less than or equal to 60kph have been assessed. The assessment has been undertaken considering the AM and PM peak hour volumes.

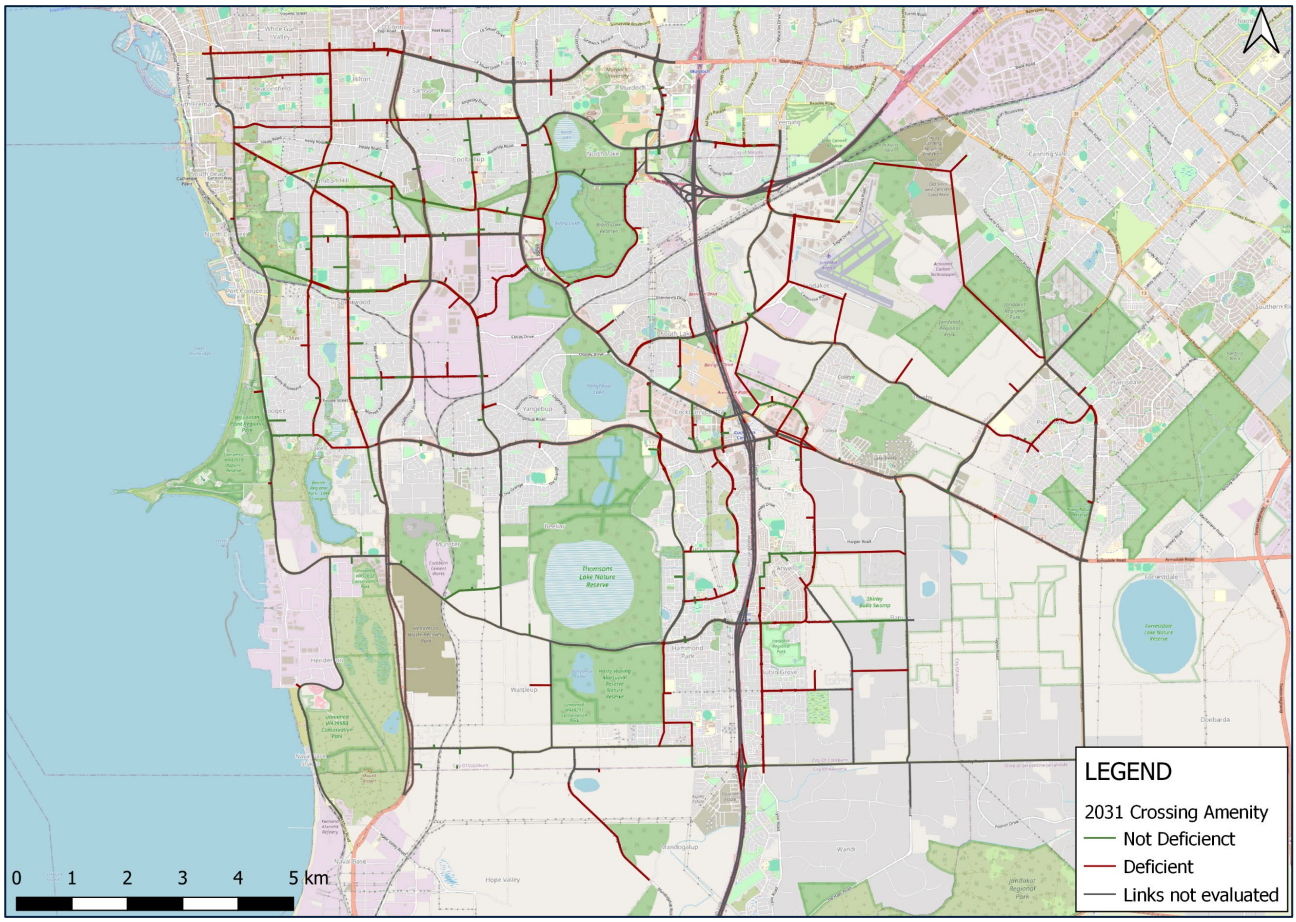

Figure 46: Scenario 6 – 2031 – Pedestrian Crossing Amenity evaluation

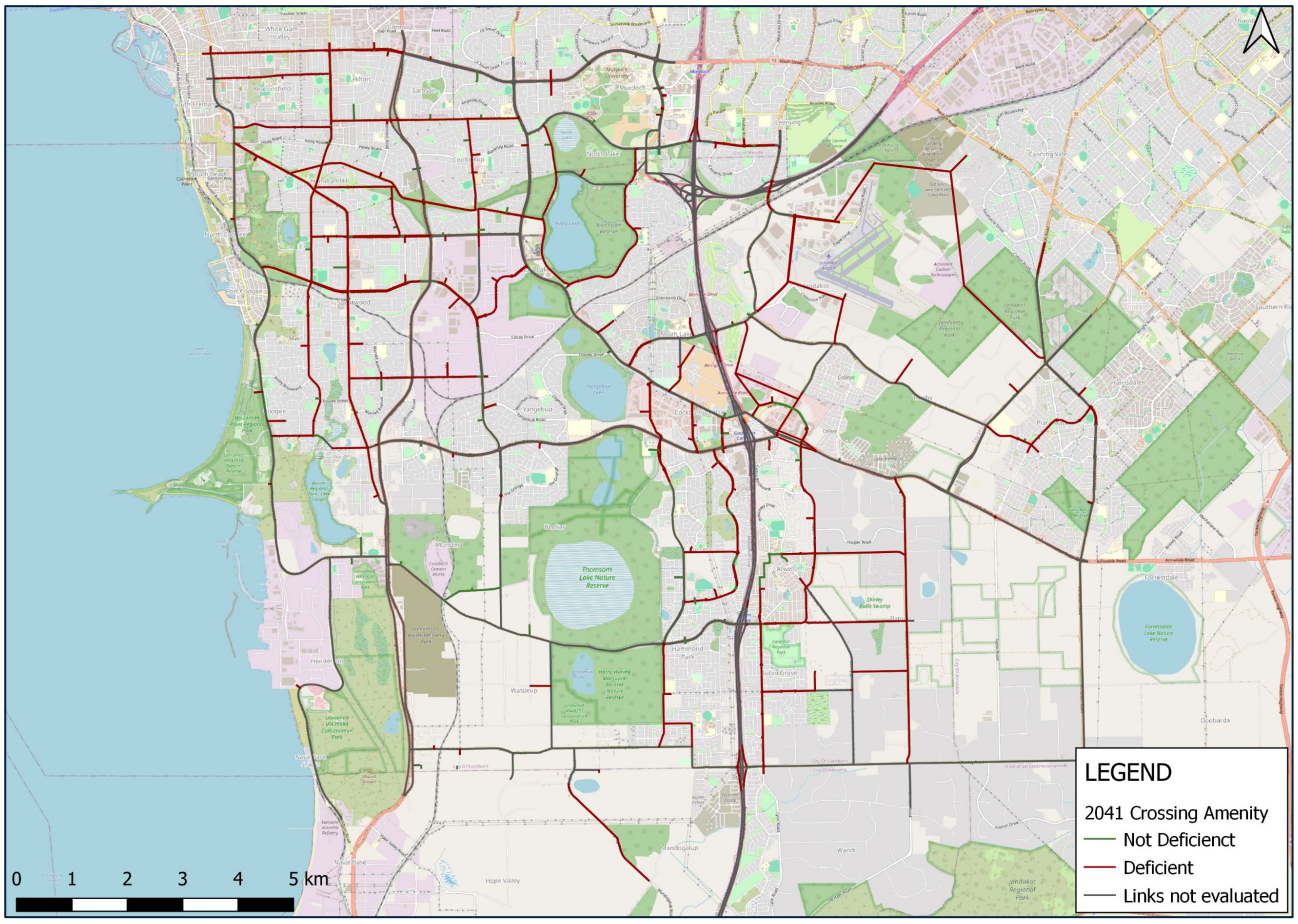

Figure 47: Scenario 6 – 2031 – Pedestrian Crossing Amenity evaluation

The maps highlight the potential focus areas for future pedestrian crossing infrastructure. It was developed in QGIS by identifying divided/ undivided lanes, presence/absence of existing pedestrian crossing infrastructure and subsequently applying the criteria mentioned in Table 11. Volumes used in this assessment are Assigned Volumes which are results from Scenario 6 model.

The type of pedestrian crossing required at these locations need to be assessed separately as the purpose of the maps is only to highlight road segments within the City of Cockburn network which satisfy the WAPC criteria and the identification of potential focus areas.

8. Conclusions

The 2023 District Traffic Study was a comprehensive review of the current and future traffic demand in the City of Cockburn road network. As part of the study, the following tasks were undertaken:

- Determination of base year (2021) peak hour for AM and PM;
- Development of AM and PM peak traffic models in Aimsun for the base year;
- Development of AM and PM peak traffic models in Aimsun for future years (2031 and 2041) for the "Do Nothing" and "Do Something" scenarios;
- Development of AM and PM peak traffic models in Aimsun for future years (2031 and 2041) for the additional scenarios;
- List of the key local road upgrades necessary for the future years (2031 and 2041) based on modelling results for the City's implementation plan; and
- Additional scenario testing to understand impacts of additional road upgrades, public transport, active transport and mode shift.

The analysis showed that there was a significant increase in traffic volumes and travel times in both future scenario years (2031 and 2041). Even with the proposed road upgrades, there are sections where the demand exceeds available road network capacity.

Results for the 2031 "Do Something" scenario did show some improvement compared to the "Do Nothing" option. The 2041 "Do Something" results highlighted that although it is better than the "Do Nothing" option, current planned upgrades themselves will not totally rectify congestion issues in the AM/PM peak period operation.

Following the base modelling, additional scenarios were evaluated. The additional scenario testing results highlighted the benefits of undertaking the upgrades to key areas in the network where traffic volumes are high and higher trips are expected.

The mode shift scenario demonstrated how significant a shift in 1% and 2% vehicular traffic demand has in the reduction of overall peak period vehicle-hours. The results from the future scenarios also indicate that additional road network demand management measures will be required beyond the planned road network upgrades to the functional road network. These involve investment in providing well connected active transport (walking and cycling routes) and public transport infrastructure to facilitate behavioural mode shift from private car trips to other modes.

An evaluation of pedestrian crossing infrastructure was undertaken which has highlighted pedestrian focus areas.

Based on the scenarios tested, it is recommended that the City's road network upgrade plan be revised to include upgrades as listed in Table 10. However, it is also recommended that these upgrades need to be accompanied by the addition of active transport and public transport infrastructure improvements as has been highlighted in previous sections.

Nb: The modelling for the District Traffic Study only highlights capacity issues. The City of Cockburn will work with Main Roads and the surrounding local government authorities to develop any future plans and investigate feasibility and options for each route as part of the planning process.

The City is committed to reducing road trauma and will continue to work collaboratively with Main Roads, Department of Transport, Road Safety Commission, Road Safety Council, Police and RoadWise WALGA, to achieve good road safety outcomes for the people who live, work and travel on the local road network in the City.

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Appendix A – Model Inputs

1. Introduction

This appendix will explain about the list of inputs needed to develop the base year (2021) and future years (2031 and 2041) model in Aimsun. The inputs consist of base year traffic volumes, determination of AM/PM peak period traffic volumes, Speed limit calibration, current and future road network upgrades, changes based on current design, total trips and sub-area matrices with network. The note also discusses about an additional scenario requested to run subject to agreement when the models have been developed.

2. List of Inputs

- Traffic Volumes
- Speed limit calibration
- Road network for base year 2021
- Road network for future years 2031, 2041
- Network Changes required based on the existing design
- Total trips and Sub-Area Matrices with network from MRWA
- Additional scenarios

2.1 Traffic Volumes

Traffic volumes along major links within City of Cockburn were analysed for 2020/21. Analysis is conducted using screenlines. In screenline analysis, the sum of observed link traffic counts that are crossed by the screenline is compared with model estimated volumes, for the same links and directions, from traffic assignment. Figure 1 is a map showing screen lines applied within the City of Cockburn area. The screenlines and sites are picked to represent major links along the network such as Freeways, Primary and Secondary Distributor roads.

For the City of Cockburn DTS, there are 21 sites included in the analysis as shown below in Figure 1.

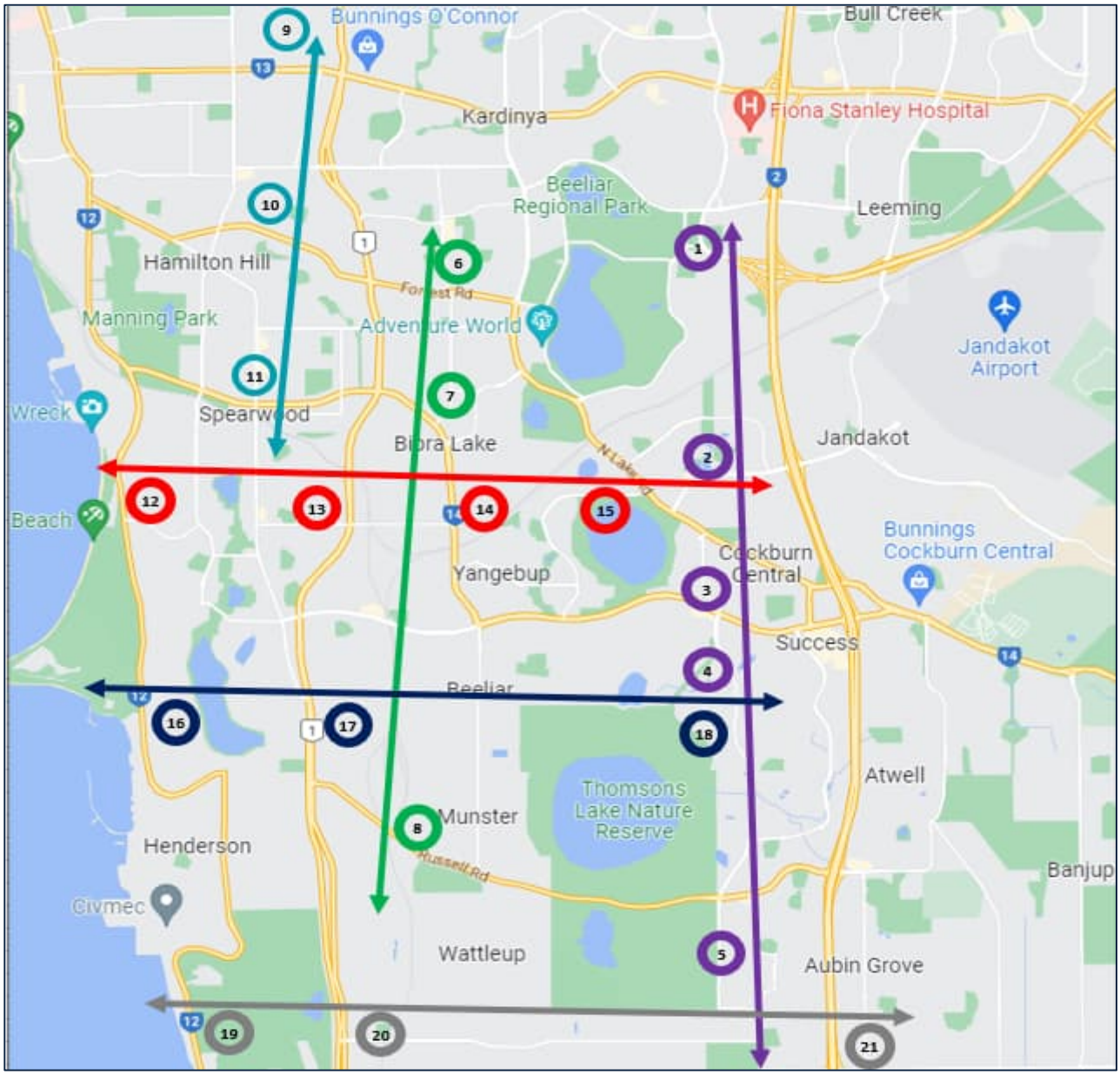

Figure 1: Screelines and sites within City of Cockburn for model calibration and validation

Traffic data was downloaded from Mainroads - Trafficmap for the above 21 sites. This is compared with the base year model for calibration and validation purpose. It also helps to establish the AM and PM peak periods within the city network. The AM and PM peak periods were determined by analysing hourly volumes for all the 21 sites and was 7:00 AM – 9:00 AM and 3:00 PM – 5:00 PM. A two-hour peak period was chosen for modelling purpose. The below table shows the site location and year of survey for the eastbound and westbound traffic volumes that were assessed.

Table 1: Site locations and year of the count (ID 1-11)

ID	Site Location	Year of count
1	Farrington Rd East of Murdoch Dr	2021/22
2	Berrigan Dr West of Kwinana Fwy	2021/22
3	North Lake Rd East of Hammond Rd	2021/21
4	Beeliar Dr East of Hammond Rd	2021/22
5	Russell Rd West of Kwinana Fwy	2020/21

ID	Site Location	Year of count
6	Forrest Rd West of North Lake Rd	2020/21
7	Spearwood Ave East of Stock Rd	2020/21
8	Russell Rd East of Rockingham Rd	2020/21
9	South St West of Carrington Rd	2020/21
10	Rockingham Rd West of Forrest Rd	2020/21
11	Spearwood Ave East of Cockburn Rd	2020/21

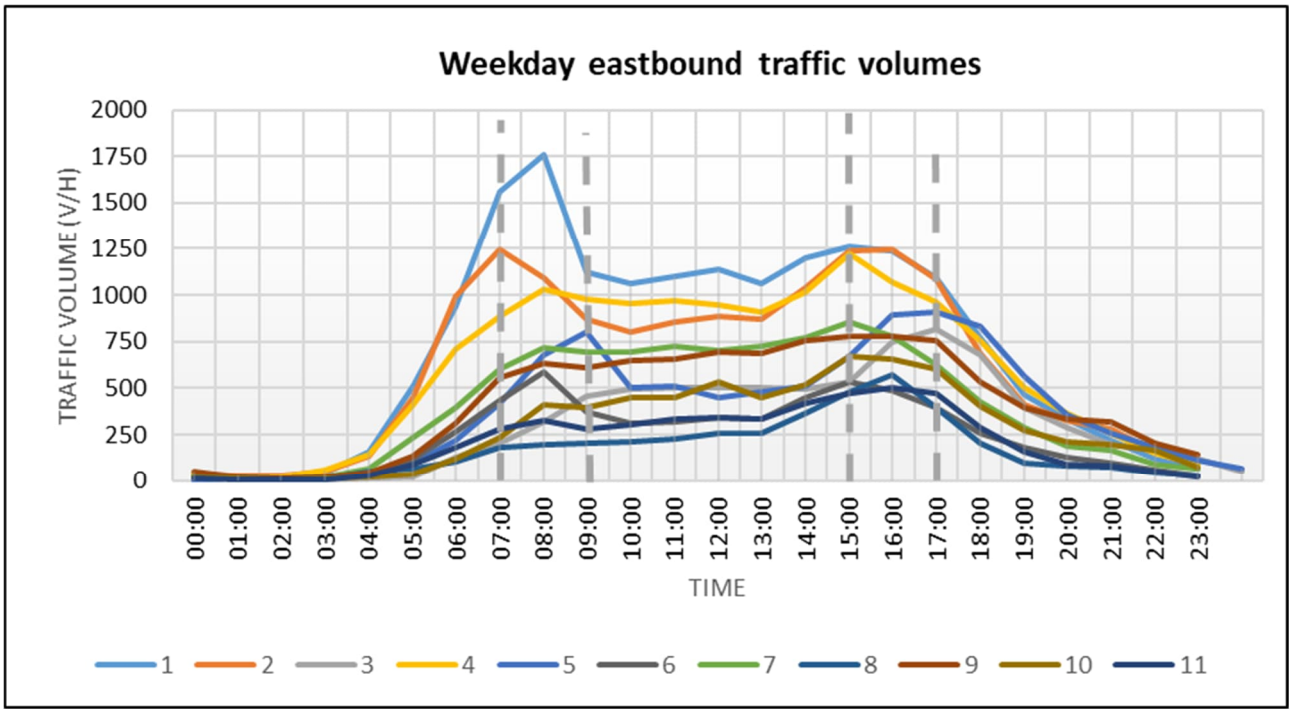

Figure 2: Average weekday eastbound traffic volumes for sites 1 to 11

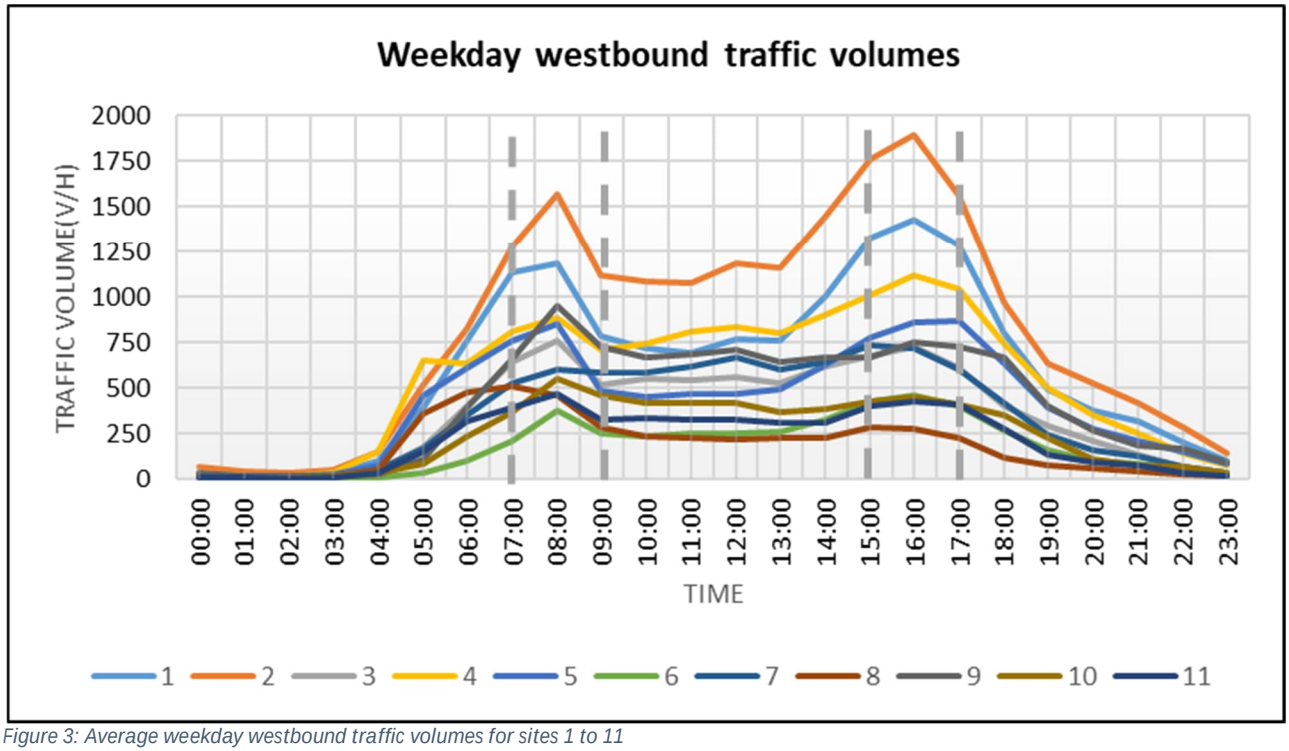

Figure 3: Average weekday westbound traffic volumes for sites 1 to 11

The below table shows the site location and year of count, where the northbound and southbound traffic volumes were assessed to determine the AM and PM peak periods.

Table 2: Site locations and year of the count (ID 12-21)

ID	Site Location	Year of count
12	Cockburn Rd South of Spearwood Ave	2021/22
13	Stock Rd North of Barrington St	2021/22
14	Spearwood Ave South of Barrington St	2021/22
15	North Lake Rd South of Bibra Dr	2021/22
16	Cockburn Rd S of Okane Ct	2021/22
17	Rockingham Rd N of Russell Rd	2021/22
18	Hammond Rd S of Beeliar Dr	2021/22
19	Cockburn Rd N of Hogg Rd	2020/21
20	Rockingham Rd S of Wattleup Rd	2019/20
21	Kwinana Fwy N of Rowley Rd	2020/21

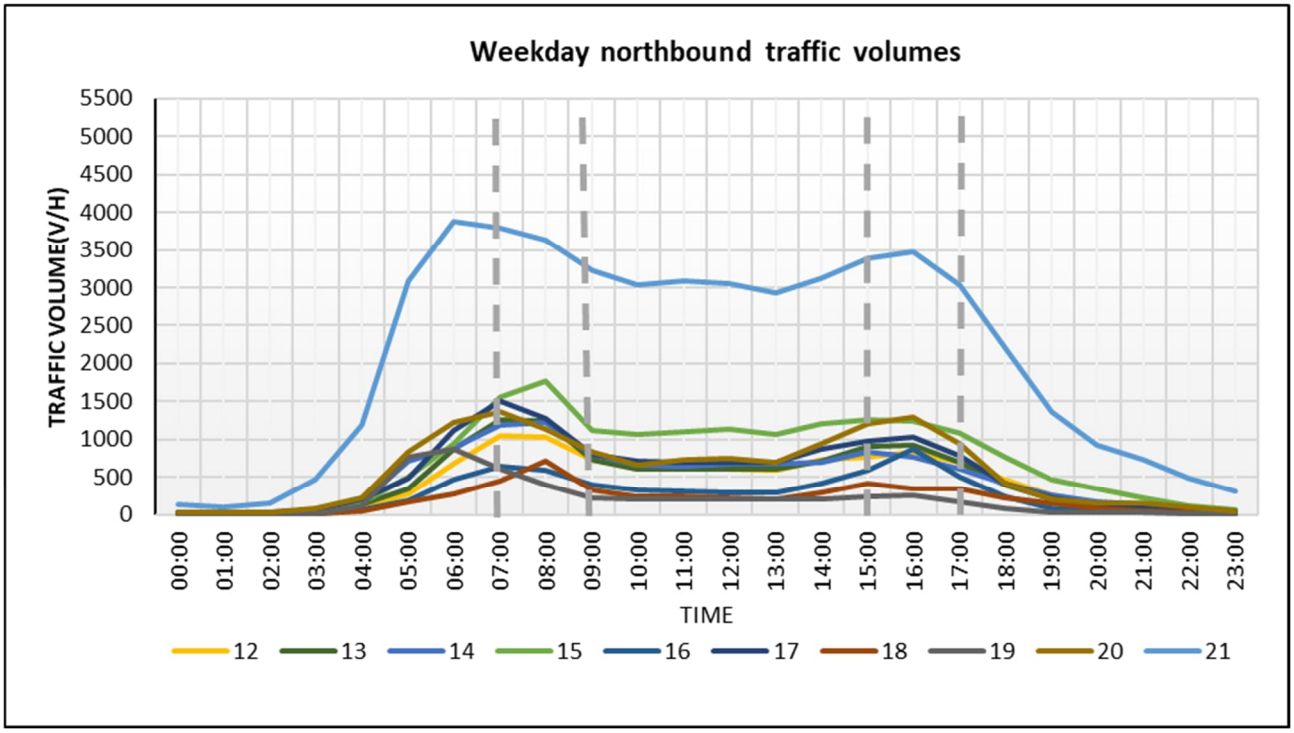

Figure 4: Average weekday northbound traffic volumes for sites 12 to 21

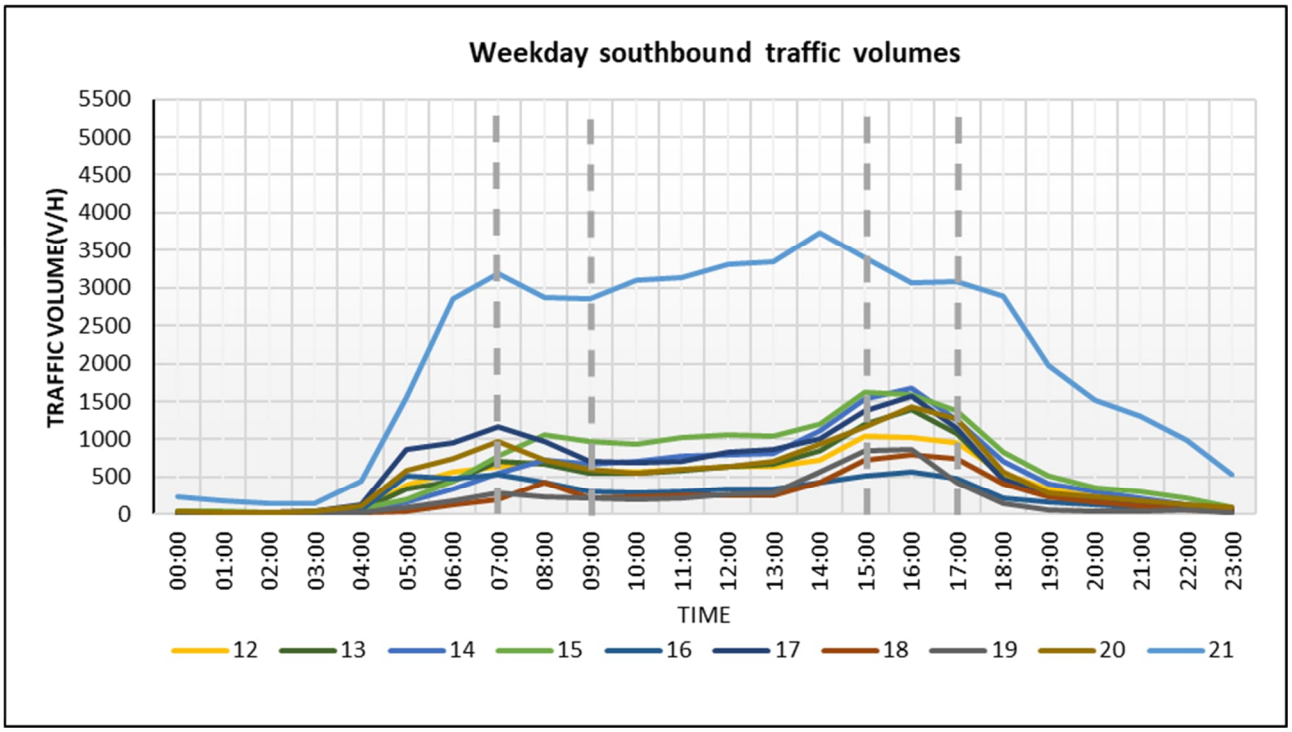

Figure 5: Average weekday southbound traffic volumes for sites 12 to 21

Sites 12 to 21 represent major links within City of Cockburn facilitating North-South movement. The weekday northbound and southbound traffic volumes also indicate that 7:00 – 9:00 AM and 3:00 – 5:00 PM are the AM and PM peak periods within the City.

The traffic volumes from these same locations will also be utilised to calibrate and validate the base model.

2.2 Speed limit calibration

The below table shows the changes in speed limits which were made to some roads in the Aimsun models received by Arup order to best match the speed limits in the Main Roads' Information Mapping System.

Table 3: Speed limit comparison

Road Name	Section	Speed limit before correction	Speed limit after correction
Stock Road	All except northbound between Wattleup Road and Russell Road	90	80
Wattleup Road	All	50	70
Pearse Road	All	50	70
Rockingham Road	All	50	60
Hamilton Road	All	50	60
Forrest Road	All	50	60
Phoenix Road	Between Rockingham Road and Stock Road	70	60
Jandakot Road	West of Soloman Road	80	70
Berrigan Drive	All	60	70
Farrington Road	West of Kwinana Freeway	50	70
Hope Road	All	50	70
South Street	Sections near Gibertson Rd intersection	90	70

Carrington Road	All	50	60
Cockburn Road	South of Spearwood Ave intersection	70	60
Hampton Road	All	50	60
Spearwood Ave	Between Rockingham Road and Cockburn Road	50	60
Kwinana Freeway	Roe Highway interchange on and off ramps	70	80
Murdoch Drive	Farrington Road turnoff and Roe Highway	50	70

The below figure shows the current speed limits of Main Roads' Information Mapping System.

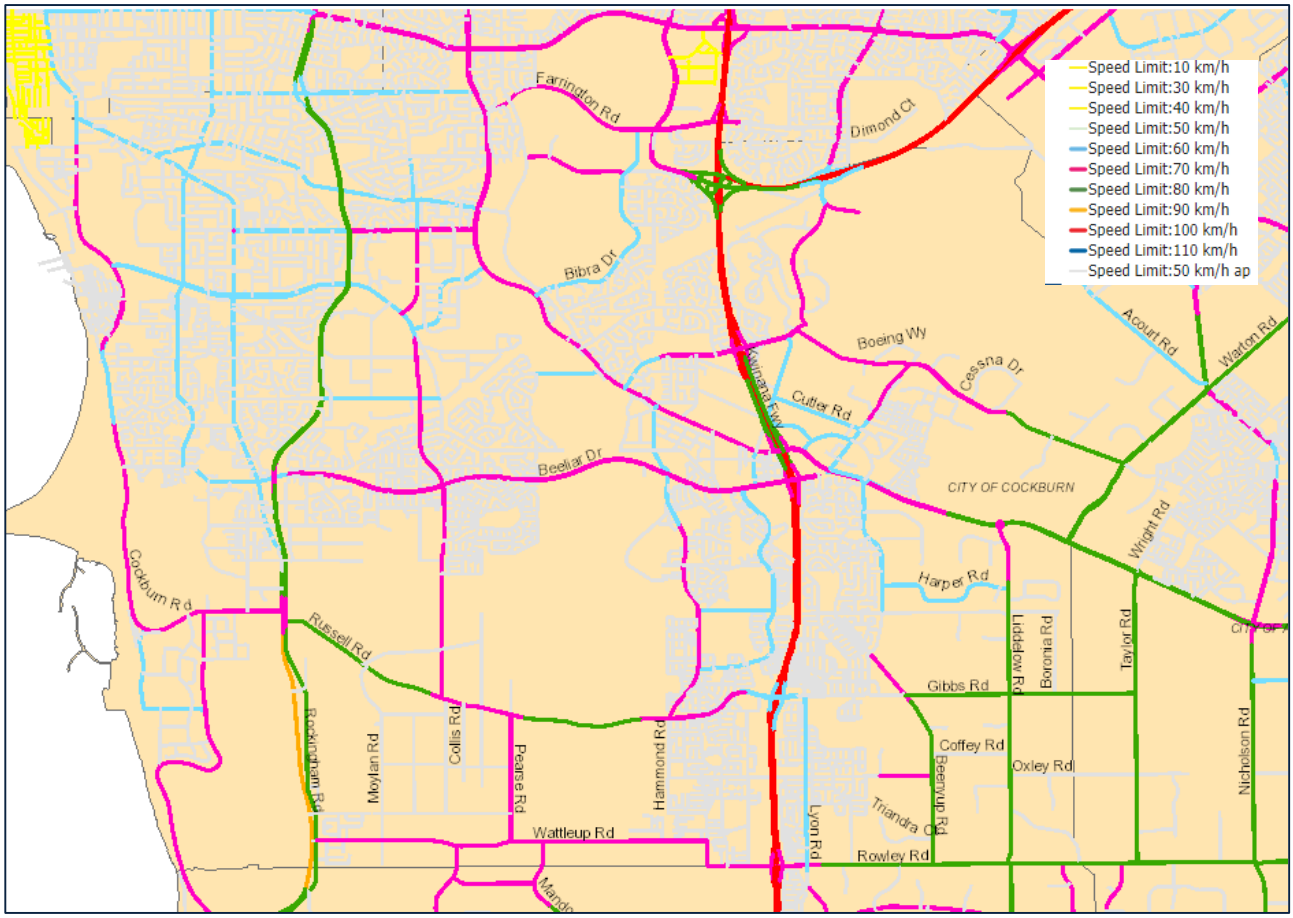

Figure 6: MRWA Road Information Mapping System showing speed limits

The below figures show the difference between the ARUP base year model - speed limits and corrected speed limits in AIMSUN.

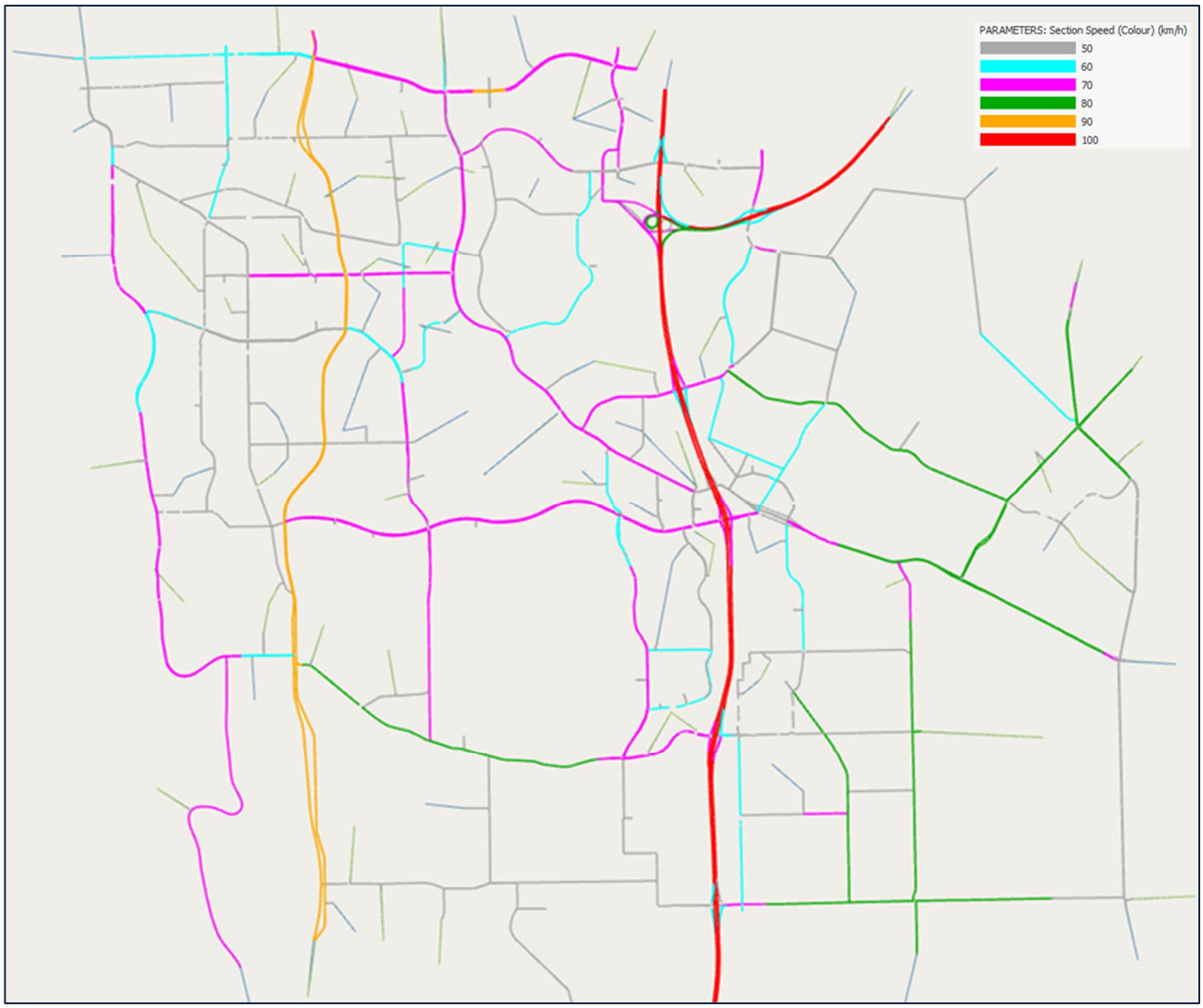

Figure 7: Network layout for base year 2021 model showing existing speed limit

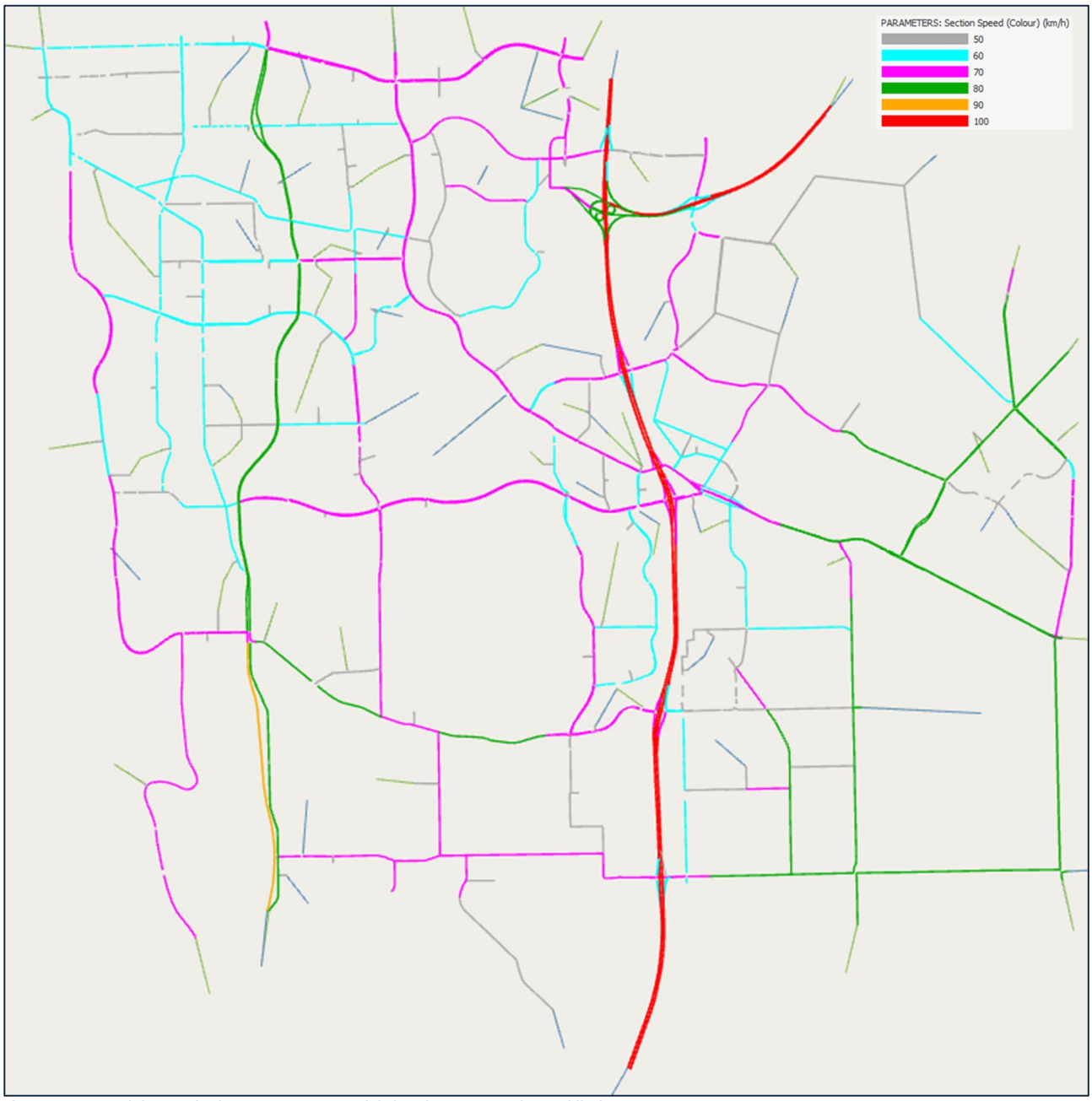

Figure 8: Network layout for base year 2021 model showing corrected speed limit

2.3 Road Network for base year 2021

The below table represents the road network upgrades completed by 2021 after the last DTS report in 2018 within the City of Cockburn boundary.

These upgrades are tabulated based on the City of Cockburn Regional & Major Roadworks 2018-2031, 2021 aerial images, and after consultation and agreement with the City. These road network upgrades will be included as part of the AIMSUN network for the base year 2021. Some of the upgrades planned in the previous DTS report for year 2021 were not upgraded and therefore will be listed for future year 2031/2041. There were also some inconsistencies in the network layout for these upgrades which will be fixed to reflect the actual base year 2021 layout.

Table 4: The agreed list of road network upgrades with completion in 2021 base year model

Implementation Plan	Completed Upgrade		Sections	Comments
	City of Cockburn	MRWA		
Road Network Upgrade	2021	2021		
Spearwood Avenue - Barrington Street to Beeliar Drive (bridge / 2nd c/w)	✓		Barrington Street to Beeliar Drive	
Beeliar Drive – Fawcett Road to Stock Road (reconstruction)	✓		Fawcett Road to Stock Road	
Verde Drive – Biscayne Way to Solomon Road (land & construct 1 c/w)	✓		Biscayne Way to Solomon Road	
Verde Drive – Solomon Road to Armadale Road (land & construct 1 c/w)	✓		Solomon Road to Armadale Road	
Prinsep Road – Cutler Road to Verde Drive (construct 1 c/w)	✓		Cutler Road to Verde Drive	
Jandakot Road – Solomon Road to Fraser Road (construct 2nd c/w)	✓		Solomon Road to Fraser Road	
Karel Avenue - Berrigan Drive to Farrington Street (construct 2nd c/w)		✓	Berrigan Drive to Farrington Street	
Kwinana Freeway - Russell Road to Roe Highway (northbound widening)		✓	Russell Road to Roe Highway	
Armadale Road - Anstley Road to Tapper Road (construct 2nd c/w)	✓		Anstley Road to Tapper Road	
Murdoch Drive Connection - Kwinana Freeway to Murdoch Drive	✓		Kwinana Freeway to Murdoch Drive	
Karel Avenue - Berrigan Drive to Farrington Street (construct 2nd c/w)		✓	Berrigan Drive to Farrington Street	
Mayor Road - Fawcett Road to Rockingham Road (reconstruct)	✓		Fawcett Road to Rockingham Road	

2.4 Road Network for future years 2031 and 2041

The below table represents the agreed road network upgrades which is anticipated to be completed by 2031 and 2041 within City of Cockburn. Some of them are not applicable for strategic modelling and have been highlighted and commented above. These are projects which are either funded by the City or by Main Roads WA. Similar to the previous list, these upgrades are tabulated based on the City of Cockburn Regional & Major Roadworks 2018-2031, spreadsheet received from City of Cockburn showing the scoring/priority of projects, consultation and agreement with the City. It must be noted that the list only includes upgrades which are applicable for strategic modelling and does not include intersection upgrades. There were also some inconsistencies in the network layout for these upgrades which will be fixed to reflect the actual base year 2021 layout.

Table 5: The agreed list of road network upgrades with completion in years 2031 and 2041.

Implementation Plan	City of Cockburn		MRWA		Comments
Road Network Upgrade	2031	2041	2031	2041	
Rockingham Road – Phoenix Road to Spearwood Avenue reconstruction (to 1 lane each way)	✓				
Jandakot Road Upgrade - Skotsch Road to Warton Road (land and construct 2 c/w)	✓				
Russell Road Upgrade - Hammond Road to Rockingham Road - Stage 1 - Hammond Road to Henderson Road (construct 2 c/w)	✓				
Russell Road – Henderson Road to Rockingham Road (land & construct 2 c/w) - Stage 2	✓				
Elderberry Drive Realignment - Jindabyne Heights to Berrigan Drive to connect to Ngort Drive	✓				
Hammond Road Upgrade - Beeliar Drive to North Lake Road (construct second c/w)	✓				
Hammond Road Upgrade and Widening - Branch Circus to Bartram Road (construct 2nd c/w & upgrade verge)	✓				
Spearwood Avenue Upgrade - Beeliar Drive to Fancote Avenue (construct 2nd c/w)	✓				
Ngort Drive Upgrade & Extension - North Lake Road to Berrigan Drive		✓			
Hammond Road Upgrade & Extension - Gaebler Road to Rowley Road - Stage 1 - Russell Road to Frankland Avenue (construct 1 c/w NB and SB)		✓			
Rowley Road Upgrade - Rockingham Road to Hammond Road - Stage 1 - Kwinana Freeway to Hammond Road (land and construct 2nd c/w)		✓			
Mayor Road Downgrade / Removal - Apium Mews to Atwell Close		✓			
Midgegooroo Avenue Downgrade - Beeliar Drive to North Lake Road (reduce to 2 lanes)		✓			
Hammond Road Upgrade & Extension - Russell Road to Rowley Road - Stage 2 - Frankland Avenue to Wattleup Road		✓			

Hammond Road Upgrade & Extension - Russell Road to Rowley Road - Stage 3 - Wattleup Road to Rowley Road		✓			
Poletti Road Upgrade - Beeliar Drive to North Lake Road (construct 2nd c/w)		✓			
Pilatus Street Upgrade - Berrigan Drive to Jandakot Airport boundary (construct 2nd c/w)		✓			
Kwinana Freeway - Rowley Road to Russell Road (northbound widening) State Planned Project				✓	

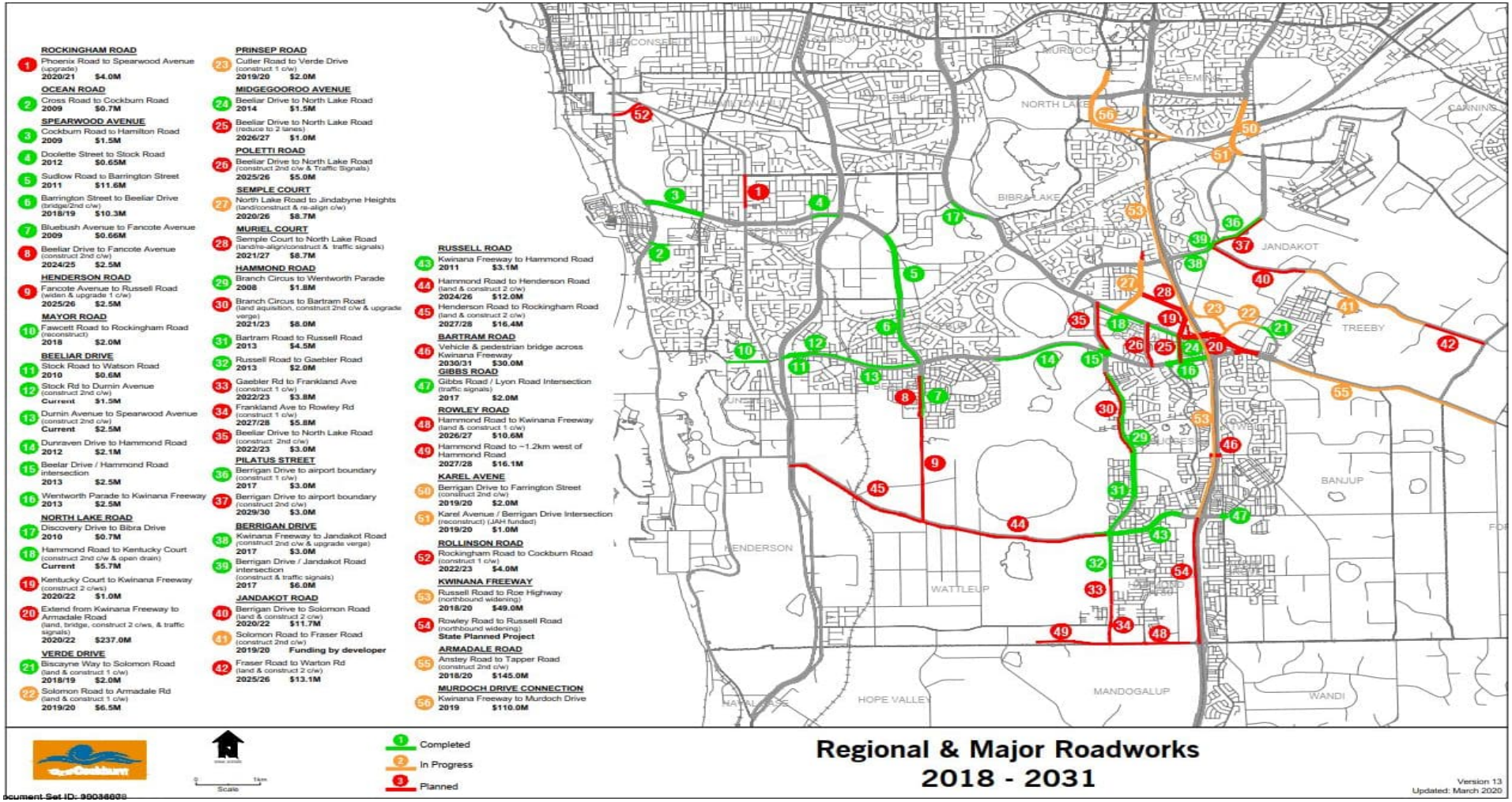

Figure 9: City of Cockburn Regional & Major Roadworks 2018 – 2031

2.5 Network Changes required based on the existing design

SMEC has conducted a desktop study using Metro Maps, which is mainly focused on the main corridors, to note any changes required to the AIMSUN models. Table 6 shows the changes which have been updated to both the base year and future years models in order to reflect the existing design.

Table 6: Network changes to the base year model

Road network / Intersection	New
Murdoch Drive / Roe Hwy Connection	• Removal of Farrington Rd / Roe Hwy interchange • Add roundabout to Bibra Lake Dr / Roe Hwy connection • Removal of NB connection from Farrington Road to Murdoch Dr & adjusted SB connection • Removal of Roe Hwy connection to Bibra Lake Dr
Roe Highway / Kwinana Freeway	• Update to the overall design of the interchange
Armadale Rd / Nicholson Rd	• Added Roundabout & Flyover lanes
Armadale Rd / Liddelow Rd	• Converted Intersection to Roundabout
Russell Road / Hammond Road	• Converted Intersection to Roundabout
Wattelup Road / Franklin Ave / Rowley Rd	• Removal of some roads
Stock Rd / Beeliar Dr Intersection	• Updated intersection lanes
Verde Dr	• Change made to most road sections to 1 way
Verde Dr/Cutler Rd	• Removal of road connection

2.6 Total trips and Sub-area matrices with network – MRWA

SMEC has requested MRWA (on behalf of City of Cockburn) to provide *Sub-Area matrices with network and Link-Volume plot* for base year 2021 and future years 2031 and 2041. The data has been received and imported into the base AIMSUN model received from Arup. The O-D matrices include current and future land use and development within the City. It was agreed between the City and SMEC that the ROM matrices for the base year 2021 be used by calibrating and validating it with Real Data Set (RDS) which are the 21 sites picked above. SMEC has used the default parameters for VDF, TPF and other parameters as per the received Arup Model basic calibration process in 2018. Therefore, SMEC will adjust the future year ROM24 matrices of 2031 and 2041 to the calibrated base year matrices for demand accuracy.

Here is the summary of the total trips based on the received data from ROM24.

Table 7: Summary of ROM24 total trips

Year	Total Trips	% Growth compare to base year
2021	746148	
2031	938730	+26%
2041	1075258	+44%

Appendix B – Modelling methodology

1. Introduction

This appendix provides information about the study purpose, modelling methodology, modelling assumptions and summary. AIMSUN is the traffic modelling software that is used to conduct this strategic modelling. The analysis is conducted for three forecast year scenarios: base year (2021), medium-term future year (2031), and long-term future year (2041). The outputs from this modelling study will assist in preparing an outline of priority road upgrade plans for the short-term, medium-term, and long-term.

2. Modelling Methodology

The Cockburn District Traffic Model (CDTM) was created as a strategic model to capture the extents of the City of Cockburn. To build the strategic model, a subarea network with matrices was requested to MRWA and extracted from the ROM24 model owned by Main Roads. Both networks and matrices were used and updated in Aimsun. The software enables the creation of both static and dynamic environment simulations and has an advantage of transferring from a strategic model to a microsimulation model for a more comprehensive analysis in the future if required. However, for this analysis, a static assignment method is used to get the results.

2.1 Study Area and Zoning System

Table 1 summarises the comparison between the initial supplied ROM24 data, previous CDTM zones (updated in 2018) and the recently revised zones.

Table 1: Zone comparison between ROM24 and CDTM

Zone Set	2016	2021	2031	2041
Previous CDTM Internal Zones	60	60	60	
Previous CDTM External Zones	48	50	52	
Previous CDTM Total Zones	**108**	***110**	***112**	
Updated CDTM Internal Zones		76	76	76
Updated CDTM External Zones		35	37	37
Updated CDTM Total Zones		**111**	**113**	**113**
ROM24 Internal Zones		77	77	78
ROM24 External Zones		37	42	41
ROM24 Total Zones		**114**	**119**	**119**

The final CDTM contains one more zone than the ROM24, reflecting the City of Cockburn area. This minor increase has been made to improve forecast precision within the study area. The increase in CDTM external zones between 2021 and 2031 is due to the addition of external network connections as new corridors in and out of the City of Cockburn area were built after the previous study for 2021 and the future network for 2031.

The previous report missed out a zone each in the 2021 and the 2031 road network. This has been rectified.

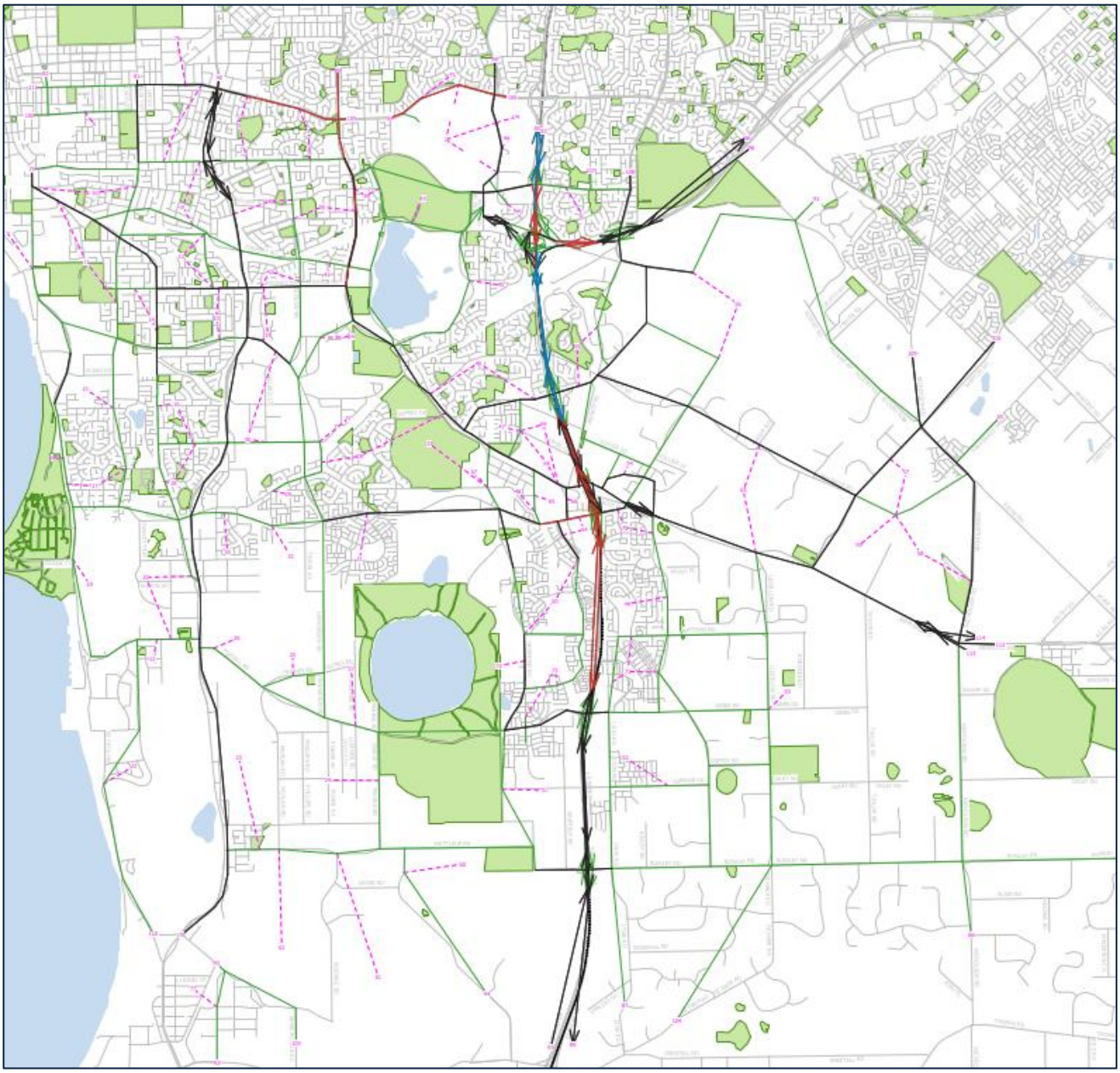

Fig.1 Cockburn ROM24 Sub-Area Zone System

Figure below illustrates the final zone scheme used for the base year model for the City of Cockburn District Study:

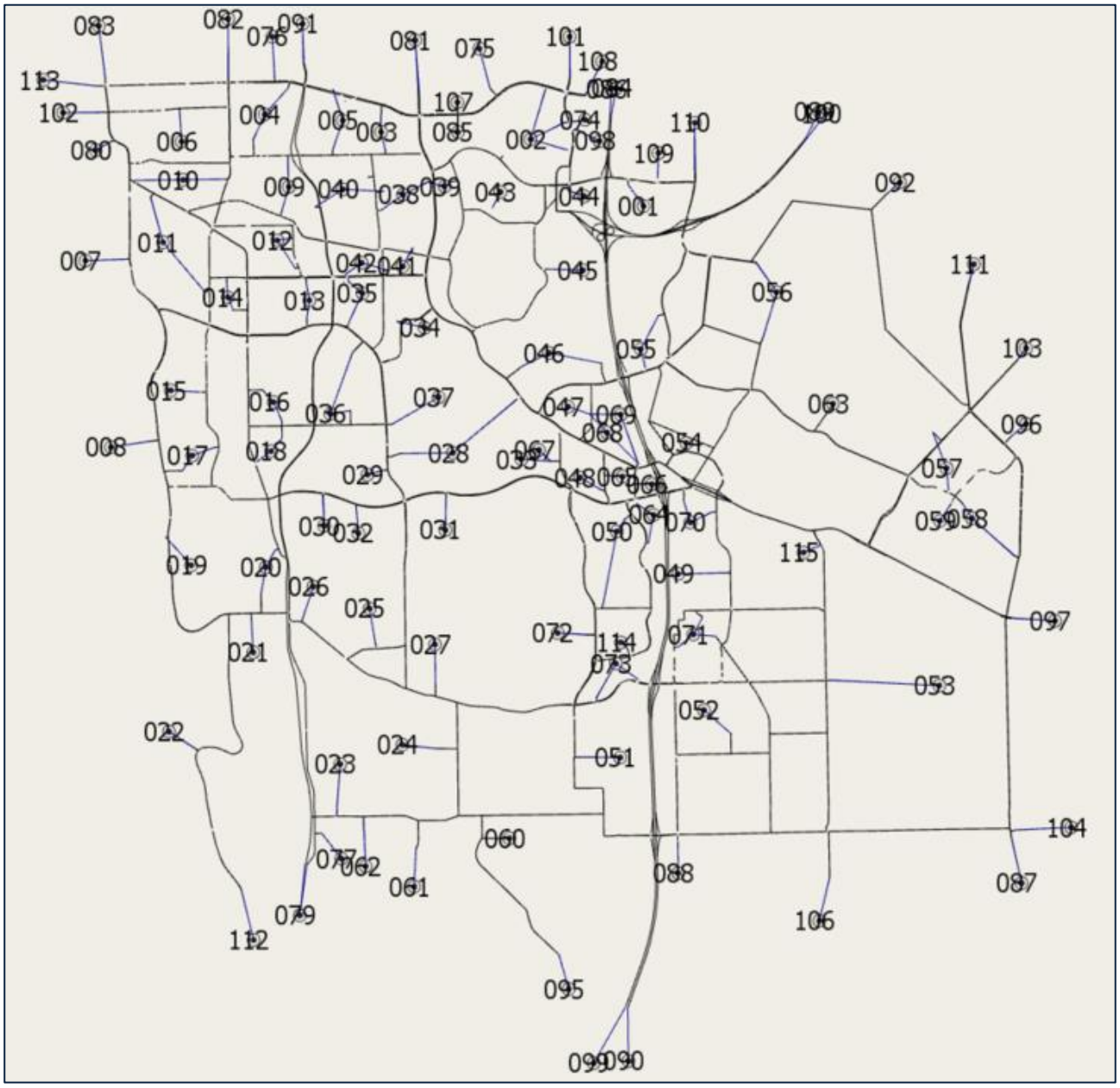

Figure 2: 2021 Modelled Aimsun zone layout

2.2 Review of CDTM

A review of the CDTM was undertaken to ensure that the base and future year models have been updated to accurately reflect the current and future year plans for the City of Cockburn. For details on these changes, please refer to the input technical memo.

2.3 Demand Matrix

The traffic demand matrices were generated from all-day sub-area matrices for all vehicle types from ROM24 for existing and future years. The 2021 matrix was used in conjunction with peak hour counts and matrix estimation to generate base 2021 AM and PM matrices.

	AM Light Vehicles	AM Heavy Vehicles	PM Light Vehicles	PM Heavy Vehicles
2021	117392	9930	128028	12244
2031	150809	14826	160641	18406
2041	187002	24776	197257	29468

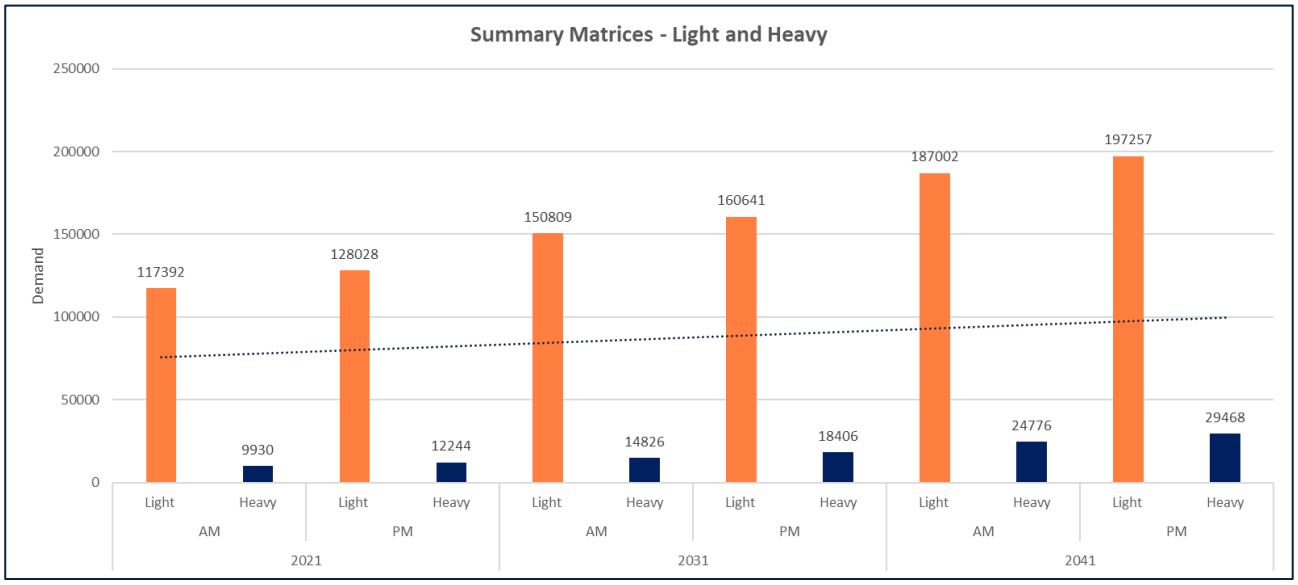

Fig.3 Summary Matrices – Light and Heavy vehicles for base and future years

The future years matrices were calculated using the estimated base year demand and the application of growth factors generated by pivoting on ROM future year matrices as shown in Figure.4 below.

Table 1: The 8 Cases

Base (B)	Synthetic Base (S_b)	Synthetic Future (S_f)	Predicted (P)		Cell Type
0	0	0	0		1
0	0	>0	S_f		2
0	>0	0	0		3
0	>0	>0	Normal growth	0	4
			Extreme growth	$S_f - X_1$	
>0	0	0	B		5
>0	0	>0	$B + S_f$		6
>0	>0	0	0		7
>0	>0	>0	Normal growth	$B.S_f / S_b$	8
			Extreme growth	$B.X_2 / S_b + (S_f - X_2)$	

Figure 4: Pivoting in Travel Demand Models (Source: Pivoting in Travel Demand Models – Australasian Transport Research Forum 2012)

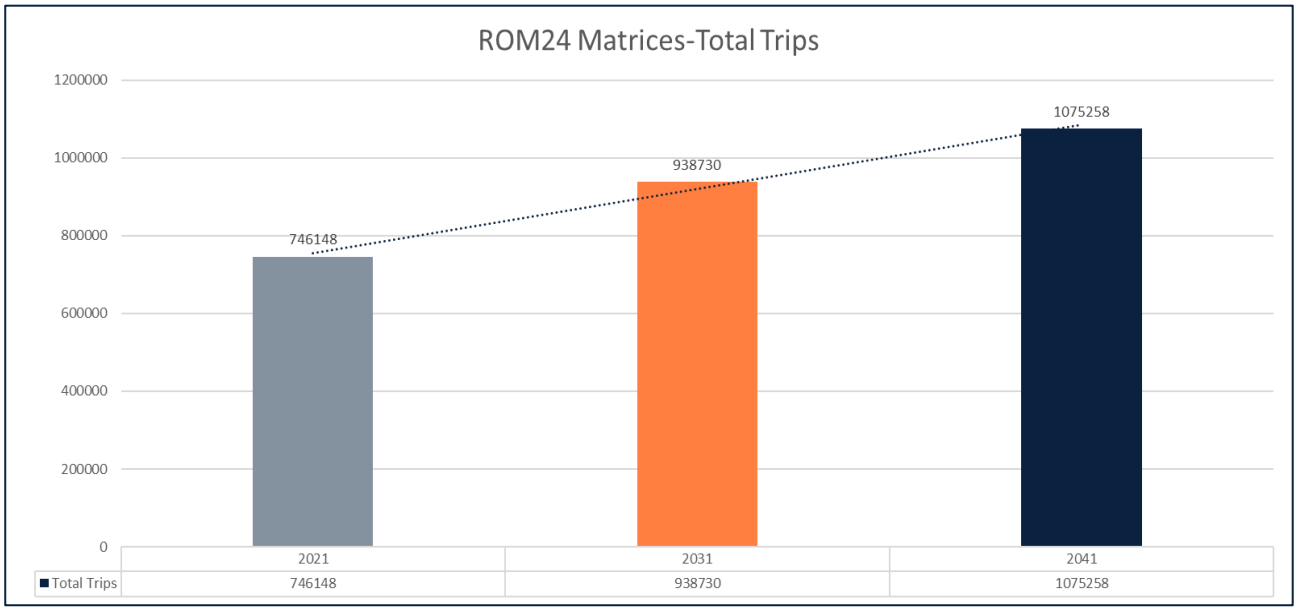

Figure 5: ROM24 Matrices – Total Trips for 2021, 2031, 2041

2.4 Time Period

The AM and PM peak periods were determined by analysing hourly volumes in the base year for all the 21 sites. A two-hour peak period was chosen for modelling purposes as shown below:

- AM peak (between 07:00-09:00)
- PM peak (between 15:00-17:00)

Throughout the report, modelling results for two-hour peaks are presented.

2.5 Mode Split

Matrices based on ROM24 have been developed to reflect the mode split and allow for the assessment of car/light and heavy vehicle network impacts. These rates were verified using traffic counts from the Main Roads Traffic Map and other information. If a more detailed traffic assessment is needed, the City may need to conduct some sensitivity testing on modal share factors to simulate greater non-car mode share; this is currently outside of the scope of this project.

2.6 Trip Assignment

To assign the initial demand, a static origin-destination matrix adjustment assignment was performed. This is identical to the trip assignment performed in the previous study and is consistent with industry standards, allowing stable convergence to a consistent outcome.

The model network and initial matrices were extracted from ROM24, then the main parameters were imported into Aimsun. This enabled the City of Cockburn Model to be consistent with the Main Roads strategic model.

3. CDTM Model Review

The updated CDTM is a macroscopic Aimsun model derived from ROM24 demand matrices and verified against count data also called as Real data set (RDS) . Based on the ROM24 matrices, mode share is divided into car/light and heavy vehicles and 'furnessed' to count data to accurately reflect the current situation. Furnessing is described as follows in the Main Roads Operational Modelling Guidelines:

“The Furness method of matrix updating is an iterative process to derive matrices that result in the best match to trip end count data. Trip end totals for each zone should be formed from external link survey data, internal link survey data and other filler zones with the values based on surveys, surrounding land use or the number of individual households. Within this, individual OD pairs should be fixed to known survey values or established during the calibration process.”

Public Transport has not been included for this modelling study.

Below is a process of the base model redevelopment and the future model development

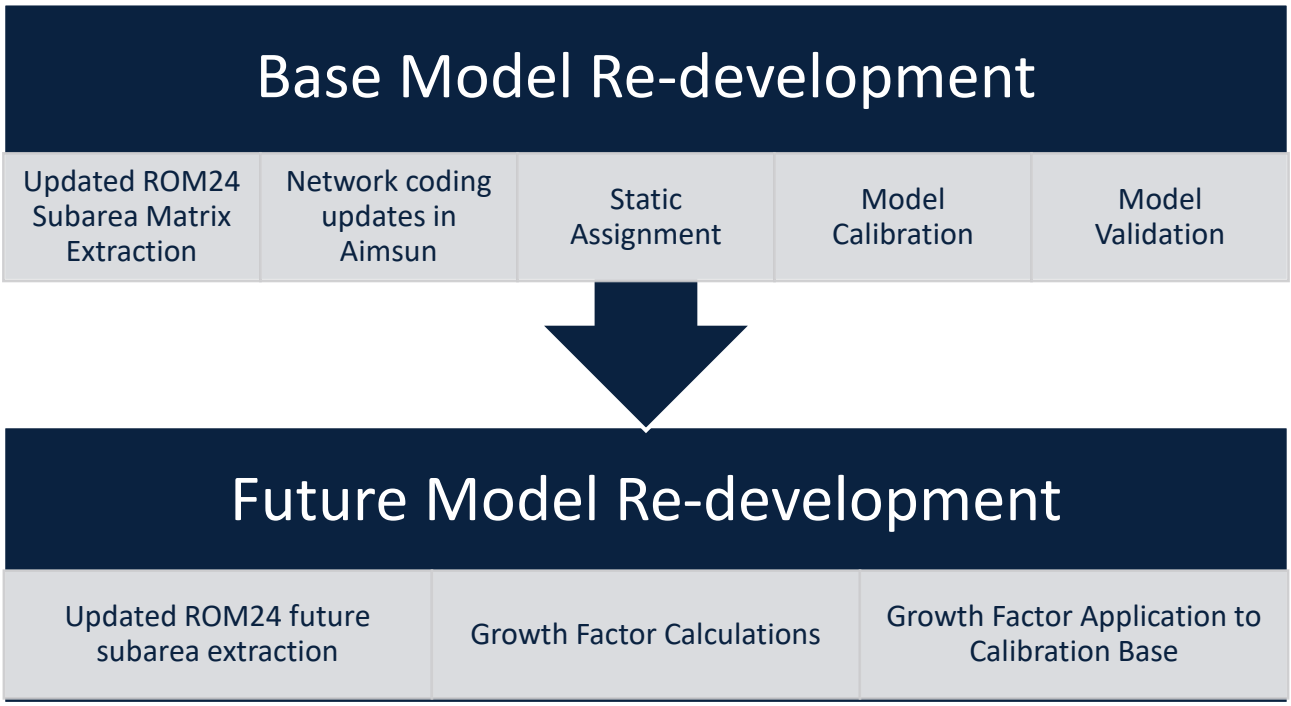

Fig.6 Base year and Future year model development process

3.1 Modelling Assumptions

3.1.1 Vehicle settings

Table 2: Car Parameters

Car Parameters	Mean	Deviation	Minimum	Maximum
Length	4m	0.5m	3.35m	5m
Width	2m	0m	2m	2m
Max Desired Speed	110km/h	10km/h	80km/h	120km/h
Speed Limit Acceptance	1.05	0.09	0.9	1.16
Clearence	1.85m	0.3m	0.5m	3.2m
Max Yield Time	15s	3s	5s	30s
Guided Acceptance Level	100%	0%	100%	100%

Table 3: Truck Parameters

Truck Parameters	Mean	Deviation	Minimum	Maximum
Length	8.65m	1.9m	6m	11.65m
Width	2.4m	0m	2.4m	2.4m
Max Desired Speed	100km/h	5.5km/h	80km/h	110km/h
Speed Limit Acceptance	1	0.1	0.9	1.10
Clearence	2m	0.5m	1m	3.3m
Max Yield Time	30s	5s	20s	36s
Guided Acceptance Level	100%	0%	100%	100%

3.2 Base Model – Calibration and Validation

To ensure that the model is suitable for purpose, a 2018 base year model was updated and calibrated with parameters using existing traffic count data located in Main Roads TrafficMap website to form the 2021 base year model.

Once the model was fully calibrated and validated, the model was used to predict future changes in traffic volumes caused by future road upgrades changes.

The 2021 CDTM model has been calibrated to the accepted standards at a daily level and satisfactorily for peak times based on the available traffic data in Traffic Maps and correlation with the ROM24 data to observed daily traffic counts within the screenlines which fall within the City of Cockburn's study area.

Table 4 contains the desired industry standards taken from the NSW Road and Maritime Services Traffic Modelling Guidelines version 1 issued in 2013 and the Main Roads OMeGA guidelines for desirable values of link calibration and validation measures.

Table 4: Link Calibration and Validation measures (Source: Traffic Modelling Guidelines" Version 1, NSW Road and Maritime Services)

Link Calibration Measure	Desirable Value
GEH < 5	85%

Link Validation Measure	Desirable Value
Coefficient of Determination (R^2)	>0.90

Additional measures, such as GEH, were included because they are needed for the Aimsun strategic modelling based on the Main Roads modelling guidelines.

3.2.1 Base model calibration – GEH statistic

The Roads and Maritime Services (RMS) guidelines stated that the model calibration criteria are built on a statistics formula known as GEH. RMS states:

"the formula is a form of Chi-square statistic that is designed to be tolerant of large errors in low flows. The reason for introducing such a statistic is the inability of either the absolute difference or the relative difference to cope over a wide range of flows."

The GEH equation is as follows:

$$GEH = \sqrt{\frac{(V_o - V_m)^2}{0.5\,(V_o + V_m)}}$$

Where:

V_o is the observed flow in vehicles per hour

V_m is the modelled flow in vehicles per hour

Figure 7: GEH Equation (Source: Roads and Maritime Services (RMS) guidelines)

According to RMS guidelines, the turn volume calibration is accomplished when "85% of individual turn volumes have a GEH 5.0".

3.2.2 Base model calibration – results

The calibration process was successful and meets the requirements. It has demonstrated a good model performance when compared to observed flows. As shown in Table 5, all time periods were calibrated above the necessary 85% margin for all types of vehicles.

Table 5: GEH Results for light vehicles and heavy vehicles.

GEH Results	GEH Range	Car (Light Vehicle)	Truck (Heavy Vehicles)
AM Peak Hour	=<5	86%	86%
	5 to 10	14%	12%
	>10	0%	2%
PM Peak Hour	=<5	88%	86%
	5 to 10	10%	14%
	>10	2%	0%

3.2.3 Validation Plots – Peak periods

The scatter plot validates well against average peak period observed traffic volumes with parameters that satisfy industry acceptable standards. Figure 8 and Figure illustrate scatter plots of traffic count locations versus 2021 CDTM volumes to demonstrate model validation for the AM and PM peak time periods, respectively.

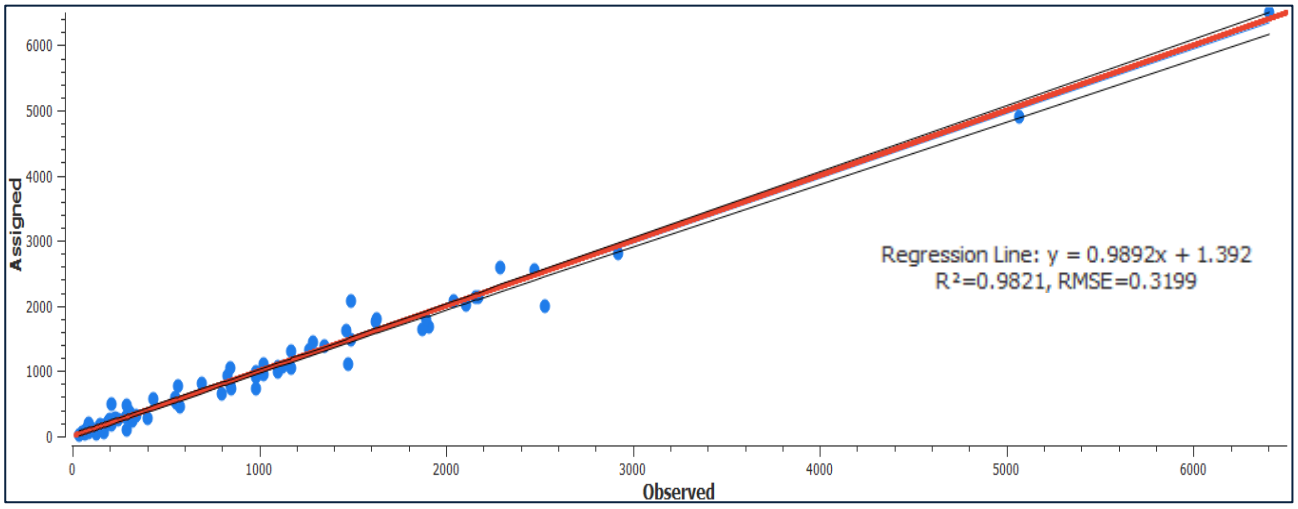

Figure 8: AM Peak period validation plot

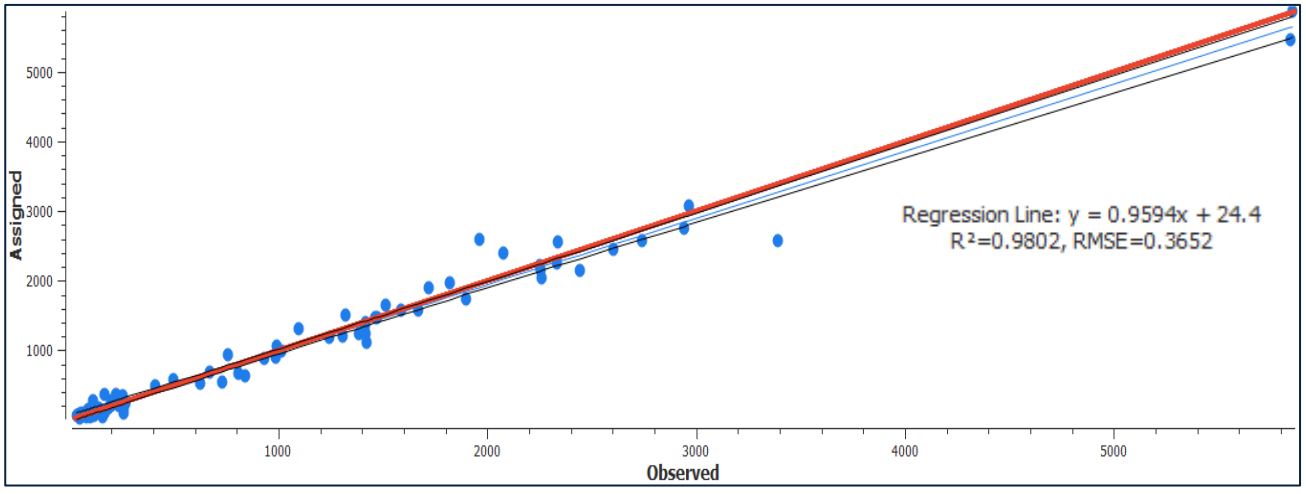

Figure 9: PM Peak period validation plot

The AM and PM peak periods validate efficiently to the guideline standards, indicating that the model is robust and suitable for purpose. As a result, both modelled peak periods are useful in understanding peak period traffic, operation, including directional bias, and traffic growth in congested conditions.

3.2.4 Model Convergence

The 2021 base model was run through 50 iterations to ensure proper convergence. The relative difference between the AM and PM peaks was 2.02% and 1.71%, respectively. When the relative gap is less than 5%, the model is deemed converged, and the results of both model calibrations indicate an acceptable model.

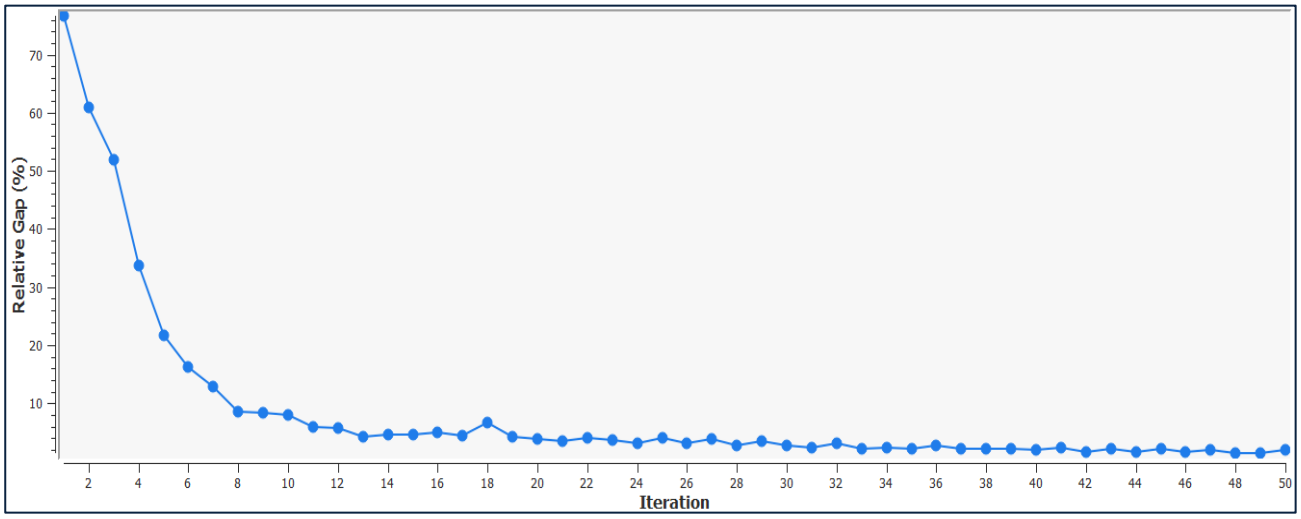

Fig.10 AM Peak Period convergence plot

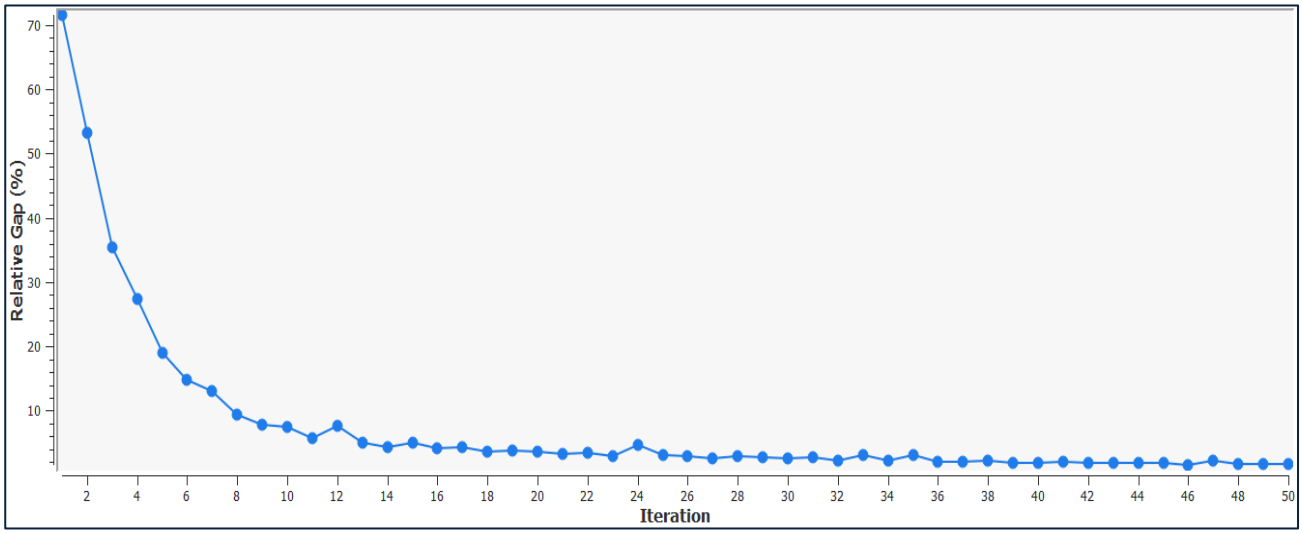

Fig.11 PM Peak Period convergence plot

3.2.5 Validation summary

From the review of the base year (2021) AM and PM peak hour traffic volumes for the 21 sites picked within the City of Cockburn boundary, the CDTM validates well and in accordance with the industry standards. While the GEH statistic was used to calibrate the model, a coefficient of determination (R^2) was used to validate the model and compare it with the industry acceptable standards. Both the coefficient of determination (R^2) values for the AM and PM peak are above 0.95. As it currently stands, the CDTM would appear to provide the best available tool to understand strategic transport flows on major roads within the City of Cockburn area. A summary of the level of validation for both AM and PM peak period is shown in the below table 6 and figures 8 and 9.

Link Validation Measure	Desirable Value	AM Peak	PM Peak
Coefficient of Determination (R^2)	>0.90	0.98	0.98

Table 6: Coefficient of Determination for AM and PM Peak