Ministry of Communication and Works, Cyprus

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Nicosia Public Transport
Enhancement Programme

MAKARIOU/KALLIPOLEOS
Traffic Study

Republic of Cyprus

A.L.A Planning Partnership

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TRANSPORT
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Makariou/Kallipoleos Traffic Study

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1 Introduction

1.1 The brief

1.1.1 The Integrated Mobility Master Plan for Nicosia (IMMP) includes a range of proposals for the road network, public transport, and cycling and pedestrian networks, as well as proposals for a parking policy, the establishment of park and ride facilities and street regeneration projects. The road projects include proposals to convert some of the major radial routes to one way pairs, the objectives being to create opportunities to reallocate road space to buses, cyclists and pedestrians; to reduce traffic conflicts and hence improve traffic flow and road safety; and to reduce rat running in adjacent areas. One of the pairs of radial routes proposed to become one way is Makariou Avenue (Northbound to the city centre) and Kallipoleos Avenue (outbound).

1.1.2 Under their contract to provide technical support for the implementation of the IMMP to the Project Management Unit (PMU) of the Nicosia Public Transport Enhancement Programme, Colin Buchanan and ALA Planning (CB/ALA) were requested to undertake a detailed study of the proposals for Makariou/Kallipoleos. This study was to develop the proposals in more detail and evaluate their impacts on the operation of the road network, road safety, the environment in residential areas, and on accessibility for residents, businesses and visitors.

1.1.3 Three traffic management options based on the principles of the IMMP were to be assessed. The study was to use the enhanced Nicosia-wide VISUM transport model for assessing the reassignment of traffic at the macro/meso level. A VISSIM microsimulation model was to be developed to evaluate the operation of the road network within the study area. The study area was defined in the brief as the area enclosed Limassol Avenue, Makariou Avenue. Leonidou Street, Omirou Avenue, Stasinou Avenue, Evgenias and Antoniou Theodotou Street and Kallipoleos Avenue.

1.1.4 While the initial study brief was concerned with options that could be implemented over the IMMP period up to 2020, CB/ALA was subsequently also asked to assess options that could be implemented in the shorter term (by 2012).

1.2 Approach to the study

1.2.1 Under a separate commission CB/ALA had enhanced the Nicosia-wide VISUM model for 2010 developed by the IMMP consultants. The enhancements implemented included: a more detailed zoning system, a more detailed representation of the road network including enhanced representation and modelling of junctions, and the development of more disaggregate trip end estimation. The IMMP model was for the AM peak period only. For this, and subsequent studies, CB/ALA developed a PM. peak model.

1.2.2 The VISUM enhancements and the recalibration and validation of the enhanced models are reported separately.

1.2.3 In this study options for Makariou/Kallipoleos based on the IMMP proposals have been tested at the 2020 ‘design year’ of the IMMP. The performance of options was evaluated against the 2020 Reference Case which represents the situation that is forecast to prevail in 2020 based on the extrapolation of current policies and plans. Thus the Reference Case includes land use and transport schemes that are either

committed or likely to be implemented by 2020 and reflects the impacts on transport demand of forecast population and employment growth.

1.2.4 VISSIM study area models for 2010 and 2020 were developed by cordoning the corresponding Nicosia-wide VISUM model. VISUM was used to model the traffic reassignment and area wide impacts arising from network changes, while VISSIM was used to evaluate the impacts on the operation of the road network within the study area and to 'fine tune' the options in terms of their traffic management detail, to maximize their benefits and mitigate adverse impacts.

1.2.5 The first option tested (Option 1) was based on the IMMP proposals, refined as considered appropriate in discussion with the PMU, including to reflect feedback received during consultations on the IMMP. Options 2 and 3 were then developed by modifying Option 1 to address issues highlighted by the modelling. In all cases options evolved in terms of their detail through an iterative process of forecasting and modification to achieve the optimum scheme.

1.2.6 To allow a comprehensive and transparent comparative assessment of options an evaluation framework was defined comprising quantitative and qualitative measures of performance against objectives relating to the provision for public transport, pedestrians and cyclists, traffic operations, road safety, accessibility and the environment. This robust comparative assessment allowed a clear recommendation to be made concerning the preferred option.

1.2.7 As noted above, following discussion of the results of these assessments with the PMU and with the Public Works Department CB/ALA was asked also to assess options that could be implemented over a shorter time scale, and that would represent a phased approach to implementing the IMMP proposals. These options were assessed based on existing (2010) traffic demand.

1.3 Structure of this report

1.3.1 The development of the base year (2010) VISSIM microsimulation model for the study area is described in Section 2. Section 3 discusses the 2020 Reference Case model and the forecast changes in traffic demand and network conditions between 2010 and the 2020 Reference Case.

1.3.2 The three traffic management options identified for Makariou/Kallipoleos are described in Section 4 and their impacts discussed. Section 5 describes the measures adopted to evaluate the performance of each option against the objectives agreed for the scheme, and a comparative assessment of the options based on these measures is presented in Section 6.

1.3.3 Short term measures for Makariou are discussed in Section 7 and the conclusions from the study are summarised in Section 8.

2 2010 Base Year Models

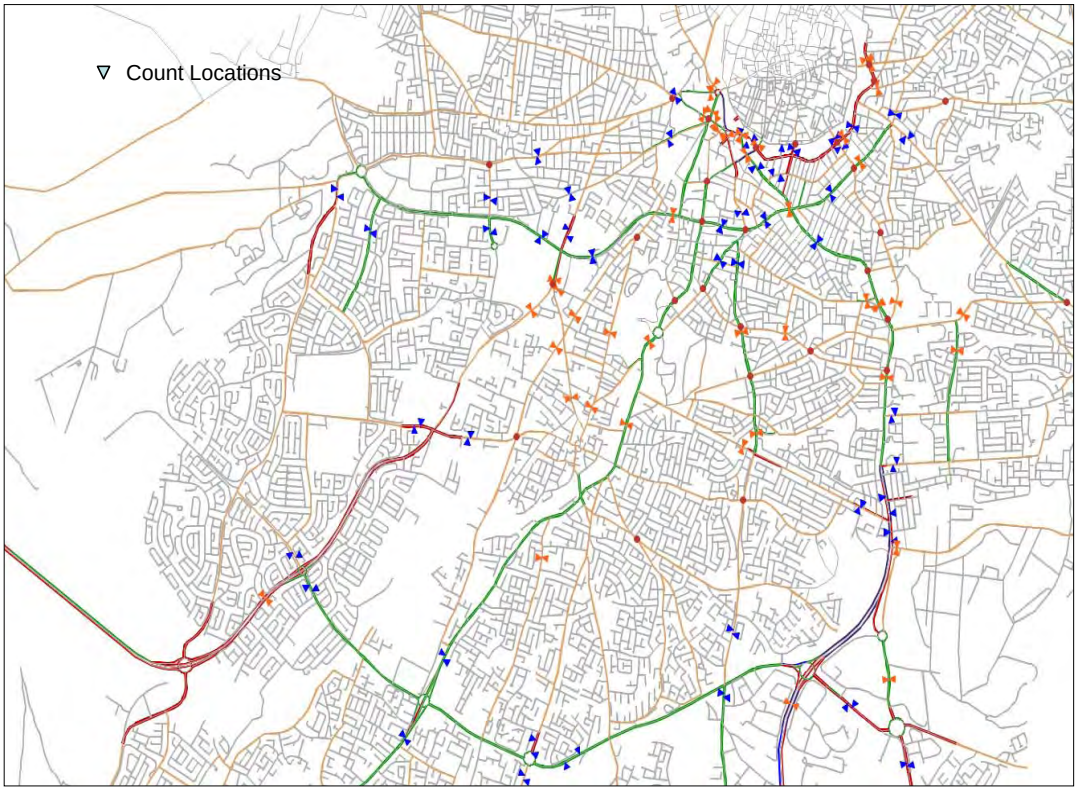
2.1 VISUM model for Nicosia

2.1.1 A VISUM transport model of Nicosia was developed for the IMMP by the Hellenic Institute of Transport (HIT), in partnership with Denco Consultants. This was a traditional transport model incorporating the basic principles of trip generation, trip distribution and assignment. In enhancing the capabilities of the model CB/ALA expanded the detail in the highway model and introduced additional demand forecasting mechanisms.

2.1.2 Figure 2.1 below shows the enhanced model network which now includes all major roads and a detailed representation of internal roads. The enhanced demand model was based on the disaggregation of the IMMP model zones into finer zones, allowing trip demand to be estimated from a more detailed spatial representation of the distribution of employment, population and major trip generators. Land use mapping and aerial photography was used to develop employment estimates for the finer zones, while zonal population estimates were derived from block level population figures. GIS data was used to extract the land-use information including the location of major activity centres such as shopping centres, colleges, and hospitals.

2.1.3 Further details of the model development process and results of model calibration can be found in the VISUM Model Enhancements and Validation Note.

Figure 2.1: Enhanced network for Nicosia VISUM model



2.2 Local area simulation model

2.2.1 The Nicosia-wide VISUM model was used to develop more detailed VISSIM microsimulation models for the Makariou-Kallipoleos study area.

Study area

2.2.2 The study area for the microsimulation models included Makariou and Kallipoleos between Stasinou and Aglantzias and all the connecting and intermediate roads. All roads were modelled with appropriate link speed and capacity flows, calibrated against observed levels of queuing.

2.2.3 Signalised junctions were modelled based on data made available by the PWD. Although some of the junctions included in the network may be operate on the SCOOT system all were modelled based on fixed time operation to simplify the modelling process and to improve the run-time for such a large network.

2.2.4 Kennedy Avenue was included in the local area model to test the impact of strategic shifts in traffic with introduction of the one-way system. The Nikis/Digeni Akrita junction was also included to monitor the impact of traffic on that junction. However, it should be noted that no junction improvements or highway changes were considered for these junctions in the area west of Makariou as they will be studied in detail in a further phase of CB/ALA's work.

2.2.5 Figure 2.2 shows the VISSIM network developed by extracting network and demand related information from the validated VISUM model. The priority rules, traffic signal timings, pedestrian movements and bus services were also coded in VISSIM.

Figure 2.2: Base year VISSIM network for Makariou-Kallipoleos study area

Time periods

2.2.6 Models were created for two time periods:

- The AM peak period between 7am and 8am
- The PM peak period between 5pm and 6pm

2.3 Local Area model calibration

2.3.1 The local area VISSIM model was calibrated using a combination of existing 2008 counts and some additional traffic counts conducted in 2010. Figure 2.3 shows location of traffic counts used for model calibration.

2.3.2 GEH value, which is a statistical measure that compares modelled and observed data, and is calculated using the following formula:

$$GEH = \sqrt{(O - E)^2 / (0.5\,(O + E))}$$

Where O = Observed Flow
E = Modelled Flow

2.3.3 The GEH is a measure that includes both the absolute and the relative difference between the observed and modelled flow. According to the UK Design Manual for Roads and Bridges Volume 12 Section 2, Part 1, the model is considered valid if, the GEH (goodness of fit) statistic is less than 5 in 85% of cases.

2.3.4 Although the counts were from different years they were not 'harmonised' to a single year given network changes in the intervening period. To reflect this, calibration criteria were adopted that allowed for greater variance of modelled flow from observed flow. Thus, the model calibration results presented in Tables 2.1 and 2.2 show whether links 'pass' the normal calibration criterion of a GEH statistic of less than 5.0 and the 'relaxed' criterion of GEH less than 10.0.

2.3.5 The results show that the model calibrates well against the broader calibration criteria. More than 85% of the counts are within the broader calibration criteria for both peak periods.

Figure 2.3: Location of counts available for AM peak

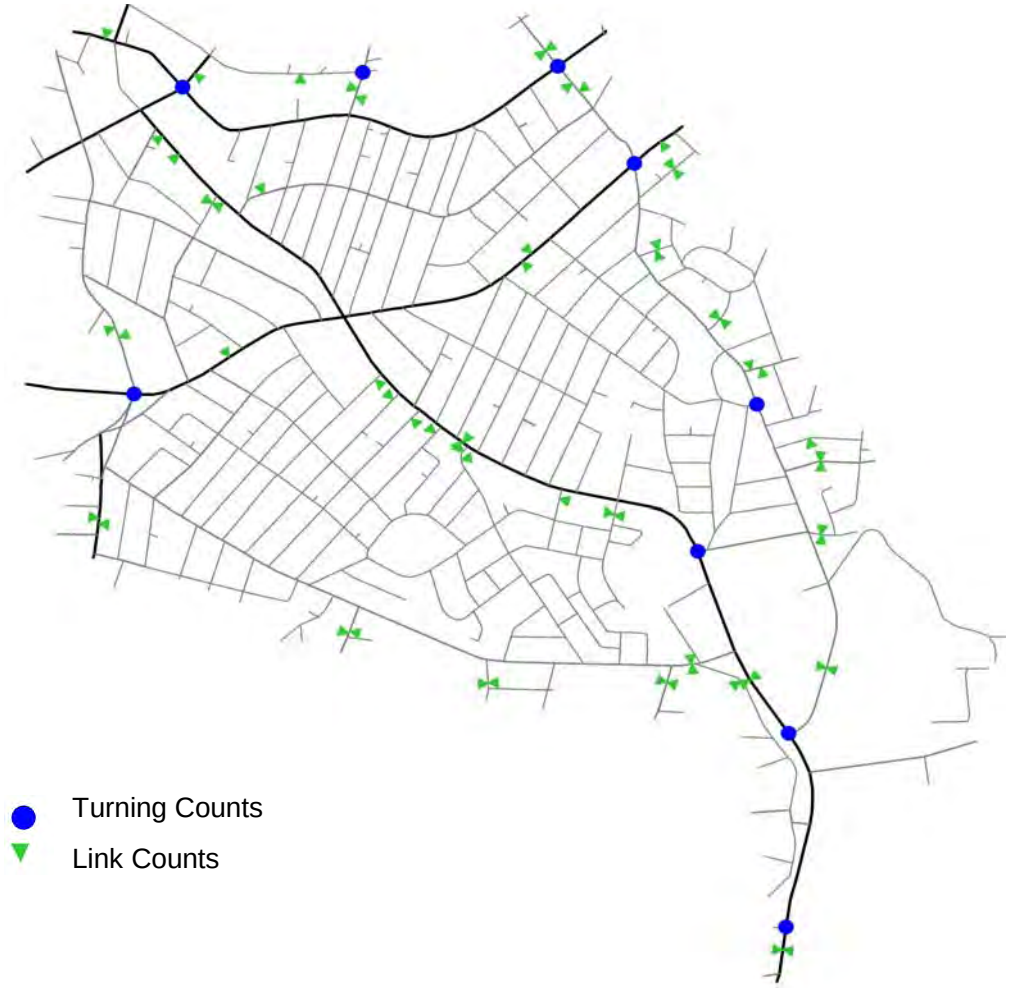


Figure 2.4: Location of counts available for PM peak

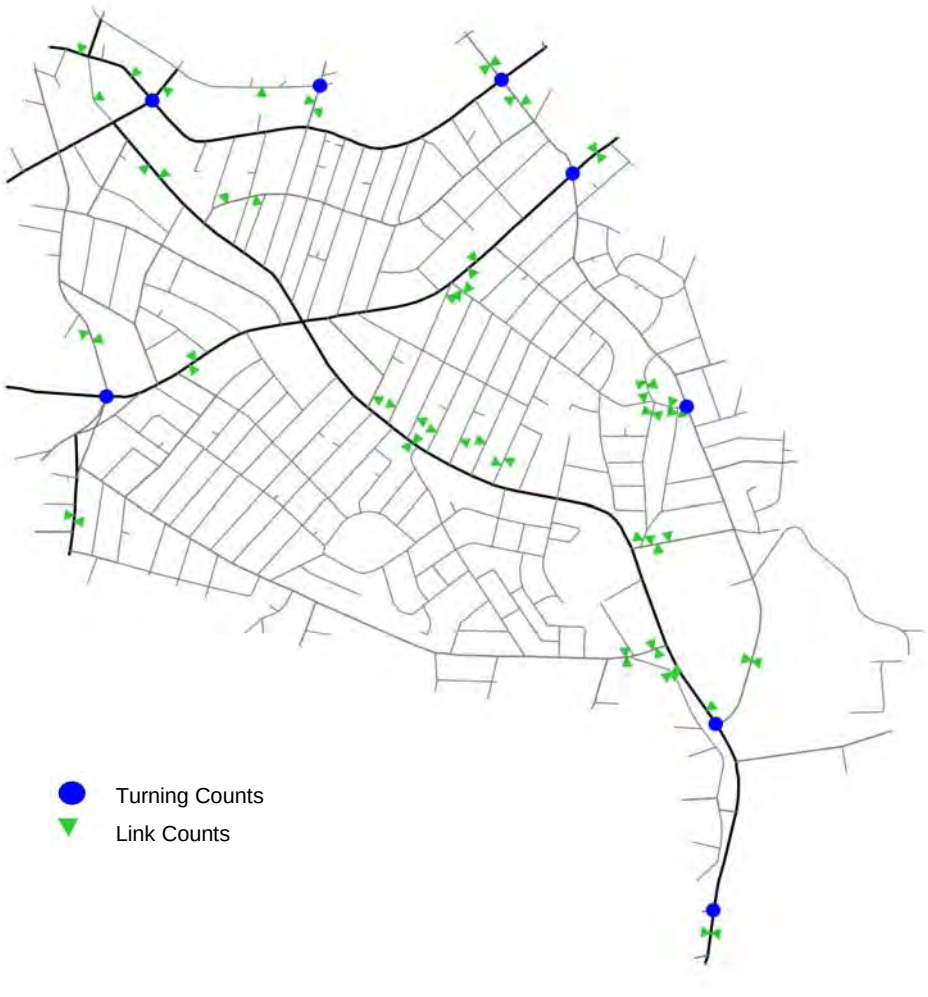


Table 2.1: Traffic flow and GEH comparison – AM peak

Road name	*Modelled flow*	*Observed flow*	*GEH*	GEH <5	GEH <10
OMIROU AVENUE(BEFORE SOLOMOU SQUARE) EASTBOUND	2599	2612	0.3	✓	✓
OMIROU AVENUE(AFTER SOLOMOU SQUARE) EASTBOUND	1279	662	19.8	–	–
LEONIDOU AVENUE SOUTHBOUND	1182	2752	35.4	–	–
K. PALEOLOGOU AVENUE (ONE WAY WESTBOUND)	610	696	3.4	✓	✓
GANNINGOS BRIDGE NORTHBOUND TO RB(DWROU LOIZOU SQUARE)	441	462	1.0	✓	✓
GANNINGOS BRIDGE SOUTHBOUND(DWROU LOIZOU SQUARE)	394	463	3.3	✓	✓
STASANDROU EASTBOUND	224	204	1.3	✓	✓
STASANDROU WESTBOUND	283	339	3.2	✓	✓
MAKARIOU 3 CENTRAL EASTBOUND	899	653	8.8	–	✓
MAKARIOU 3 CENTRAL WESTBOUND	665	680	0.6	✓	✓
DHIGENI AKRITA AVENUE EASTBOUND	886	1007	3.9	✓	✓
DHIGENI AKRITA AVENUE WESTBOUND	1509	1434	2.0	✓	✓
EVGENIAS THEODOTOU WESTBOUND	560	608	2.0	✓	✓
EVGENIAS THEODOTOU EASTBOUND	445	377	3.4	✓	✓
MAKARIOU 3 HILTON SOUTHBOUND	752	1079	10.8	–	–
MAKARIOU 3 HILTON NORTHBOUND	904	1145	7.5	–	✓
SPYROU KYPRIANOU AVENUE EAC - WESTBOUND	1626	848	22.1	–	–
SPYROU KYPRIANOU AVENUE EAC - EASTBOUND	1170	1125	1.3		
THEMISTOKLI DERVI AVENUE - SOUTHBOUND	592	558	1.4		
THEMISTOKLI DERVI AVENUE - NORTHBOUND	836	1222	12.0	–	–
NIKIS AVENUE SOUTHBOUND	1231	738	15.7	–	–
NIKIS AVENUE NORTHBOUND	540	768	8.9	–	✓
MAKARIOU 2 - Eastbound	276	177	6.5	✓	✓
MAKARIOU 2 - Westbound	656	502	6.4	✓	✓
DIGENI AKRITA AVE. (PELICAN) NORTHBOUND	914	1533	17.7	–	–
DIGENI AKRITA AVE. (PELICAN) SOUTHBOUND	1116	1055	1.9	✓	✓
KALLIPOLEOS AVE. SOUTHBOUND	688	677	0.4	✓	✓
KALLIPOLEOS AVE. NORTHBOUND	510	538	1.2	✓	✓
MAKARIOU AVE. (NEAR APOEL) SOUTHBOUND	802	1111	10.0	–	–
MAKARIOU AVE. (NEAR APOEL) NORTHBOUND	1281	1568	7.6	–	✓
AG. ANTONIOU STR. - NICOSIA SOUTHBOUND	0	41	9.1	–	✓
AG. ANTONIOU STR. - NICOSIA NORTHBOUND	209	254	3.0	✓	✓
KENNEDY AVE. WESTBOUND 2010	942	677	9.3	–	✓
KENNEDY AVE. EASTBOUND 2010	751	701	1.8	✓	✓

Road name	Modelled flow	Observed flow	GEH	GEH <5	GEH <10
ELEFTHERIA SQUARE - NICOSIA WESTBOUND	609	405	9.1	–	✓
LEMESOU AVE. (NEAR ARMENIAS) SOUTHBOUND	1817	1712	2.5	✓	✓
LEMESOU AVE. (NEAR ARMENIAS) NORTHBOUND	1673	2150	10.9	–	–

Table 2.2: Traffic flow and GEH comparison – PM peak

Road Name	Modelled flow	Observed flow	GEH	GEH <5	GEH <10
OMIROU AVENUE(BEFORE SOLOMOU SQUARE) EASTBOUND	1947	2099	3.4	✓	✓
OMIROU AVENUE(AFTER SOLOMOU SQUARE) EASTBOUND	1448	1634	4.7	✓	✓
LEONIDOU AVENUE SOUTHBOUND	920	1840	24.8	-	-
K. PALEOLOGOU AVENUE (ONE WAY WESTBOUND)	516	777	10.3	-	-
GANNINGOS BRIDGE NORTHBOUND TO RB(DWROU LOIZOU SQUARE)	556	549	0.3	✓	✓
GANNINGOS BRIDGE SOUTHBOUND(DWROU LOIZOU SQUARE)	810	939	4.4	✓	✓
STASANDROU EASTBOUND	494	547	2.3	✓	✓
STASANDROU WESTBOUND	442	476	1.6	✓	✓
MAKARIOU 3 CENTRAL EASTBOUND	1182	1301	3.4	✓	✓
MAKARIOU 3 CENTRAL WESTBOUND	1126	1338	6.0	-	✓
DHIGENI AKRITA AVENUE EASTBOUND	850	784	2.3	✓	✓
DHIGENI AKRITA AVENUE WESTBOUND	1276	1165	3.2	✓	✓
EVGENIAS THEODOTOU WESTBOUND	168	128	3.3	✓	✓
EVGENIAS THEODOTOU EASTBOUND	803	465	13.4	-	-
MAKARIOU 3 HILTON SOUTHBOUND	1197	1544	9.4	-	✓
MAKARIOU 3 HILTON NORTHBOUND	1134	1163	0.9	✓	✓
SPYROU KYPRIANOU AVENUE EAC - WESTBOUND	1603	1195	10.9	-	-
SPYROU KYPRIANOU AVENUE EAC - EASTBOUND	1130	1031	3.0	✓	✓
THEMISTOKLI DERVI AVENUE - SOUTHBOUND	681	765	3.1	✓	✓
THEMISTOKLI DERVI AVENUE - NORTHBOUND	1305	1332	0.8	✓	✓
NIKIS AVENUE SOUTHBOUND	986	1471	13.8	-	-
NIKIS AVENUE NORTHBOUND	871	591	10.4	-	-
MAKARIOU 2 - Eastbound	231	225	0.4	✓	✓
MAKARIOU 2 - Westbound	318	410	4.8	✓	✓

3 2020 Reference Case

3.1 Introduction

3.1.1 Changes in traffic demand on the road network up to 2020 will derive from a number of sources. These include changes in the road network itself, 'background' growth in trip making primarily driven by population changes, and changes in trip making resulting from land use changes.

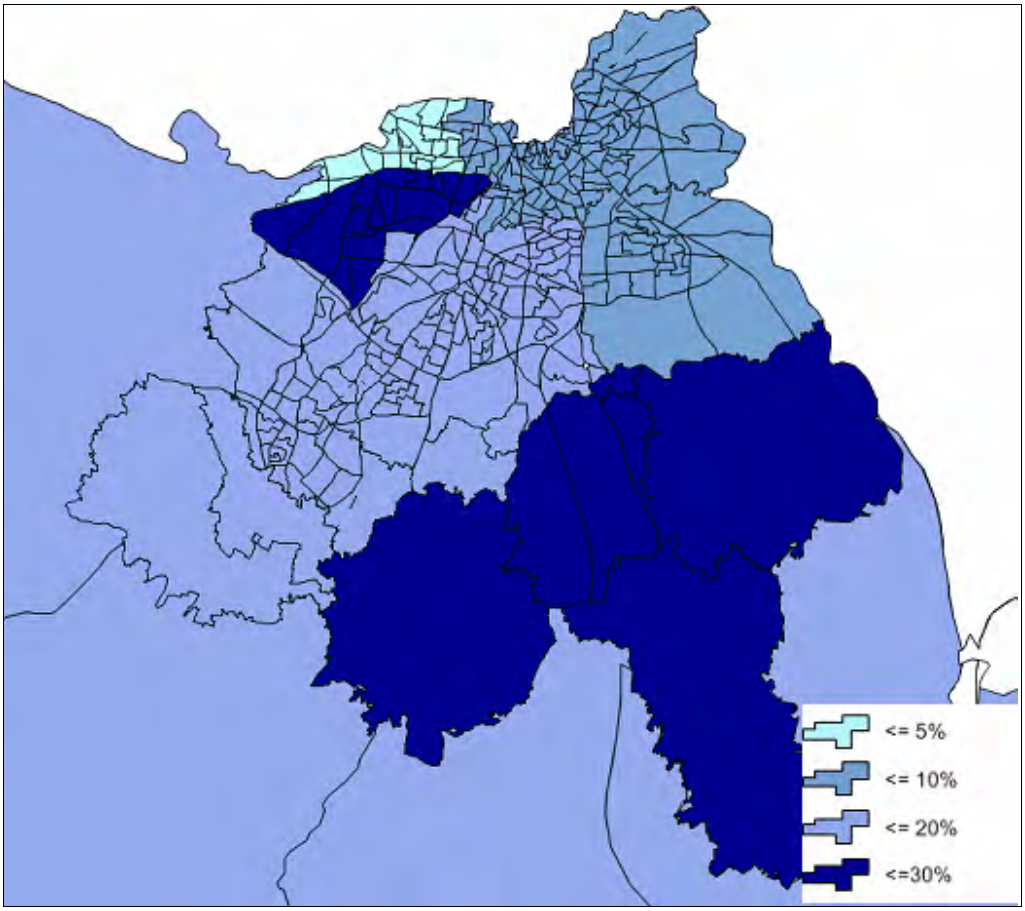
3.1.2 Background growth, committed highway schemes and land use changes are discussed further in 3.2 to 3.4 below. In 3.5 the process of developing the 2020 demand matrices is outlined, while in 3.6 the key forecasts for the 2020 Reference Case and changes from 2010 are summarised.

3.2 Background growth

3.2.1 The base year trip matrices were first updated using background growth factors. These factors were based on the population projections reported by Statistical Service of the Republic of Cyprus.

3.2.2 Figure 3.1 shows the population growth of the study area. On average, the population growth was about 15% for Nicosia Municipality. More detailed information can be found in Table A.1 of Appendix 1.

Figure 3.1: Population growth in the study area 2010-2020



3.3 Committed highway schemes

3.3.1 There are a number of road schemes planned for Nicosia. These schemes are at various stages of the planning/design process. In order to best represent the future network of Nicosia, information was gathered on schemes that are likely to be in place by 2020.

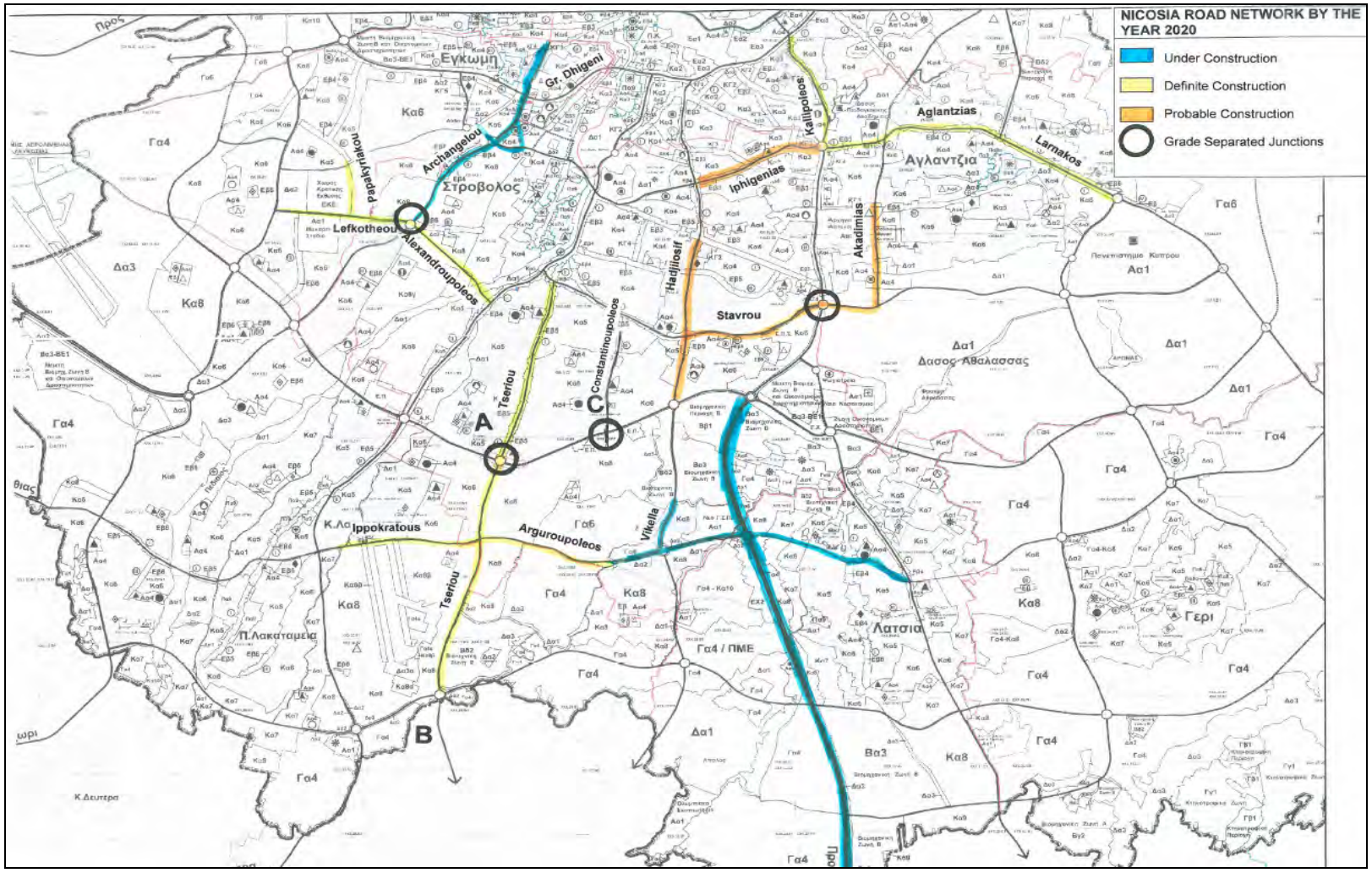
3.3.2 Discussions took place with the Department of Town Planning and the Public Works Department, where a number of road schemes were identified for inclusion in the 2020 road network. These schemes are summarised in Table 3.1 and Figure 3.2, and include road schemes that are either currently under construction, committed for construction prior to 2020, or probable candidates for construction by 2020.

3.3.3 All these schemes were coded into the 2020 Reference Case network, apart from the Aluminium Tower junction (no. 11) and the Iphigenias upgrading (no. 9). The reason for not including these schemes were that the Iphigenias corridor will be the subject of a further traffic study by CB/ALA under the technical support contract,, while there is still some uncertainty as to the precise way forward for the Aluminium Tower junction, with at-grade solutions not being ruled out. As a consequence it was decided not to risk prejudicing the recommendations of this study, by basing them on the aforementioned schemes being in place.

Table 3.1: Committed road schemes

Ref. no.	Scheme name	Status	Scheme details/comments
1	Argyroupoleos-Ippokratous-Tseriou Upgrading	Definite	Will be implemented by 2015, and comprise a 4-lane road plus cycle route for Argyroupoleos and Ippokratous, and a dual 2-lane road for Tseriou (section A –B on plan)
2	Sp. Kyprianou/Tseriou Junction	Definite	Grade-separation scheme, with an underpass on Sp. Kyprianou. (Point A on the plan).
3	Constantinoupoleos/Sp. Kyprianou		Grade-separation scheme with a flyover on Constantinoupoleos. (Point C on plan).
4	Stavrou Link & Akademias Upgrading	Probable	Akademias will be upgraded to 2 or 3 lanes (however, there are issues with its route through the forest). Parts of Stavrou exist at present as a two lane road with a left in entrance form the Limassol motorway. However, if the entire scheme is constructed by 2020, there will be a grade separated junction with the motorway.
5	Upgrading of Hadjiosif	Probable	This will be to a dual-2 lane standard.
6	Alexandroupoleos Link & upgrading of Lefkotheou & Papakyriakou	Definite	This scheme will be constructed to serve the new government complex, and will be a dual-2 lane standard. The junction with Archangelou will be grade separated.
7	Tseriou Upgrading	Definite	The section north of Sp. Kyprianou will be upgraded to three lanes.
8	Aglantzias –Larnakos Upgrading	Definite	The route will be upgraded to a dual 2-lane standard, up to the junction of the University.
9	Iphigenias Upgrading	Probable	The route will be improved to 3 lanes, with some new road sections.
10	Kallipoleos Upgrading	Definite	Precise details of this scheme will depend on this study.
11	Aluminum Tower Junction Improvement	Probable	Grade-separation scheme, with fly-over or underpass along Makariou or Kallipoleos.
12	Limassol Highway Widening	Under construction	This scheme comprises widening of the highway to dual 3-lane standard, new grade-separation junction at ΓΣΠ, plus new roads links to Latsia & Lakatameia.
13	Archangelou Upgrading	Under construction	Widening of route to a dual 2-lane standard, plus the inclusion of a bus lane.

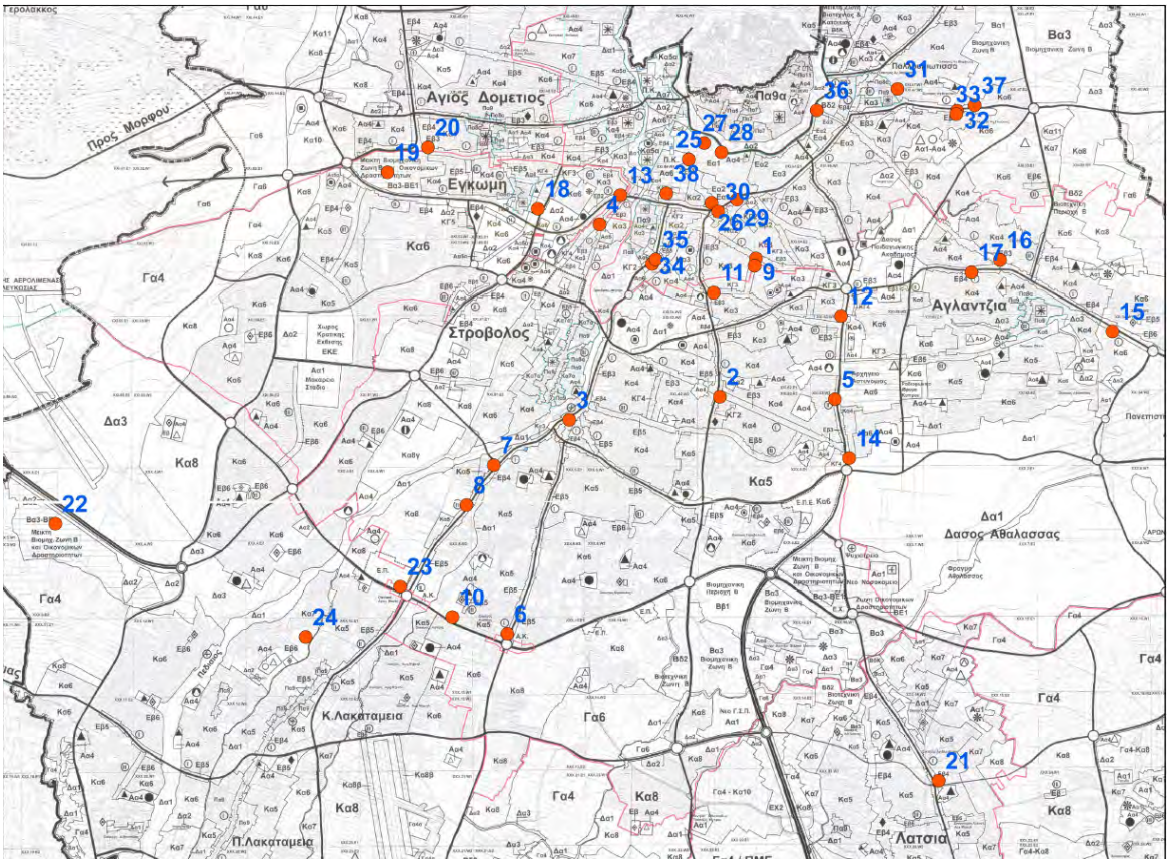
Figure 3.2: Reference Case highway schemes



3.4 Land use developments and trip generation

3.4.1 In addition to the background growth, there is traffic generated by new developments to be taken account of. Information on 'committed' development was obtained from discussions with the Department of Town Planning and the Municipality of Nicosia. New developments included the proposed relocation of Government offices in Engomi and Keryneias.

Figure 3.3: Land use developments up to 2020



3.4.2 Information was acquired for major developments located within the Greater Nicosia Urban area which had been given planning consent in the last five years, and were not yet implemented. Major developments were classified generally as schemes greater than 1000m^2. A total of 40 developments were identified. The locations of these developments are shown in Figure 3.2.

3.4.3 For each development, trip generation estimates for the AM and PM peak periods were collated for input to the respective matrices. In some cases, generated traffic estimates were acquired from the Traffic Impact Assessment (TIA) reports, whilst in other cases, where TIAs were not available, estimates were made by CB/ALA. These estimates were based on local approved trip rates used in previous TIAs. However, assumptions were made on the likely public transport use (assumed to be 10%), and the extent of diverted traffic (which was also assumed to be 10%).

3.4.4 The results of the above exercise are contained in Appendix 2. The appendix includes the details of each development and the estimates of traffic generated in

each time period. A total of 3,366 generated vehicle movements were estimated for the AM period, and 6,459 for the PM period.

3.4.5 As noted above, the relocation of Government offices to new locations in the area by the State Fair and in Aglantzias (reference numbers 39 and 40 in Appendix 2), have to be taken into account. The table in the Appendix shows the traffic generated by these offices in the new location. However, these are relocated offices, which means that the sites of the original office buildings will have a reduction in traffic.

3.4.6 Therefore, estimates have been made for each Government department of the traffic reduction that will take place in the zone where the offices are currently located. This exercise is shown in Appendix 2, and results in overall reductions of 2351 arrivals and 98 departures trip in the AM peak period only. (The offices are not in operation during the PM peak period).

3.4.7 The overall increase in vehicle traffic as a result of the committed developments and the relocation of the government office is therefore 917 in the AM and 6459 in the PM. A more detailed breakdown is presented in the Table 3.2.

Table 3.2: Committed development traffic generation estimates

Direction	07.00-08.00			17.00-18.00
	Total generated traffic	Relocated traffic	New traffic	New traffic
Arrivals	2863	2351	512	2646
Departures	503	98	405	3813
Total	3366	2449	917	6459

3.5 Demand growth 2010 to 2020

3.5.1 Figure 3.4 outlines the process of developing the 2020 demand matrices. (The relocation of Government offices only affects the AM trip matrix.)

3.5.2 The 2020 trip matrices were split into car and public transport trips assuming that 10% of demand in zones with access to public transport may shift to public transport. Table 3.3 shows the final 2020 matrix totals and compares them with the figures for 2010.

Figure 3.4: 2020 trip matrix development

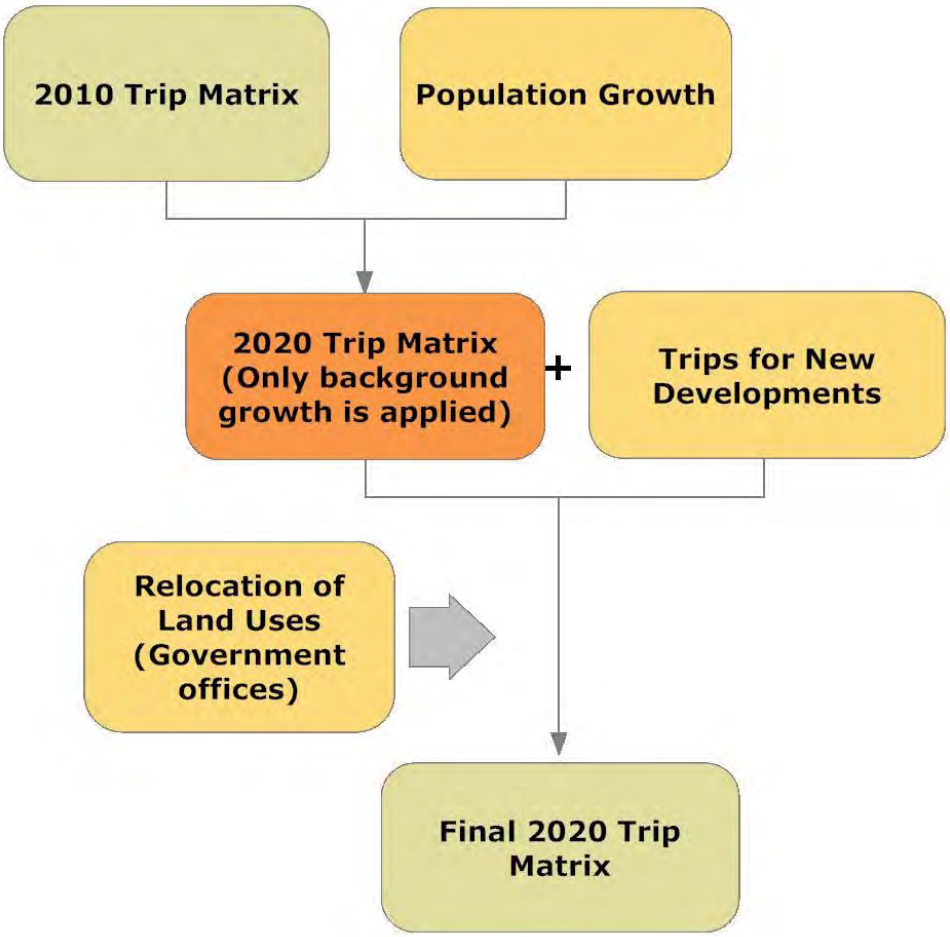


Table 3.3: Summary of 2010 and 2020 trip matrices

	AM trips	% change	PM trips	% change
2010 car trips	58,160		55,785	
Background growth	15%		15%	
Additional development traffic	1,359		6,459	
Reduction due to PT services	8%		8%	
Final car trips	62,653	8%	64,122	15%
2010 base year Goods trips	1,934		1,934	
2020 goods vehicle trips	2,200	14%	2,200	14%

3.6 2020 Reference Case traffic flow forecasts

3.6.1 The following figures show the Reference Case forecasts for flows and queues on the Nicosia-wide network, and compares them with the base (2010) situation:

- Figure 3.5 – 2020 Reference Case AM peak traffic flows
- Figure 3.6 – 2020 Reference Case AM peak junction queue length and delays
- Figure 3.7 – 2020 Reference Case PM peak traffic flows
- Figure 3.8 – 2020 Reference Case PM peak junction queue length and delays
- Figure 3.9 – Changes in AM peak flows between base and 2020 Reference Case
- Figure 3.10 – Changes in PM peak flows between base and 2020 Reference Case

3.6.2 In the 2020 AM peak hour flows on Makariou are forecast to be around 1,520 vehicles per hour (vph) Northbound and 1,030 vph Southbound at its southern end (north of Kallipoleos), falling to around 1,220 vph and 1,050 vph Northbound and Southbound north of Digeni Akrita. These flows show only marginal changes from 2010.

3.6.3 In the PM peak hour the forecast flows on Makariou in 2020 are around 1,320 vehicles per hour (vph) Northbound and 1,280 vph Southbound at its southern end and 1,710 vph and 1,210 vph Northbound and Southbound north of Digeni Akrita. These flows at the southern end of the corridor again show little growth from 2010. However, more growth is evident north of Digeni Akrita. Here Southbound flows from Evagorou are forecast to increase to around 2,860 vph.

3.6.4 More traffic growth is forecast for Kallipoleos. In this corridor in the AM peak forecast flows are between 670 and 810 vph Northbound and between 800 and 1,090 vph outbound, representing growth of between 150 and 200 vph from 2010.

3.6.5 In the PM peak forecast flows are between 850 and 1,000 vph Northbound and between 880 and 1,470 vph outbound, growth from 2010 being in the order of 300 vph.

3.6.6 Away from these corridors the influence of new road infrastructure and land use developments are clearly evident in the growth in traffic flows up to 2020. Significant growth is also forecast on Stasinou in the PM peak.

Queues and delays

3.6.7 In the AM peak in 2020 the most significant queues and delays on Makariou emanate from the junction with Evagorou. On Kallipoleos a substantial queue is shown southbound to the Aluminium Tower junction. In both cases average modelled delays in VISUM are around 30 seconds.

3.6.8 A substantial queue is also forecast for Digeni Akrita westbound from Makariou with a modelled average delay of around one minute at that junction. Queueing is evident on Antoniou Theodotou southbound to Kallipoleos, on Stasinou westbound and over much of the main road network to the west of Makariou.

3.6.9 Queues and delays are generally less extensive in the PM peak hour. However on Kallipoleos they are more extensive, with a more extensive southbound queue forecast to develop from Aluminium Tower back towards Digeni Akrita.

Figure 3.5: Traffic Flows for 2020 Reference Case AM peak

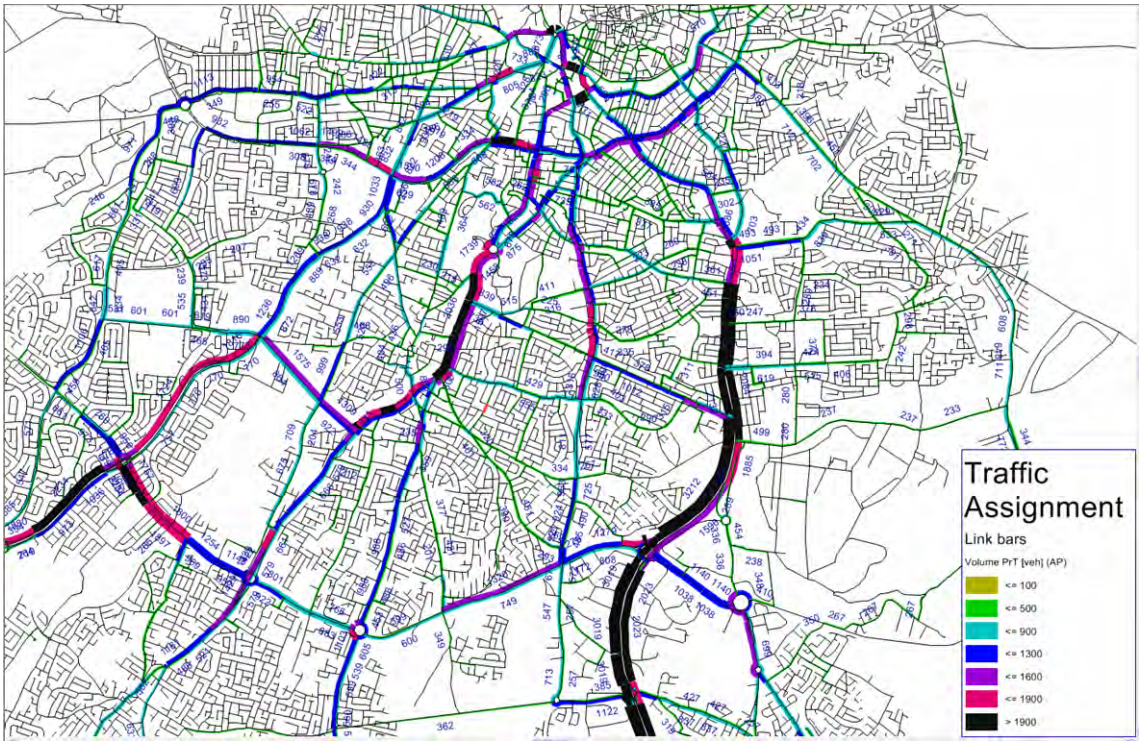


Figure 3.6: Queue lengths for 2020 Reference Case AM peak

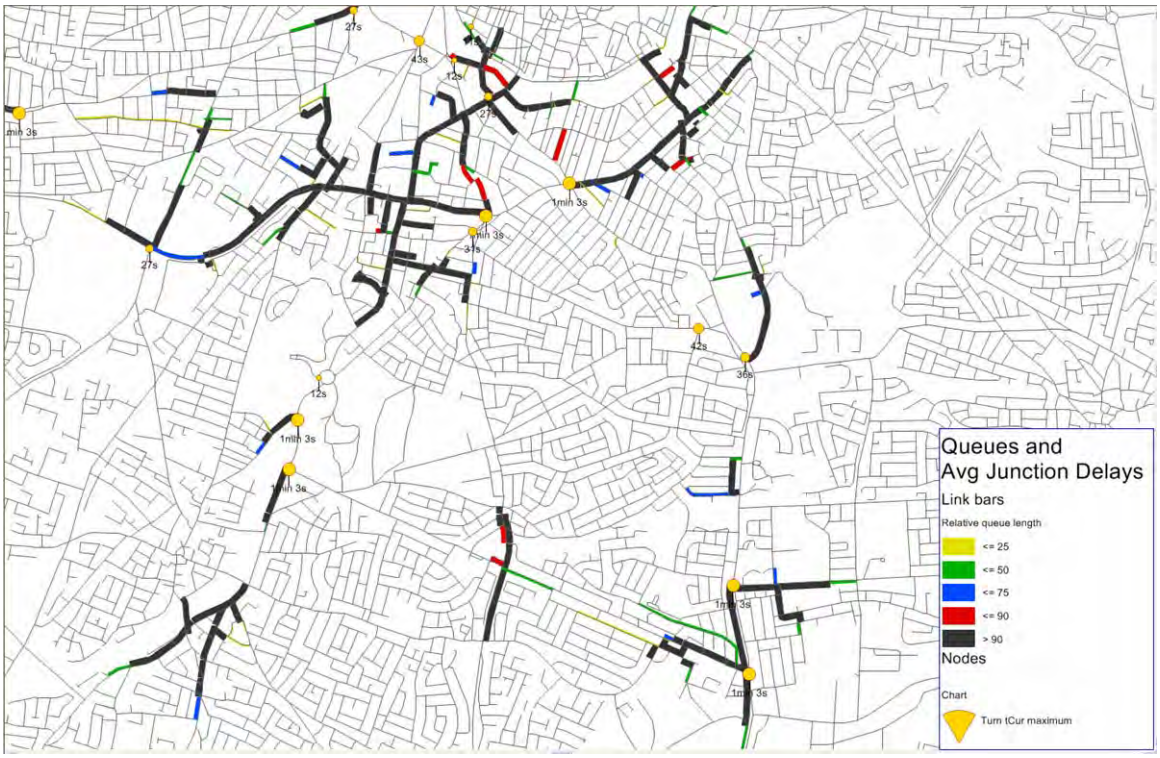


Figure 3.7: Traffic Flows for 2020 Reference Case PM peak

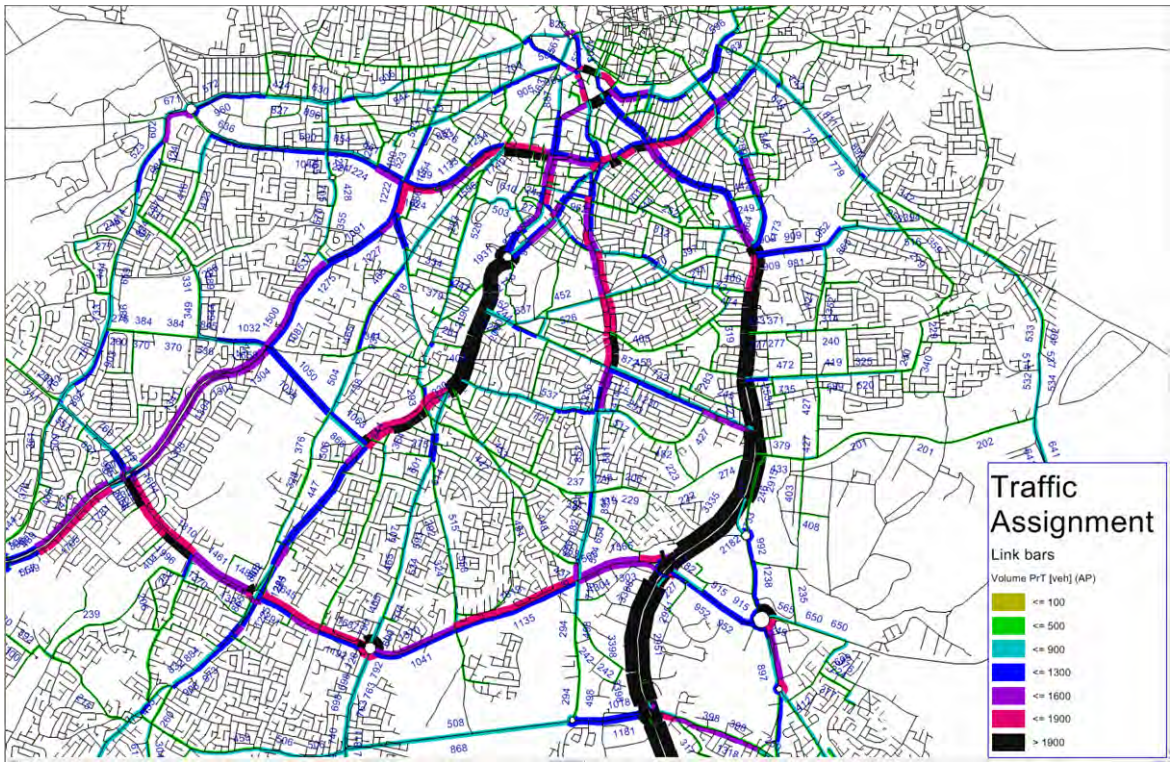


Figure 3.8: Queue lengths for 2020 Reference Case PM peak

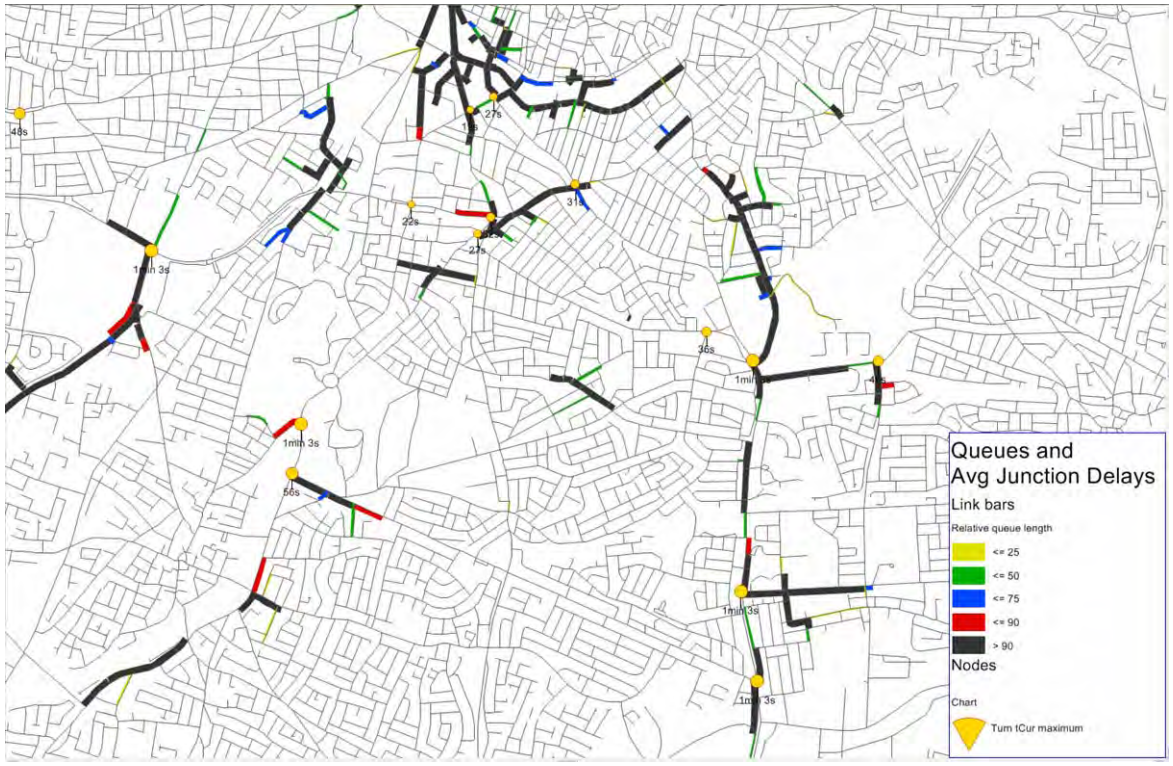


Figure 3.9: Comparison of traffic flow on links, 2010 base versus 2020 Reference Case –AM peak period

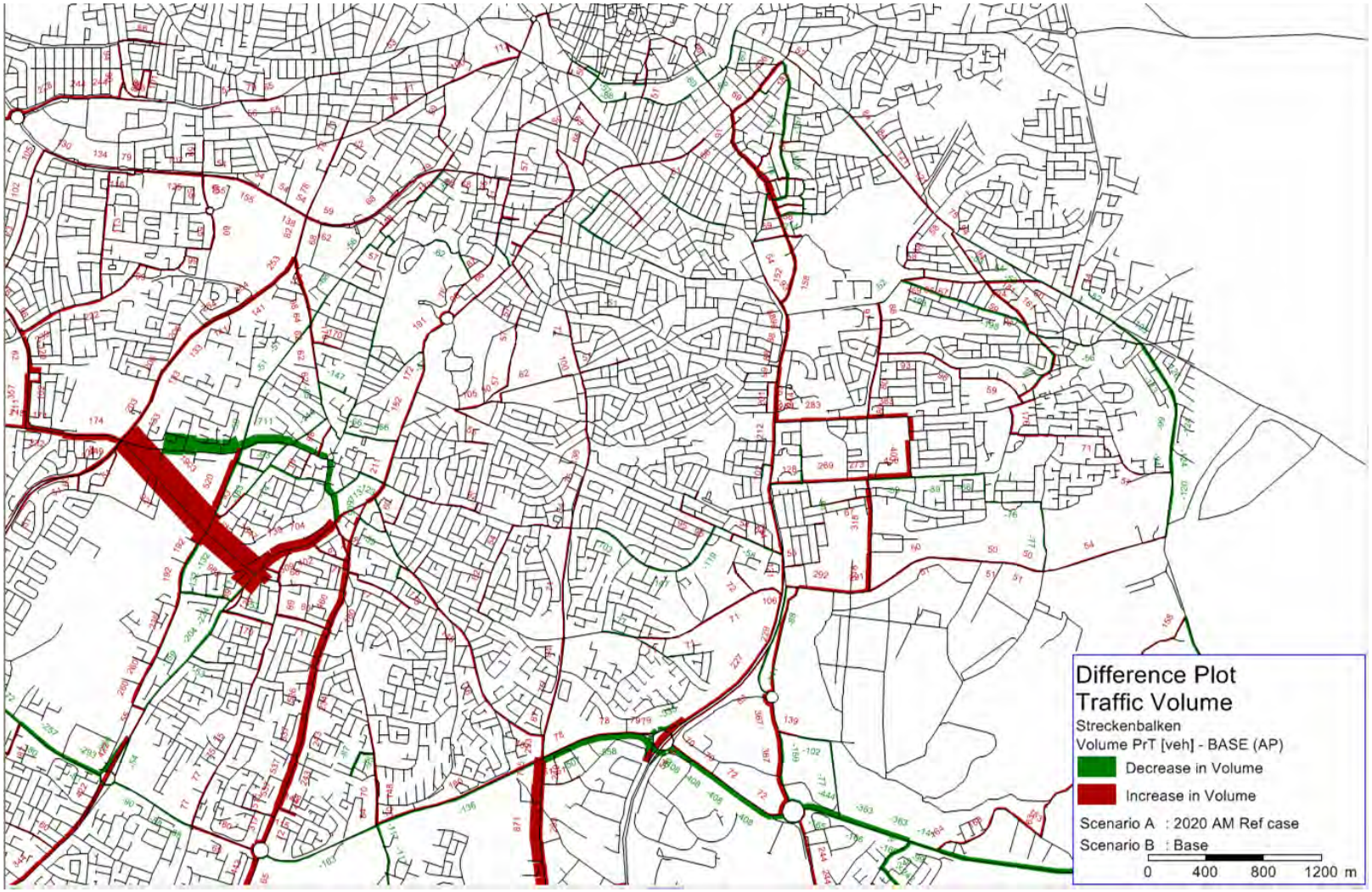
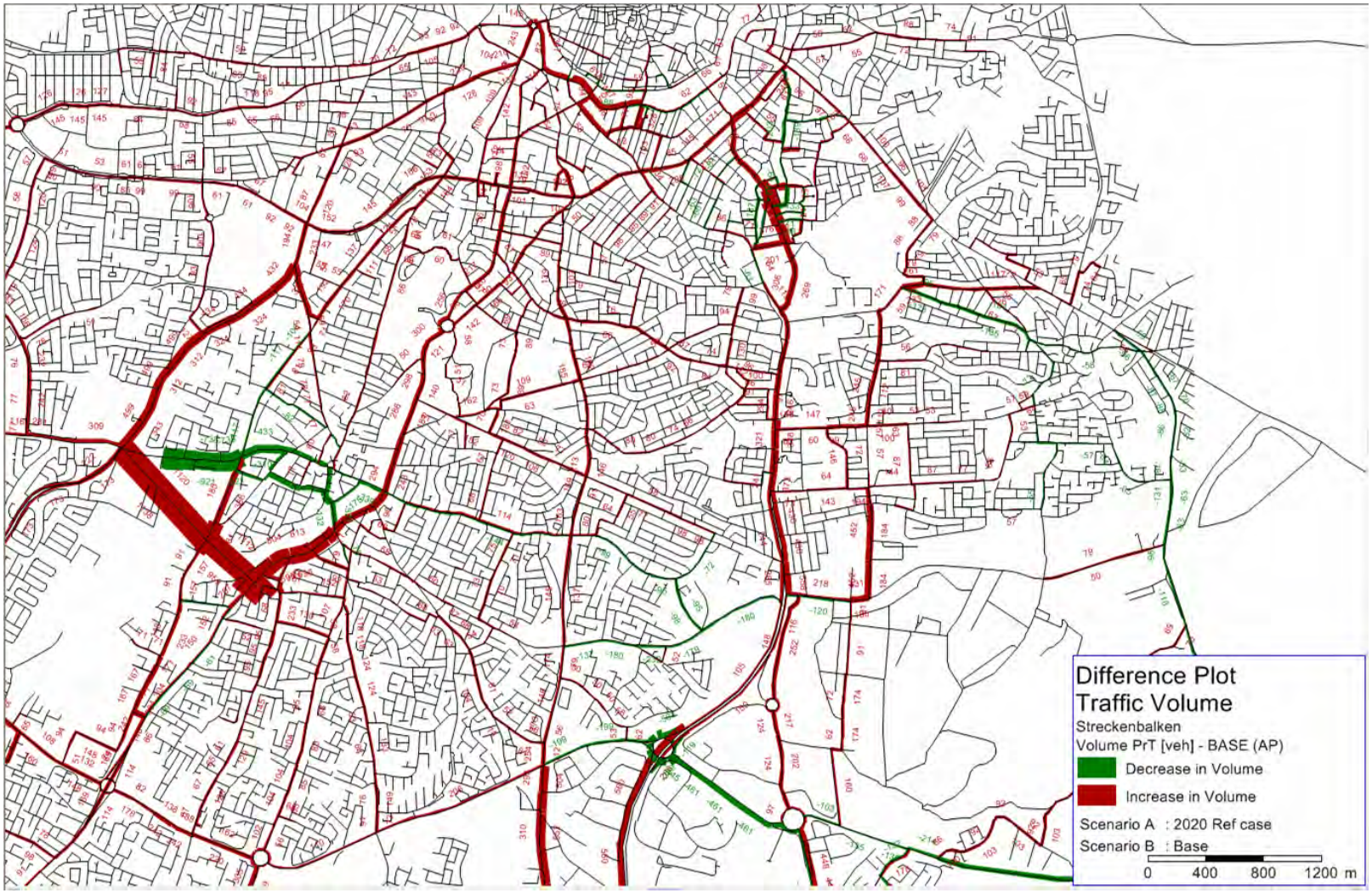


Figure 3.10: Comparison of traffic flow on links, 2010 base versus 2020 Reference Case –PM peak period



3.7 2002 Reference Case forecasts - local area network operation

3.7.1 The following figures summarise the operation of the local area network in the base year and in the 2020 Reference Case:

- Figure 3.11 – Average AM peak delay time per vehicle in base and 2020 Reference Case
- Figure 3.12 – Average AM peak network speeds in base and 2020 Reference Case
- Figure 3.13 – AM peak network journey times in base and 2020 Reference Case
- Figure 3.14 – Average AM peak bus journey speeds in base and 2020 Reference Case
- Figure 3.15 to 3.18 – as Figures 3.11 to 3.14 for the PM peak

3.7.2 The network operation measures in Figures 3.11 to 3.14 show that in the AM peak between 2010 and 2020:

- Average total delay per vehicle increases from around 280 seconds to nearly 400 seconds and average speeds fall from just over 10kph to just under 8 kph
- Average journey times northbound on Makariou increase by around 5 minutes
- Bus journey times increase on average by around 5 minutes for northbound journeys and nearly 2 minutes for southbound journeys

3.7.3 In the PM peak (Figures 3.15 to 3.18) the study area is forecast to be heavily congested. As a consequence :

- Average total delay per vehicle increases from just over 200 seconds to over 1200 seconds and average speeds fall from around 12kph to around 2kph
- Average journey times northbound on Makariou increase by over 8 minutes and southbound on Kallipoleos by over 6 minutes
- Bus journey times increase on average by around 12 minutes for northbound journeys and by over six minutes for southbound journeys

Figure 3.11: Comparison of average network delay – AM peak

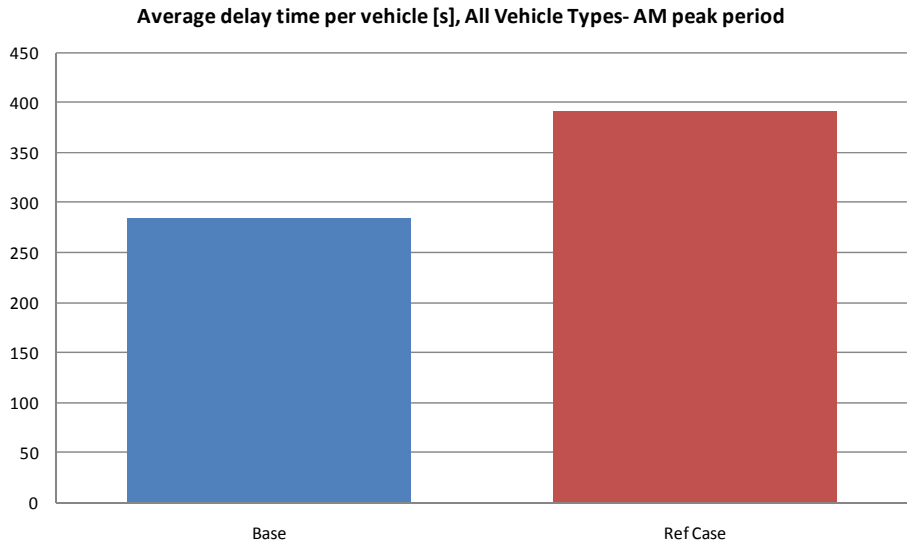


Figure 3.12: Comparison of average network speed – AM peak

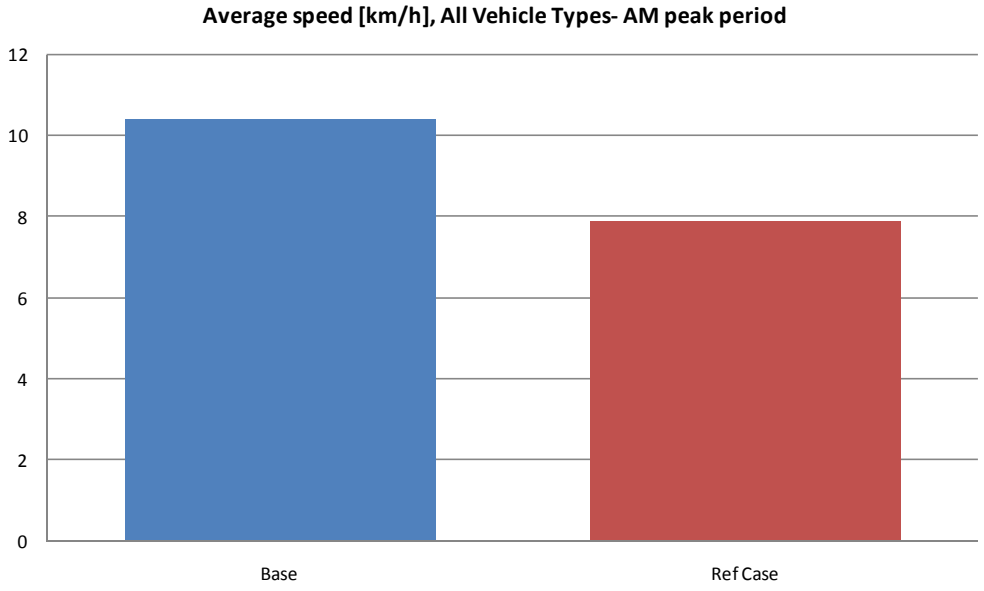


Figure 3.13: Comparison of network journey time– AM peak

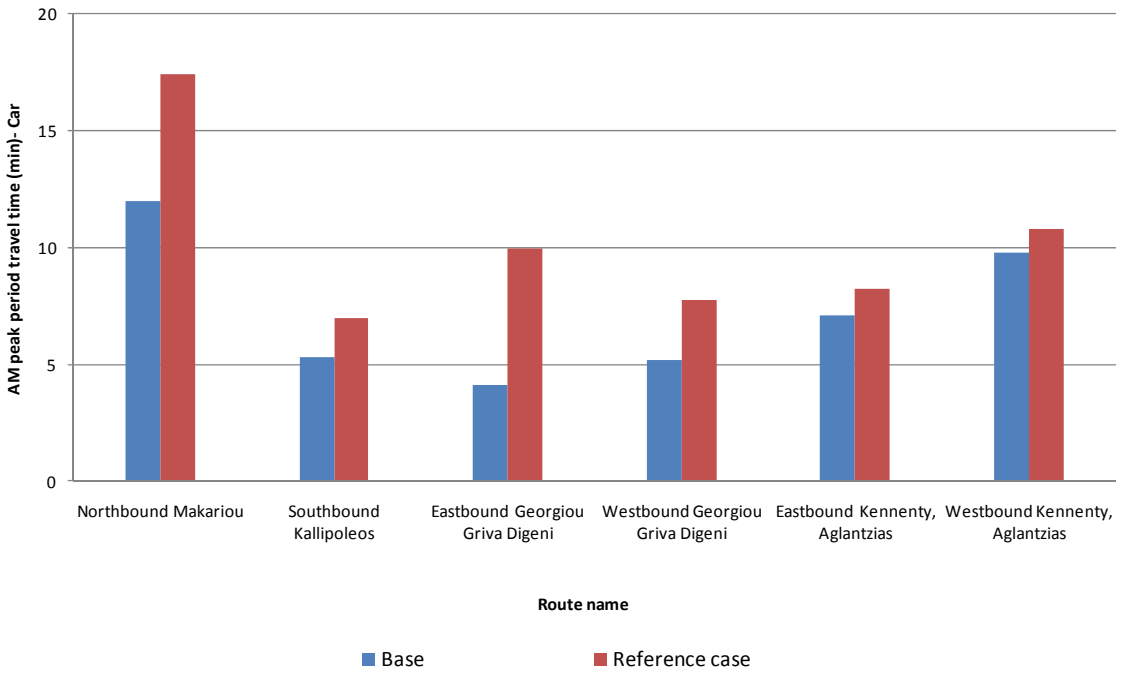


Figure 3.14: Comparison of network bus journey time– AM peak

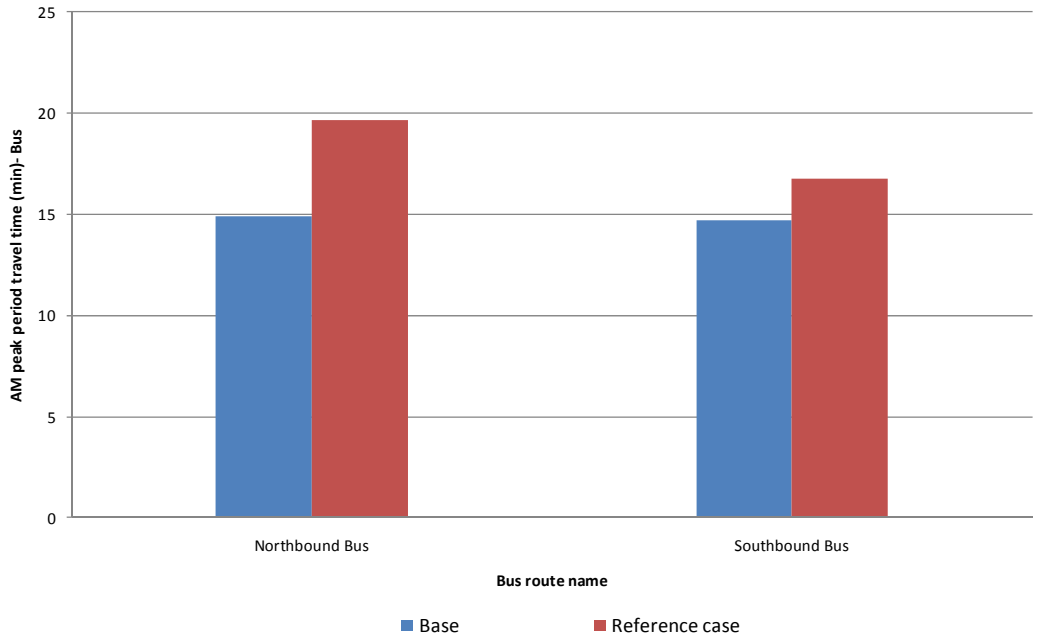


Figure 3.15: Comparison of average network delay – PM peak

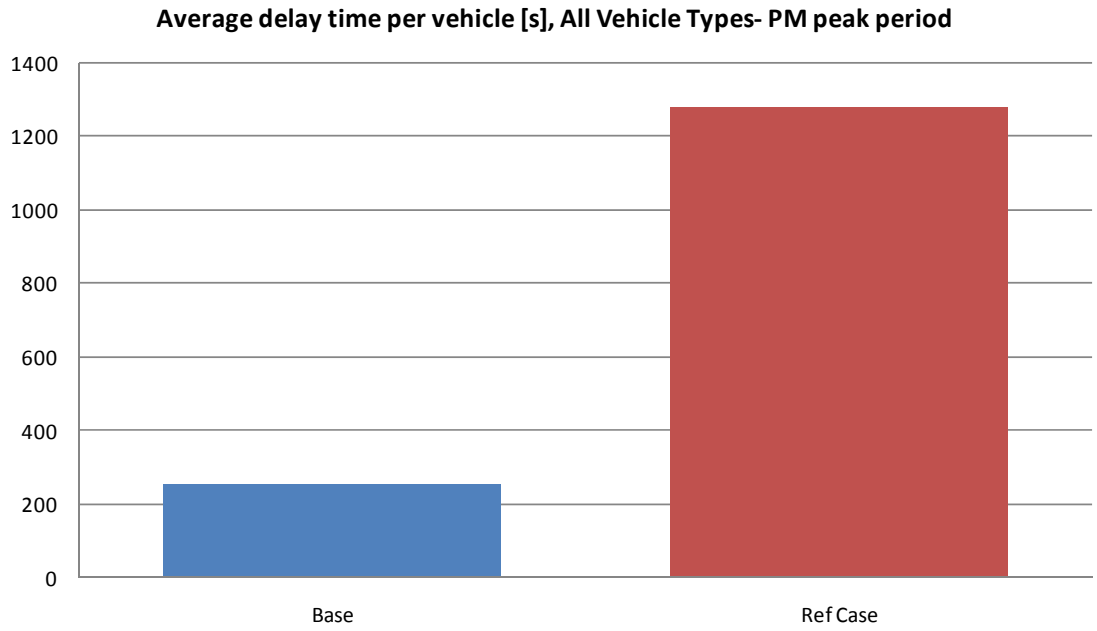


Figure 3.16: Comparison of average network speed – PM peak

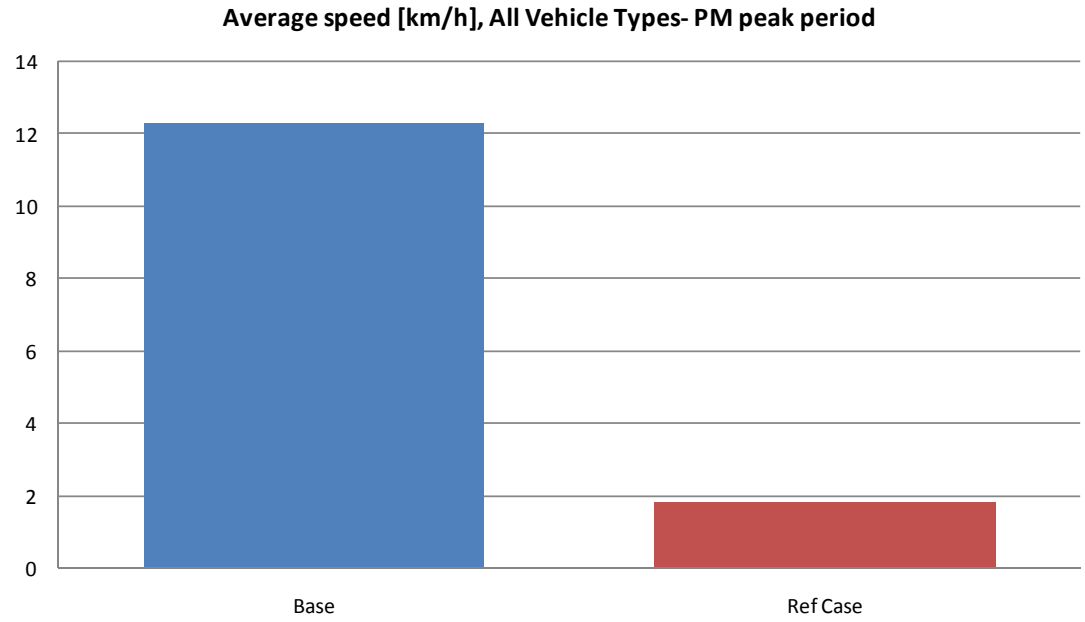


Figure 3.17: Comparison of network journey time– PM peak

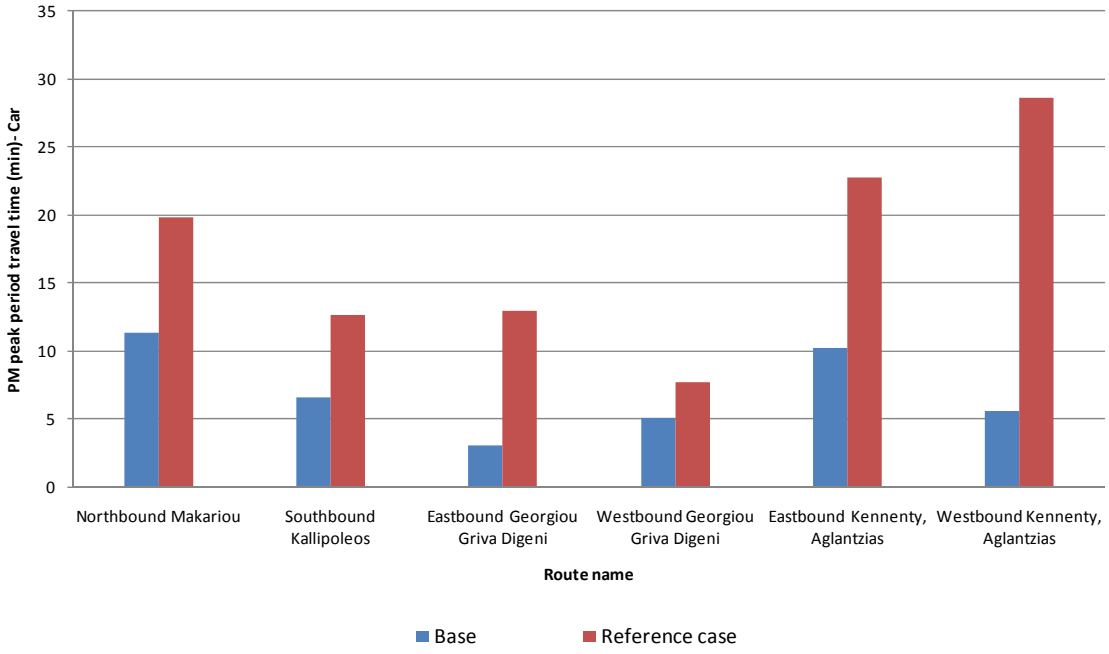
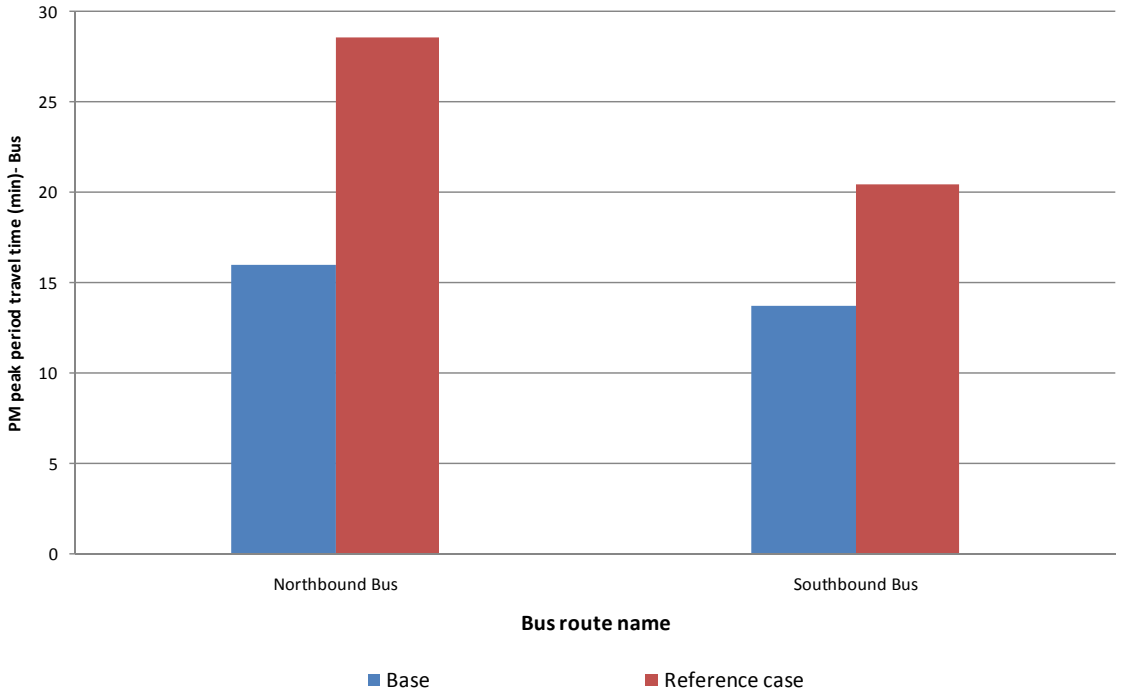


Figure 3.18: Comparison of network bus journey time– PM peak



4 Makariou/Kallipoleos Scheme Options

4.1 Introduction

4.1.1 The basic concept behind the option definition was to facilitate the provision of more sustainable forms of transport on the road network, without unduly prejudicing travel by private car. This is obviously a difficult balance to achieve. The private car currently caters for the vast majority of trips taking place in Nicosia, particularly as no seemingly viable travel alternatives exist at present.

4.1.2 However, the IMMP aims to progress measures that reduce the reliance on the private car, and facilitate the use of sustainable modes. Hence, it can be viewed as the starting point or the first step towards developing a more balanced transport network and infrastructure that supports these alternatives, and offers travel choices to the residents, workers and visitors of Nicosia.

4.1.3 This section describes the development of the three 2020 options for Makariou/Kallipoleos and the impacts of these options on traffic flows and queues. For each option these impacts are shown in comparison with the Reference Case. A comparison is also made between Options 2 and 3 and Option 1.

4.1.4 The traffic forecasts for Options 2 and 3 show only marginal differences. Hence, while the development of Option 2 is discussed in 4.3, the traffic impacts are discussed together with Option 3 in 4.4.

4.2 Option I

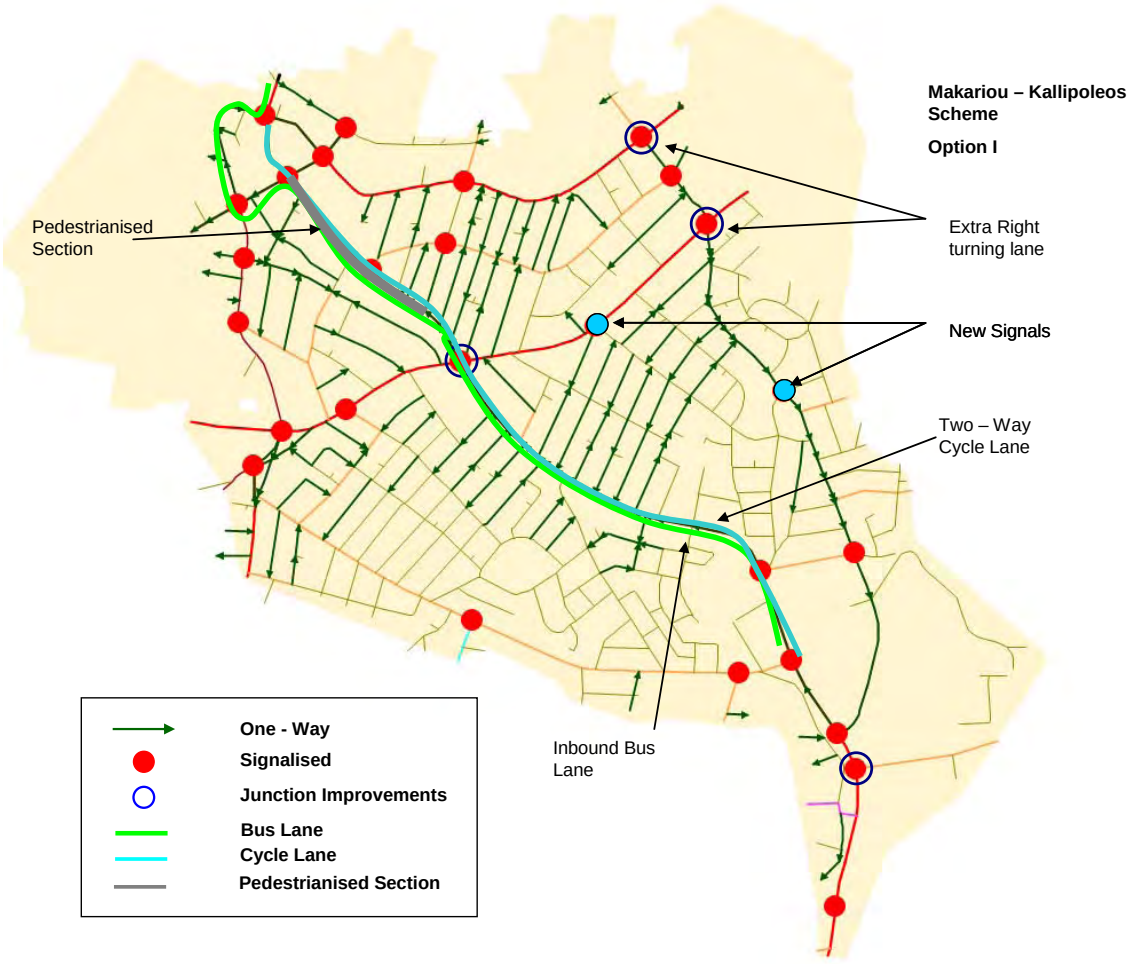
4.2.1 Option 1 is based on the original proposals recommended in the IMMP. These centre around the conversion of Makariou and Kallipoleos into a one-way system, with road space re-allocated to facilitate bus priority, the provision of cycle lanes, and footway widening where possible.

4.2.2 This scheme was assessed using the VISSIM/VISUM model, and some adjustments and alterations were required in order for it to be better integrated into the existing road infrastructure. The components and specific details of the revised IMMP option that form Option 1 are shown in Figure 4.1 and described in Table 4.1. In the table the individual elements have be divided into the type of measure, for instance, bus, cycle, traffic management, etc.

Table 4.1: Components of Option 1

Type of measure	Details of measure
Bus	B1. Northbound bus lane on Makariou, between Kennedy and Evagorou, and continuing along Evagorou, Diagorou and Omirou to the bus station.
Cycle	C1. Two way cycle lane on Makariou between Kennedy and Evagorou, and continuing along Leonidou (including cycle crossing facilities at all junctions).
Pedestrian	P1. Pedestrianisation of the northern section of Makariou between Boumpoulinas and Evagorou (but allowing buses and cycles). P2. Improved crossing facilities at junctions. P3. Improved footway provision on Kallipoleos.
Traffic management	TM1. Conversion of Makariou to one-way northbound, between Kallipoleos and Digeni Akrita. TM2. Conversion of Makariou to one-way northbound, between Digeni Akrita and Boumpoulinas. TM3. Conversion of Boumpoulinas to one-way northbound between Makariou and Stasinou. TM4. Conversion of Kallipoleos to one-way southbound between Digeni Akrita and Makariou. TM5. Conversion of E & A Theodotou to one-way southbound between Stasinou and Digeni Akrita TM6. Conversion of Chalkokondyli to one-way southbound between Ypatias and G. Frankoudi. TM7. Conversion of Demokratous and Doiranis to one-way northbound between Makariou and Kallipoleos. TM8. Conversion of I. Kliridi and Damaskinou to one-way southbound between Makariou and Kallipoleos. TM9. Improvement of Digeni Akrita/Kallipoleos: junction (with extra right turning lane). TM10. Improvement of Stasinou/Kallipoleos junction (with extra right turning lane). TM 11.Improvement of Makariou/Digeni Akrita (to facilitate one-way working and bus and cycle lanes) TM12. Improvement of Makariou/Aglantzias Junction (with 3 lanes southbound on Makariou between Kallipoleos and Aglantzias, and a segregated left-turn lane). TM13. New signals on Kallipoleos/Ypatias junction. TM14. New Signals on Digeni Akrita/Nikodimou Mylona.
Traffic calming/ speed reduction	TC1. 30kph Zone in area between Makariou, Digeni Akrita and Kallipoleos with self-enforcing measures (e.g. speed humps, etc.)

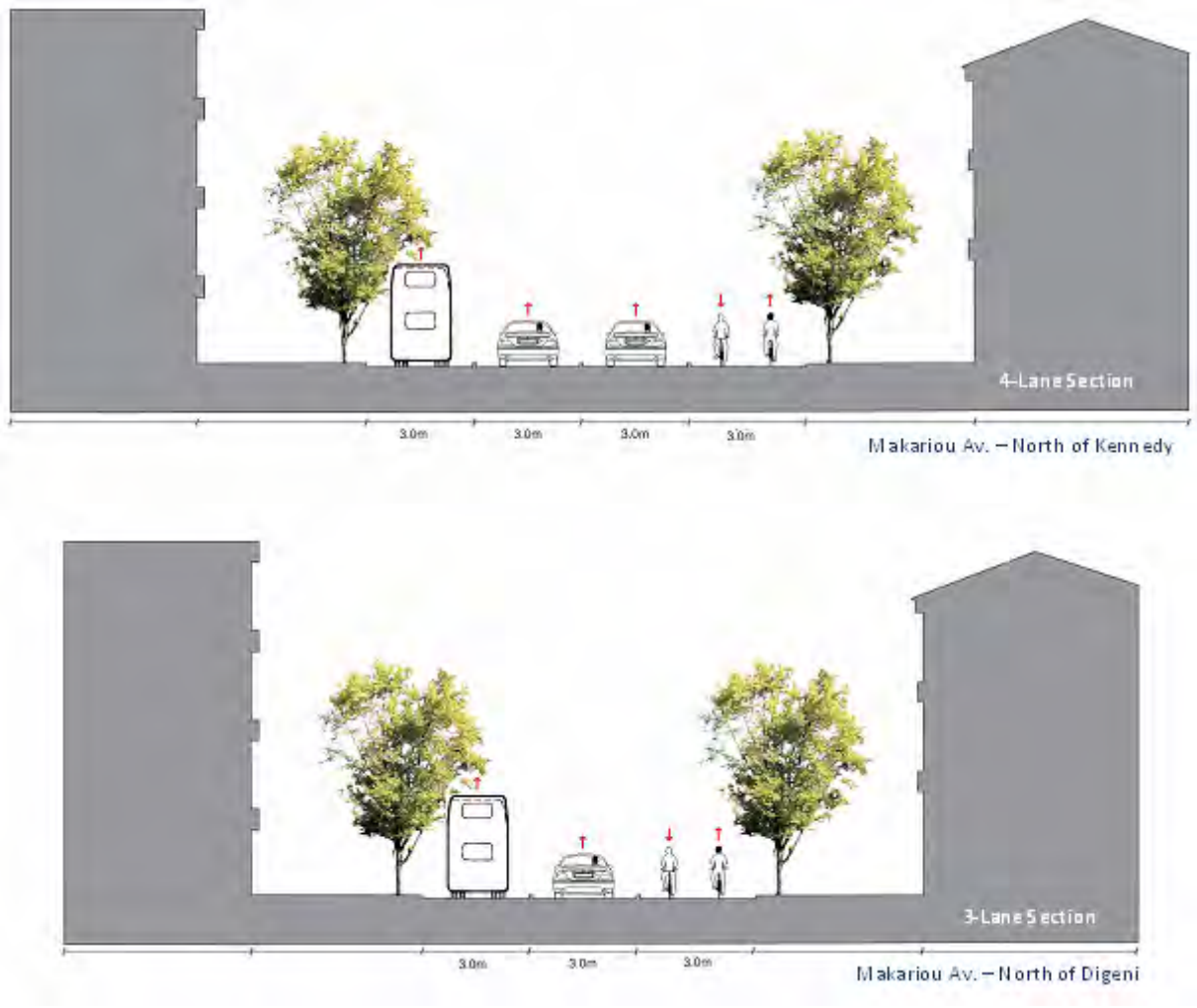
Figure 4.1: Makariou/Kallipoleos Option I



4.2.3 Some indicative key cross-sections have been created utilising the existing carriageway widths, to visualise the roadway on Makariou once the scheme is in place. These are shown in Figure 4.2. On Makariou (south) the cross section provides for a northbound bus lane, two northbound traffic lanes and two-way cycle lane. On Makariou (north) only one traffic lane can be provided.

4.2.4 On Kallipoleos two traffic lanes can be provided, but no bus lane.

Figure 4.2: Cross-section on Makariou Avenue with Option I



Traffic flow forecasts

4.2.5 The VISUM forecasts for Option 1 are presented in the following figures:

- Figure 4.3 - AM peak traffic flows
- Figure 4.4 – AM peak queues (in terms of % of link queued) and junction delays
- Figure 4.5 – Comparison of AM peak link flows with the Reference Case
- Figures 4.6 to 4.8 – as Figures 4.3 to 4.5 for the PM peak hour

Option 1 – key impacts

4.2.6 A comparison of Figures 4.3 and 4.4 with Figures 4.6 and 4.7 shows that, in general over the Nicosia network, the PM peak is the critical period. In the PM peak extensive queueing is shown in the Kallipoleos corridor between the city centre and Aluminium Tower. Queueing continues south from Aluminium Tower on Limassol Avenue. Queueing is also shown to develop on Stasinou.

4.2.7 Away from the study area corridors significant congestion is forecast to occur around the junctions of Georgiou Grivas Digeni/Thermistokli Dervi/Kyriakou Matsi/Spyrou Kyprianou, and extending along these corridors.

4.2.8 When forecast flows for Option 1 are compared to those for the Reference Case it can be seen that Southbound traffic on Makariou appears to largely reassign to Kallipoleos when Makariou becomes one way. However, the Northbound flows displaced from Kallipoleos do not simply switch to Makariou, where Northbound flows are not forecast to increase significantly. Instead these flows seem to filter through the network via a number of alternative routes.

4.2.9 On Stasinou traffic is predicted to increase by over 800vph in the AM peak and by over 900vph in the PM peak.

4.2.10 As would be expected, significant increases in flows are also predicted for the streets retained as through routes between Makariou and Kallipoleos. In addition there is a general increase in traffic within the areas between Makariou and Kallipoleos, in particular south of Digeni Akrita, albeit that the increases on individual streets are relatively low.

Figure 4.3: Modelled flows in 2020 Option 1 – AM peak

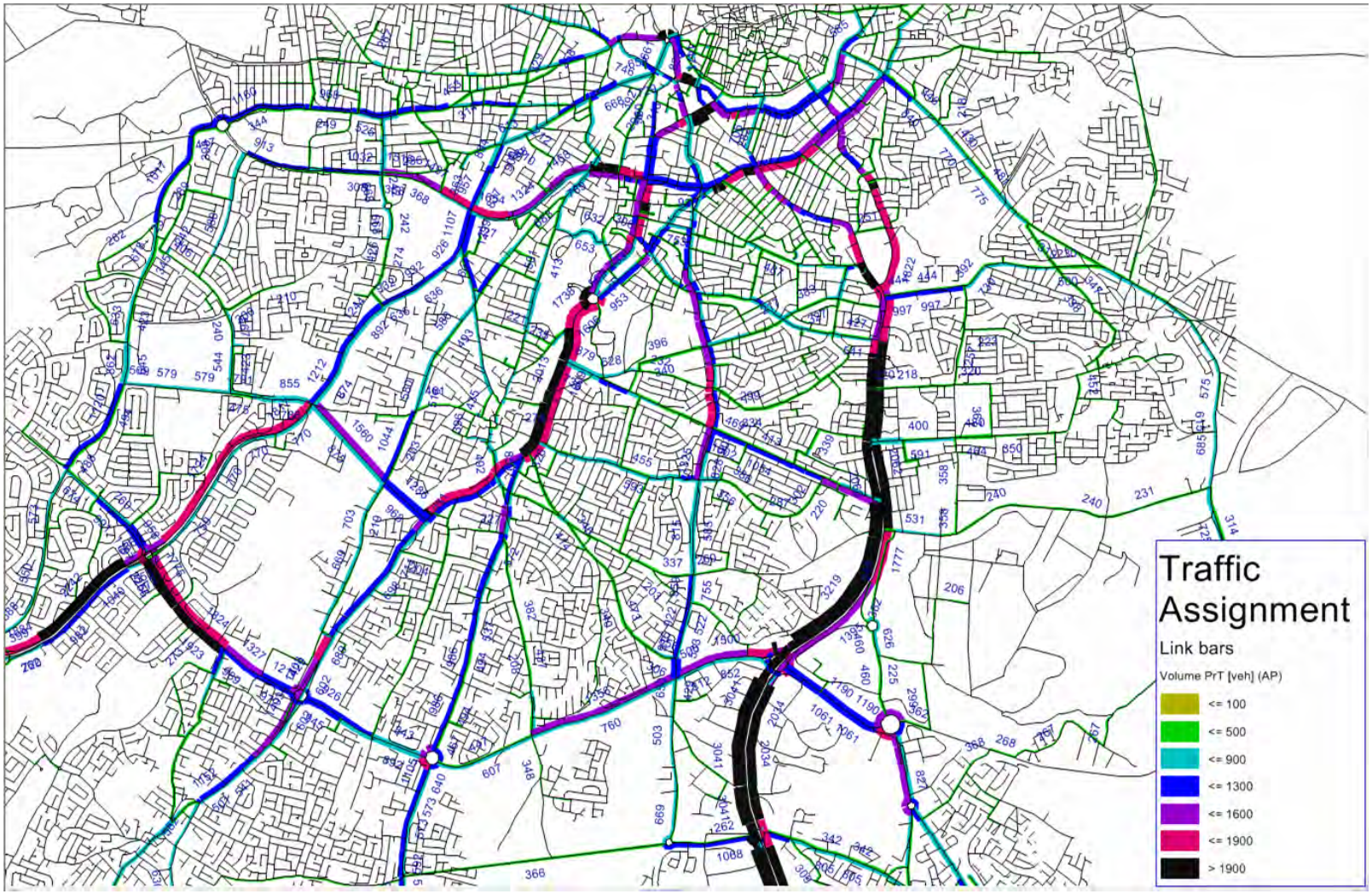


Figure 4.4: Modelled queues in 2020 Option 1 – AM peak

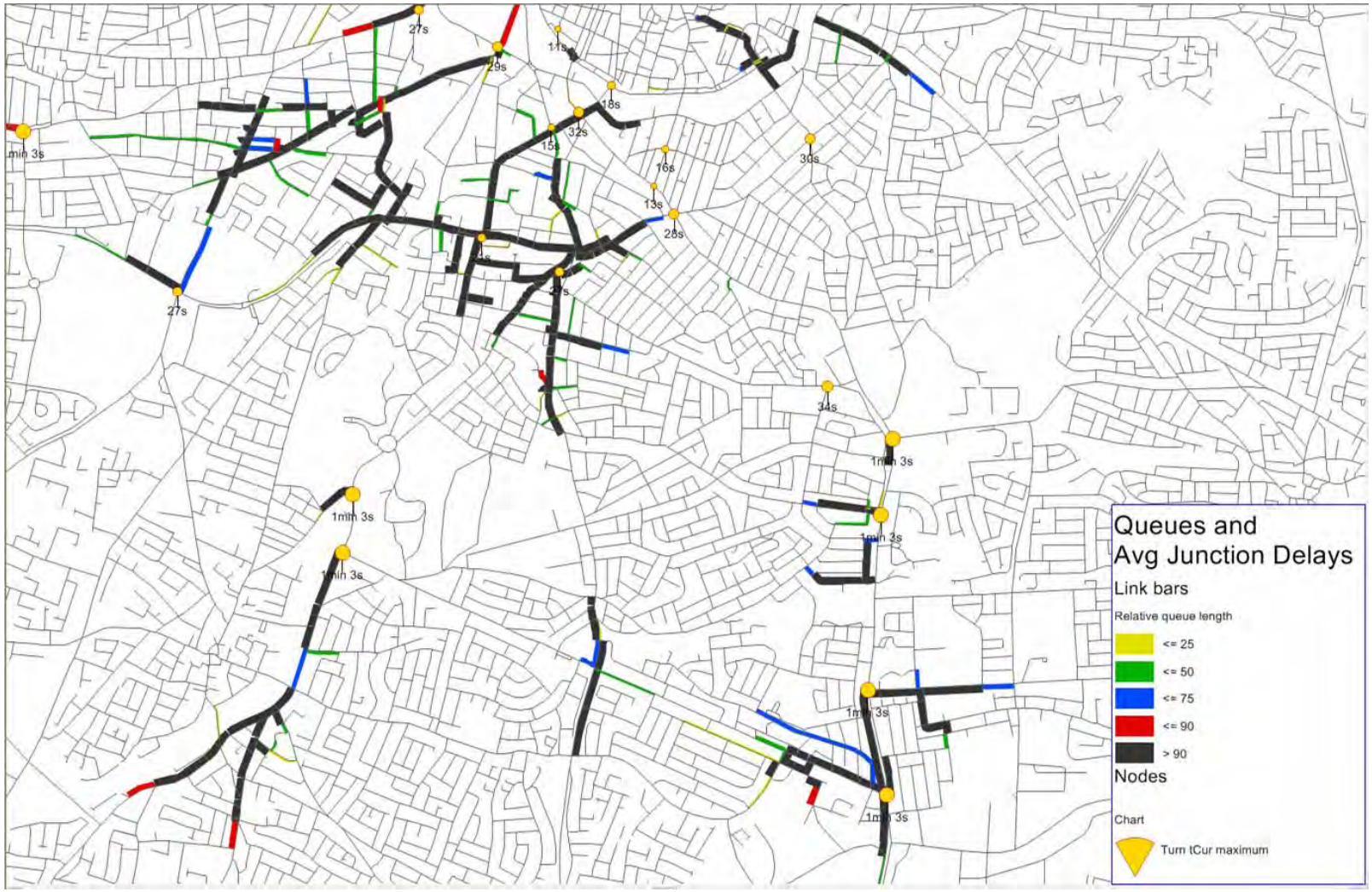


Figure 4.5: Comparison of link flows 2020 Option 1 vs Reference Case – AM peak

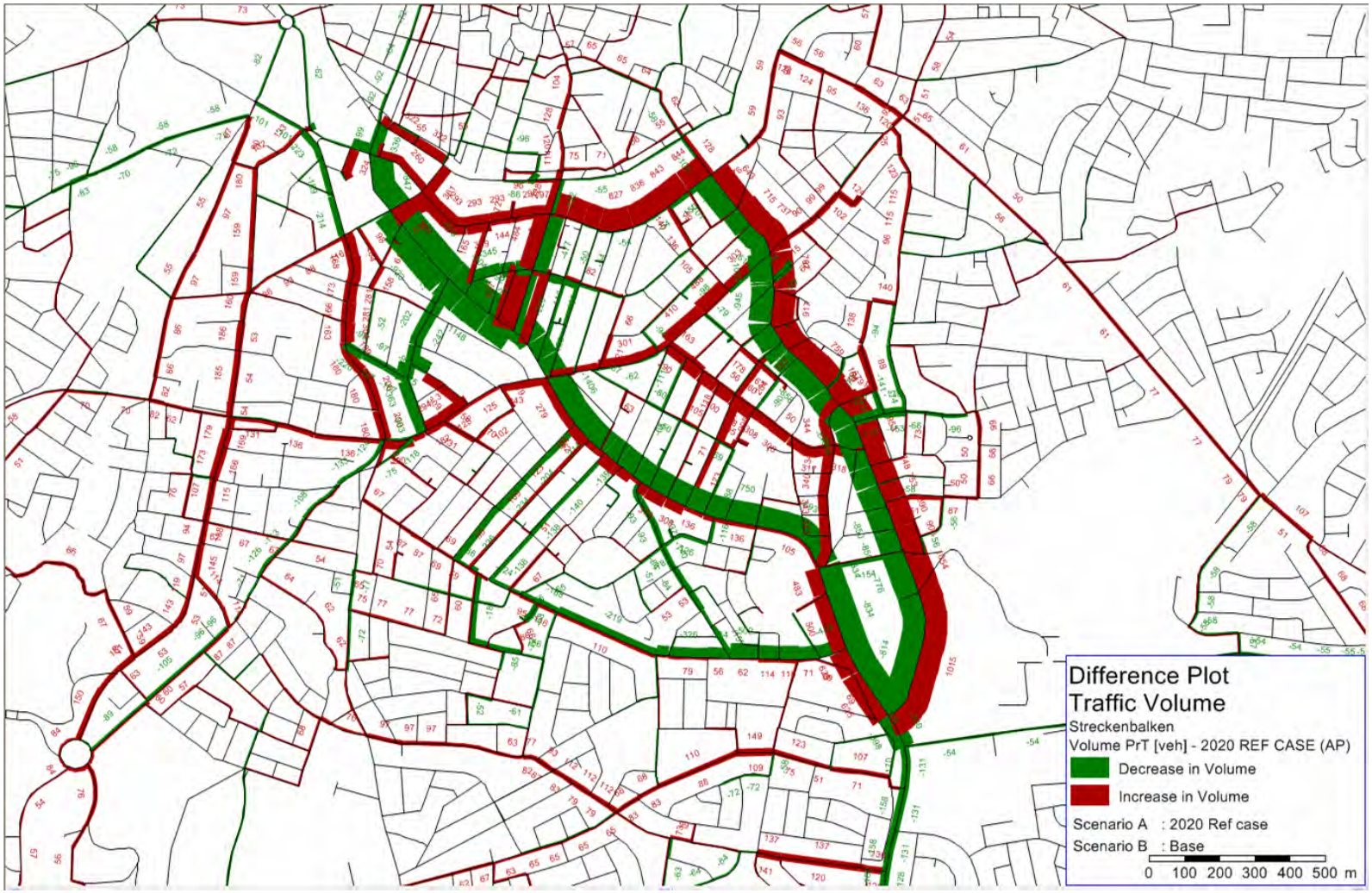


Figure 4.6: Modelled flows in 2020 Option 1 – PM peak

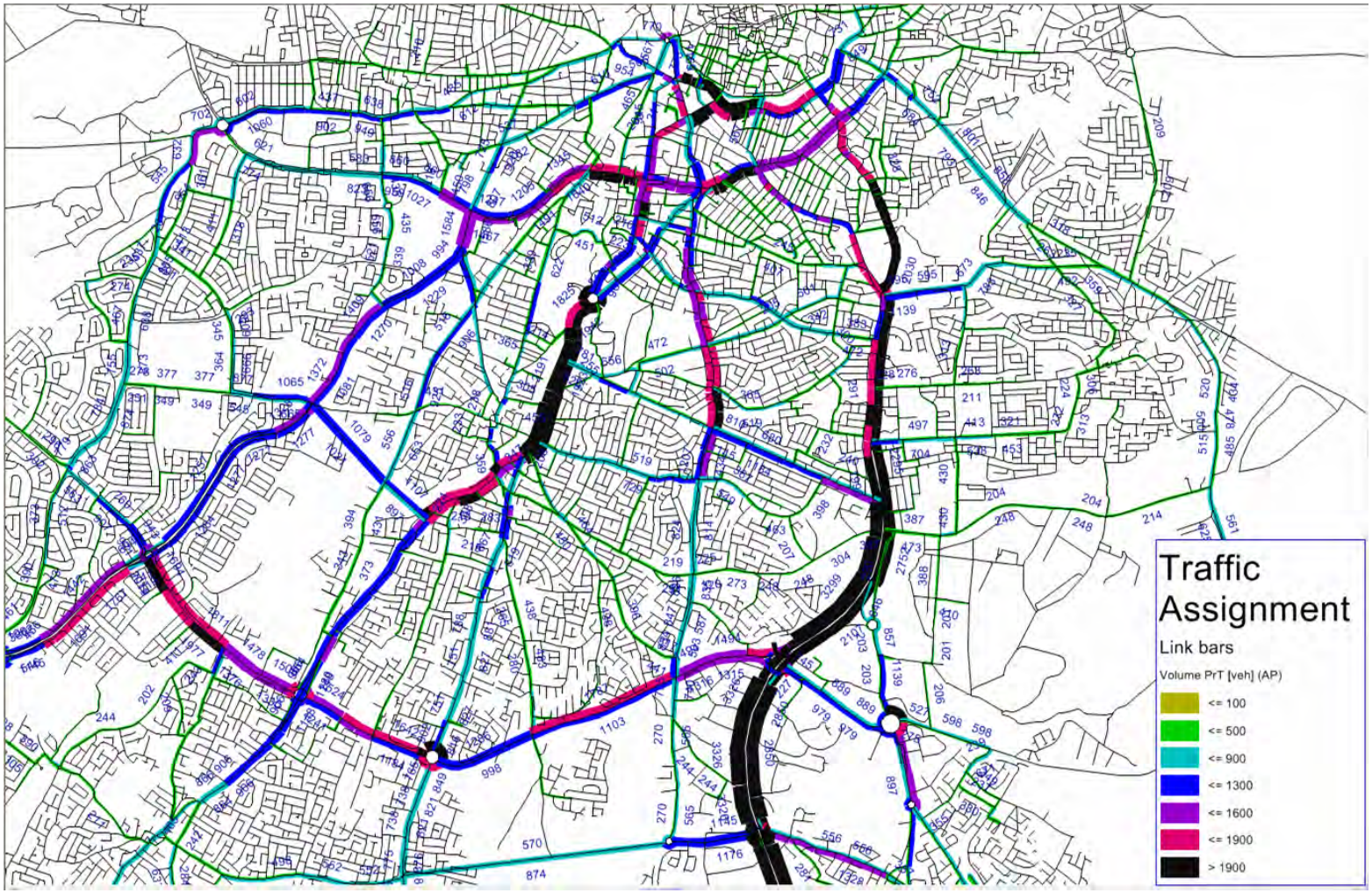


Figure 4.7: Modelled queues in 2020 Option 1 Scenario – PM peak

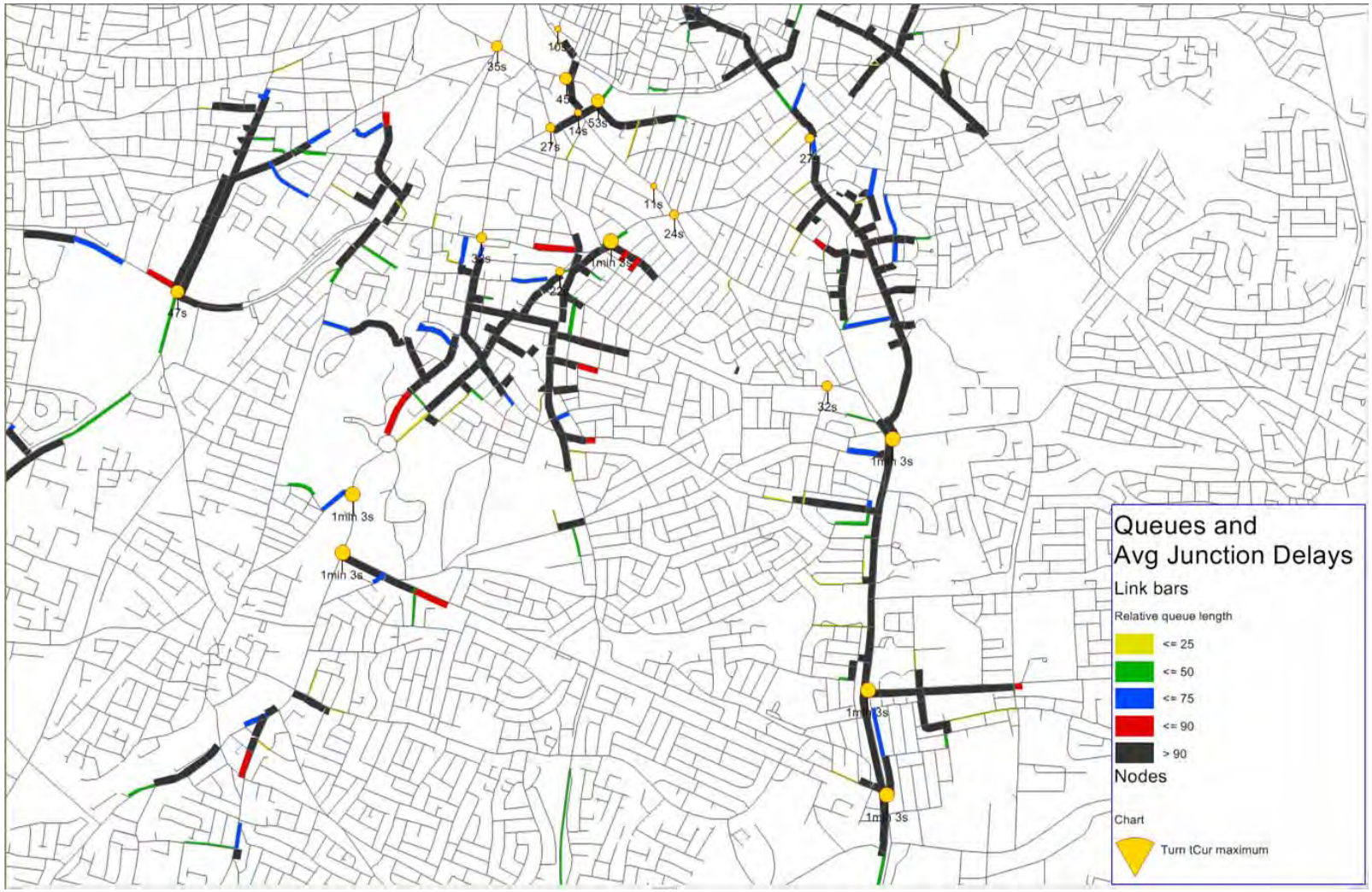
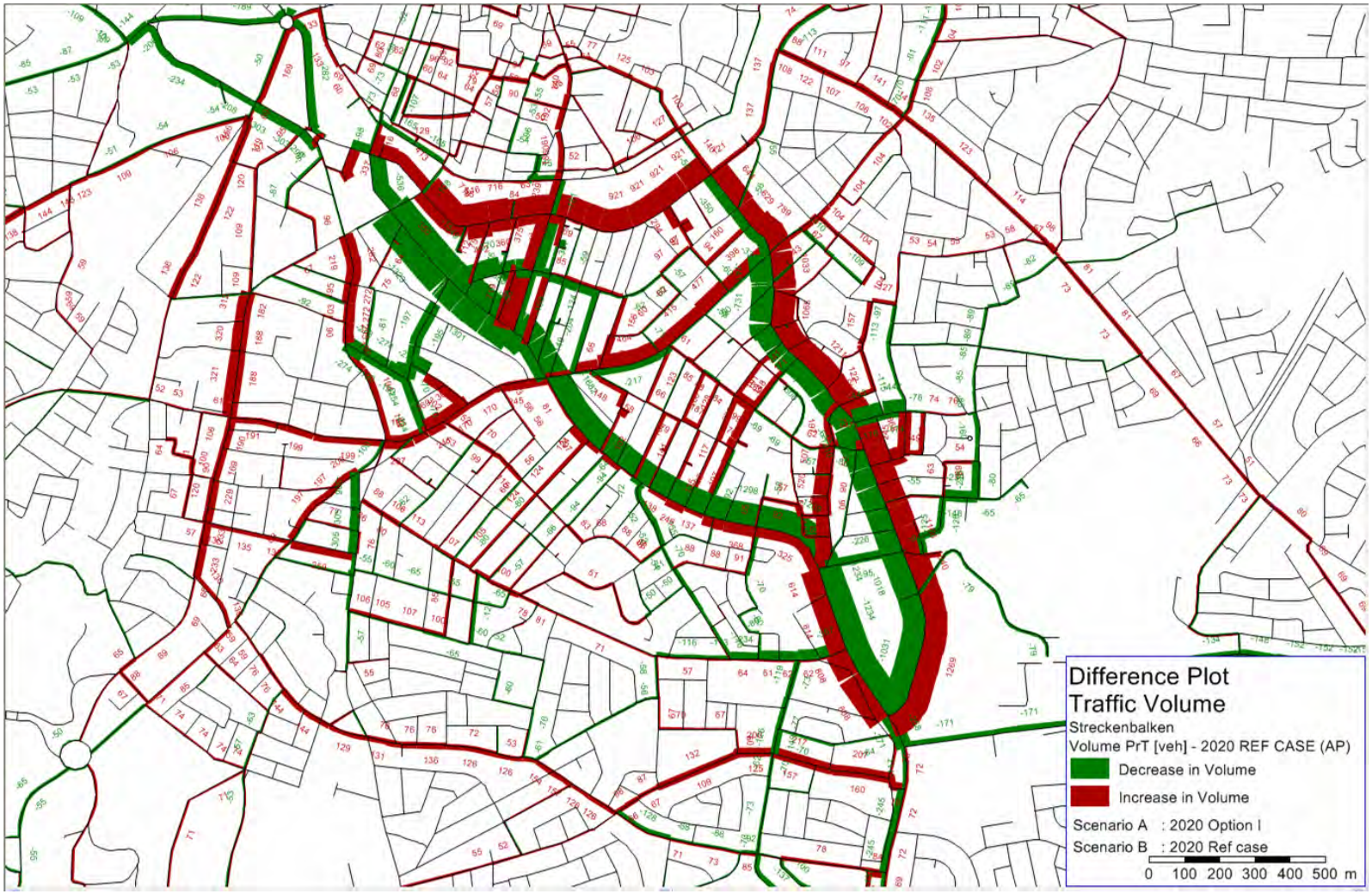


Figure 4.8: Comparison of link flows 2020 Option 1 vs Reference Case – PM peak



4.3 Option 2

4.3.1 Option 2 is essentially Option 1 without the pedestrianisation of the northern section of Makariou. An option without the pedestrianisation has been tested as the removal of traffic from this key section of road in central Nicosia was shown with Option 1 potentially to have wide-ranging traffic implications.

4.3.2 The specific details of Option 2 are shown in Figure 4.9 and are summarised in Table 4.2.

Table 4.2: Components of Option 2

Type of measure	Details of measure
Bus	B1. Northbound bus lane on Makariou, between Kennedy and Evagorou, and continuing along Evagorou, Diagorou and Omirou to the bus station.
Cycle	C1. Two way cycle lane on Makariou between Kennedy and Evagorou, and continuing along Leonidou (including cycle crossing facilities at all junctions).
Pedestrian	P2. Improved crossing facilities at junctions. P3. Improved footway provision on Kallipoleos.
Traffic management	TM1. Conversion of Makariou to one-way northbound, between Kallipoleos and Digeni Akrita. TM2. Conversion of Makariou to one-way northbound, between Digeni Akrita and Evagorou. TM4. Conversion of Kallipoleos to one-way southbound between Digeni Akrita and Makariou. TM5. Conversion of E & A Theodotou to one-way southbound between Stasinou and Digeni Akrita TM6. Conversion of Chalkokondyli to one-way southbound between Ypatias and G. Frankoudi. TM7. Conversion of Demokratous and Doiranis to one-way northbound between Makariou and Kallipoleos. TM8. Conversion of I. Kliridi and Damaskinou to one-way southbound between Makariou and Kallipoleos. TM9. Improvement of Digeni Akrita/Kallipoleos: junction (with extra right turning lane). TM10. Improvement of Stasinou/Kallipoleos junction (with extra right turning lane). TM 11.Improvement of Makariou/Digeni Akrita (to facilitate one-way working and bus and cycle lanes) TM12. Improvement of Makariou/Aglantzias Junction (with 3 lanes southbound on Makariou between Kallipoleos and Aglantzias, and a segregated left-turn lane). TM13. New signals on Kallipoleos/Ypatias junction. TM14. New Signals on Digeni Akrita/Nikodimou Mylona.
Traffic calming/ speed reduction	TC1. 30kph Zone in area between Makariou, Digeni Akrita and Kallipoleos with self-enforcing measures (e.g. speed humps, etc.)

4.3.3 Indicative cross sections on Makariou are shown in Figure 4.10 and are the same as for Option 1.Again, the existing carriageway width is utilised.

Figure 4.9: Makariou/Kallipoleos Scheme Option 2

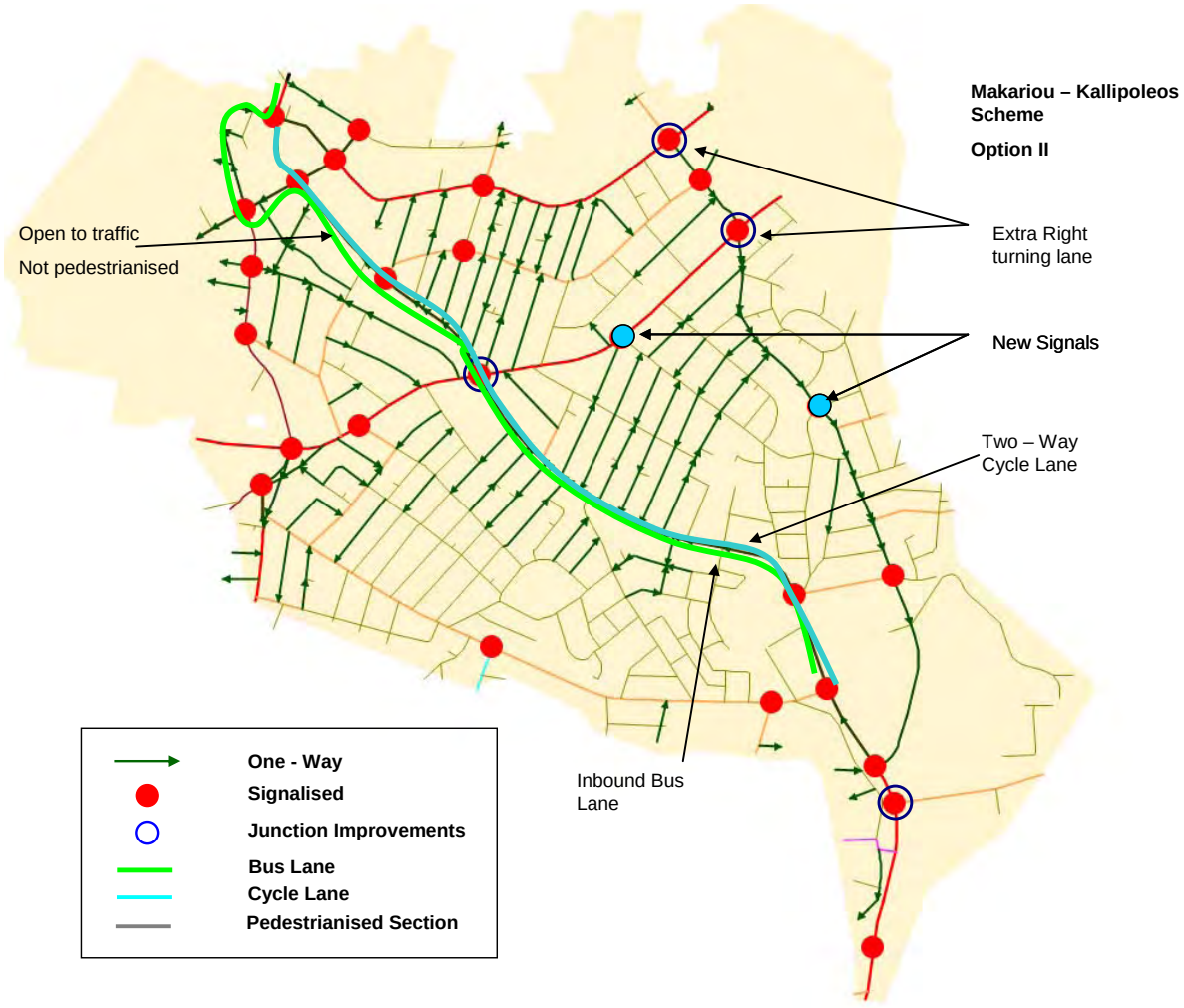
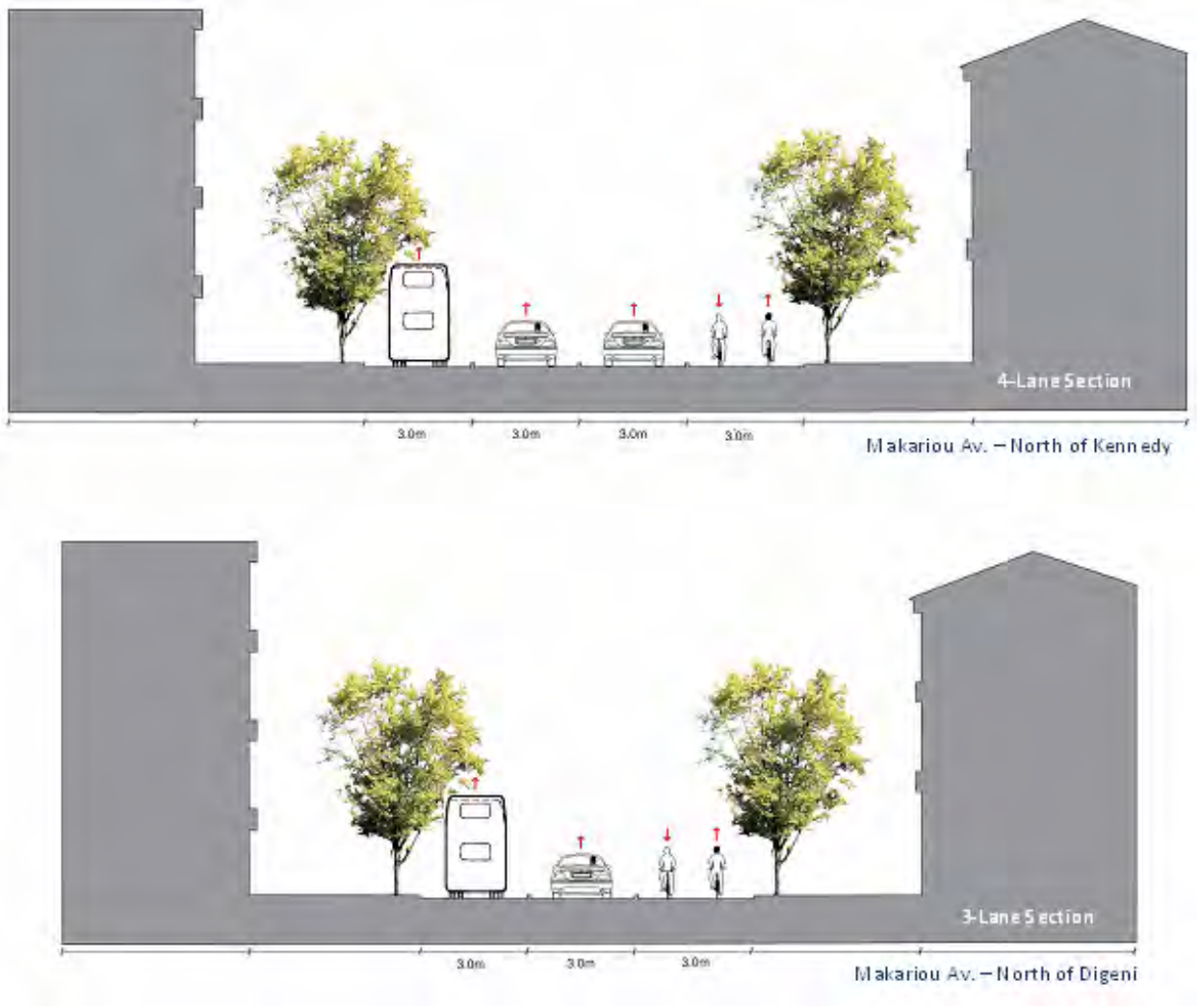


Figure 4.10: Cross-section on Makariou Avenue with Option 2



4.4 Option 3

4.4.1 The third option is a 'maximum public transport option', as buses are given extra priority on the Makariou corridor. It is basically Option 2 (as outlined previously) with the replacement of the 2-way cycle lane by a southbound contra-flow bus lane. In this scheme cyclists will use the bus lanes.

4.4.2 The specific components of this option are shown in Figure 4.11 and are summarised in Table 4.3.

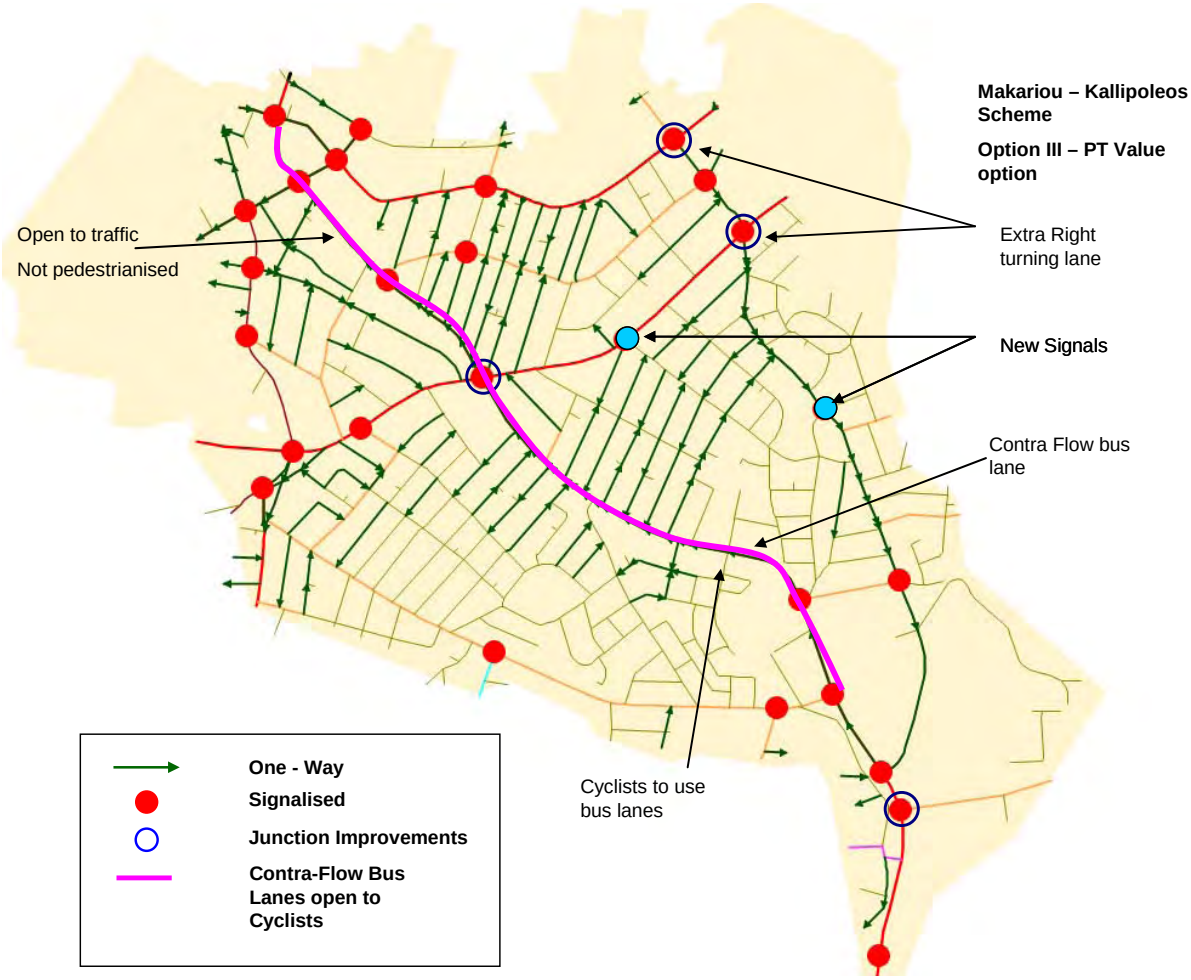
Table 4.3: Components of Option 3

Type of measure	Details of measure
Bus	B3. Northbound bus lane on Makariou, between Kennedy and Evagorou, and continuing along Leonidou (contra-flow) to the bus station. B4. Southbound bus lane on Makariou, between Kennedy and Evagorou, and along Leonidou from the bus station.
Cycle	C2.Cycle use of bus lanes on Makariou and Leonidou, between Kennedy and Evagorou, and the bus station (this also includes cycle crossing facilities at all junctions).
Pedestrian	P2. Improved crossing facilities at junctions. P3. Improved footway provision on Kallipoleos.
Traffic management	TM1. Conversion of Makariou to one-way northbound, between Kallipoleos and Digeni Akrita. TM2. Conversion of Makariou to one-way northbound, between Digeni Akrita and Evagorou. TM4. Conversion of Kallipoleos to one-way southbound between Digeni Akrita and Makariou. TM5. Conversion of E & A Theodotou to one-way southbound between Stasinou and Digeni Akrita TM6. Conversion of Chalkokondyli to one-way southbound between Ypatias and G. Frankoudi. TM7. Conversion of Demokratous and Doiranis to one-way northbound between Makariou and Kallipoleos. TM8. Conversion of I. Kliridi and Damaskinou to one-way southbound between Makariou and Kallipoleos. TM9. Improvement of Digeni Akrita/Kallipoleos: junction (with extra right turning lane). TM10. Improvement of Stasinou/Kallipoleos junction (with extra right turning lane). TM 11.Improvement of Makariou/Digeni Akrita (to facilitate one-way working and bus and cycle lanes) TM12. Improvement of Makariou/Aglantzias Junction (with 3 lanes southbound on Makariou between Kallipoleos and Aglantzias, and a segregated left-turn lane). TM13. New signals on Kallipoleos/Ypatias junction. TM14. New Signals on Digeni Akrita/Nikodimou Mylona. TM15. Reallocation of road space on Leonidou to with and contra flow bus lane, and 1 lane for general traffic (southbound).
Traffic calming/ speed reduction	TC1. 30kph Zone in area between Makariou, Digeni Akrita and Kallipoleos with self-enforcing measures (e.g. speed humps, etc.)

4.4.3 Cross-sections on Makariou with this third option are shown in Figure 4.12. The cross sections show bus lane widths of 3.5m. This is less than the desirable minimum width for a shared bus/cycle lane of 4m but will still require around 0.5m to be taken from each footway for carriageway widening.

4.4.4 Further more detailed investigation is required to establish the feasibility and impact of this reduction in footway width along the corridor. Where it is deemed not to be desirable the bus lane widths can be reduced further to reduce the impact on pedestrians. If it is shown that additional carriageway widening is feasible in places while still maintaining appropriate provision for pedestrians, then widening the bus lane will enhance the benefits of the scheme to buses and cyclists.

Figure 4.11: Makariou/Kallipoleos Scheme Option 3



Traffic flow forecasts

4.4.1 The VISUM forecasts for Option 2 and 3 are presented in the following figures:

- Figure 4.13 - Comparison of AM peak link flows with Option 1
- Figure 4.14 - Comparison of PM peak link flows with Option 1
- Figure 4.15 - AM peak traffic flows
- Figure 4.16 – AM peak queues and junction delays
- Figure 4.17 – Comparison of AM peak link flows with the Reference Case
- Figures 4.18 to 4.20 – as Figures 4.15 to 4.17 for the PM peak hour

Option 2/3 – key impacts

4.4.2 In general, Option 2 and 3 has a similar impact to Option 1 in the wider area network. In comparison with Option 1, Options 2 and 3 give rise to slightly lower increases in traffic on Stasinou, compared to the Reference Case. However, more traffic is attracted to Makariou in the PM peak in northbound direction.

4.4.3 The reintroduction of general traffic at the northern end of Makariou appears to draw relatively little additional traffic into the Makariou corridor further south. South of Digeni Akrita the increase compared to Option 1 is forecast to be less than 100vph in the AM peak and around 150vph or less in the PM peak.

4.4.4 In Option 3, southbound buses get priority through contra flow bus lanes. This is a positive impact on public transport accessibility and service rates.

Figure 4.12: Cross-section on Makariou Avenue with Option 3

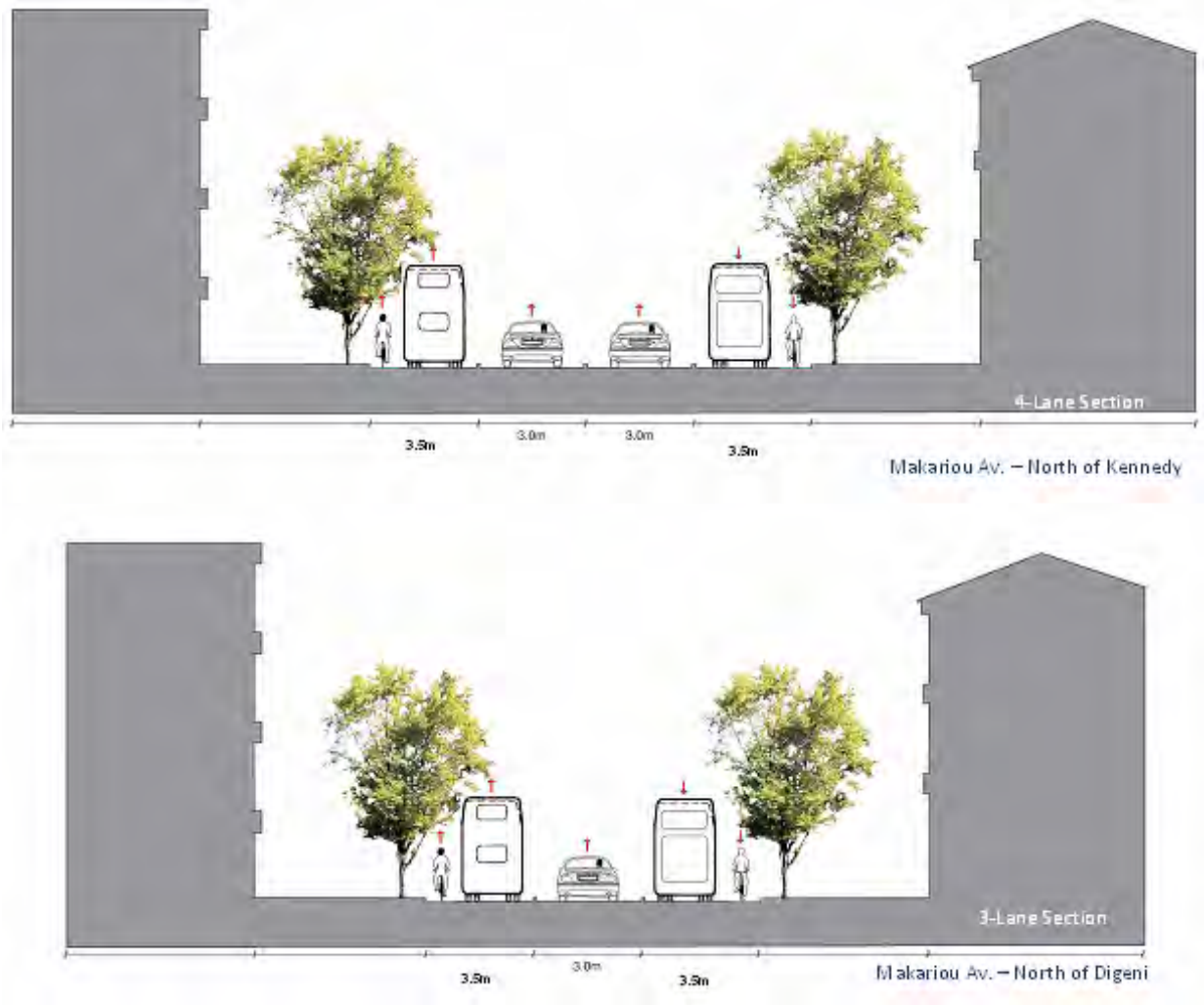


Figure 4.13: Flow comparison between Option 1 and Options 2/3 –AM peak

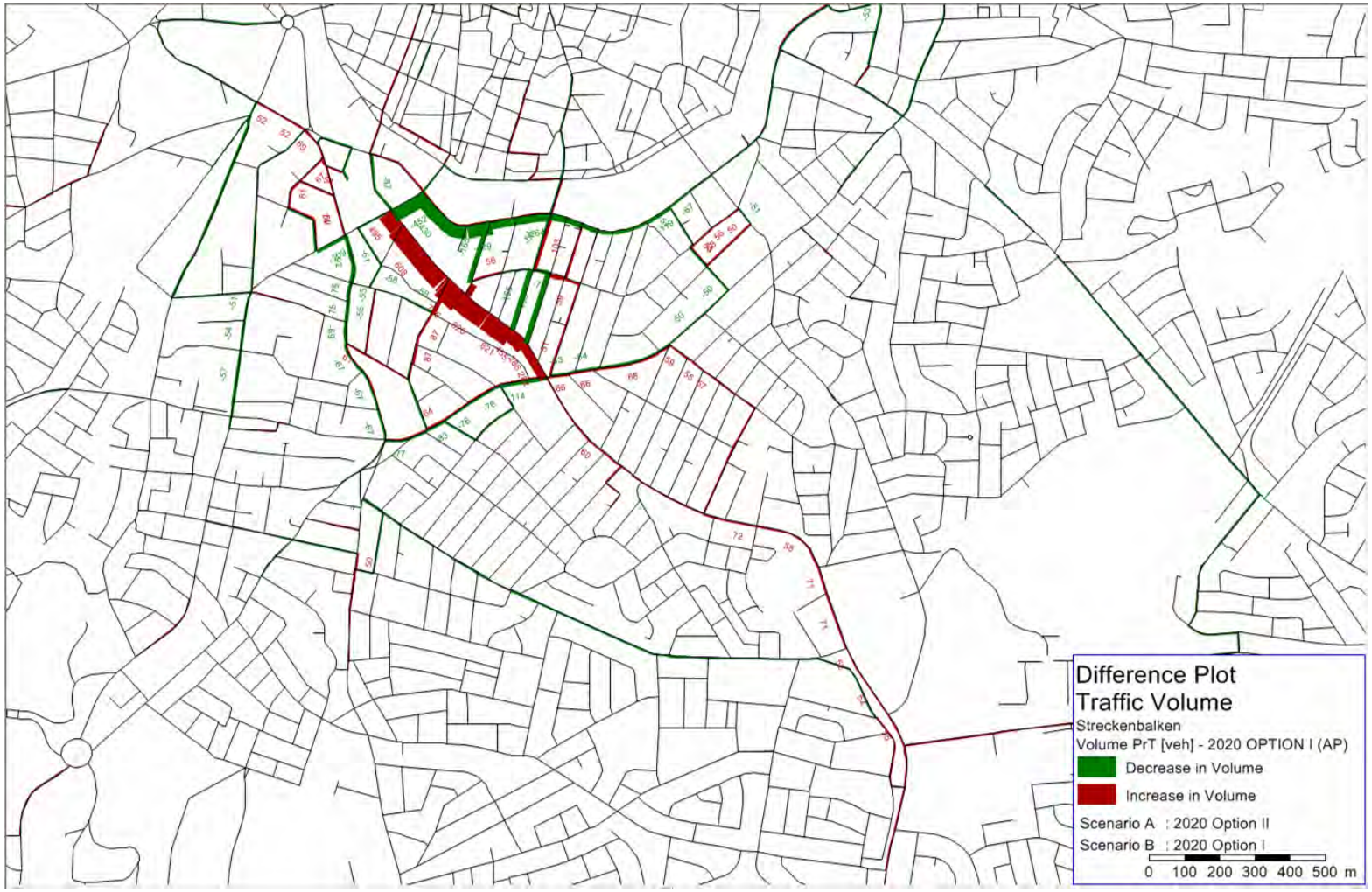


Figure 4.14: Flow comparison between Option 1 and Options 2/3 Scenarios –PM peak

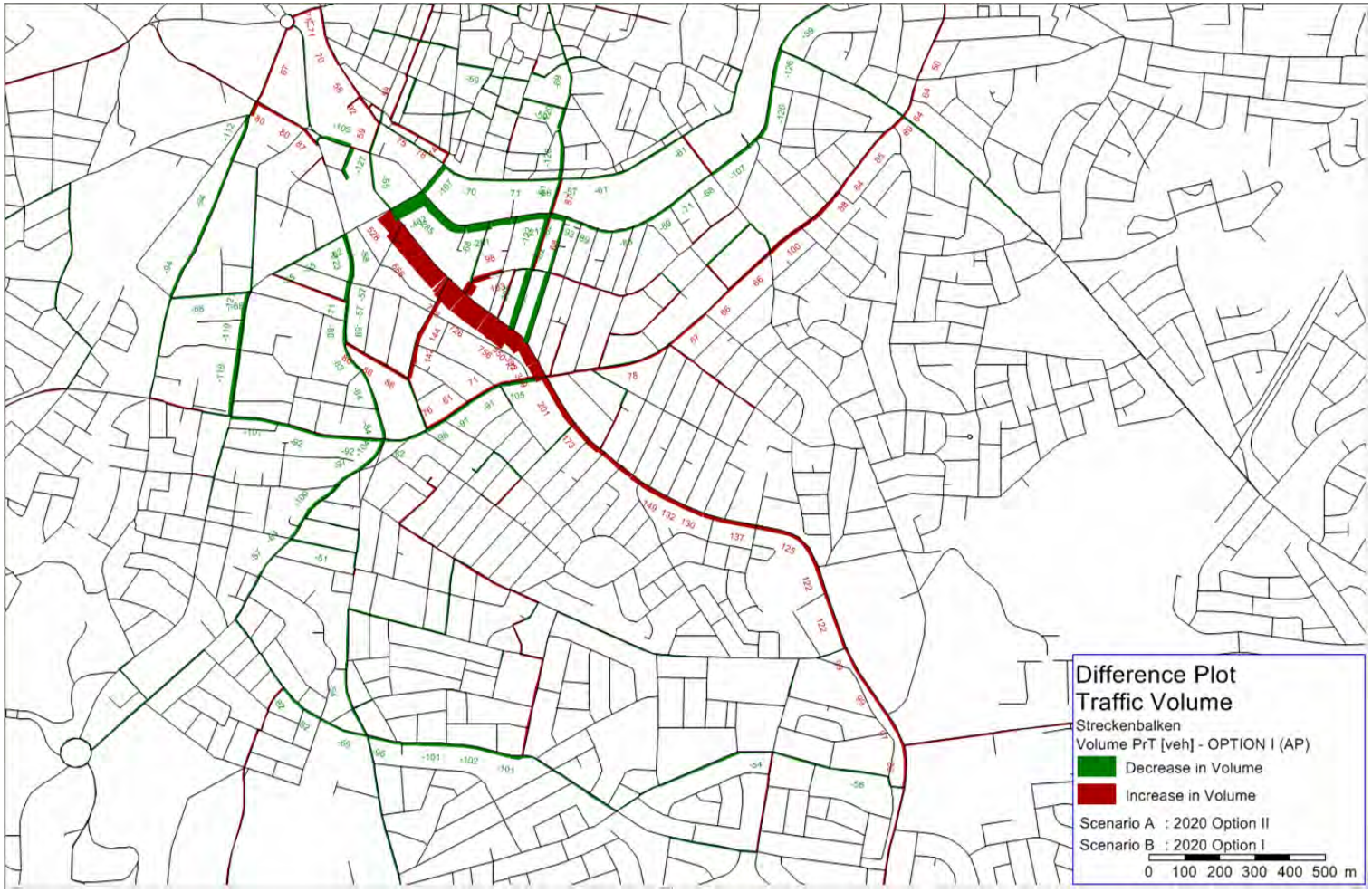


Figure 4.15: Modelled flows in 2020 Options 2/3 – AM peak

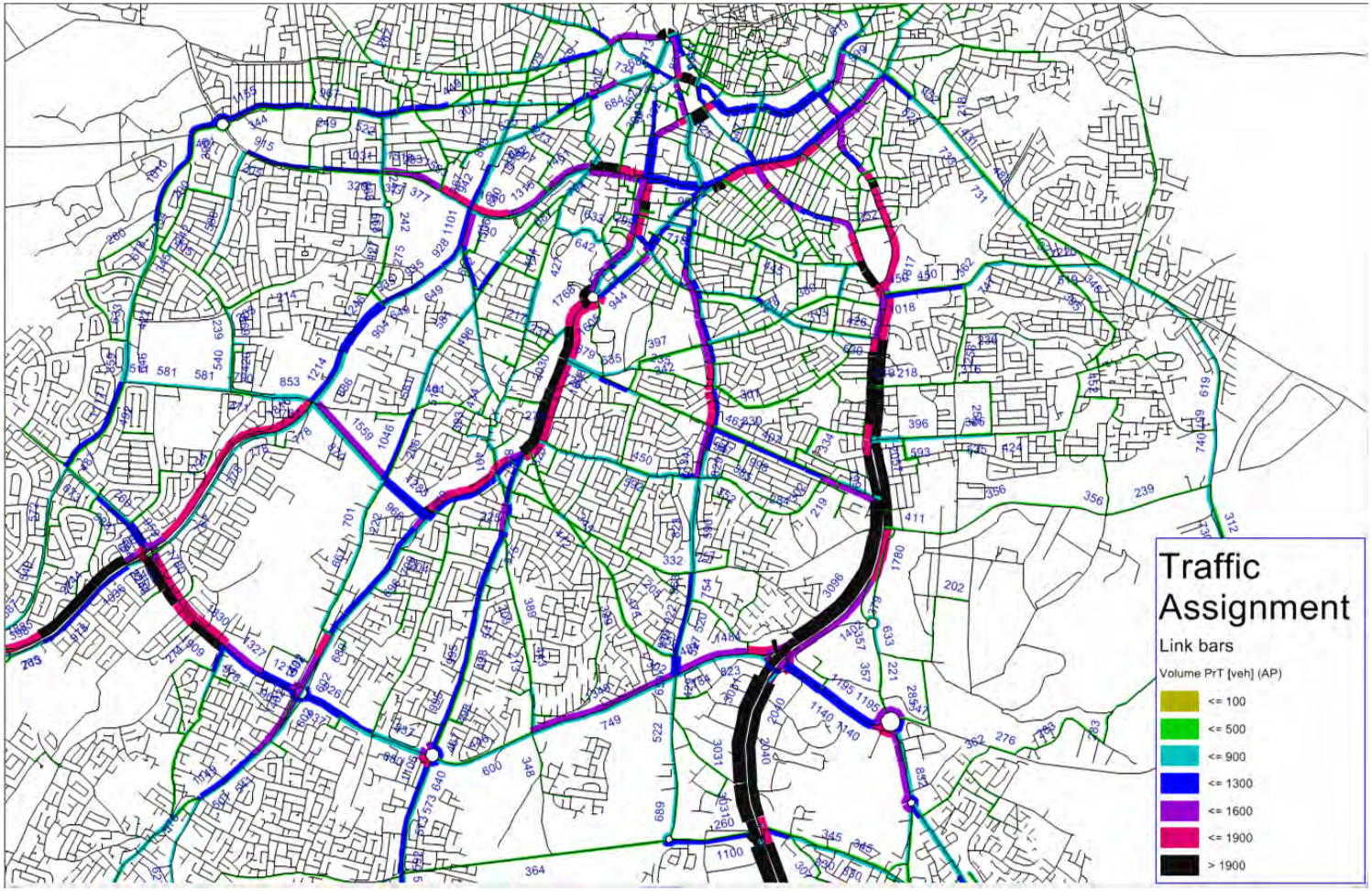


Figure 4.16: Modelled queues in 2020 Options 2/ 3 – AM peak

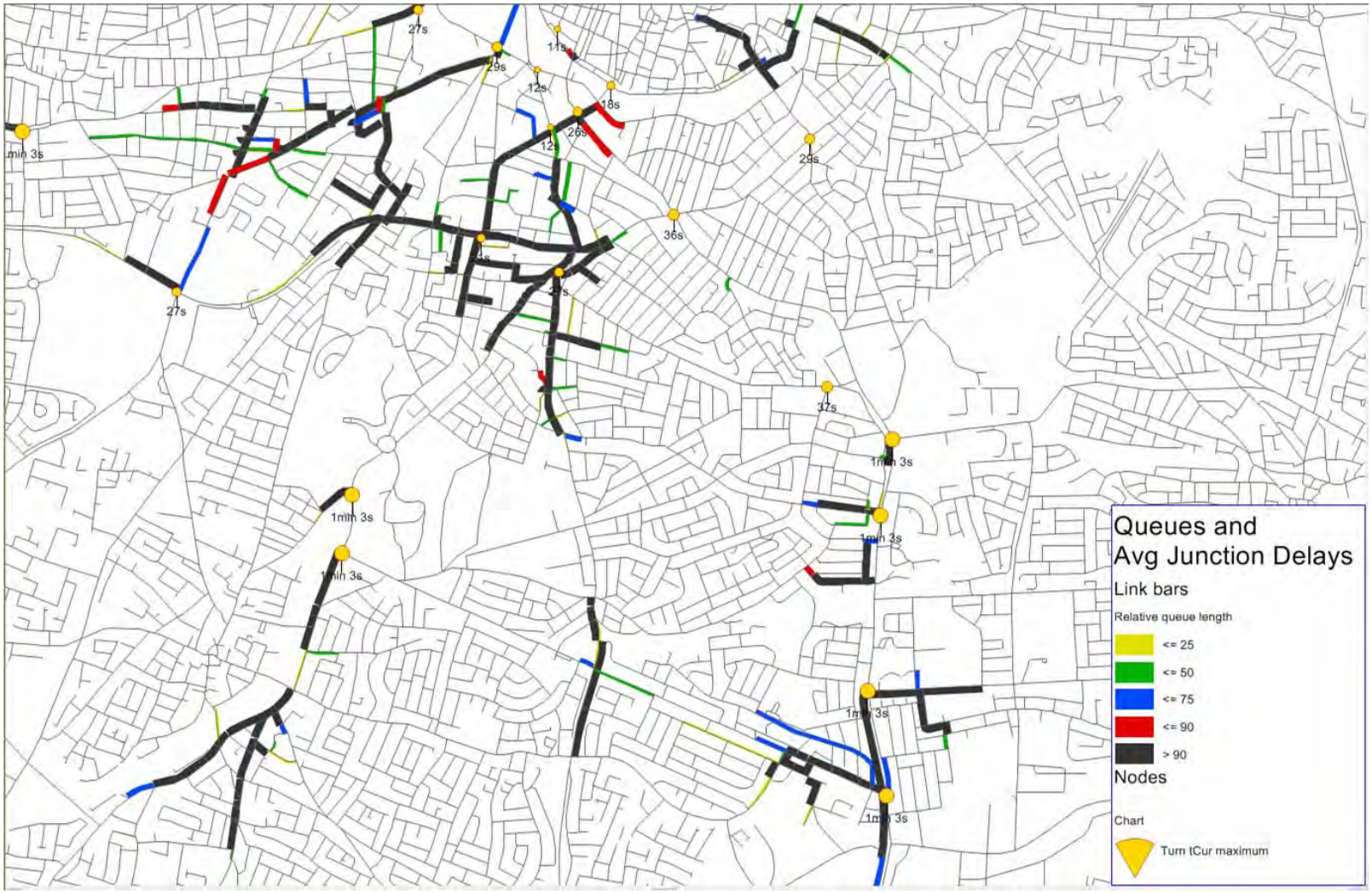


Figure 4.17: Comparison of link flows 2020 Options 2/ 3 vs Reference Case – AM peak

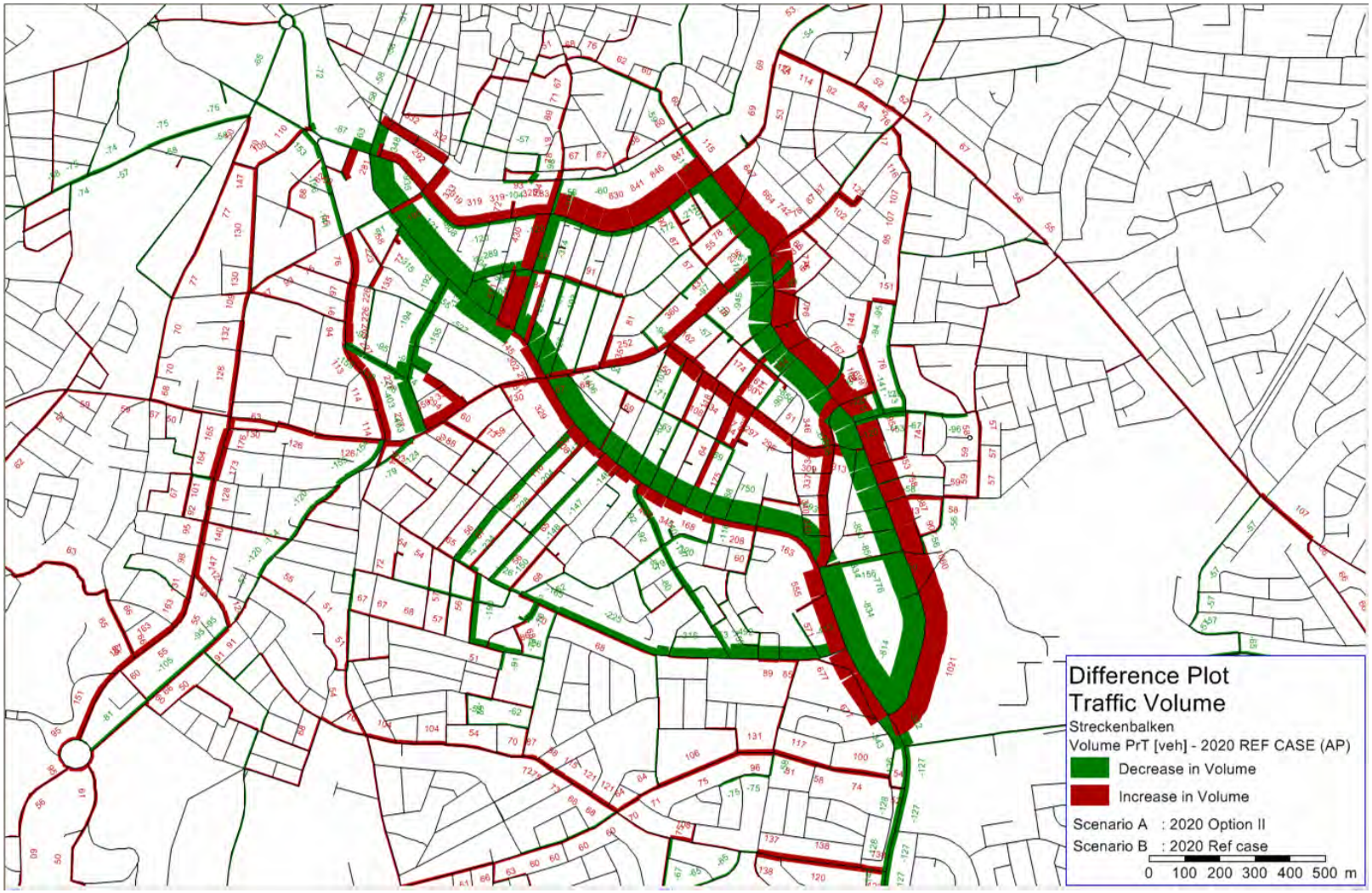


Figure 4.18: Modelled flows in 2020 Options 2/3 – PM peak

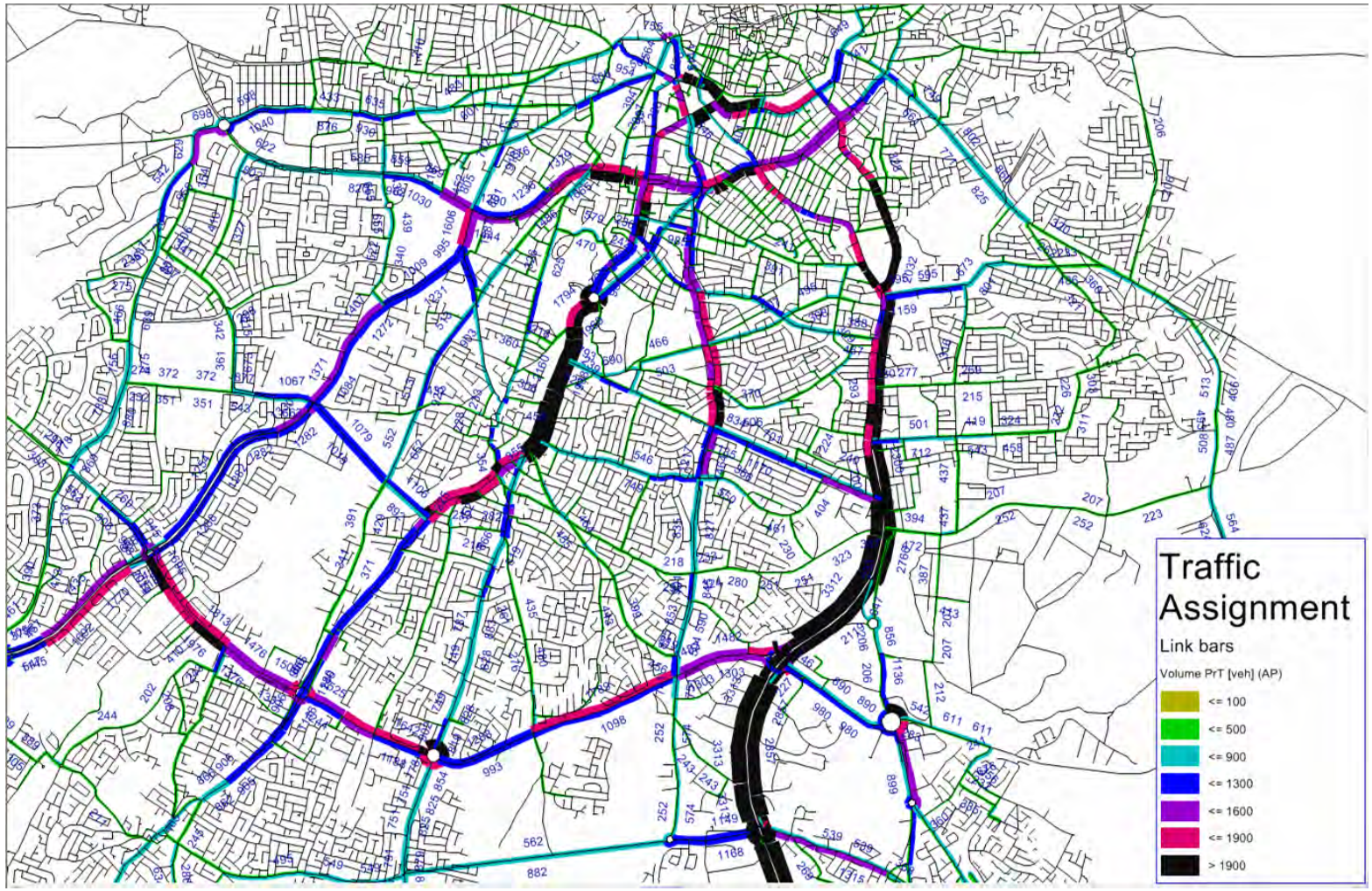


Figure 4.19: Modelled queues in 2020 Options 2/3 – PM peak

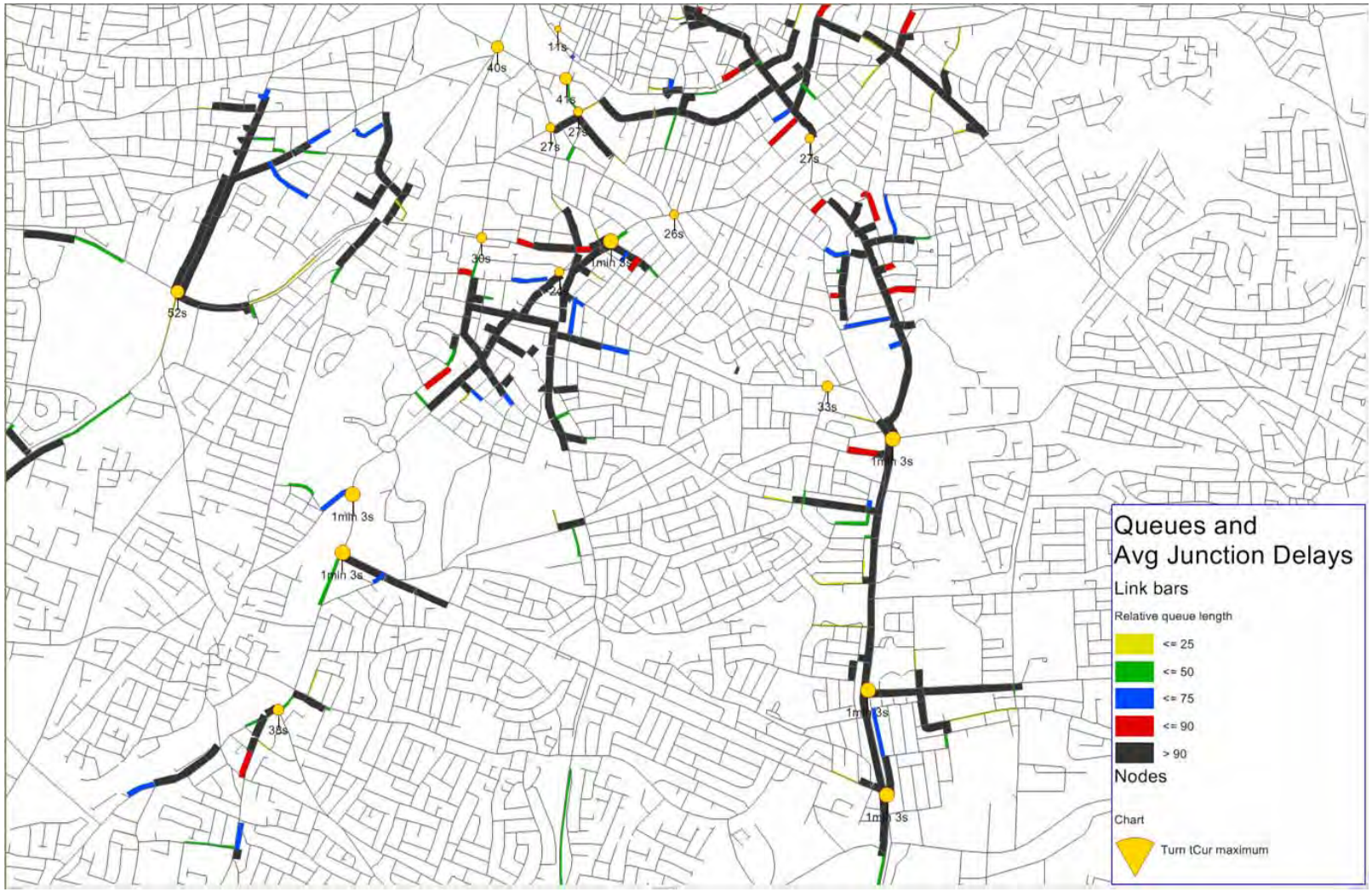
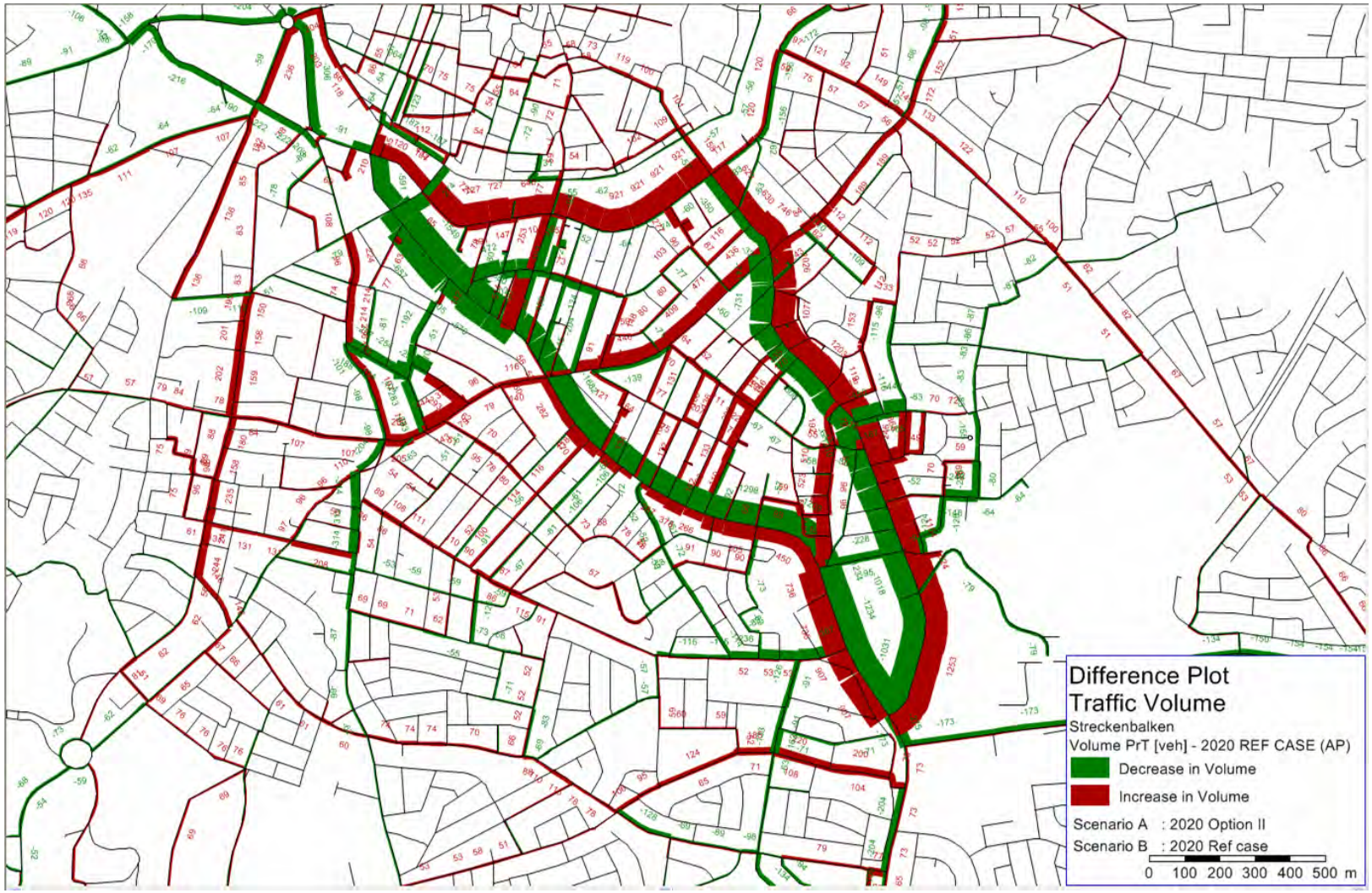


Figure 4.20: Comparison of link flows 2020 Options 2/3 vs Reference Case – PM peak



5 Evaluation framework

5.1 Introduction

5.1.1 An evaluation framework was developed that allowed the performance of options to be measured against the objectives for the scheme. The broad evaluation criteria were agreed at an inception meeting for the study in November 2010. The criteria covered seven categories of potential impact, these being:

1. Impact on network operation
2. Impact on road safety
3. Impact on accessibility
4. Environmental impact
5. Impacts on public transport
6. Impacts on pedestrians
7. Impacts on cyclists

5.1.2 These criteria and their associated measures were developed further in the course of the study and are described in more detail below. The assessments reported in Section 6 compare the options with the Reference Case and with each other based on the performance measures described.

5.2 Network operation

5.2.1 The operation of the road network under each scenario has been assessed through the comparison of travel times, delays and speeds. In particular the following have been analysed:

- Average travel times and speeds on the strategic road network
- Average delays per vehicle and average speeds on the local area network
- Total number of vehicles using the network (a measure of overall network capacity)
- Journey times on selected routes

5.2.2 The impacts on delays at junctions in the study area have been evaluated. The main junctions are listed in Table 5.1.

Table 5.1: Main junctions

Ref. no.	Junction	Junction type
1	Lemesou/Aglantzias	Signals
2	Arch. Makariou/Kallipoleos	Signals
3	Arch. Makariou/Kennedy	Signals
4	Arch. Makariou/E. Frouras	Signals
5	Kallipoleos/E. Frouras	Signals
6	Arch. Makariou/D. Akrita	Signals
7	Kallipoleos/D. Akrita	Signals
8	Sp. Kyprianou/Th. Dervi/Nikis	Signals

5.3 Road safety

5.3.1 Improving road safety is one of the key objectives of the IMMP traffic schemes.

5.3.2 One measure of the impact of an option on road safety could be the impact the scheme has at existing accident 'black spots'. This can be measured in terms of changes in:

- Link speeds
- Link flows
- Number of conflict points/movements

5.3.3 However, no 'black spots' were identified in the study area.

5.3.4 Hence, potential impacts on road safety have been measured by:

- Changes in average speeds by link type
- Changes in the number of conflict points at the major junctions

5.4 Accessibility

5.4.1 Changes in average (weighted by the number of trips) travel times and distances to and from selected zones within the study area have been evaluated, to measure the impact of options on accessibility for local residents and to local businesses.

5.5 Environmental impacts

5.5.1 The environmental impact of options has been measured in terms of changes in traffic flows (vehicle/kilometres) by road type.

5.5.2 In addition, changes in traffic flows on Makariou and Kallipoleos, and on 'sensitive' local streets have been assessed separately. Sensitive streets have been defined as those containing land uses such as schools, hospitals, and old persons homes.

5.6 Impacts on public transport

5.6.1 The impact that options may have on bus services is assessed by considering changes in average bus speeds and journey times for routes operating within the study area.

5.6.2 The impact on bus passenger access times to stops was also evaluated on a qualitative basis.

5.7 Impacts on pedestrians

5.7.1 The impact on pedestrians has been evaluated with reference to the scope afforded by each option for:

- Footway widening
- Additional pedestrian crossings
- Improved crossings at junctions, e.g. through simplified signal stage design - more direct crossings, longer green times etc.

5.8 Impacts on cyclists

5.8.1 These have been evaluated with reference to the standard of provision for cyclists that is feasible with each option compared to the Reference Case. Factors taken into consideration were:

- Is provision in the form of dedicated or shared spaces for cyclists?
- The widths of dedicated or shared facilities, compared to desirable minimum widths

6 Comparative assessment of options

6.1 Overview

6.1.1 Options have been assessed with reference to their impacts in the AM and PM peak hours on the evaluation measures described in Section 5. These measures covered seven categories of impact, which were:

1. Impact on network operation
2. Impact on safety
3. Impact on accessibility
4. Environmental impact
5. Impacts on public transport
6. Impacts on pedestrians
7. Impacts on cyclists

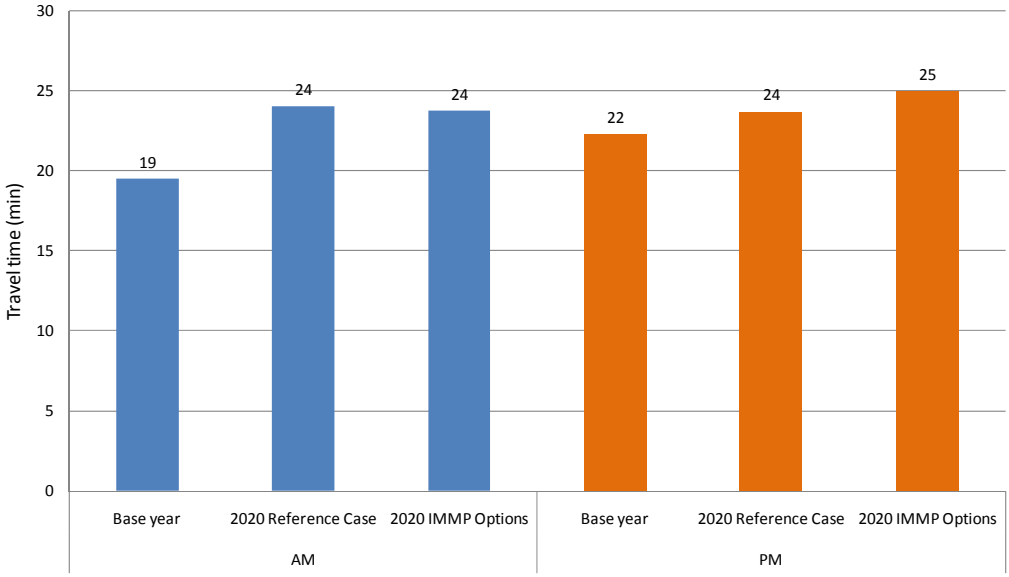
6.1.2 The performance of the options is discussed below, for each category of impact in turn. A comparison is first made between the 2020 Reference Case and the base (2010) situation, and then between the options and the Reference Case and between the options themselves.

6.2 Network operation

Strategic network

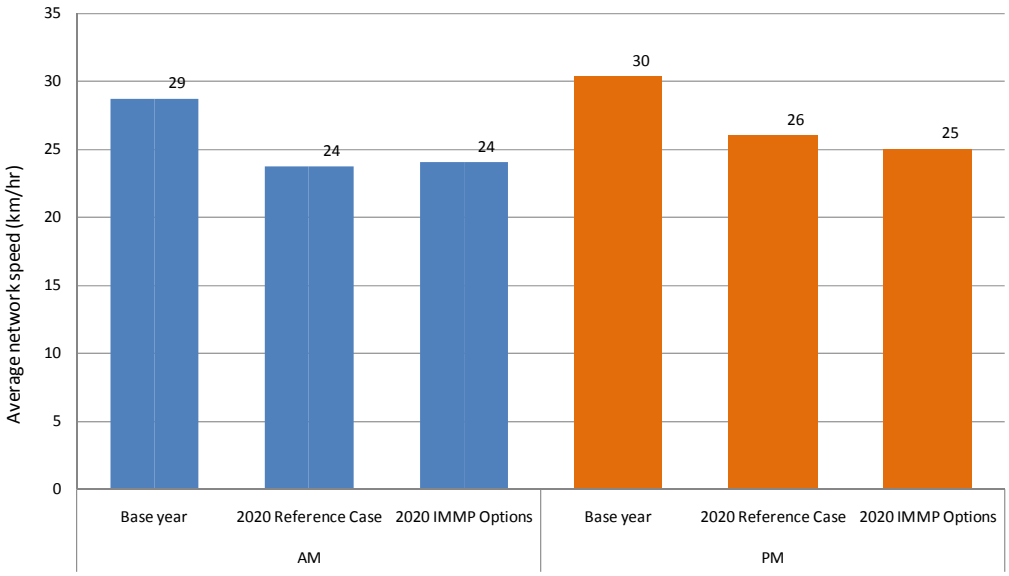
6.2.2 The operation of the network was first considered at the strategic level. Figure 6.1 shows that, as may be expected, average travel times (in minutes per trip) increase between 2010 and 2020. However, there is then little difference in 2020 between the Reference Case and the three options. It should be noted that there will be substantial spatial variations hidden with these averages.

Figure 6.1: Comparison of average travel time on the strategic network



6.2.3 Average network speeds (in kilometres per hour) are compared in Figure 6.2. Again as may be expected, these decrease between 2010 and 2020 despite the highway improvement schemes assumed to be implemented. There is then, again, little difference in 2020 between the Reference Case and the three options.

Figure 6.2: Comparison of average speeds on the strategic network



Operation of the local area network

6.2.4 The operation of the road network within the study area (the microsimulation area) has also been assessed for each peak period by comparing vehicle hours and vehicle kilometres in each scenarios. Flows, delays and speeds at key points in the network have also been compared.

AM peak

6.2.5 The average delay per vehicle in the AM peak hour is shown in Figure 6.3 and average speeds are shown in Figure 6.4. It can be seen that delays increase (and speeds reduce) markedly between the 2010 base scenario and the 2020 Reference Case. With all three options delays are forecast to reduce to below (and speeds to increase above) the levels in 2010. Of the options, delays and speeds are forecast to be similar for Options 1 and 2. Delays are highest and speeds lowest with Option 3.

Figure 6.3: Comparison of average network delay – AM peak

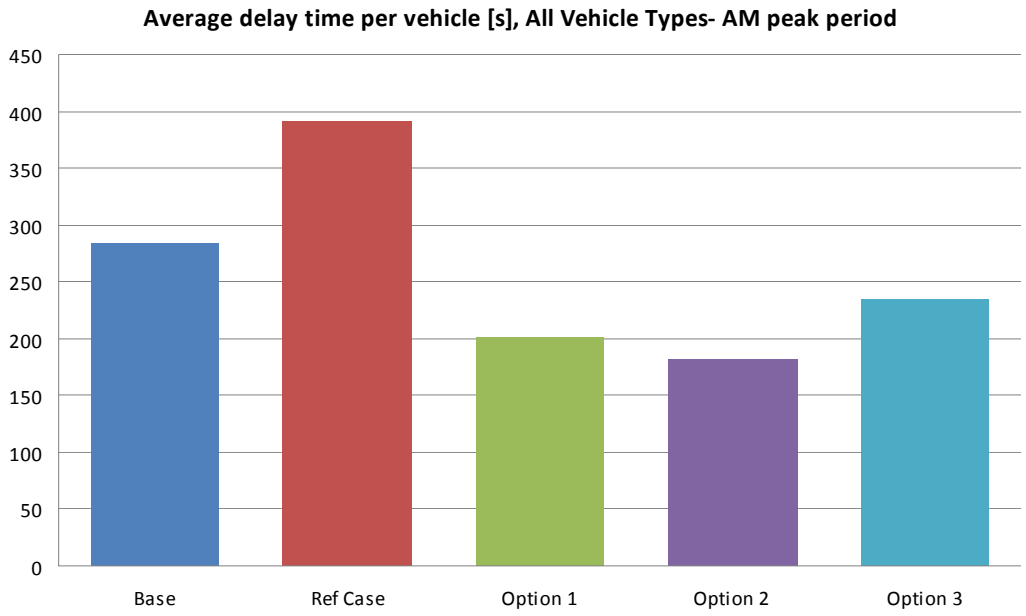
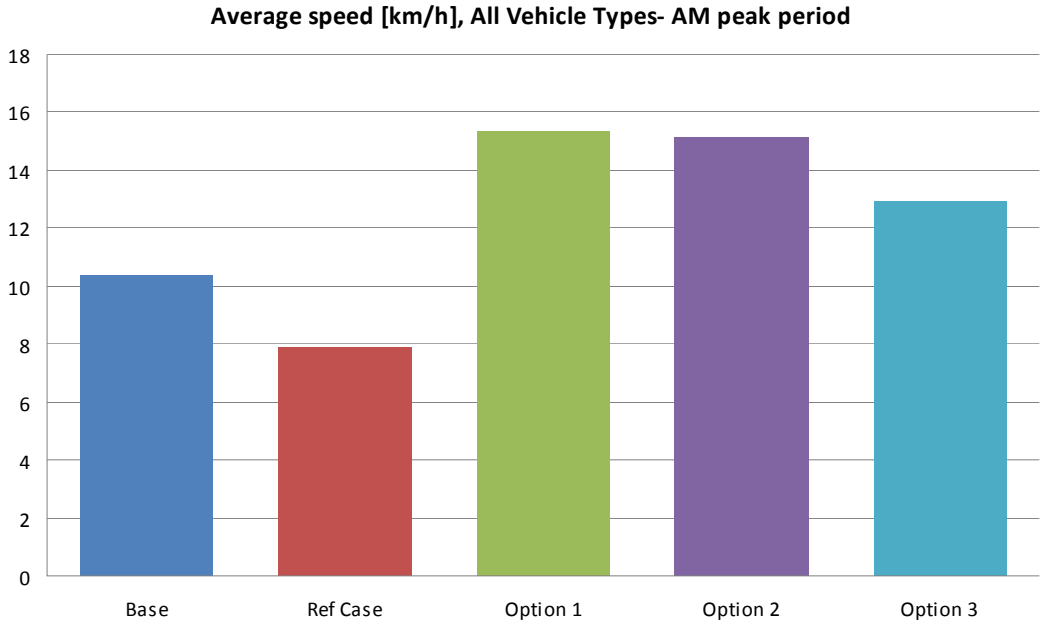
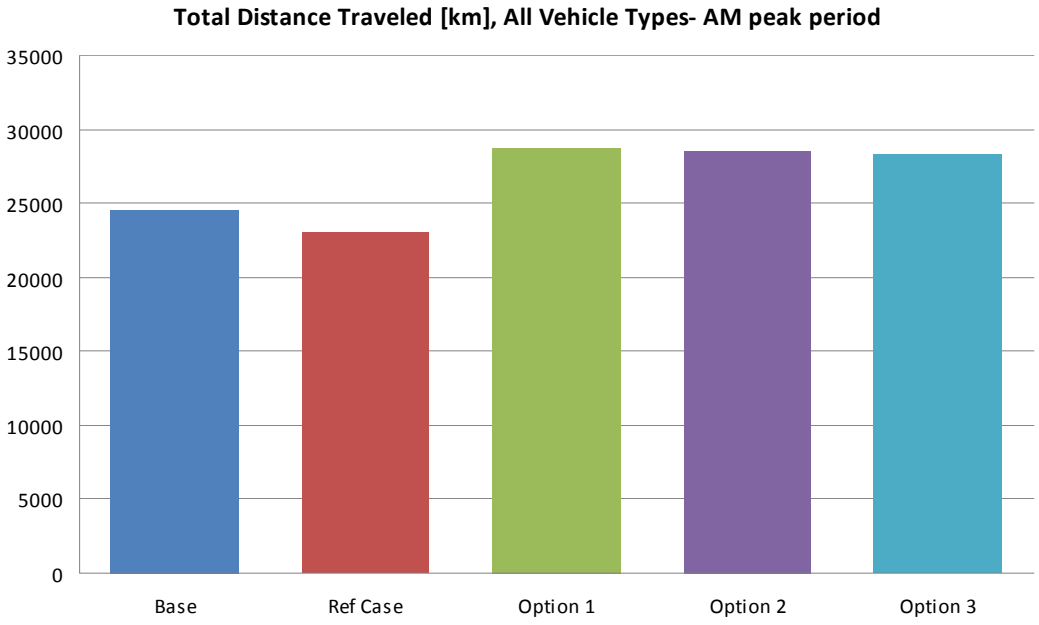


Figure 6.4: Comparison of average network speed – AM peak



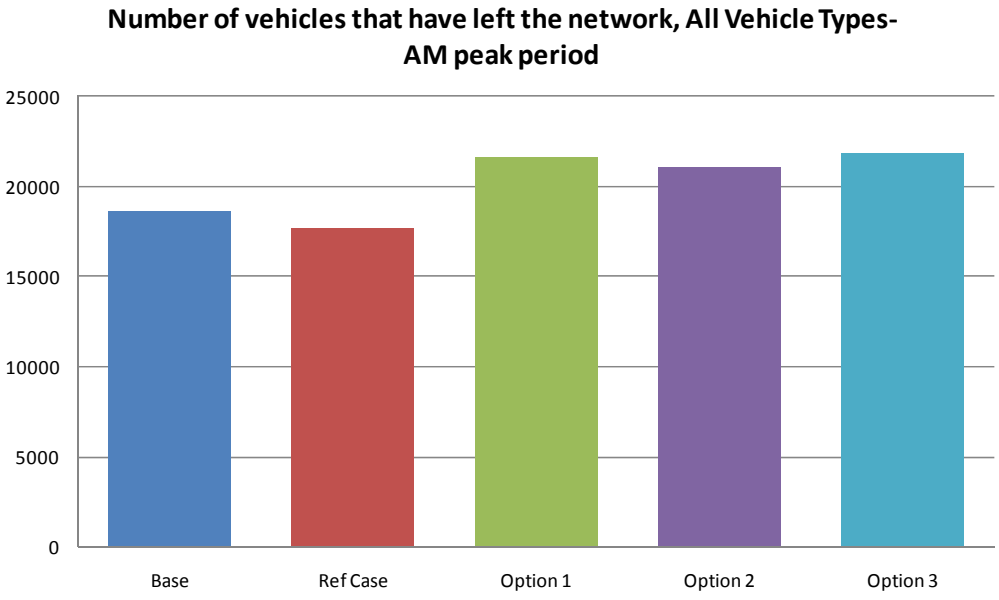
6.2.6 The total distance travelled within the study area increases with the options, as a direct result of the extra distances involved in using the one-way system. This is demonstrated by Figure 6.5 which also shows that there is little difference between the options on this measure.

Figure 6.5: Comparison of total vehicle-kilometres – AM peak



6.2.7 When comparing the overall network capacity or throughput (Figure 6.6) –measured in VISSIM as the number of vehicles that have left the network - it can be seen that this decreases between 2010 and 2020 but is increased significantly by each of the scheme options. This is a result of the reductions in traffic conflicts on the network due to the one ways system. The performance of the three options is very similar on this measure.

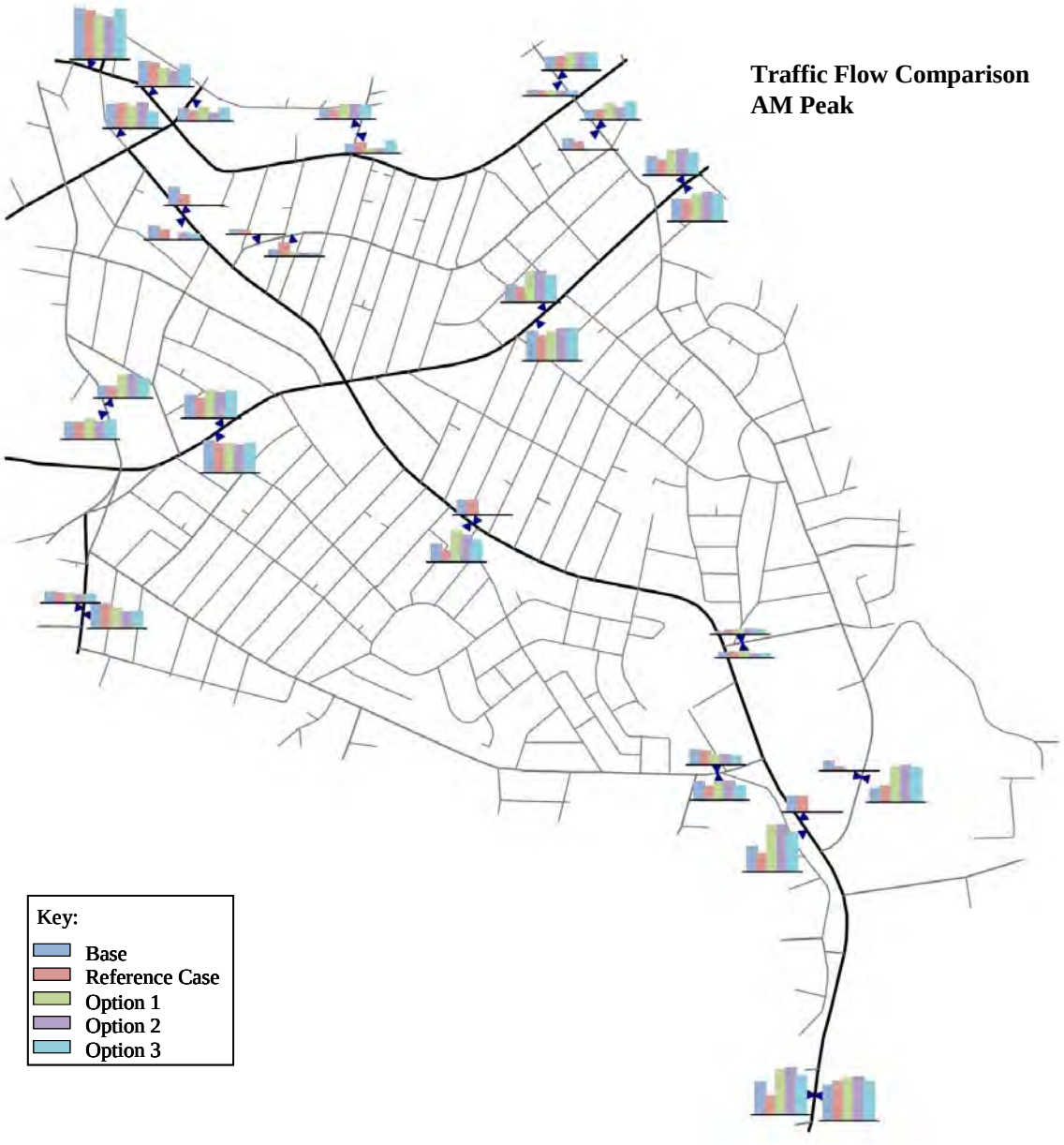
Figure 6.6: Comparison of total network throughput– AM Peak



6.2.8 A more detailed consideration of specific links and junctions has also been undertaken. There are a number of important junctions in the study are network, and the critical ones were listed in Table 5.1.

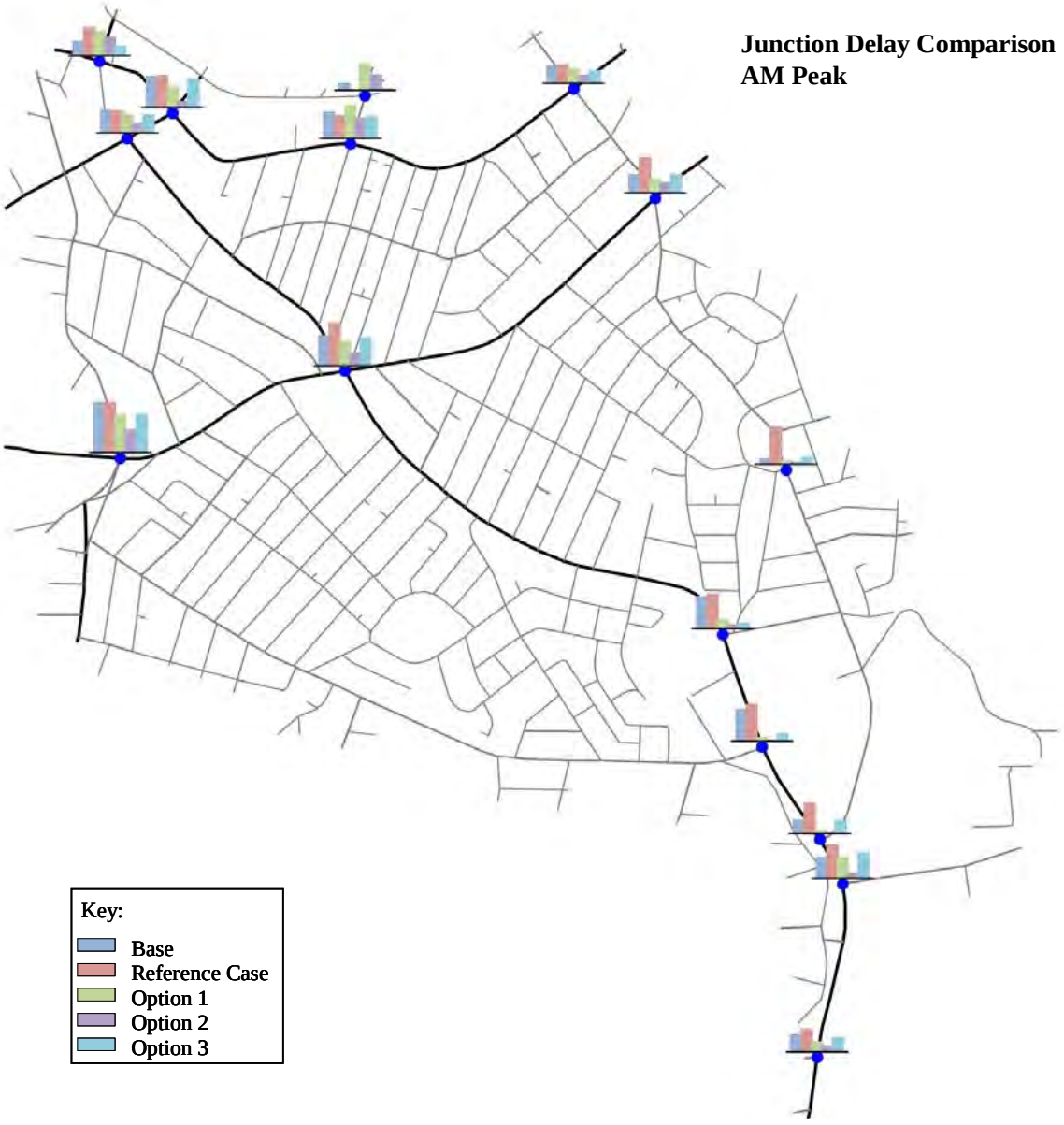
6.2.9 Figure 6.7 shows the relative flow levels on links (by direction) for all scenarios. The patterns are more or less what would be expected with the introduction of the one-way system, with less variability on the peripheral links, and increases on links forming the one-way system, as traffic is channelled.

Figure 6.7: Comparison of flows on links – AM peak



6.2.10 There is a general reduction in junction delays with the three options compared to the Reference Case (Figure 6.8), particularly at junctions along Makariou and Kallipoleos. With Option 1, however, there is some increase in delays on Stasinou.

Figure 6.8: Comparison of delays at junctions – AM peak



6.2.11 Figure 6.9 compares spot speeds across the network under each scenario. Speeds with the three options are generally similar and higher than in the Reference Case and in the 2010 base scenario. This is further illustrated by Figure 6.10 which shows changes in spot speeds between 2010 base and the 2020 scenarios.

Figure 6.9: Comparison of spot speeds – AM peak

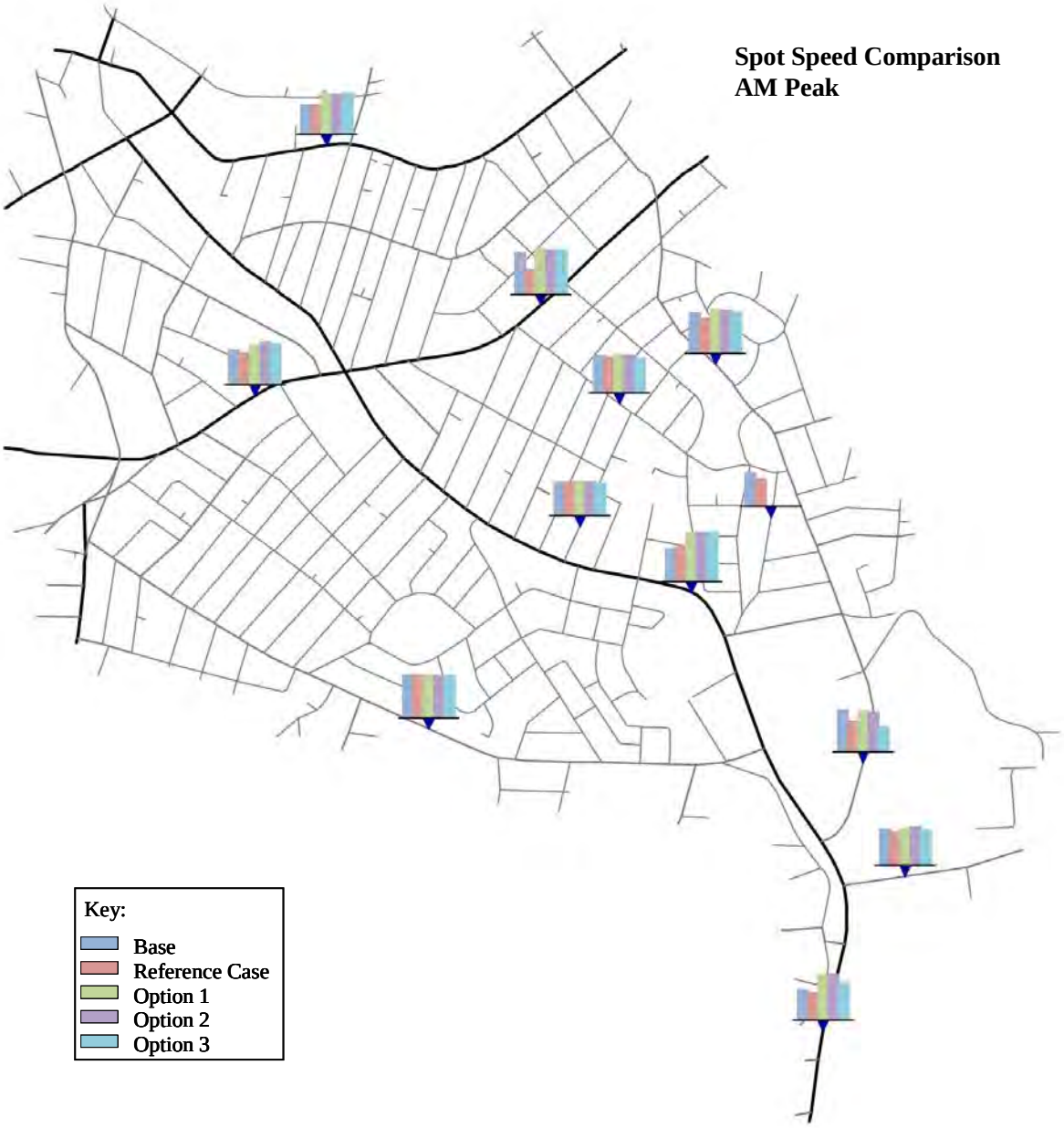
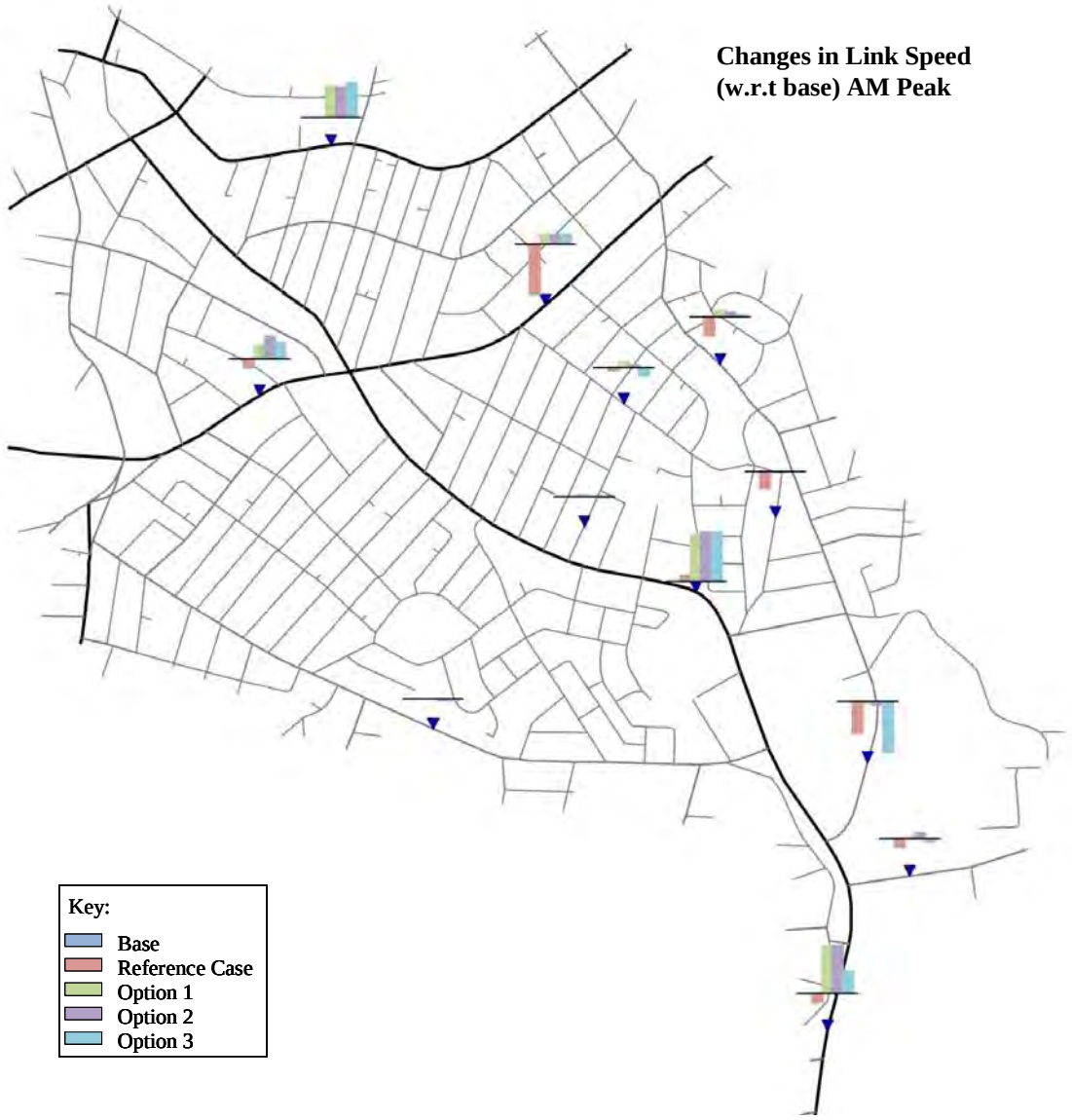


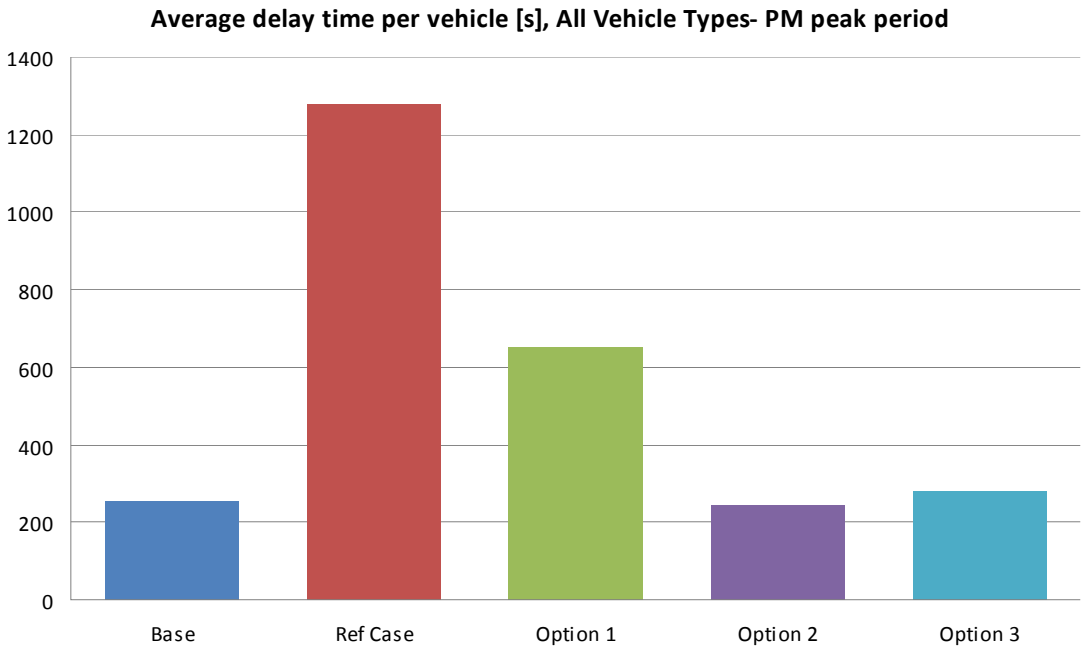
Figure 6.10: Changes in spot speeds – AM peak



PM peak period

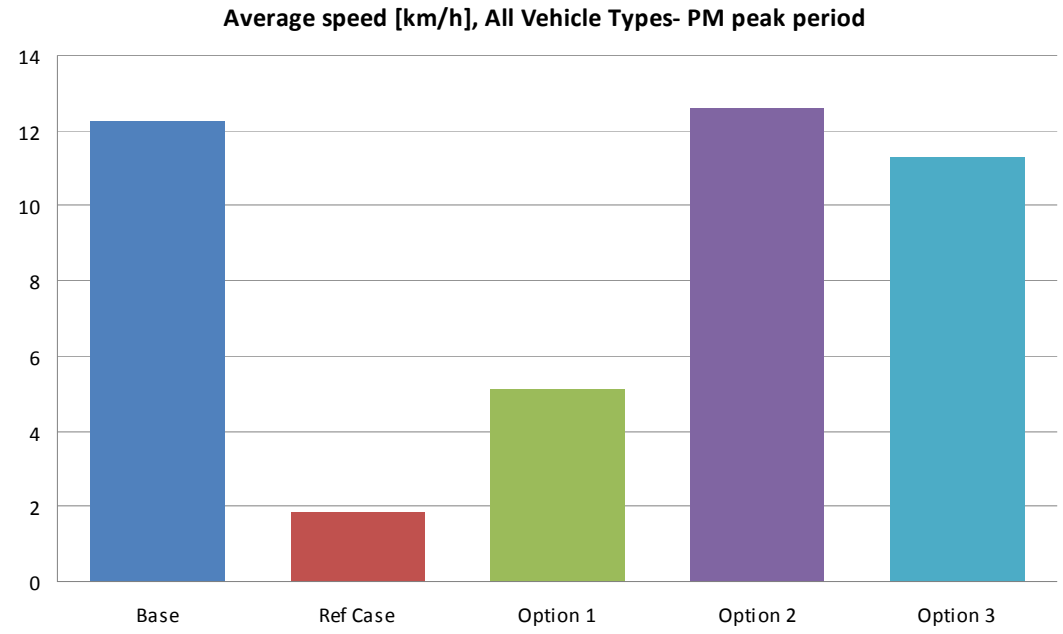
6.2.12 As in the AM peak period, average delay per vehicle (Figure 6.11) is substantially reduced as a result of all the scheme options. However, while with Options 2 and 3 delays are not dissimilar at between around 210 and 220 seconds per vehicle (similar to those in the 2010 base case) with Option 1 they are significantly greater at over 600 seconds per vehicle (still less than in the Reference Case).

Figure 6.11: Comparison of average network delay – PM peak



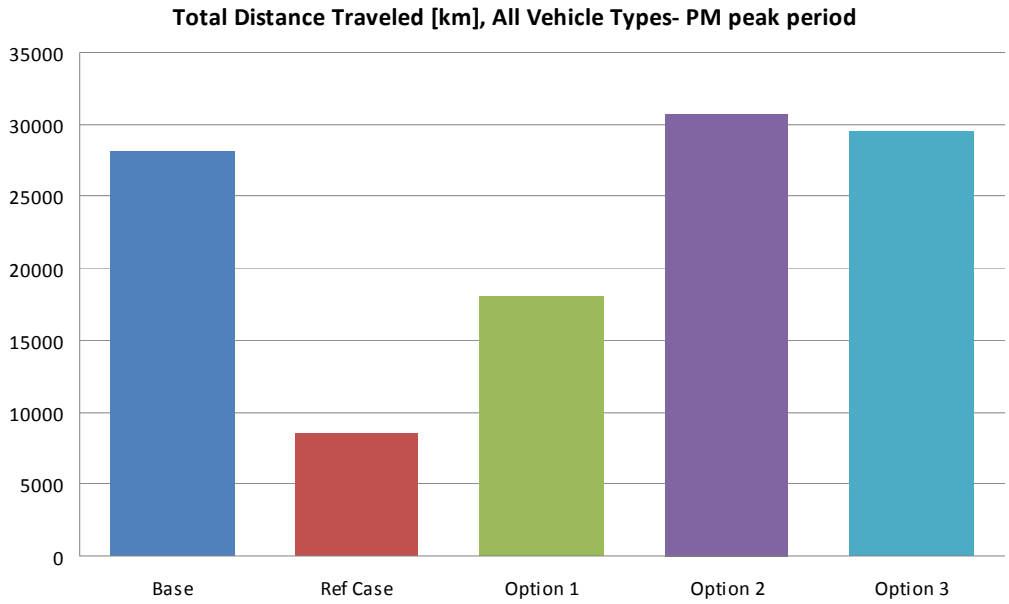
6.2.13 Average speeds on the local area network are shown in Figure 6.12 and mirror the picture described above with regards to comparative delays. It will be noted, however, that speeds during the PM peak period increase less with the scheme options than was the case in the AM peak period.

Figure 6.12: Comparison of average network speed – PM peak



6.2.14 As in the AM peak period, total distance (vehicle kilometres) increase with all options due to the one way system (Figure 6.13). The increase is greatest for Options 2 and 3.

Figure 6.13: Comparison of total vehicle-km – PM peak



6.2.15 As with the AM peak, the number of vehicles that have left the detailed study area network has also risen, due to the reduction in capacity for general traffic. This seems to be at lower levels than the AM peak in some of the scenarios, as shown in Figure 6.14.

Figure 6.14: Comparison of total network throughput– PM peak

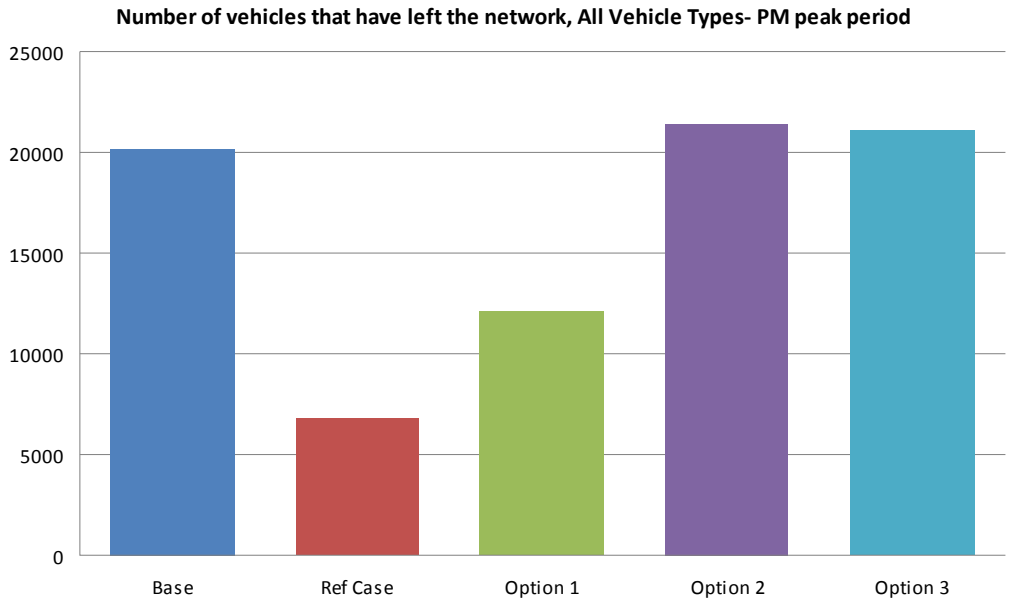
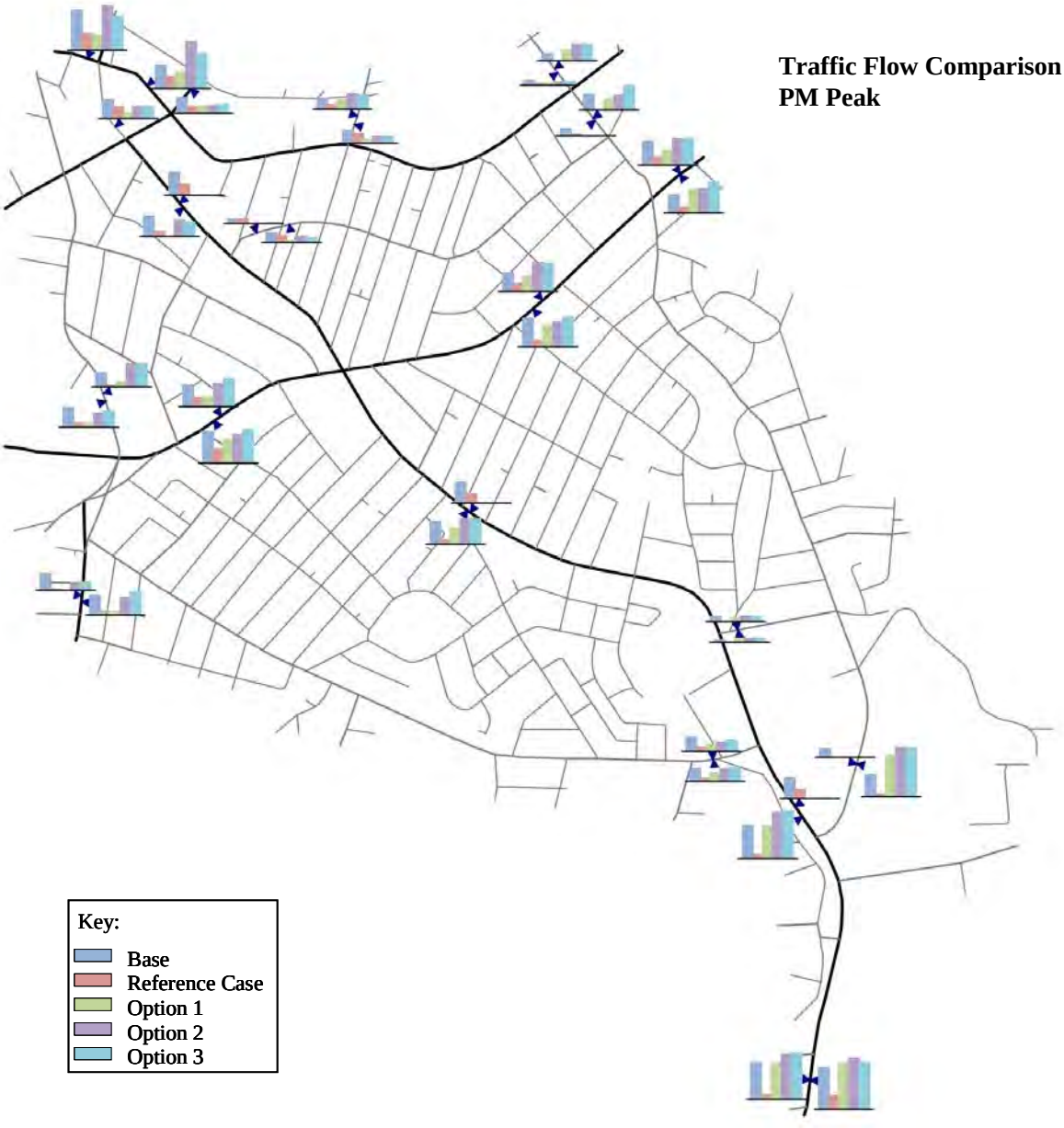


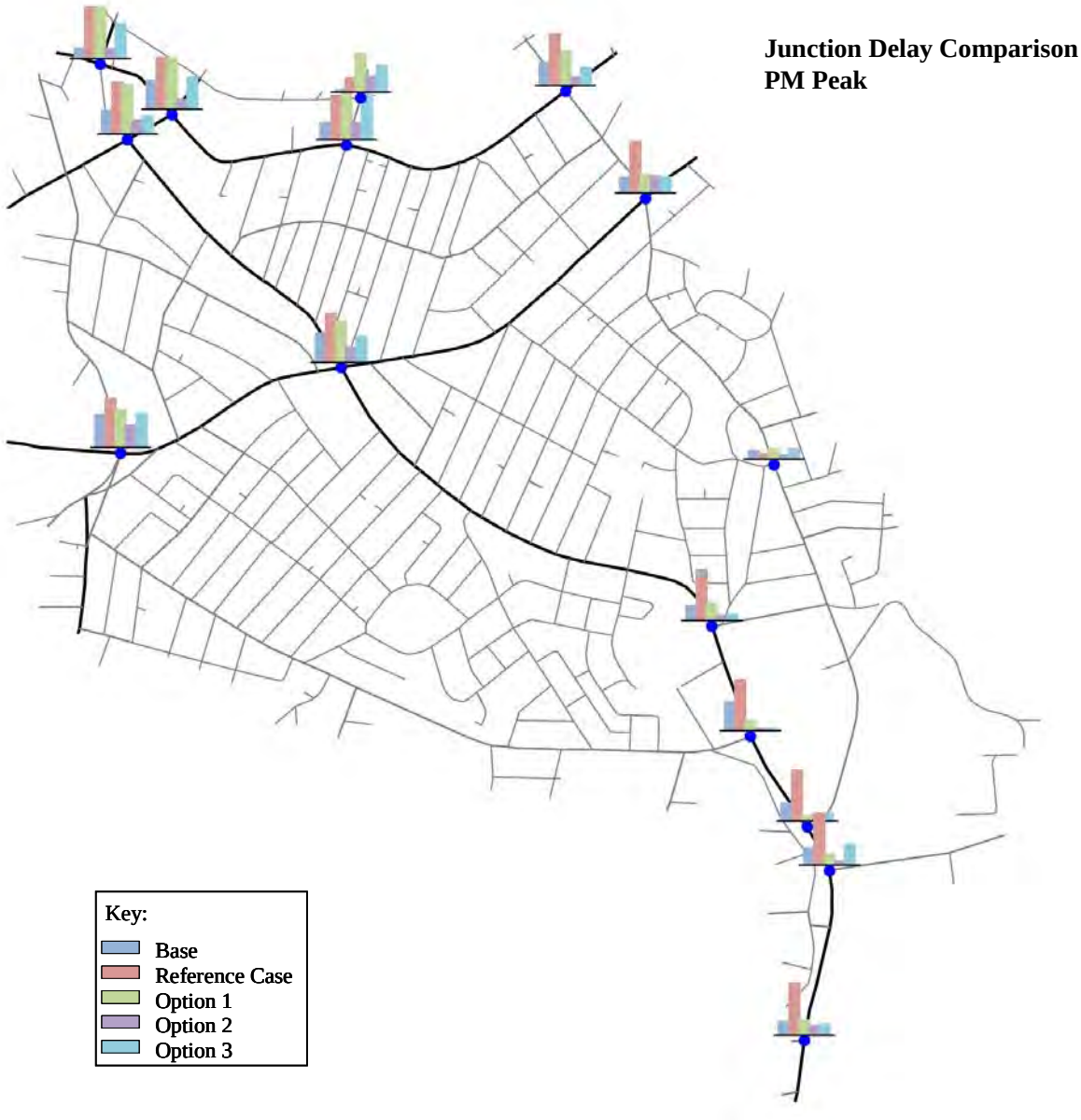
Figure 6.15: Comparison of flows on links – PM peak



6.2.16 Figure 6.2.15 compares link flows with each scenario while Figure 6.16 compares junction delays. As in the AM peak period flow changes are greatest within the one way system. At the southern end of the Makariou/Limassol Avenue corridor Reference Case flows show the 'bottleneck' effect of congestion at the junctions feeding this section of the network.

6.2.17 Figure 6.16 shows that all three options substantially reduce the delays evident in the Reference Case, particularly at the southern end of Makariou/Limassol Avenue. With Option 1, however, delays on Stasinou are similar to those in the Reference Case and substantially greater than with Options 2 and 3. These patterns similar to those evident in the AM peak period.

Figure 6.16: Comparison of delays at junctions – PM peak



6.2.18 The spot speed comparisons presented in Figures 6.17 and 6.18 shows that some increases occur with the options, but generally spot speeds remain similar across the network. This pattern is similar to that discussed earlier for the AM peak period

Figure 6.17: Comparison of spot speeds – PM peak

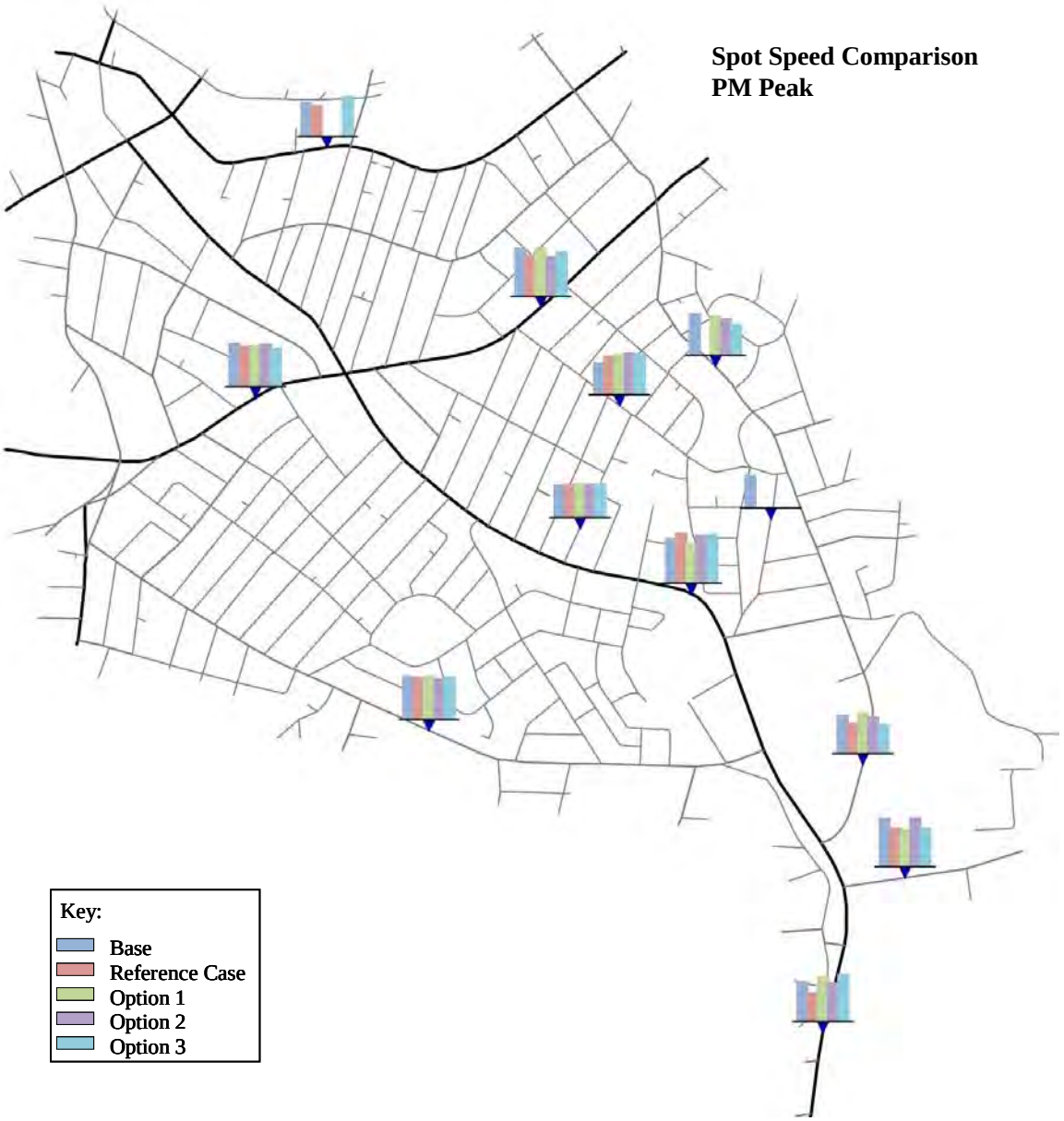
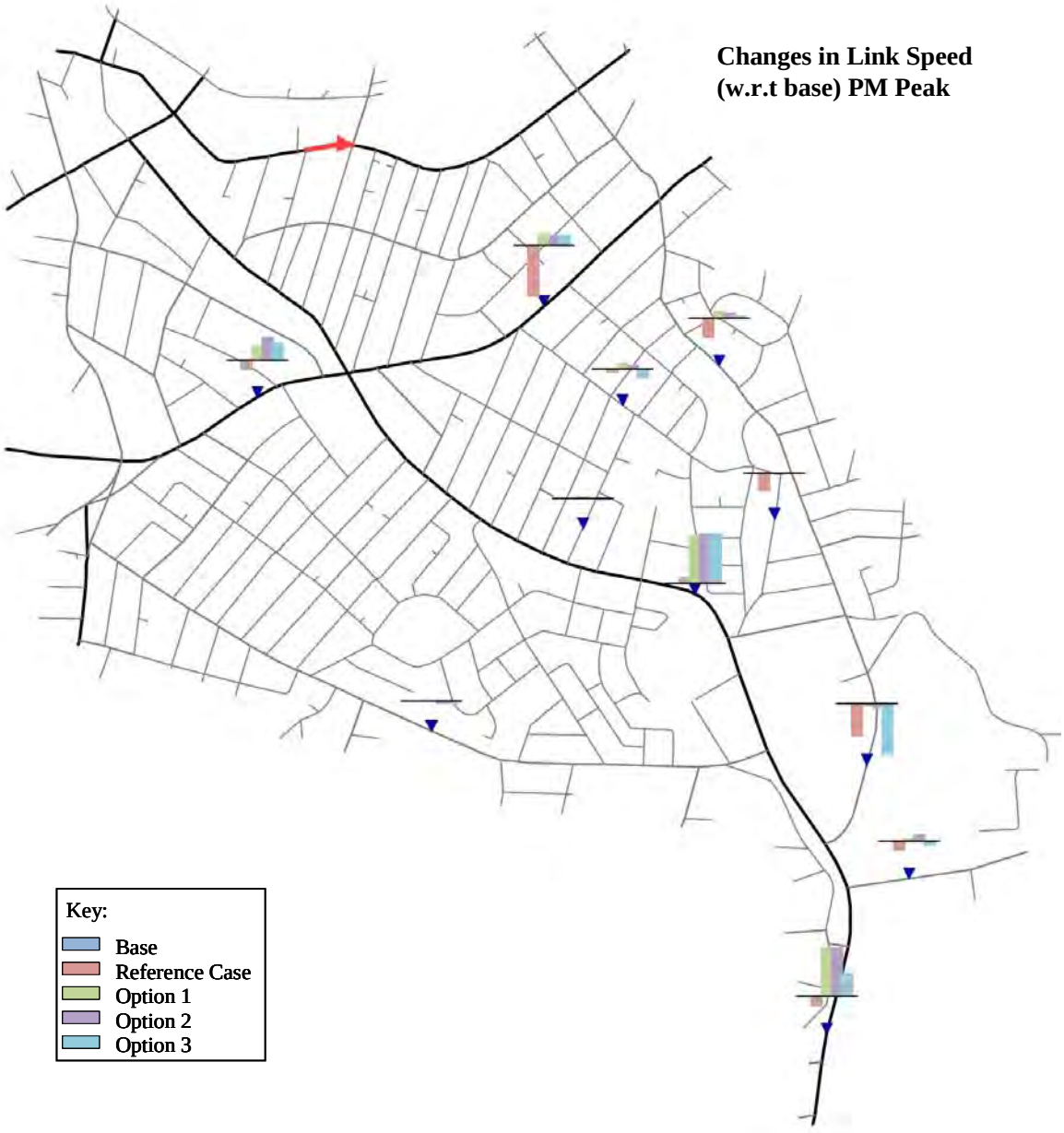


Figure 6.18: Changes in spot speeds – PM peak



6.2.19 The journey times on the following routes within the study area have also been compared:

- Makariou - northbound;
- Kallipoleos - southbound;
- Grivas Digeni - both directions;
- Kennedy Av - both directions.

6.2.20 As can be seen in Figure 6.19 the three options generally reduce journey times on these routes in the AM peak period. However, with Option 3 journey times on Kallipoleos southbound show little reduction while on Kennedy eastbound they are forecast to increase. This is as a result of junction delays associated with facilitating the contra-flow bus lane.

6.2.21 In the PM peak period (Figure 6.20), all options perform well compared to the Reference Case and generally reduce journey times to levels not dissimilar to those in 2010. However, with Option 1 the reduction in journey times compared to the Reference Case is less marked on Makariou northbound, while they are forecast to increase on Georgiou Grivas Digeni westbound.

Figure 6.19: Comparison of network journey times (minutes) – AM peak

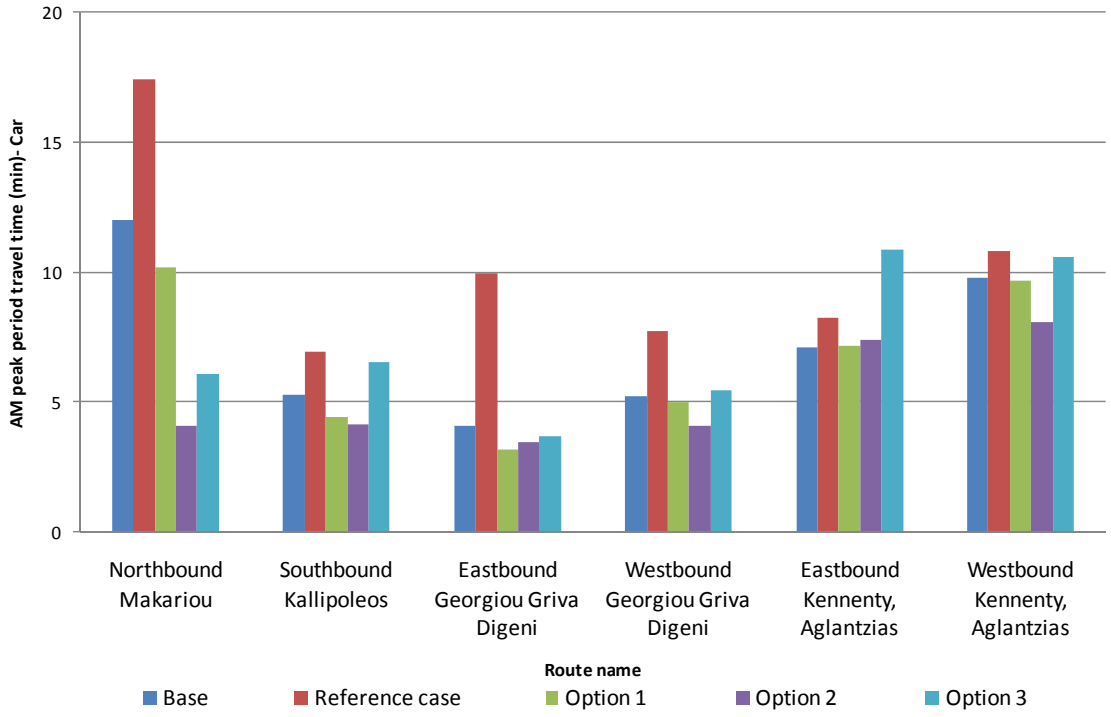
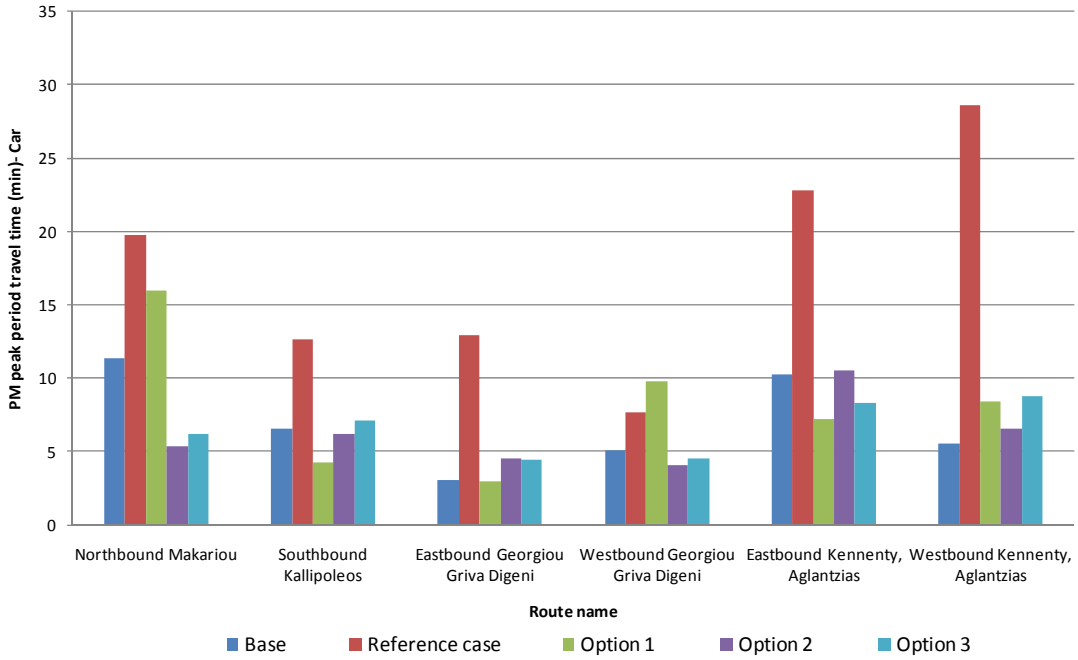


Figure 6.20: Comparison of network journey times (minutes) – PM peak



6.3 Safety

6.3.1 Improving or maintaining a good level of road safety is a key objective for any traffic scheme. The effect on road safety that a scheme would have can be assessed by changes in the following parameters:

- Link speeds
- Link flows
- Number of conflict points/movements.

6.3.2 There are no identified 'black spots ' located within the study area. In this study, therefore, changes in average speeds by link type have been analysed to assess potential impacts on road safety.

6.3.3 Tables 6.2 and 6.3 show that speeds are generally predicted to fall between 2010 and the 2020 Reference Case. The three options for Makariou/Kallipoleos are not predicted to have a significant impact on average speeds (two-way) on the non-major roads analysed. With regards to the major roads, speeds are predicted to increase substantially in the AM and by a lesser amount in the PM peak. The increase in link speeds is forecast to be less with Option 3 than with Options 1 and 2.

6.3.4 Overall, this analysis suggests that on this measure there may be some impact on safety on the major roads unless measures are taken to control the increase in speeds. On the non-major road network road safety will not be significantly affected by the scheme options.

Table 6.1: Average two-way link speeds (kph) - AM peak

Road	Link type	2010	2020 Reference Case	2020 Option 1	2020 Option 2	2020 Option 3
Stasinou	Major road	26.0	25.9	35.1	34.6	35.9
Grivas Digeni west of Makariou	Major road	30.4	27.8	34.3	37.0	35.1
Grivas Digeni east of Mylonas	Major road	36.0	21.3	38.9	38.6	38.7
Makariou (NB) north of Hilton	Major road	28.9	30.6	42.6	43.2	43.2
Makariou (NB) south of Aglantzias	Major road	26.4	23.6	40.2	40.3	32.6
Aglantzias	Major road	31.7	29.0	32.4	33.4	30.6
Kallipoleos south of University	Major road	36.1	26.7	35.6	35.2	21.5
Kallipoleos north of Mylonas	Major road	35.9	30.3	37.8	37.3	36.5
Mylonas	Minor road	32.1	31.2	33.6	32.8	29.7
Doiranis St	Residential	29.2	29.1	29.5	29.1	28.7
Kennedy Av	Minor road	37.9	37.8	38.0	37.3	37.2
Dimistanis	Residential	29.3	29.0	29.7	29.3	29.3
Average for major roads		**31.4**	**26.9**	**37.1**	**37.5**	**34.3**
Average for other roads		**32.1**	**31.8**	**32.7**	**32.1**	**31.2**

Table 6.2: Average two-way link speeds (kph) – PM peak

Road	Link type	2010	2020 Reference Case	2020 Option 1	2020 Option 2	2020 Option 3
Stasinou	Major road	29.1	27.2	0.0	0.0	34.6
Grivas Digeni west of Makariou	Major road	37.4	35.1	35.7	37.1	33.4
Digeni east of Mylonas	Major road	41.3	35.3	41.2	34.6	38.6
Makariou (NB) north of Hilton	Major road	38.8	43.8	33.9	42.1	42.5
Makariou (NB) south of Aglantzias	Major road	34.8	24.6	39.0	33.5	40.4
Aglantzias	Major road	42.2	33.3	32.5	42.8	33.6
Kallipoleos south of University	Major road	32.6	25.9	35.2	31.2	24.7
Kallipoleos north of Mylonas	Major road	36.2	-	34.0	31.4	26.9
Mylonas	Minor road	27.6	33.4	34.9	36.0	35.3
Doiranis St	Residential	27.8	28.5	28.6	28.5	28.3
Kennedy Av	Minor road	37.9	37.2	37.6	36.1	37.0
Dimistanis	Residential	29.8	-	29.4	29.2	29.1
Average for major roads		**36.6**	**32.0**	**35.9**	**36.1**	**34.3**
Average for other roads		**30.8**	**33.0**	**32.6**	**32.5**	**32.4**

6.3.5 In addition to changes in average speeds, the change in the number of conflict points at the major junctions in the study area has been considered (Table 6.3). This analysis shows that with the implementation of the schemes, the conflict points are reduced quite substantially, which would imply safer conditions due to reduced risk. However, there are slightly more conflict points in Option 3, where the contra-flow bus lane is accommodated at junctions.

Table 6.3: Conflicts points at junctions*

Junction Name	2010	2020 Reference Case	2020 Option 1	2020 Option 2	2020 Option 3
Lemesou/Aglantzias	10	10	10	10	10
Arch. Makariou/Kallipoleos	10	10	1	1	2
Arch. Makariou/Kennedy	10	10	1	1	1
Arch. Makariou/E. Frouras	10	10	1	1	2
Kallipoleos/E. Frouras	52	52	18	18	18
Arch. Makariou/D. Akrita	40	40	17	17	26
Kallipoleos/D. Akrita	52	52	18	18	18
Stasinou/Boumpoulinas	52	52	52	52	52
Stasinou/E & A Theodotou	52	52	22	22	22
Total	**288**	**288**	**140**	**140**	**151**

* Vehicular conflict points only

6.4 Accessibility

6.4.1 The area bounded by Makariou, Kallipoleos and Digeni Akrita, can be considered to be the core of the study area, and is mainly residential in nature. It is the area whose accessibility could potentially be most affected by the implementation of the one-way system. In order to assess the impact the scheme options could have on accessibility, the change in average (weighted by the number of trips) travel times to and from this core area have been analysed.

6.4.2 Figures 6.21 to 6.24 show average travel times to and from this area from and to four major locations - the centre of Nicosia, the area to the east of Makariou, the area to the west of Makariou and the University area. Results are only presented for Option 2, as there was shown to be no difference between the three options on this measure.

6.4.3 During the AM peak period, weighted travel times are less than in the Reference Case for travel to/from the area which suggest that accessibility is not adversely affected by the scheme in place, indeed it improves it slightly.

6.4.4 However, in the PM peak, the travel times generally increase by between two and four minutes, as the bulk of trips have to use more circuitous routing to and from this core area. In the case of the University area average travel times to the Makariou/Kallipoleos area are forecast to increase by six minutes. Travel times from Makariou/Kallipoleos to the University area, however, reduce by four minutes.

6.4.5 Overall the impact on accessibility is broadly neutral.

Figure 6.21: Travel time to Makariou-Kallipoleos area (minutes)- AM peak

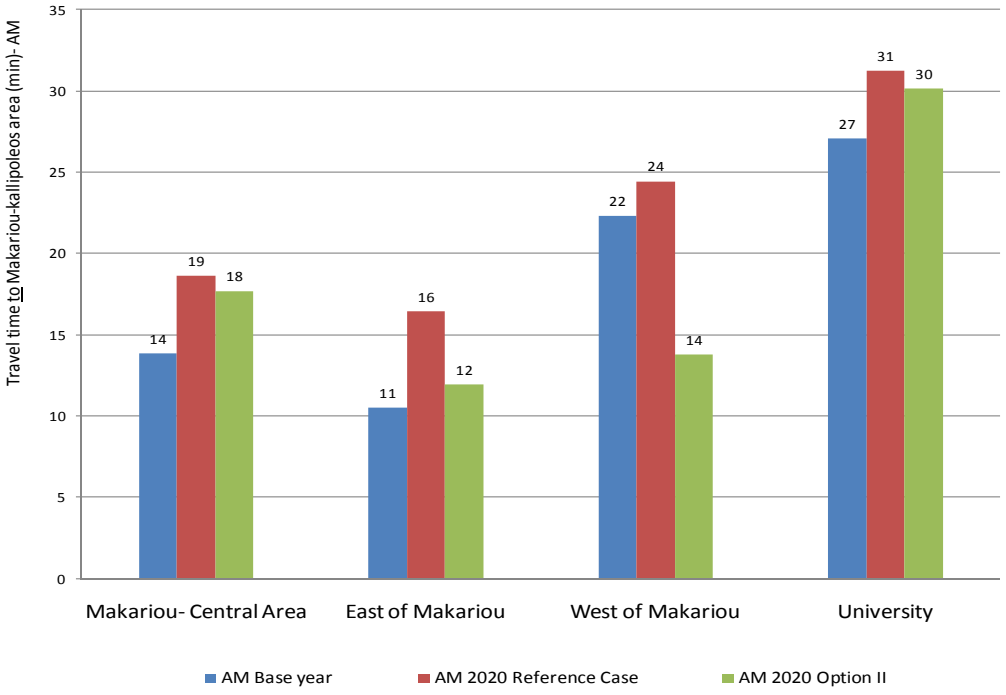


Figure 6.22: Travel time to Makariou-Kallipoleos area (minutes)- PM peak

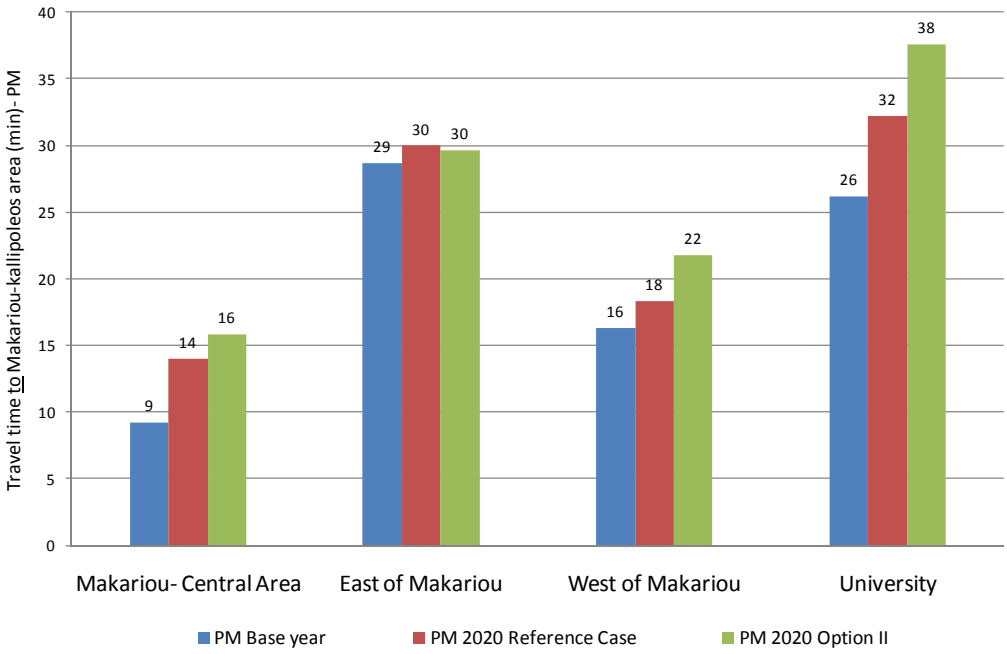


Figure 6.23: Travel time from Makariou-Kallipoleos area (minutes)- AM peak

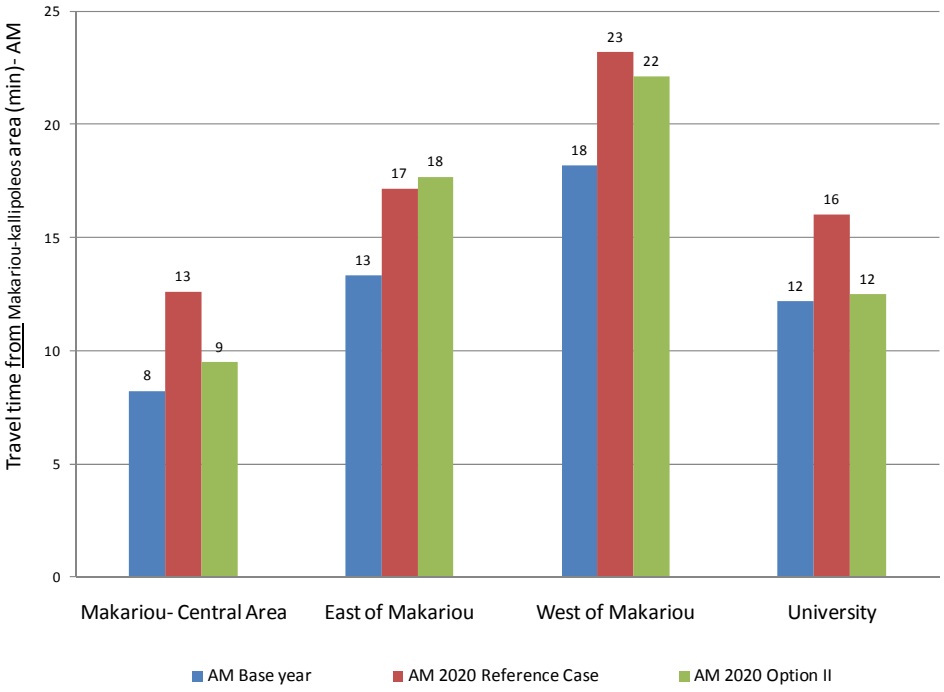
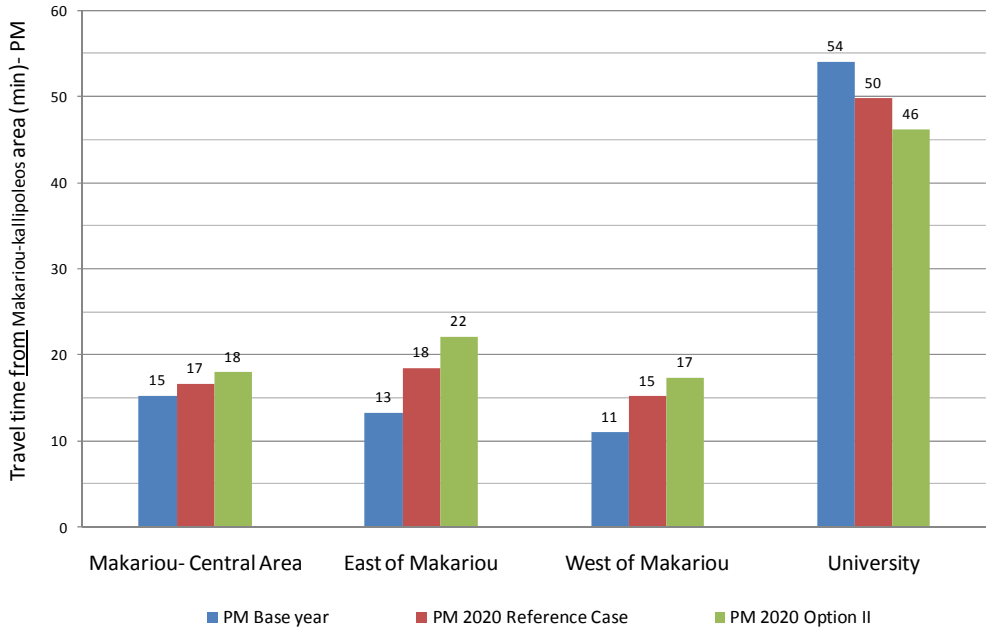


Figure 6.24: Travel time from Makariou-Kallipoleos area (minutes)- PM peak



6.5 Environmental impacts

6.5.1 The environmental impacts of the options for the Makariou/Kallipoleos traffic scheme have been assessed by comparing the total vehicle-kilometres travelled on the network with each option. This acts as a proxy measure for the changes in emissions, and traffic noise.

6.5.2 Table 6.4 shows that vehicle/kilometres increase but by less than 30% in the AM peak hour, as the one-way system results in longer distances being travelled in the study area network. The level of increase is similar for all three options.

6.5.3 In the PM peak the low values for vehicle-kilometres in the Reference Case and with Option 1 reflect the bottleneck effects of severe congestion - less vehicles are able to move through the network and are stuck in queues. No meaningful comparisons are, therefore, possible for this period.

Table 6.4: Total vehicle-kilometres on the network

	2010	2020 Reference Case	2020 Option 1	2020 Option 2	2020 Option 3
AM peak	24,547	23,073	28,697	28,524	29,824
PM peak	28,060	8,481	18,042	30,692	30,067

6.5.4 As a further measure of environmental impact changes in traffic flows on Makariou and Kallipoleos (including Theodotou) and on 'sensitive' local streets have been assessed. A 'sensitive street' was defined as one containing land uses such as schools, hospitals, old persons homes, churches, or streets with high pedestrian activity. Eight such locations were identified in the study area, and traffic flows for them are shown in Tables 6.5 and 6.6.

Table 6.5: Traffic flows on 'sensitive streets' - AM peak

Road	Two way flow (vph)				
	2010	2020 Reference Case	2020 Option 1	2020 Option 2	2020 Option 3
Makariou (south)	2,808	2,412	3,584	3,778	3,198
Makariou (north)	1,360	1,181	1,213*	883	1,075
Kallipoleos (south)	1,198	1,020	1,832	1,857	1,731
Kallipoleos (north)	929	966	1,338	1,361	1,349
Doiranis	182	219	80	158	119
N. Mylona	138	162	315	512	504
E & A Theodotou	1,673	961	2,304	2,400	2,003

* Note – Traffic flow in non-pedestrianised section

Table 6.6: Traffic flows on 'sensitive streets' – PM peak

Road	Two way flow (vph)				
	2010	2020 Reference Case	2020 Option 1	2020 Option 2	2020 Option 3
Makariou (south)	3,544	3,381	3,846	3,008	4,190
Makariou (north)	1,545	2,128	693	857	1,020
Kallipoleos (south)	1,528	1,842	2,160	2,551	2,503
Kallipoleos (north)	897	942	1,463	953	1,823
Doiranis	371	421	154	186	393
N. Mylona	404	377	297	181	437
E & A Theodotou	1,940	1,950	1,885	2,332	2,416

6.5.5 Thus, on Makariou flows are forecast to increase over the Reference Case by between 19% (Option 3) and 34% (Option 1) in the AM peak, but to reduce by between 5% (Option 3) and 30% (Option 1) in the PM peak. Taking both peaks together the changes are marginal - -varying from -6% with Option 2 to +4% with Option 3.

6.5.6 On Kallipoleos/Theodotou the forecast increases are greater – varying from 72% (Option 3) to 91% (Option 2) in the AM peak and between 16% (Option 1) and 42% (Option 3) in the PM peak. Taking both peaks together the changes in flow are between 43% (Option 1) and 54% (Option 3).

6.5.7 The picture is even more variable with the minor roads, which would be expected given the relatively low flows on these roads. Looking at the two peaks together to smooth out some of the 'random' variations, flows on these two roads are forecast to increase by 23% with Option 3 and to fall by 12% with Option 2 and by 28% with Option 1.

6.6 Impacts on public transport

6.6.1 The impact that the three options have on bus services has been assessed by considering changes in average bus speeds, delays and journey times for routes operating within the study area. These are routes operating on Makariou, Kallipoleos and Digeni Akrita. The impact on bus passenger access times to stops has also assessed qualitatively, for the most significant internal zones for public transport trip generation/attraction.

AM peak bus speeds and journey times

6.6.2 In the AM period average bus speeds increase substantially with all options (Figure 6.25). Commensurately, delays to buses reduce with all three options (Figure 6.26).

Figure 6.25: Comparison of average bus journey speed – AM peak

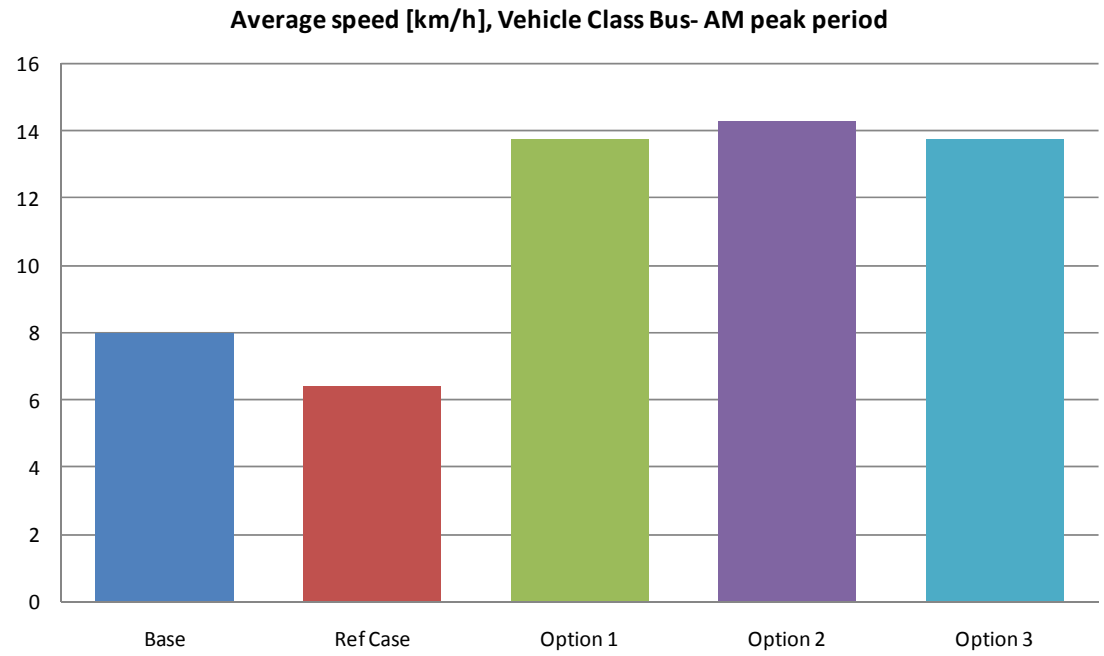
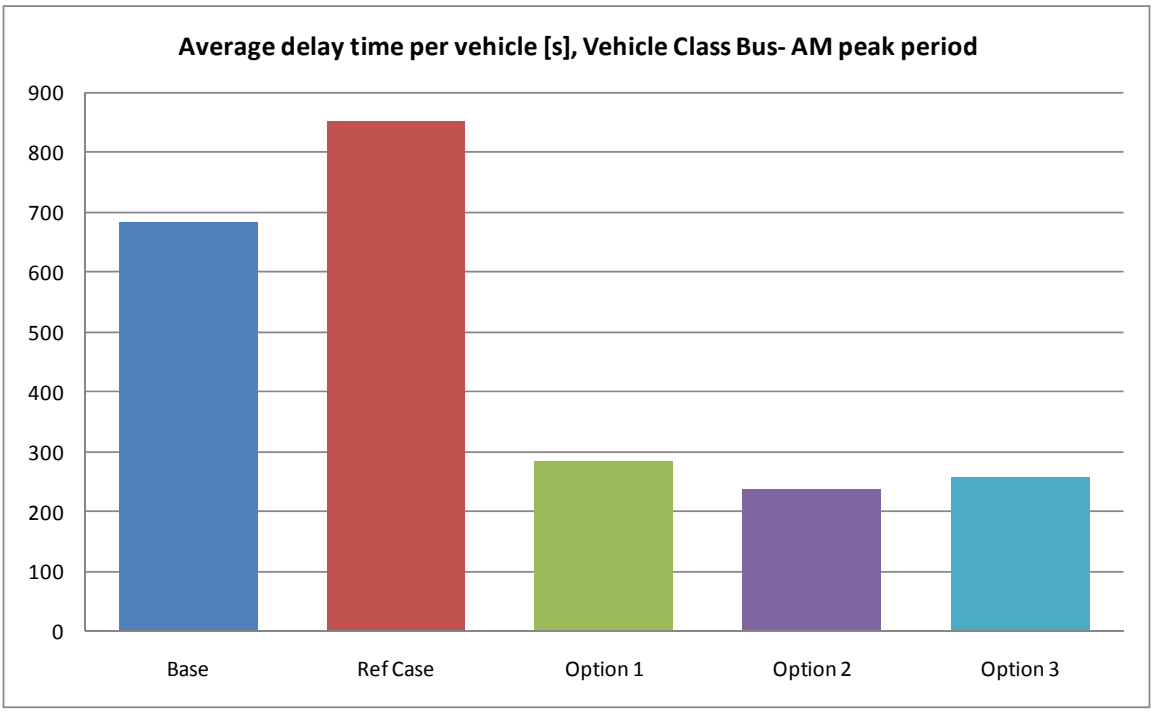
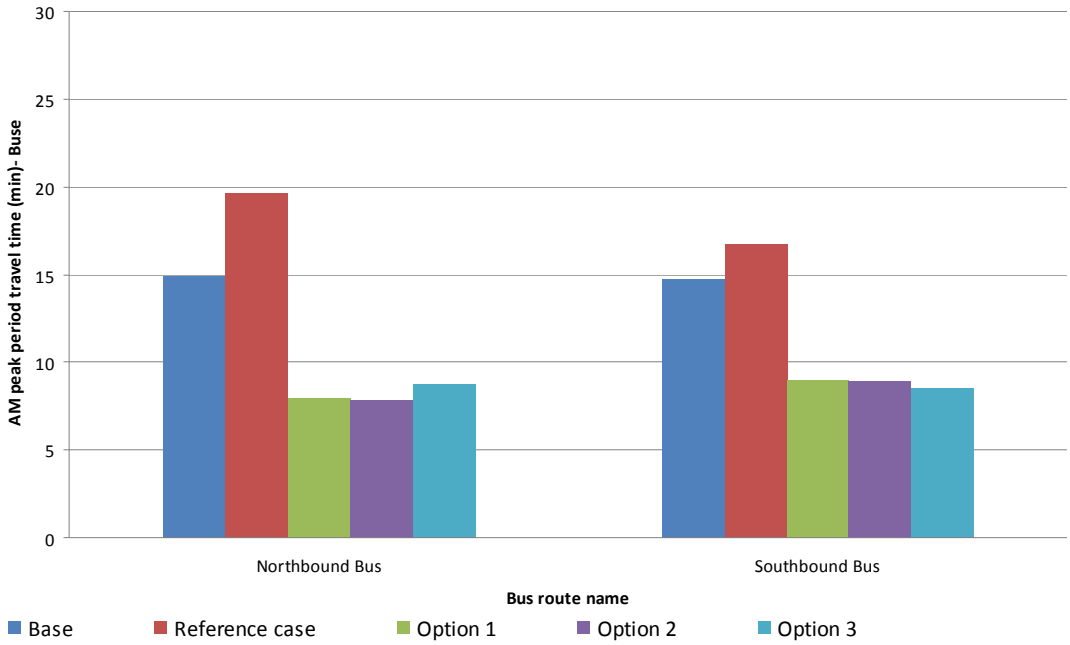


Figure 6.26: Comparison of average bus journey delay – AM peak



6.6.3 When specifically considering the bus travel times on Makariou, it can be seen from Figure 6.27 that, again, these are reduced with all three options have lower travel times in both directions.

Figure 6.27: Comparison of bus travel time on Makariou – AM peak



PM peak bus speeds and journey times

6.6.4 In the PM period, average bus speeds are forecast to increase with all three options when compared to the Reference Case. However, the increase in speeds is considerably greater with Options 2 and 3 than with Option 1 (Figure 6.28). The corresponding comparisons of delays to buses is shown in Figure 6.29.

Figure 6.28: Comparison of average bus journey speed – PM peak

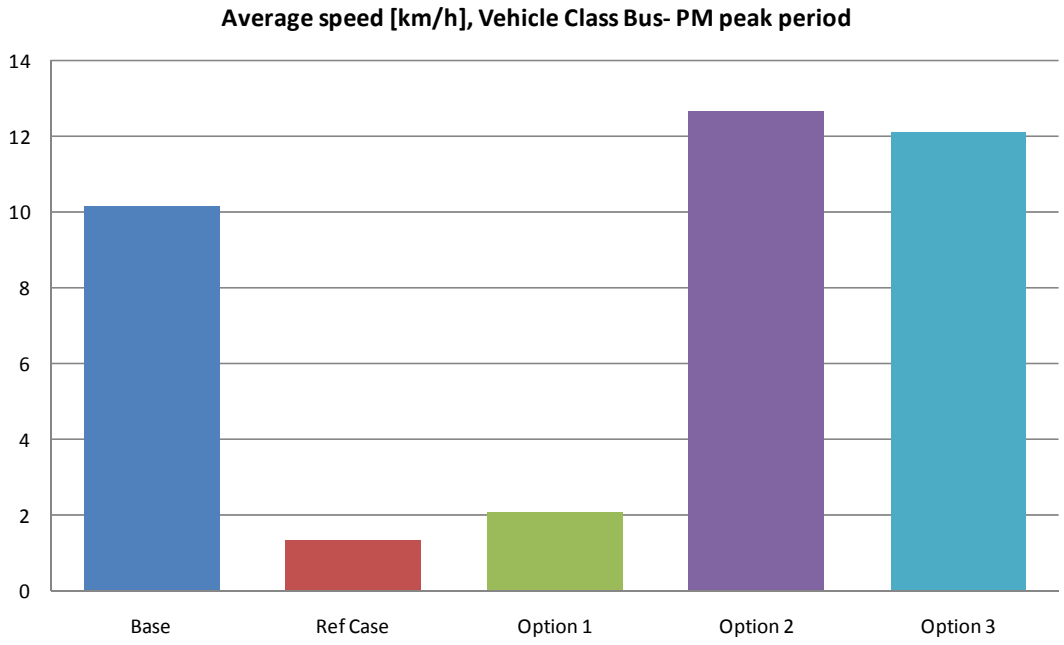
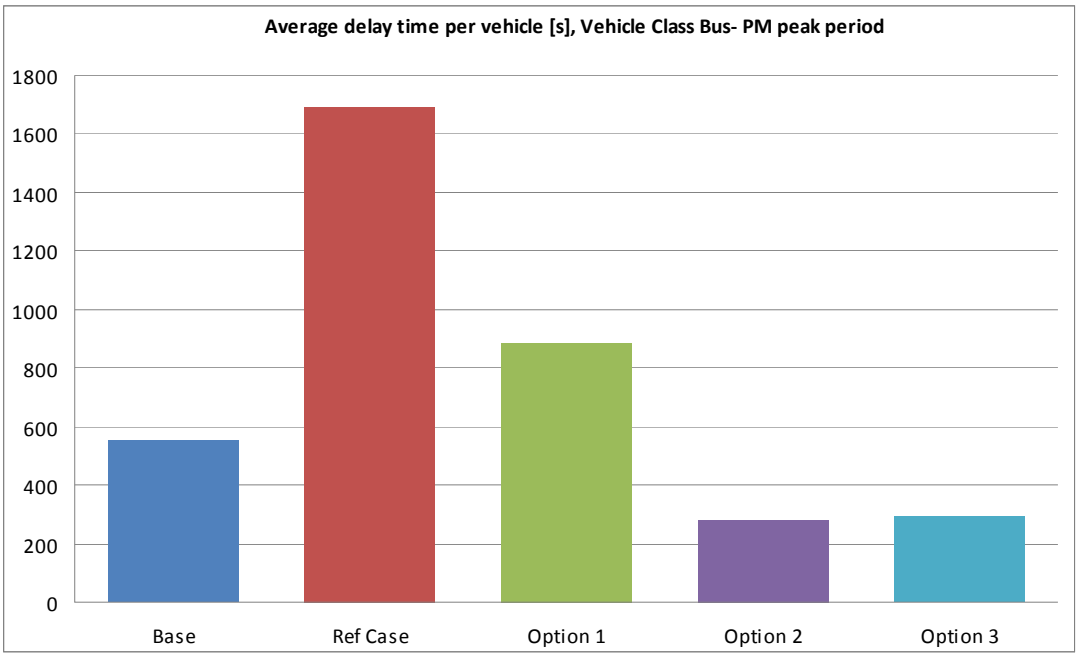
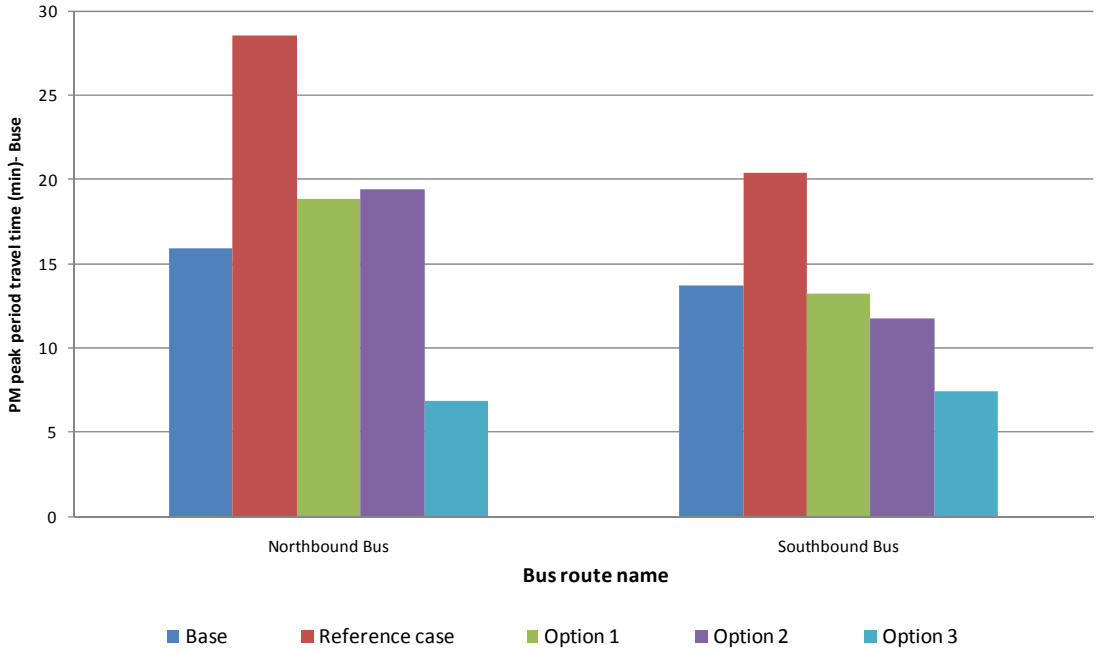


Figure 6.29: Comparison of average bus journey delay – PM peak



6.6.5 PM peak bus travel times specifically on Makariou are shown in Figure 6.30. It can be seen that they decrease with all options when compared to the Reference Case, but that the reduction is substantially for Option 3 which includes a southbound bus lane.

Figure 6.30: Comparison of bus travel time on Makariou – PM peak



Passenger access times to stops

6.6.6 A qualitative assessment has been carried out of the impacts on walk distances/times to and from stops for passengers using bus services on Makariou and Kallipoleos.

6.6.7 With Options 1 and 2 buses follow the one-way system. Hence southbound bus services on Makariou have to be rerouted to use Kallipoleos, and northbound buses on Kallipoleos are rerouted on to Makariou. Passengers alighting on Makariou from northbound services thus have to walk some distance to Kallipoleos to make the return journey. Similarly, passengers using southbound services to or from Kallipoleos have to walk from or to Makariou for the reverse journey.

6.6.8 In Option 3 as a contra-flow southbound bus lane is provided on Makariou, eliminating these adverse impacts of Options 1 and 2 on passengers using Makariou services. However, the impacts on passengers using services in the Kallipoleos corridor will remain.

6.7 Impacts on pedestrians

6.7.1 The impact on pedestrians has been assessed in terms of the scope afforded by each option (when compared with the reference case) for:

- Footway widening;
- Additional pedestrian crossings;
- Improved crossings at junctions, e.g. through simplified signal stage design - more direct crossings, longer green times etc.

6.7.2 Table 6.7 shows the improvements in pedestrian facilities that could be delivered by each of the three options. It can be seen that Options 2 and 3 are similar in this

respect. Option 1 gives more benefits to pedestrians as it includes pedestrianisation at the northern end of Makariou. Option 3 requires some footway width reductions.

Table 6.7: Pedestrian facilities provided by each option

Type of pedestrian facility	Option 1	Option 2	Option 3
Footway widening	1*	0	-1
Additional pedestrian crossings	1	1	1
Improved crossing facilities at junctions	6	6	6

* Pedestrianisation of northern section of Makariou

6.8 Impacts on cyclists

6.8.1 The cycle facilities for each option have been evaluated in terms of the standard of provision for cyclists that is feasible, compared to the Reference Case. Factors taken into consideration include:

- Whether provision is in the form of dedicated or shared space
- The widths of dedicated or shared facilities, compared to desirable minima

6.8.2 With Options 1 and 2 cyclists benefit from dedicated facilities that match the minimum recommended width for a two-way cycle lane of 3.0m. With Option 3 cyclists have shared use of the bus lanes, which, while of adequate width, will be less than the 4.0m minimum width recommended width for a bus and cycle lane.

6.8.3 Thus, while all three options provide good facilities for cyclists, Options 1 and 2 are preferred on this criterion.

Table 6.8: Cycle facilities provided with each option

Type of facility	Option 1	Option 2	Option 3
Dedicated or shared space for cyclists	2-way cycle lane	2-way cycle lane	Use of bus lanes
Widths of dedicated or shared facilities	3.0m	3.0m	3.5m

6.9 Option comparison

6.9.1 In order to compare the three options the assessments against the evaluation criteria described in this section have been collated and summarised in tabular format in an 'Impact Matrix'.

6.9.2 Each option has been scored against individual performance measures within the seven assessment criteria, in terms of whether its impact (in comparison with the Reference Case) is positive or negative, and the scale of impact. The scoring adopted was as follows:

2 Large positive impact
1 Moderate positive impact
0 Neutral/slight impact
-1 Moderate negative impact
-2 Large negative impact

6.9.3 The scores on each assessment criteria can be weighted to reflect the relative importance attached to the objectives to which they relate. This has specifically not been done in this exercise.

6.9.4 The detailed assessments are included in Appendix 3 together with thresholds adopted to distinguish 'neutral/slight', 'moderate' and 'large' impacts. Scores on measures within each criterion have been summed. The sum is then divided by the number of measures within that criterion to get a summary score. These summary scores are included in an 'Impact Matrix' which is shown in Table 6.9.

6.9.5 This methodology obviously entails some simplification in summarising transparently what can be complex impacts. These simplifications can lead to anomalies in arriving at final 'scores'. Where possible judgement has been applied to resolving such anomalies.

6.9.6 It should also be noted that the scores measure the performance of options against the Reference Case, not against each other. This can mask significant differences between options. However where such differences do exist these are brought out in the discussion below.

Table 6.9: Option impact matrix (compared to Reference Case)

Assessment criteria	Option 1	Option 2	Option 3
Network operation	1	2	2
Safety	0	0	0
Accessibility	0	0	0
Environment	0	0	-1
Public transport	0	0	2
Pedestrians	2	1	1
Cyclists	2	2	1

6.9.7 The key points to be noted from comparative assessments are as follows:

Network operation

- Option 1 gives moderate benefits overall when compared to the Reference Case, while Options 2 and 3 give more substantial benefits. With all three options there are localised operational problems associated with them that will need to be addressed in particular relating to congestion on the major road network west of Makariou.

- When the three options are compared to each other Option 1 performs significantly less well than Options 2 and 3 due to the impacts on Stasinou of traffic displaced by the pedestrianisation.

Safety

- There is little to choose between the options on this criterion. All are expected to have a broadly neutral impact on road safety - the benefits from reduced levels of conflict at junctions potentially being balanced, unless mitigation measures are introduced, by increased risks due to higher speeds on the major roads in the study area

Accessibility

- The options are not expected to have any significant overall impact on the accessibility of the area by car, with small forecast reductions in access times in the AM peak balanced by small increases in the PM peak.

The environment

- Option 3 is shown to have moderate negative environmental impacts as a result of a general increase in vehicle kilometres travelled on the study area network and the forecast increase in traffic flows on the major roads in the area.

- However, it should be noted that the increase in vehicle kilometres with Option 3 (29%) is only just above the 25% threshold adopted for significant impact, while at 24% the increases with Options 2 and 3 are just below it.

- The picture is similarly with the increase in traffic on the major roads. All three options have similar impacts – with Option 3 however the increase is just above the threshold adopted for significant impact while with Option 1 and 2 it is just below it.

Public transport

- Option 3 is clearly the best option in terms of the assistance given to buses. With Options 1 and 2 the benefits in terms of reduced bus running times are countered by increased walk times to bus stops for some passengers.

Pedestrians

- Option 1 is the best in terms of improvements afforded to the provision for pedestrians since it includes pedestrianisation at the northern end of Makariou

- Options 2 and 3 have the same overall score. Option 3 entails some reduction in footway widths, but this would only be carried out where it is feasible without adverse impacts on pedestrians.

Cyclists

- With Options 1 and 2 cyclists benefit from dedicated cycle lanes while with Options 3 they share the bus lanes. Hence the lower score for Option 3 on this criterion.

6.9.8 The comparative assessment suggests that Option 3 represents the most balanced option. It provides the greatest assistance to public transport and enhances the provision made for pedestrians and cyclists, without major negative impacts on other users.

6.9.9 With Options 1 and 2 it. Is considered that the reduction in the accessibility of southbound bus services for passengers travelling to/from the Makariou corridor significantly undermines the journey time benefits gained by passengers. With Option 1 there is the further issue of the impact on Stasinou of displaced traffic. This problem may be mitigated by proposed improvements to orbital corridors to the south, but these solutions are only likely to be delivered in the longer term.

7 Short Term Options

7.1 Introduction

7.1.1 The three options described in Section 4 and assessed in Section 6 were formulated to deliver the objectives of the IMMP in terms of facilitating enhancements to the provision for sustainable forms of transport on the road network, without unduly prejudicing travel by private car. The preferred option was anticipated to be implemented over the IMMP period up to 2020. During that time public transport would be improved progressively inducing a mode shift away from the private car and other IMMP highway schemes outside the Makariou/Kallipoleos corridors would be implemented, allowing the implementation of the changes on Makariou/ Kallipoleos without undue adverse traffic impacts on the wider network.

7.1.2 Given the desire to implement more immediate measures to promote bus use, CB/ALA was also asked to assess options that may be implemented in the shorter term, say before the end of 2012, with minimum highway changes. These short term options would represent the first phase in the implementation of the longer term preferred option.

7.1.3 Initially, two such options were assessed, both of which retain two way traffic on Makariou and Kallipoleos. In short term Option 1 bus lanes are introduced in both directions on Makariou north of Kennedy, which does necessitate Makariou becoming one way northbound for general traffic north of Digeni Akrita.

7.1.4 In short term Option 2 only a northbound bus lane is provided north of Digeni Akrita to allow Makariou to remain two way for general traffic. This is to allow additional capacity for traffic moving in southbound direction.

7.1.5 Following discussions within PMU and and PWD, it was noted that major reconstruction work is scheduled imminently for Kallipoleos which will require that route to be reduced to one lane, and hence, to one way traffic, for a considerable period. This raises the potential opportunity to retain one way traffic on Kallipoleos once the work is completed and, therefore, perhaps to implement the 2020 Option 3 over a shorter timescale.

7.1.6 Hence, the short term impacts of implementing the preferred longer term option, Option 3, have also been assessed and compared to the impacts of the two specific short term options described above. In the short term it is assumed that Option 3 would be implemented without any changes to carriageway widths.

7.1.7 The short term impacts of all three options have been assessed on base year (2010) traffic demand. A simplified comparative assessment has been undertaken that focuses on the impacts on general traffic and buses

7.1.8 The short-term options were modelled for the more critical PM peak period only. In addition, the preferred option, Option 3 was also tested for the AM peak period to provide a full assessment of the scheme. The following sections present the impacts of short term Options 1 and 2 in the PM peak period and the impacts of Option 3 for the AM and PM peak periods.

7.1.9 The short term options are described in more detail in 7.2. Their impacts on traffic flows on the wider network are discussed in 7.3. A comparative assessment of the three options is presented in 7.4.

7.2 Options Description

Option 1 – Northbound and southbound bus lanes on Makariou

7.2.2 Figure 7.1 shows the salient features of this short term option. It also shows the junction improvements that will be required to ensure a smooth flow of traffic. Table 7.1 describes individual elements of the scheme.

Figure 7.1: Short Term Option 1 – Northbound and southbound bus lanes on Makariou

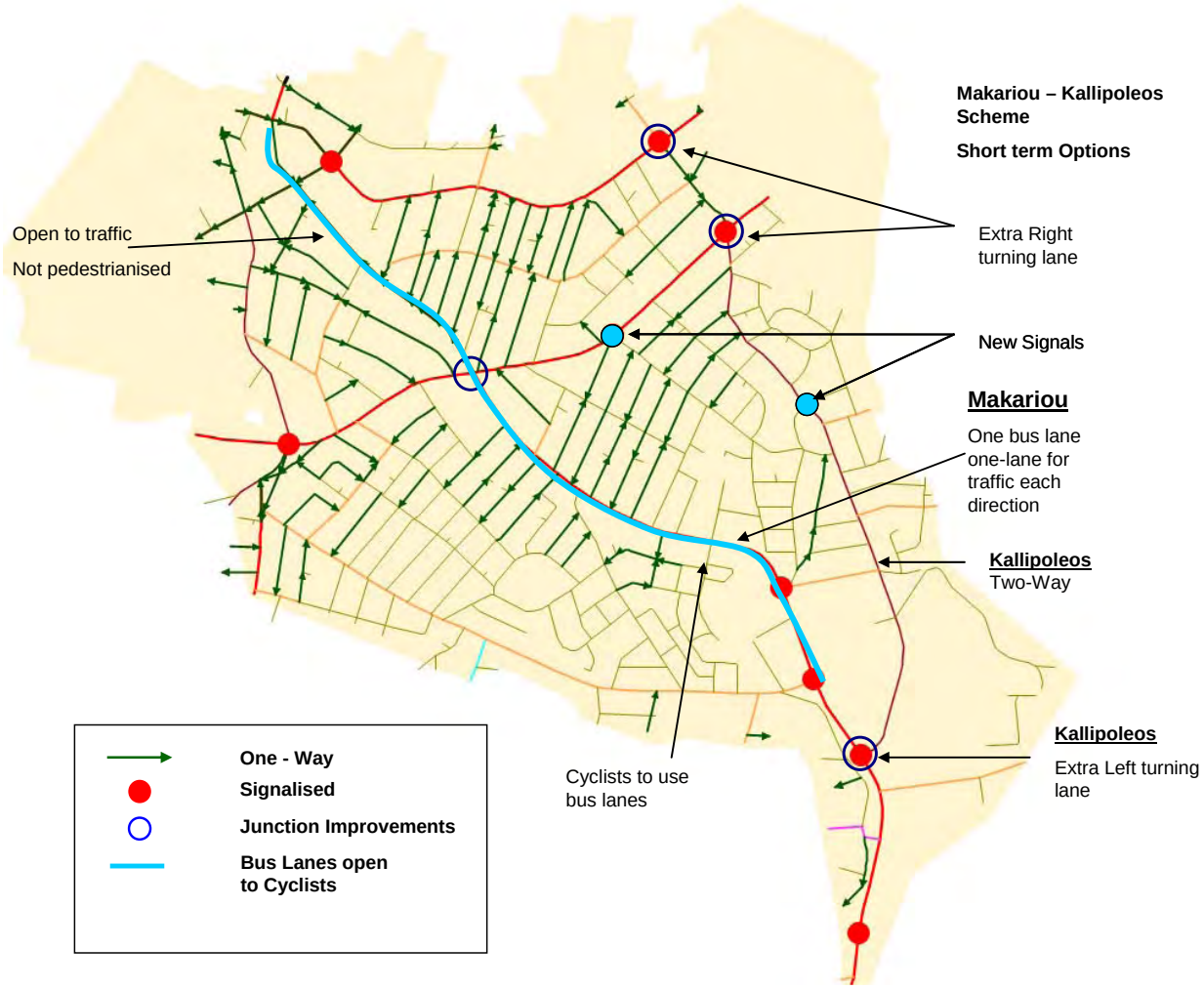
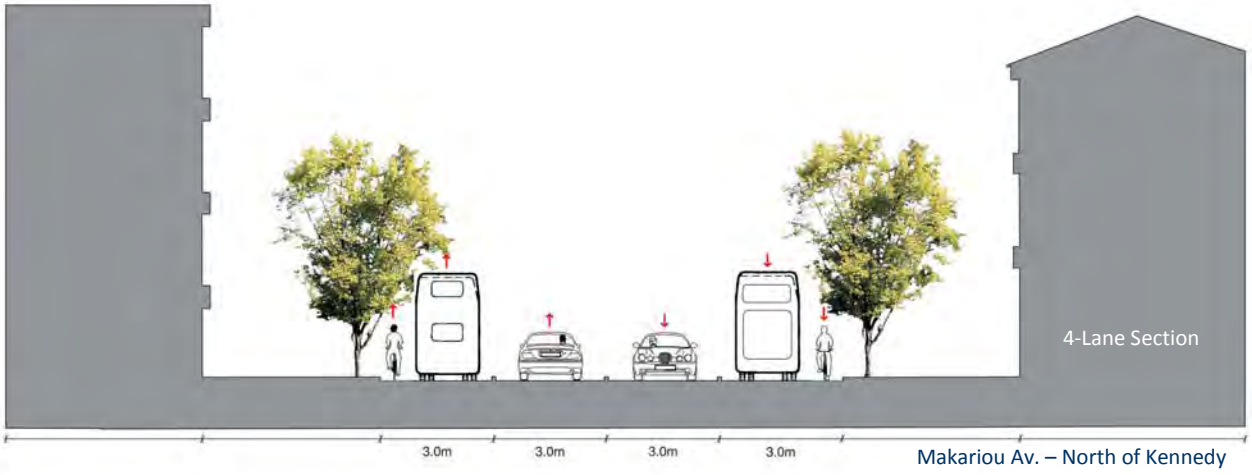


Table 7.1: Components of Short-Term Option 1

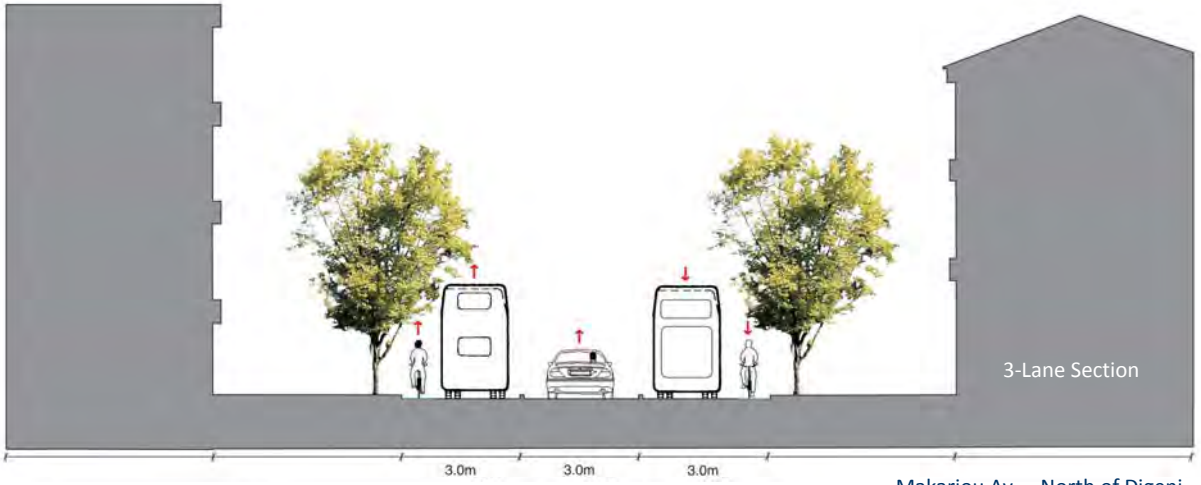
Type of Measure	Details of Measure
Bus	B1. Bus lanes in each direction on Makariou between Kennedy and Evagorou, and continuing along Evagorou, Diagorou and Omirou to the Bus Station.
Cycle	C1. Cycle use of bus lanes on Makariou and Leonidou, between Kennedy and Evagorou, and the bus station (this also includes cycle crossing facilities at all junctions).
Pedestrian	P2. Improved crossing facilities at junctions. P3. Improved footway provision on Kallipoleos.
Traffic management	TM7. Conversion of Demokratous and Doiranis to one-way northbound between Makariou and Kallipoleos. TM8. Conversion of I. Kliridi and Damaskinou to one-way southbound between Makariou and Kallipoleos. TM9. Improvement of Digeni Akrita/Kallipoleos: junction (with extra right turning lane). TM 11.Improvement of Makariou/Digeni Akrita (to facilitate bus and cycle lanes) TM12. Improvement of Makariou/Aglantzias Junction (with 3 lanes southbound on Makariou between Kallipoleos and Aglantzias, and a segregated left-turn lane). TM13. New signals on Kallipoleos/Ypatias junction. TM14. New Signals on Digeni Akrita/Nikodimou Mylona/ Androkleus.
Traffic calming/ speed reduction	TC1. 30kph Zone in area between Makariou, Digeni Akrita and Kallipoleos with self-enforcing measures (e.g. speed humps, etc.)

7.2.3 Indicative cross sections on Makariou are shown in Figure 7.2.

Figure 7.2: Cross-sections on Makariou - Short Term Option 1



Makariou Av. – North of Kennedy



Makariou Av. – North of Digeni

Option 2 – No southbound bus lane on Makariou north of Digeni Akrita

7.2.4 In the second short-term option northbound and southbound bus lanes are provided between the Kennedy and Digeni Akrita as with Short Term Option 1. To the north, however, only an Northbound bus lane is provided and two way general traffic is retained.

7.2.5 Figure 7.3 shows the salient features of this short term option. It also shows the junction improvement which will be required to ensure a smooth flow of traffic. Table 7.2 describes individual elements of the scheme.

Figure 7.3: Short Term Option 2 – No southbound bus lane on Makariou north of Digeni Akrita

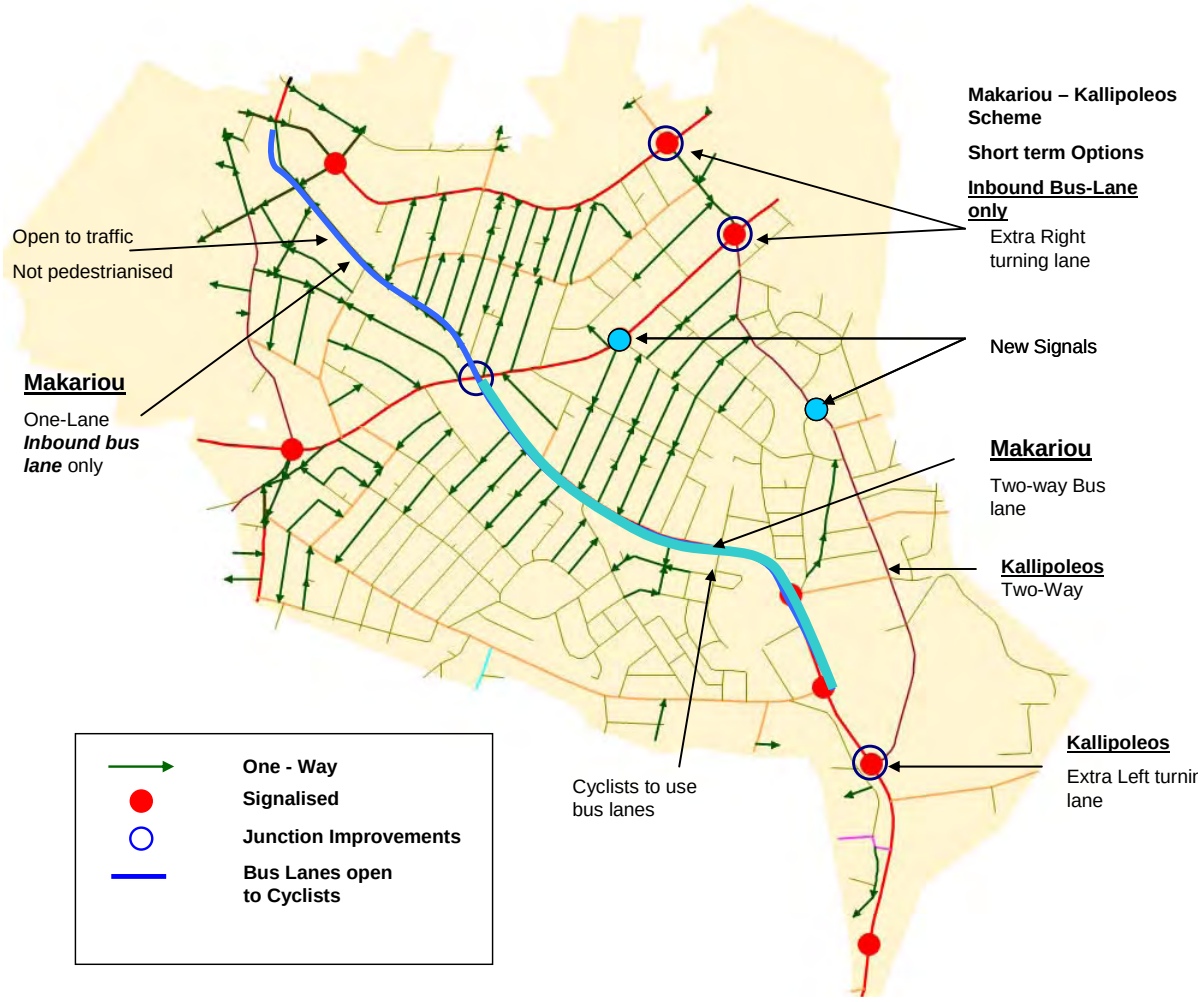


Table 7.2: Components of Short-Term Option 2

Type of Measure	Details of Measure
Bus	B1. Northbound and southbound on Makariou between Kennedy and Digeni Akrita
	B2. Northbound bus lane on Makariou between Digeni Akrita and Evagorou. Continuing along Evagorou, Diagorou and Omirou to the Bus Station.
Cycle	C1. Cycle use of bus lanes on Makariou and Leonidou, between Kennedy and Evagorou, and the bus station (this also includes cycle crossing facilities at all junctions).
Pedestrian	P2. Improved crossing facilities at junctions. P3. Improved footway provision on Kallipoleos.
Traffic management	TM7. Conversion of Demokratous and Doiranis to one-way northbound between Makariou and Kallipoleos. TM8. Conversion of I. Kliridi and Damaskinou to one-way southbound between Makariou and Kallipoleos. TM9. Improvement of Digeni Akrita/Kallipoleos: junction (with extra right turning lane). TM 11.Improvement of Makariou/Digeni Akrita (to facilitate bus and cycle lanes) TM12. Improvement of Makariou/Aglantzias Junction (with 3 lanes southbound on Makariou between Kallipoleos and Aglantzias, and a segregated left-turn lane). TM13. New signals on Kallipoleos/Ypatias junction. TM14. New Signals on Digeni Akrita/Nikodimou Mylona/ Androkleus.
Traffic calming/ speed reduction	TC1. 30kph Zone in area between Makariou, Digeni Akrita and Kallipoleos with self-enforcing measures (e.g. speed humps, etc.)

7.2.6 Indicative cross sections on Makariou for Option 2 are shown in Figure 7.4.

Figure 7.4: Cross-sections on Makariou - Short Term Option 2

Option 3 – One way system with northbound and southbound (contra flow) bus lanes on Makariou

7.2.7 The above two short term options have been assessed against the short term impacts of the preferred longer term option, Option 3, as described in Section 4. This option is based on Makariou and Kallipoleos becoming one way as proposed in the IMMP and contra flow bus lanes being introduced on Makariou. However, in the short term it is assumed that this option would be implemented without any carriageway widening. To achieve this, bus lane widths are reduced to 3m.

7.2.8 The specific components of this option are shown in Figure 7.5 and are summarised in the Table 7.3 below.

Figure 7.5: Short Term Option 3 - One way system with northbound and southbound (contra flow) bus lanes on Makariou

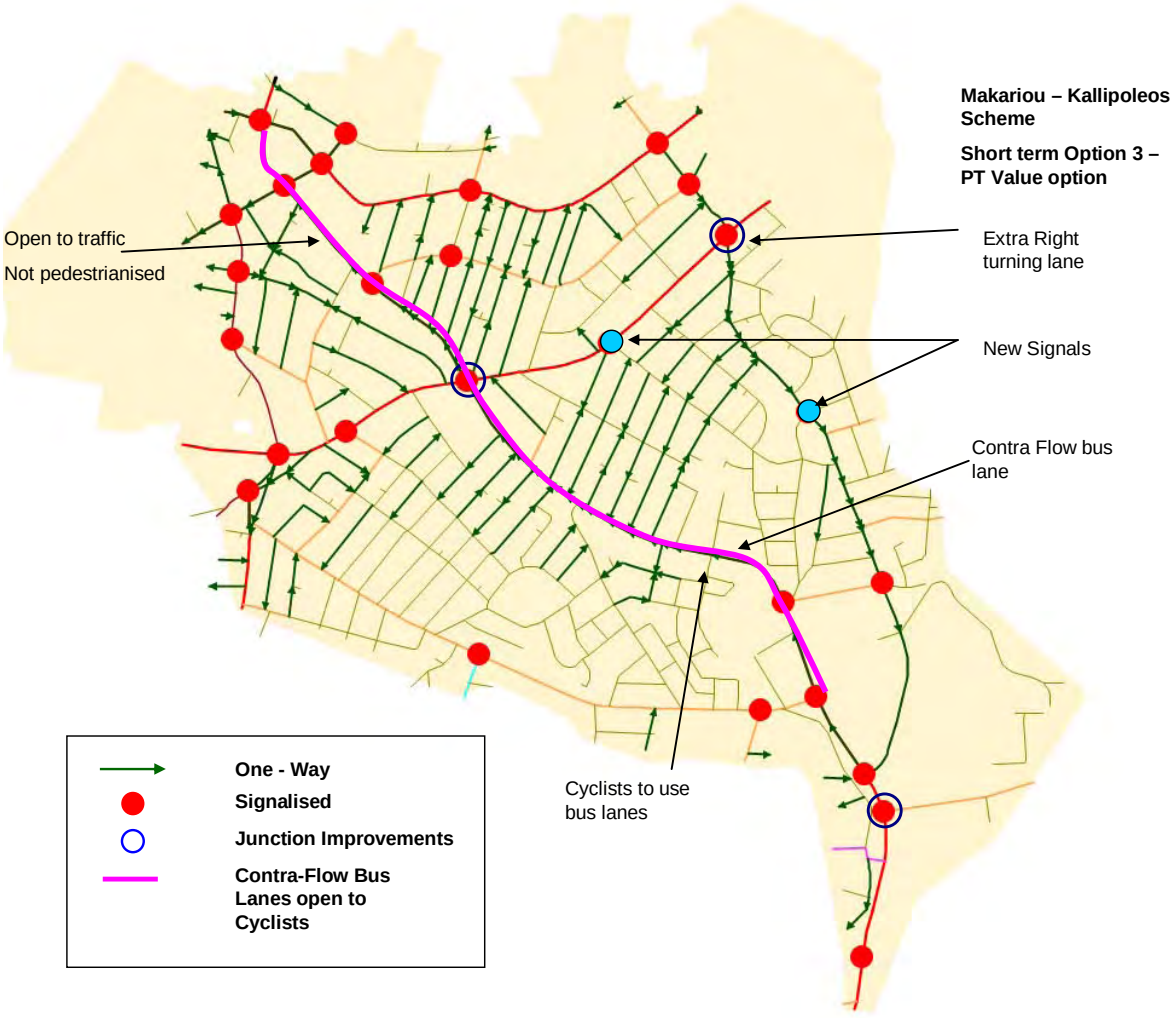
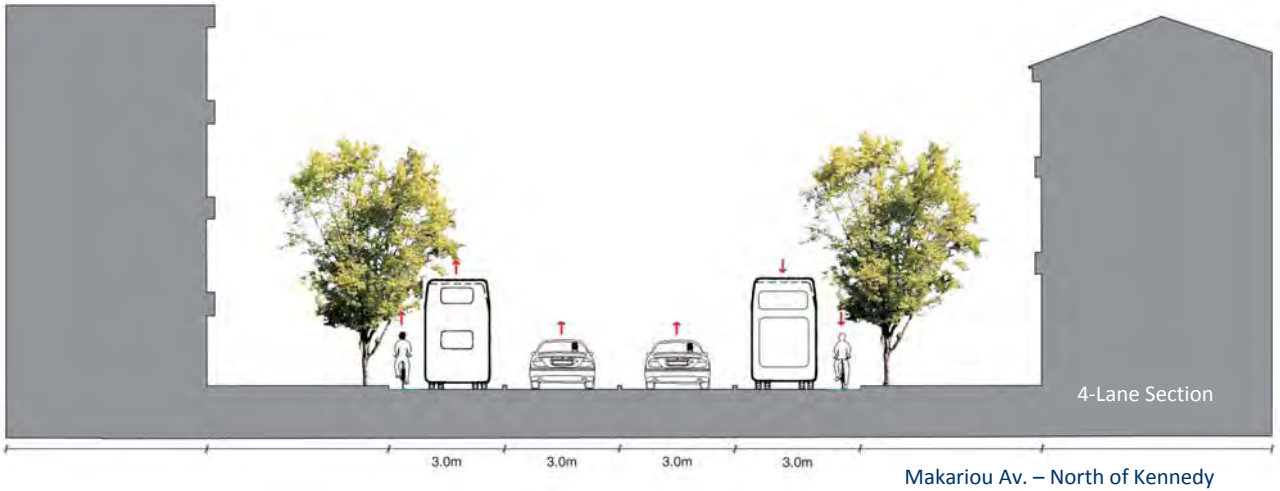


Table 7.3: Components of Short Term Option 3

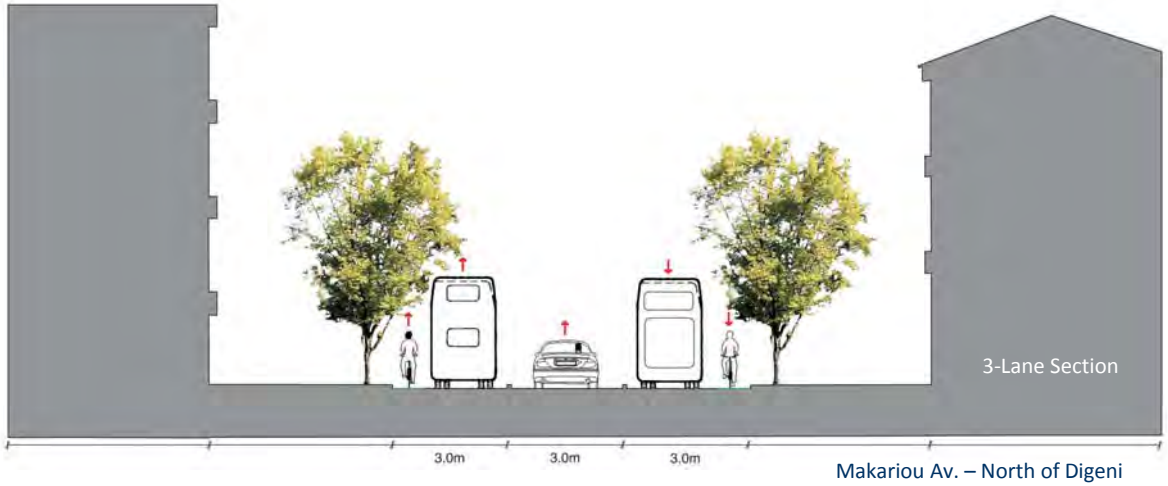
Type of Measure	Details of Measure
Bus	B3. Northbound bus lane on Makariou, between Kennedy and Evagorou, and continuing along Leonidou (contra-flow) to the bus station. B4. Southbound bus lane on Makariou, between Kennedy and Evagorou, and along Leonidou from the Bus Station.
Cycle	C2.Cycle use of bus lanes on Makariou and Leonidou, between Kennedy and Evagorou, and the bus station (this also includes cycle crossing facilities at all junctions).
Pedestrian	P2. Improved crossing facilities at junctions. P3. Improved footway provision on Kallipoleos.
Traffic management	TM1. Conversion of Makariou to one-way northbound, between Kallipoleos and Digeni Akrita. TM2. Conversion of Makariou to one-way northbound, between Digeni Akrita and Evagorou. TM4. Conversion of Kallipoleos to one-way southbound between Digeni Akrita and Makariou. TM5. Conversion of E & A Theodotou to one-way southbound between Stasinou and Digeni Akrita TM6. Conversion of Chalkokondyli to one-way southbound between Ypatias and G. Frankoudi. TM7. Conversion of Demokratous and Doiranis to one-way northbound between Makariou and Kallipoleos. TM8. Conversion of I. Kliridi and Damaskinou to one-way southbound between Makariou and Kallipoleos. TM9. Improvement of Digeni Akrita/Kallipoleos: junction (with extra right turning lane). TM 11.Improvement of Makariou/Digeni Akrita (to facilitate one-way working and bus and cycle lanes) TM12. Improvement of Makariou/Aglantzias Junction (with 3 lanes southbound on Makariou between Kallipoleos and Aglantzias, and a segregated left-turn lane). TM13. New signals on Kallipoleos/Ypatias junction. TM14. New Signals on Digeni Akrita/Nikodimou Mylona. TM15. Reallocation of road space on Leonidou to with and contra flow bus lane, and 1 lane for general traffic (southbound).
Traffic calming/speed reduction	TC1. 30kph Zone in area between Makariou, Digeni Akrita and Kallipoleos with self-enforcing measures (e.g. speed humps, etc.)

7.2.9 Indicative cross-sections on Makariou with Option 3 are shown in Figure 7.6.

Figure 7.6: Cross-sections on Makariou - Short Term Option 3



Makariou Av. – North of Kennedy



Makariou Av. – North of Digeni

7.3 Traffic displacement

7.3.1 Figures 7.7 to 7.10 show the forecast displacement of traffic on the wider network with each option.

7.3.2 Figure 7.7 shows that with Option 1 traffic will be expected to increase on

- Boumpoulinas northbound
- Stasinou eastbound and on the right turn into Kallipoleos
- Digeni Akrita eastbound and on the right turn into Kallipoleos
- Kennedy Avenue in both directions
- Androkleus Street.

7.3.3 Figure 7.8 shows that removing the southbound bus lane on Makariou north of Digeni Akrita, and reintroducing the southbound lane for general traffic, significantly reduces the scale of displacement from Makariou, generally but particularly on to Boumpoulinas, Digeni Akrita, Androkleus, Stasinou and Konstantinou Palaiologou.

7.3.4 Figures 7.9 and 7.10 show the impact of the introduction of the one way system and bus lanes, with substantial increases in traffic on

- Kallipoleos
- Stasinou eastbound
- Digeni Akrita eastbound and on the right turn into Kallipoleos (mainly in the PM peak)
- Nikodimou Mylona, both directions

7.3.5 Option 1 is associated with more displacement of traffic onto the network west of Makariou than either Option 3 or Option 2 (the least displacement). The differences between the options are, however, not great. Traffic will be expected to decrease on Kennedy Avenue, particularly in the eastbound direction.

7.3.6 With all the options there is an increase in traffic through the Digeni Akrita/ Nikis/Kennedy junctions. This junction is outside the scope of the current study and the need for improvements here to accommodate the additional traffic has not been assessed.

Figure 7.7: Comparison of traffic flow on links - Short term Option 1 vs 2010 base –PM peak period

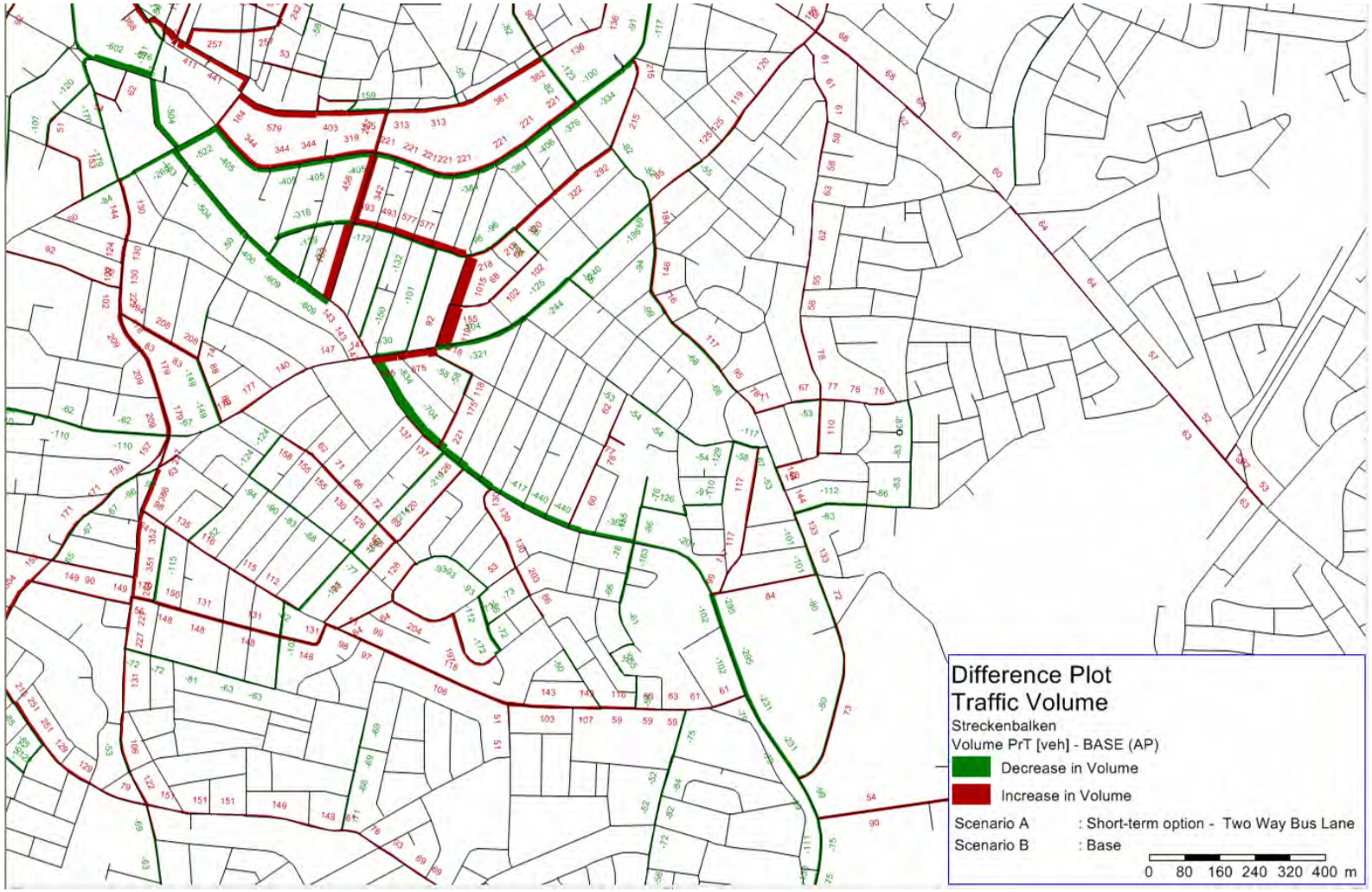


Figure 7.8: Comparison of traffic flow on links - Short term Option 2 vs 2010 base – PM peak period

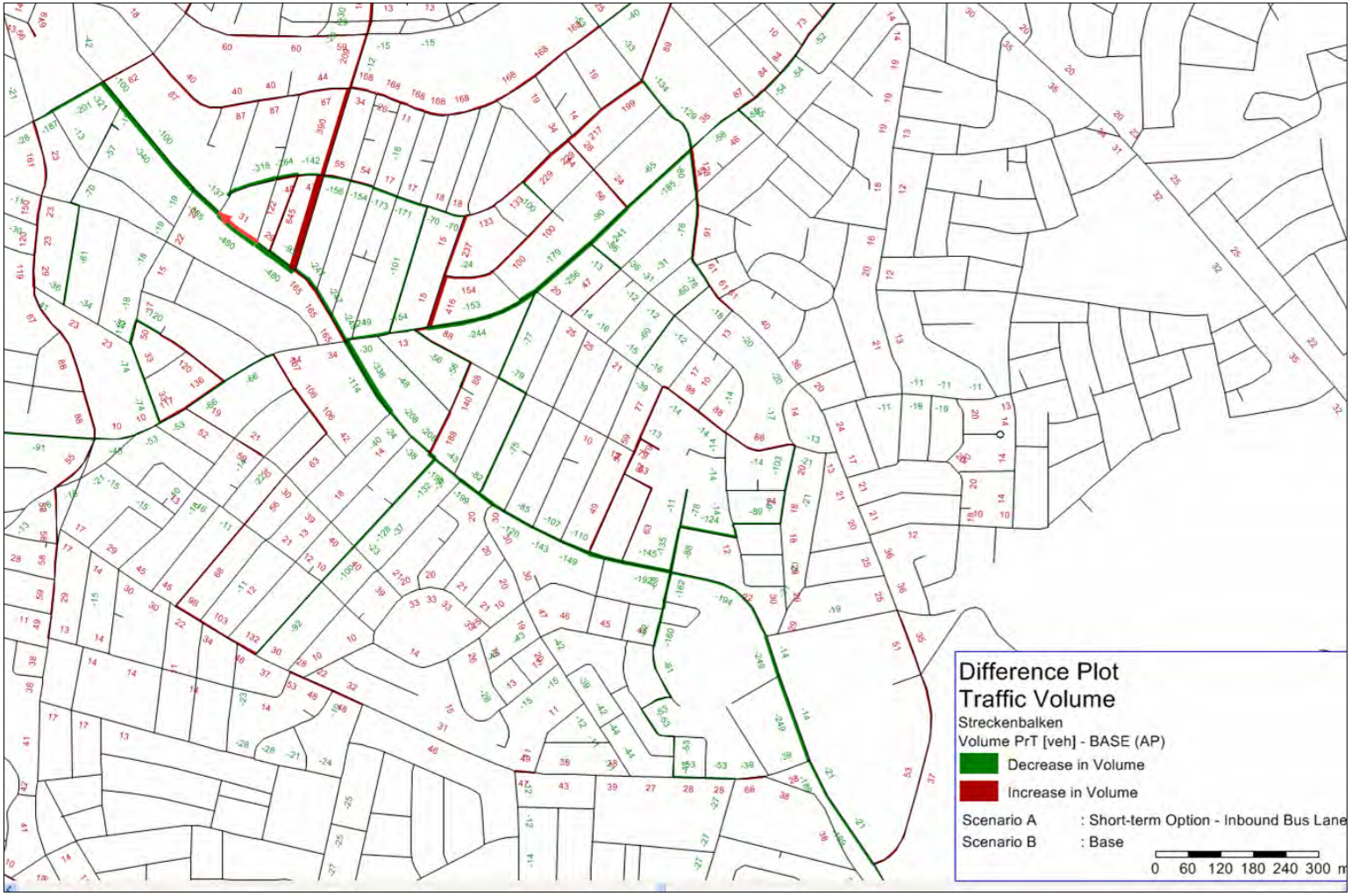


Figure 7.9: Comparison of traffic flow on links - Short Term Option 3 vs 2010 Base – AM peak period

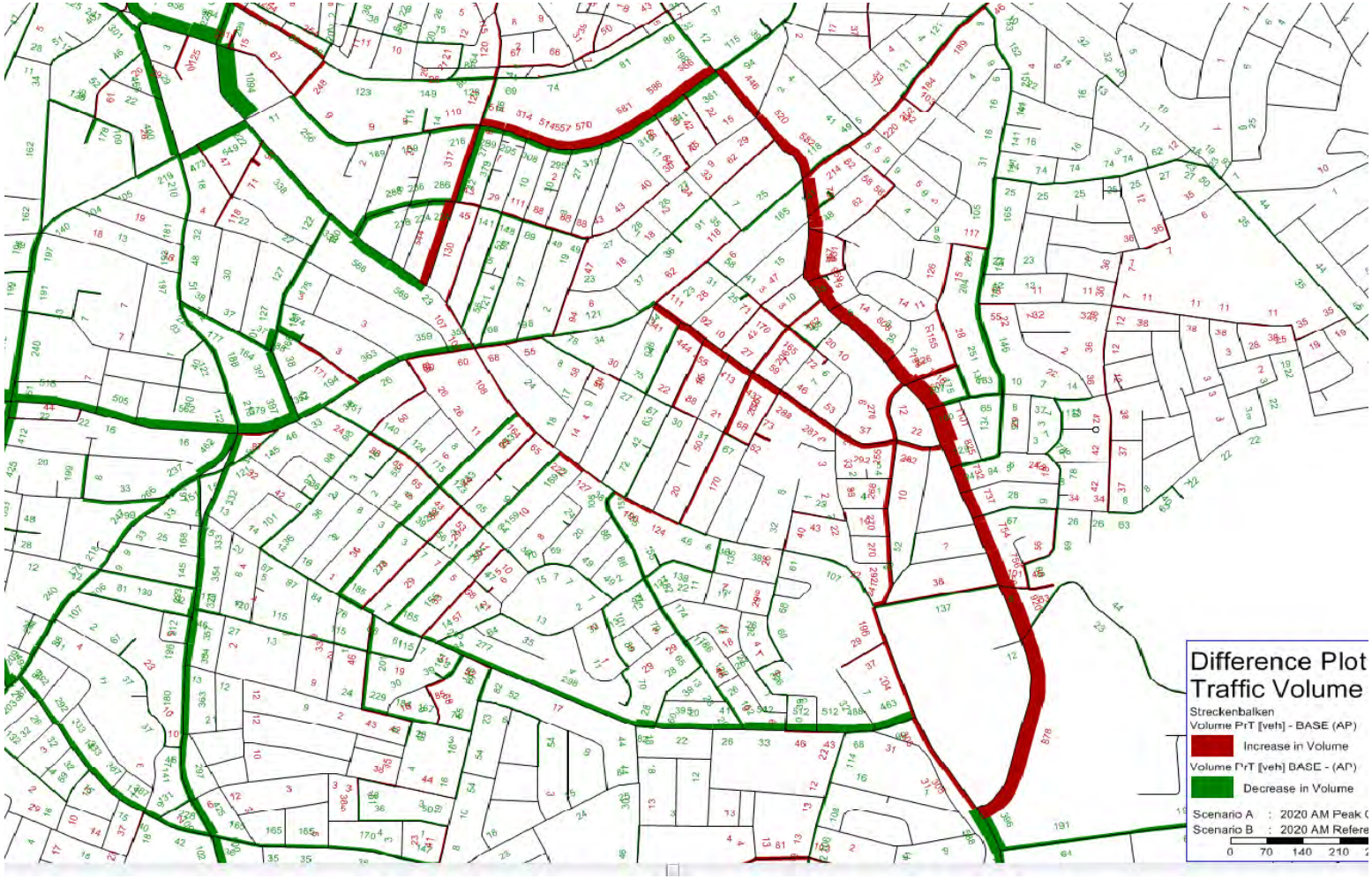
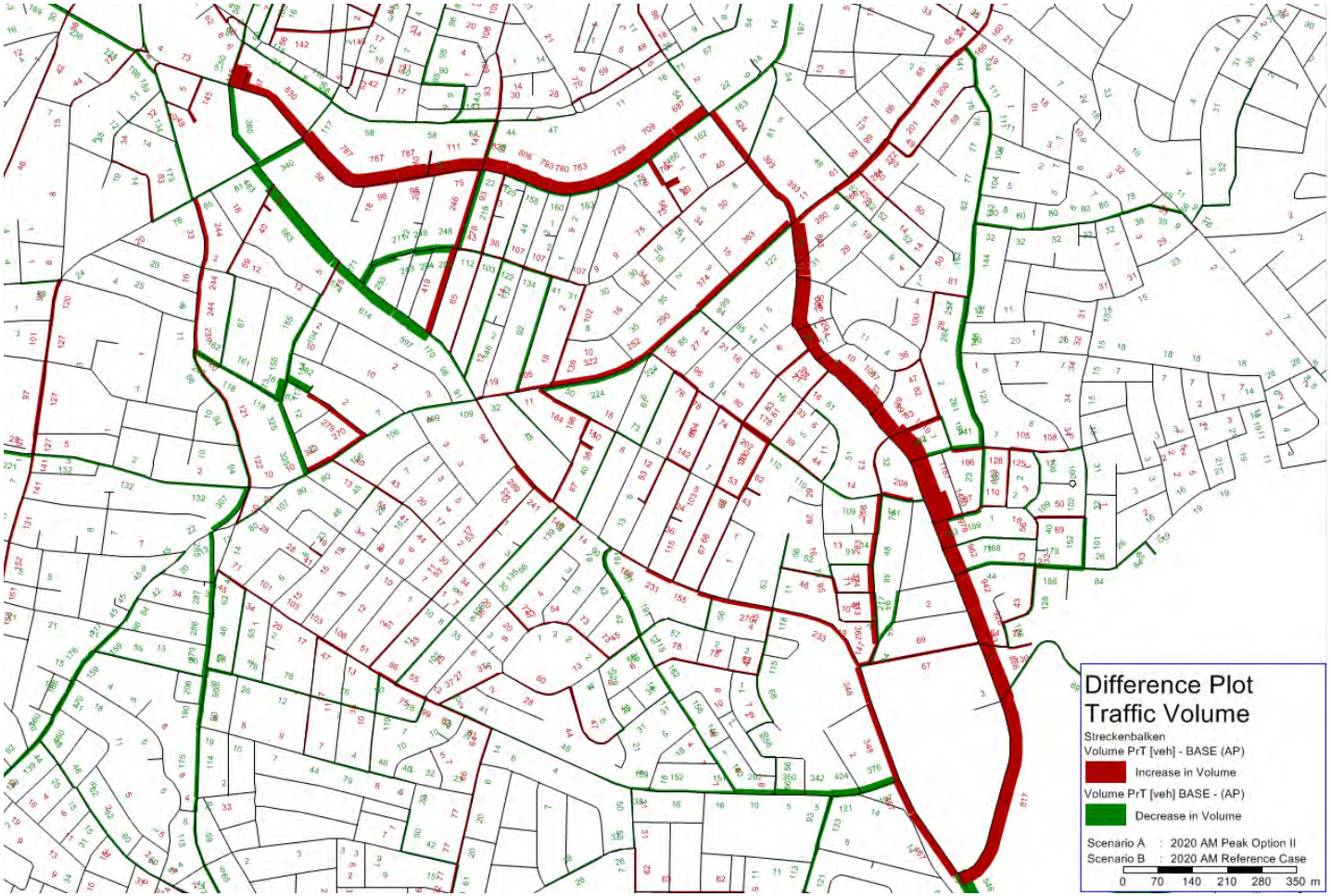


Figure 7.10: Comparison of traffic flow on links - Short Term Option 3 vs 2010 Base – PM peak period



7.4 Comparative assessment of local network operation

7.4.1 The following figures present a comparative assessment of the three options against the existing situation, for the PM peak period:

- Figure 7.11 – average delay per vehicle
- Figure 7.12 - average speed through the study area
- Figure 7.13 - total vehicle-kilometres on the network
- Figure 7.14 - total traffic through the study area
- Figure 7.15 – network journey times

7.4.2 The results shows that with the junction improvements described earlier for each option, with Option 2 the average delay on the network is comparable to the base case while Option 1 gives a marginal reduction in delays. With Option3, however, delays are forecast to reduce by around an average of 70 seconds per vehicle.

7.4.3 Option 3 does increase the total vehicle kilometres on the network, due to the introduction of the one way system. However, this increase is below the threshold adopted in Section 6 for significant environmental impact.

7.4.4 It is also noted in Figure 7.14 for short term Options 1 and 2 have a negligible impact on network throughput/capacity. With Option 3 there is some increase but this is only slight.

7.4.5 Figure 7.15 shows a sample of journey times for the base situation and with the three short term options. While the picture is mixed with some journey times reducing and some increasing when the options are compared to the base, when the options are compared to each other journey times tend to be lowest with Option 3 and highest with Option 2. Most of the differences are, however, not substantial.

Figure 7.11: Comparison of average network delay for short term options- PM

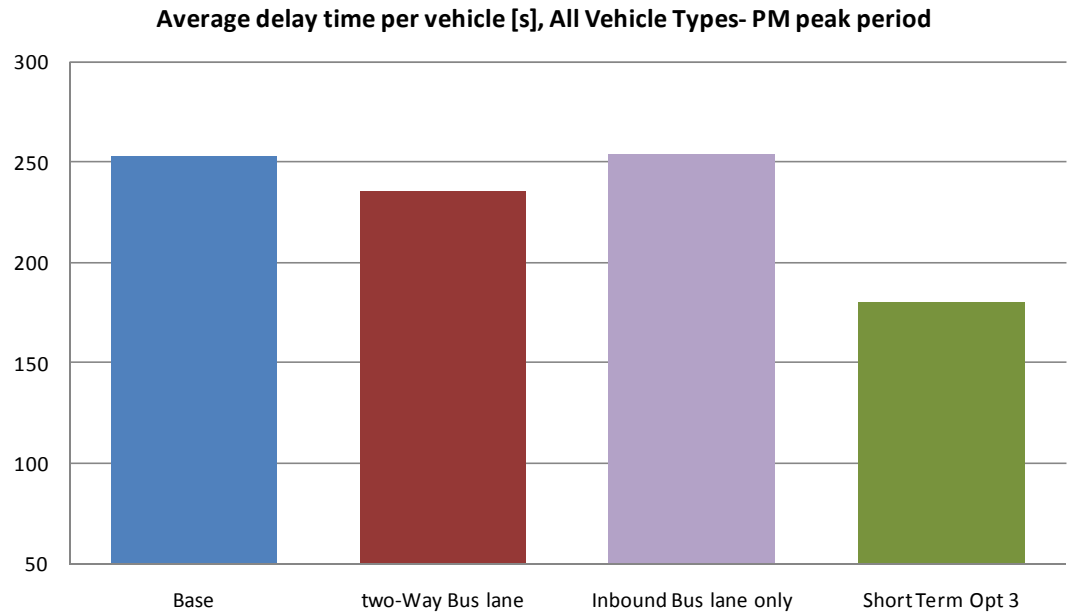


Figure 7.12: Comparison of average network speed for short term options- PM

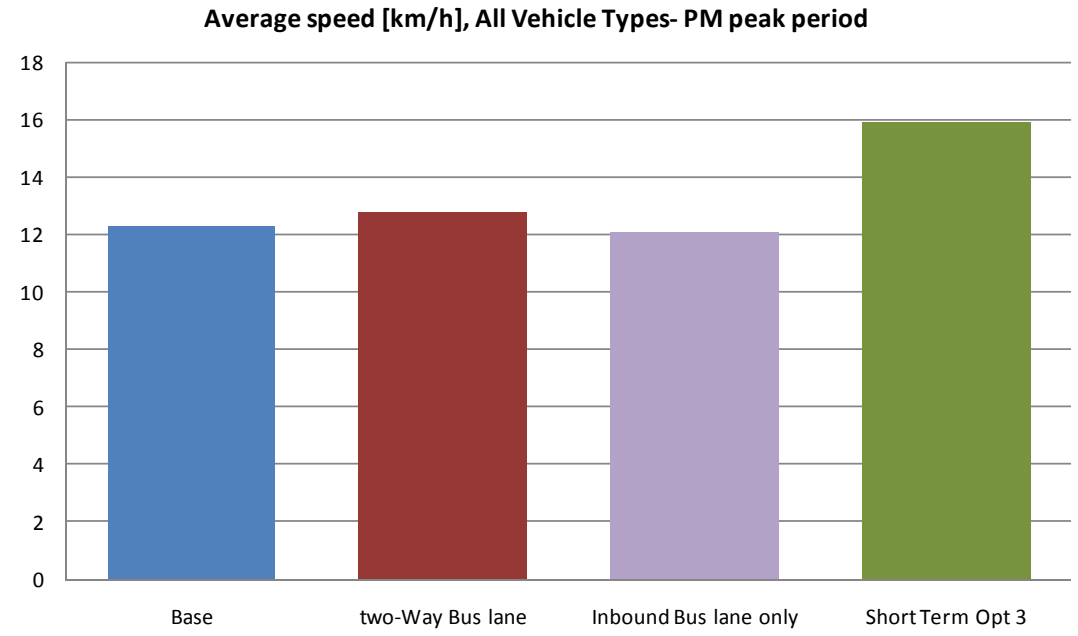


Figure 7.13: Comparison of total vehicle-kilometres for short term options- PM

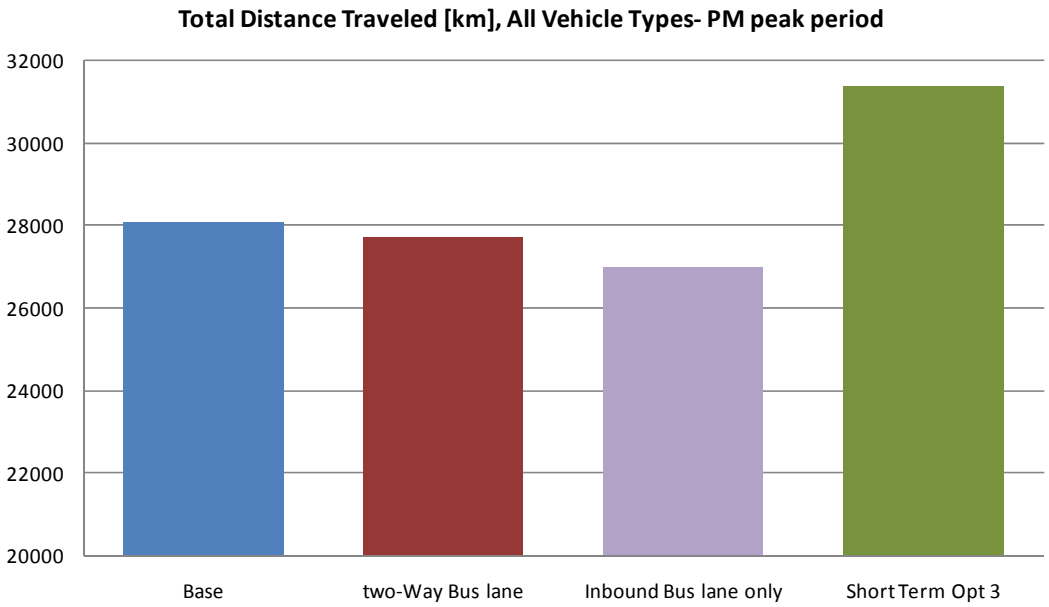


Figure 7.14: Comparison of total network throughput for short term options- PM

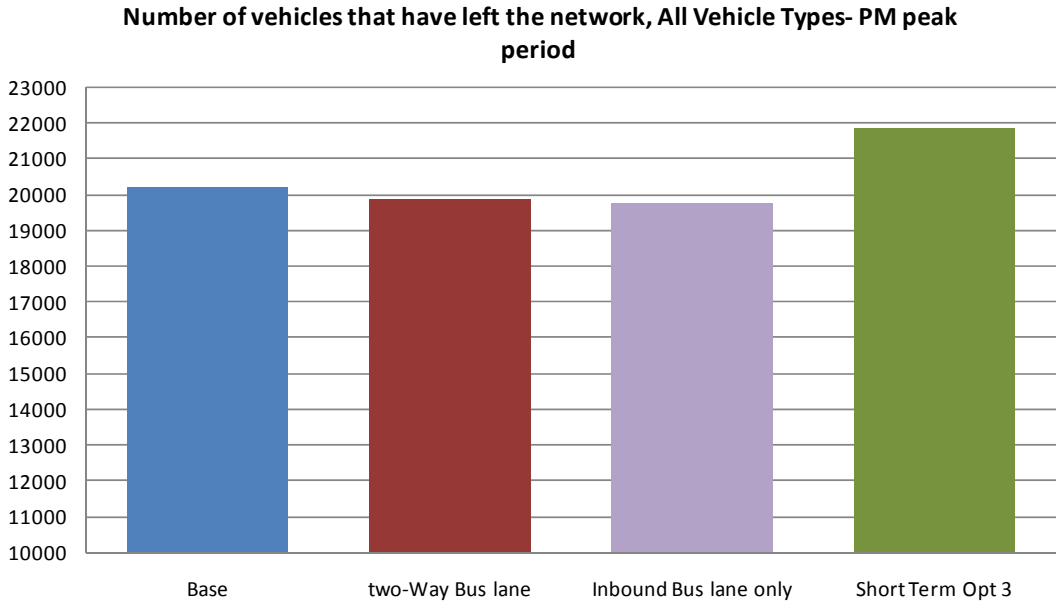
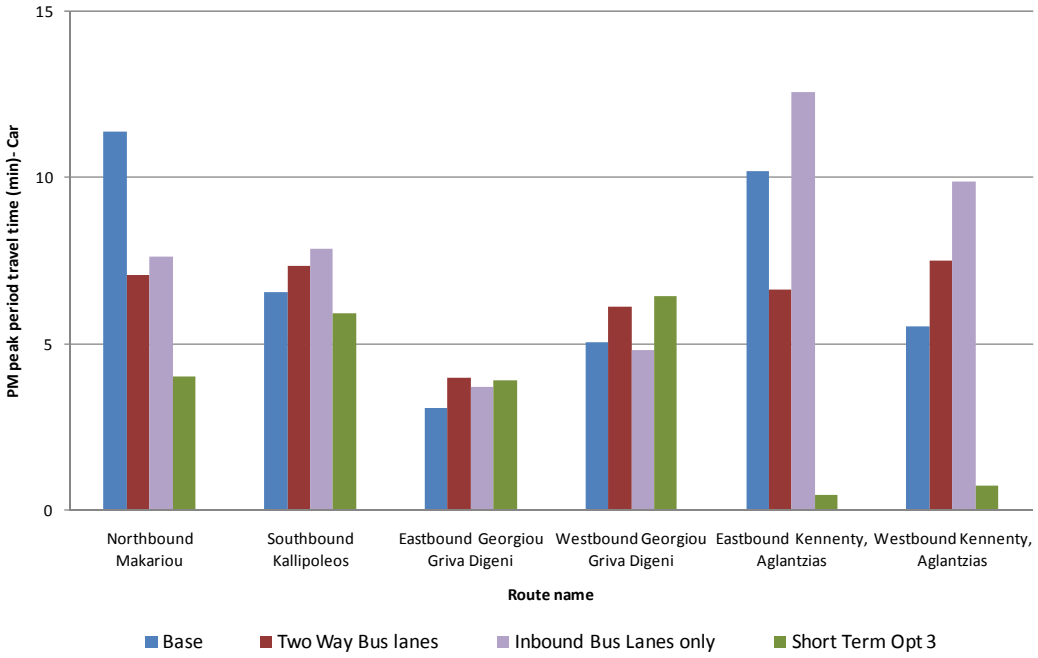


Figure 7.15: Comparison of network journey times for short term options- PM



AM peak – Option 3

7.4.6 Given that it is, in principle, the preferred option, the impact of Option 3 has also need assessed for the AM peak period. The results are presented in the following figures:

- Figure 7.16 – average delay per vehicle
- Figure 7.17 - average speed through the study area
- Figure 7.18 - total vehicle-kilometres on the network
- Figure 7.19 - total traffic through the study area
- Figure 7.20 – network journey times

7.4.7 The results suggest that, allowing for the suggested network changes and junction improvements, in the short-term Option 3 will also deliver a significant reduction in delay on the local area network in the AM peak period. As in the PM peak, the network throughput and total travelled distance also increase but not sufficiently to have more than a slight to moderate impact.

7.4.8 Figure 7.20 shows that Option 3 reduces journey times for general traffic on Makariou, as would be expected, and to lesser extent on Kennedy/Aglantzias. Elsewhere journey timers are little affected..

Figure 7.16: Comparison of average network delay, Short Term Option3 vs 2010 base- AM

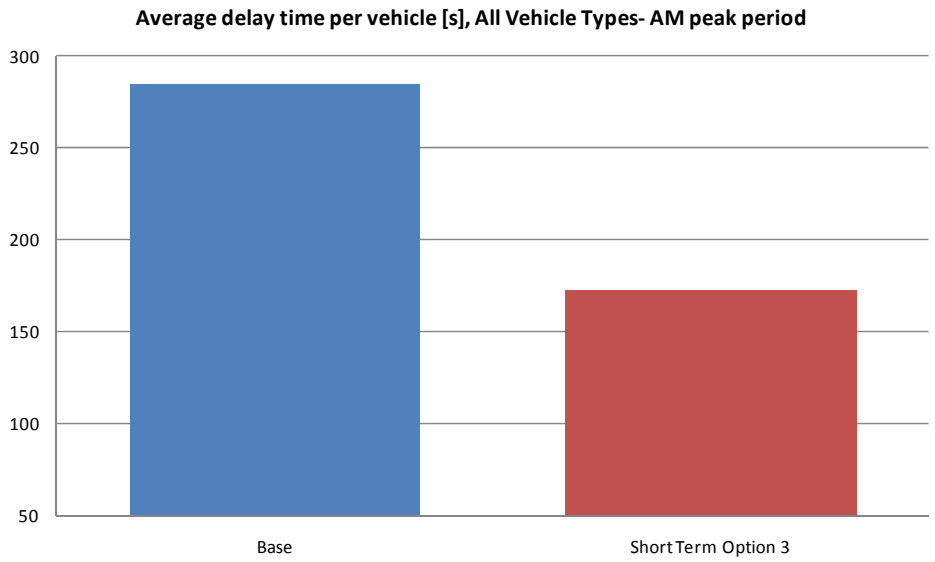


Figure 7.17: Comparison of average network speed, Short Term Option 3 vs 2010base- AM

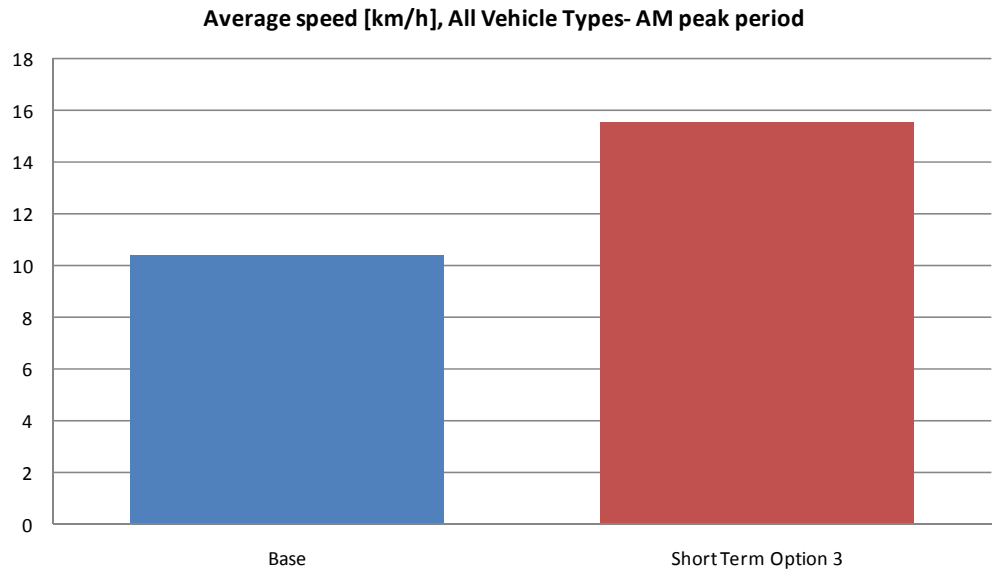


Figure 7.18: Comparison of total vehicle-km, Short Term Option 3 vs 2010 base- AM

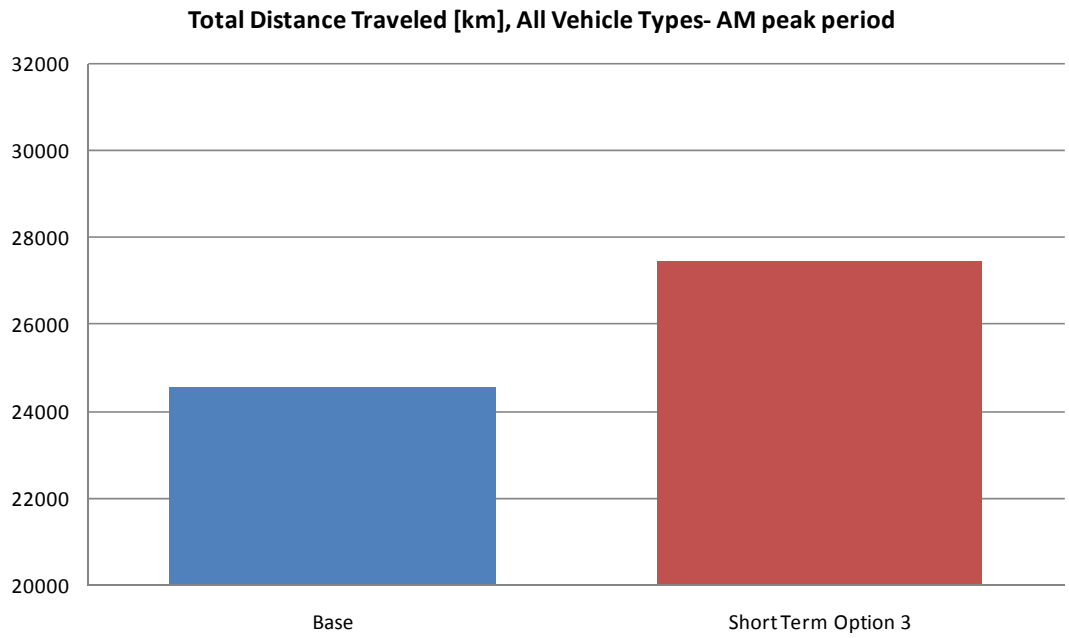


Figure 7.19: Comparison of total network throughput, Short Term Option 3 vs 2010 base- AM

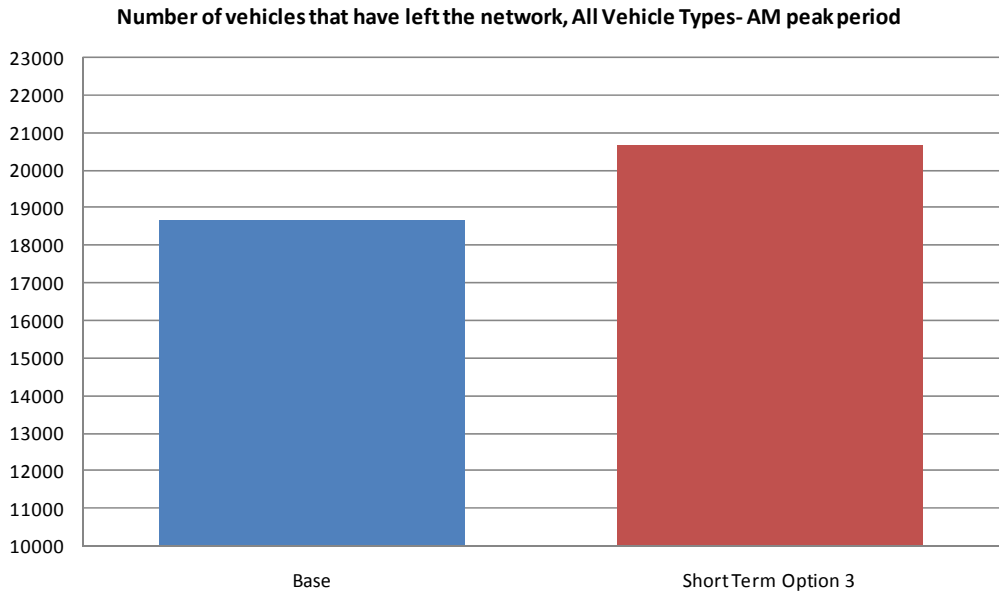
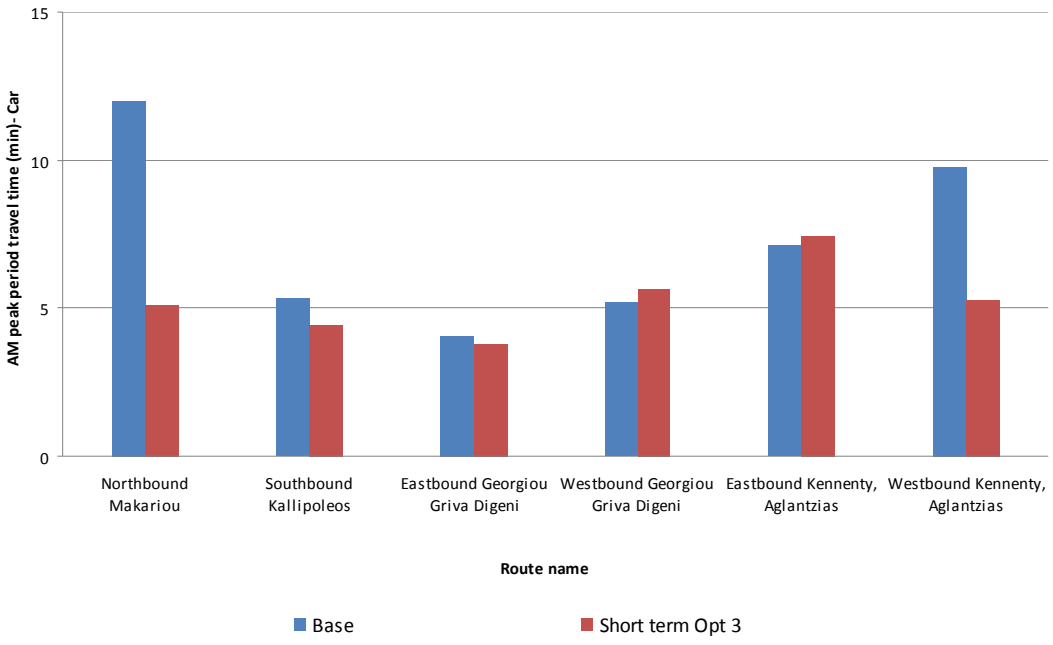


Figure 7.20: Comparison of journey times, Short Term Option 3- AM



Impacts on public transport

7.4.9 Figures 7.21 and 7.22 show that all the short-term options will lead to increases in PM peak journey speeds and decreases in delays for buses compared to the existing situation. Figures 7.24 and 7.254 confirm that Option 3 will also deliver very substantial benefits to buses in the AM peak.

7.4.10 When bus journey times on Makariou specifically are considered (Figures 7.23 and 7.26), the benefits of the bus lanes are clearly demonstrated. As would be expected the options that provide the more extensive bus lanes tend to give the greater reductions in journey time.

Figure 7.21: Comparison of average bus journey speed for short term options- PM

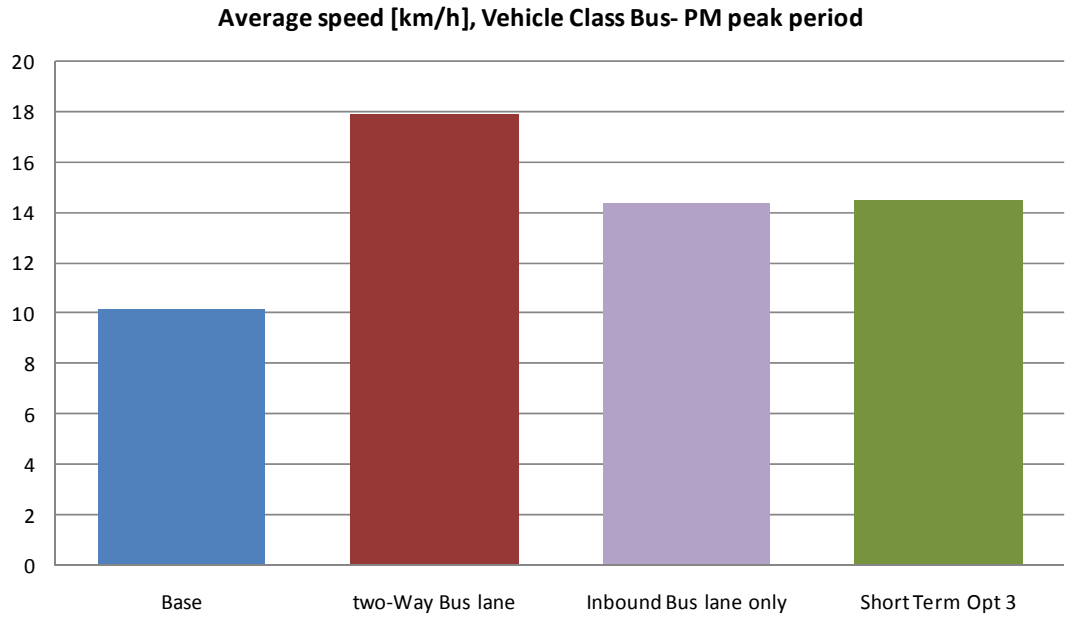


Figure 7.22: Comparison of average bus journey delay for short term options- PM

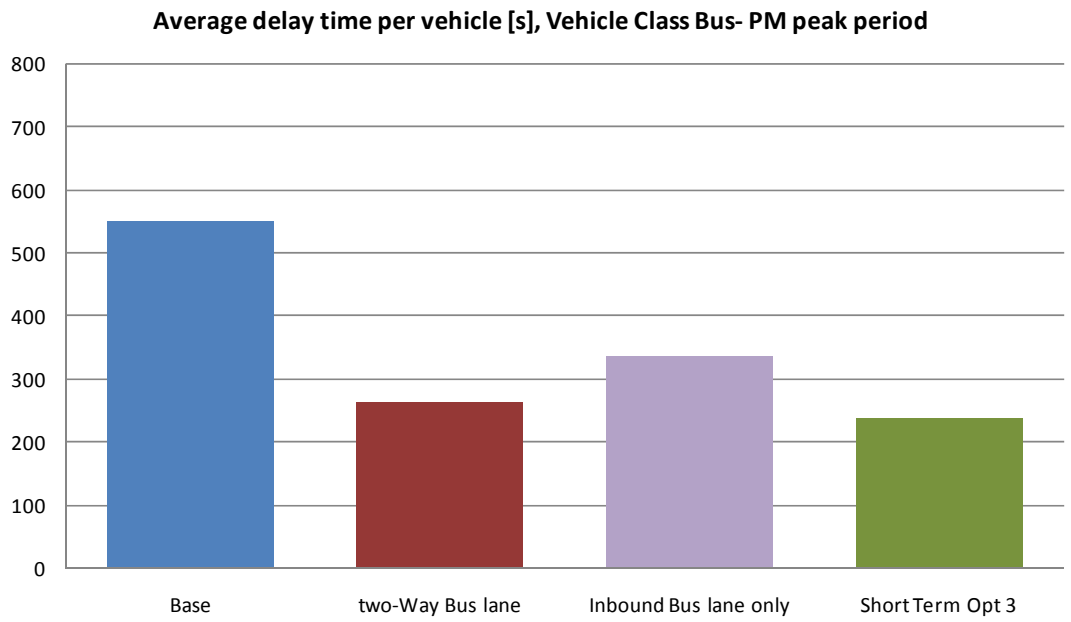


Figure 7.23: Comparison of bus travel time on Makariou Av for short term options- PM

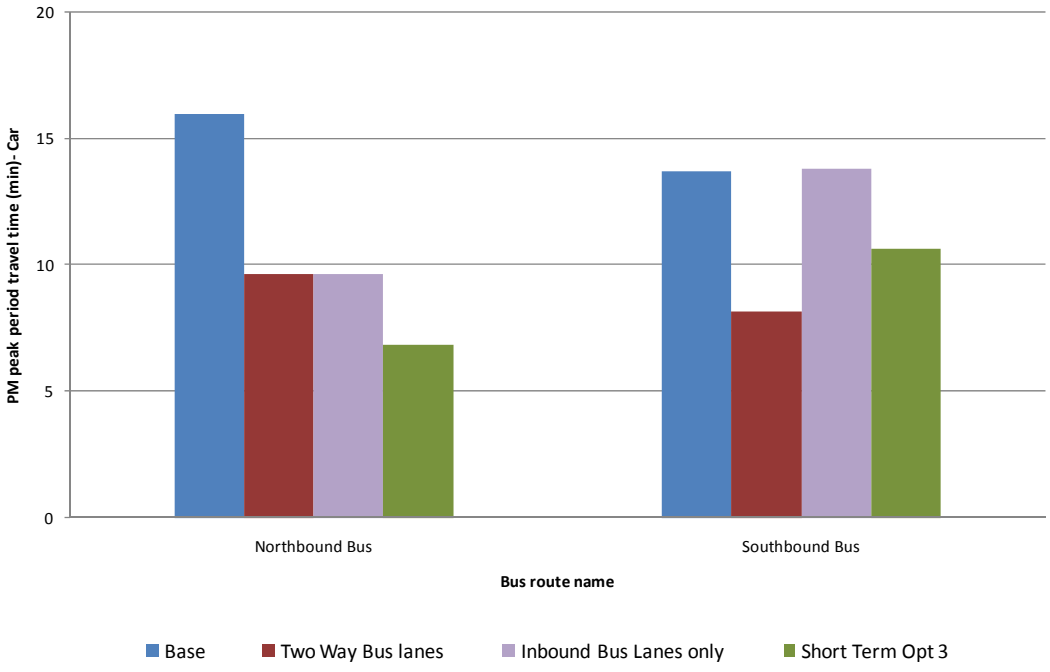


Figure 7.24: Comparison of bus journey speed , Short term option 3 vs Base- AM

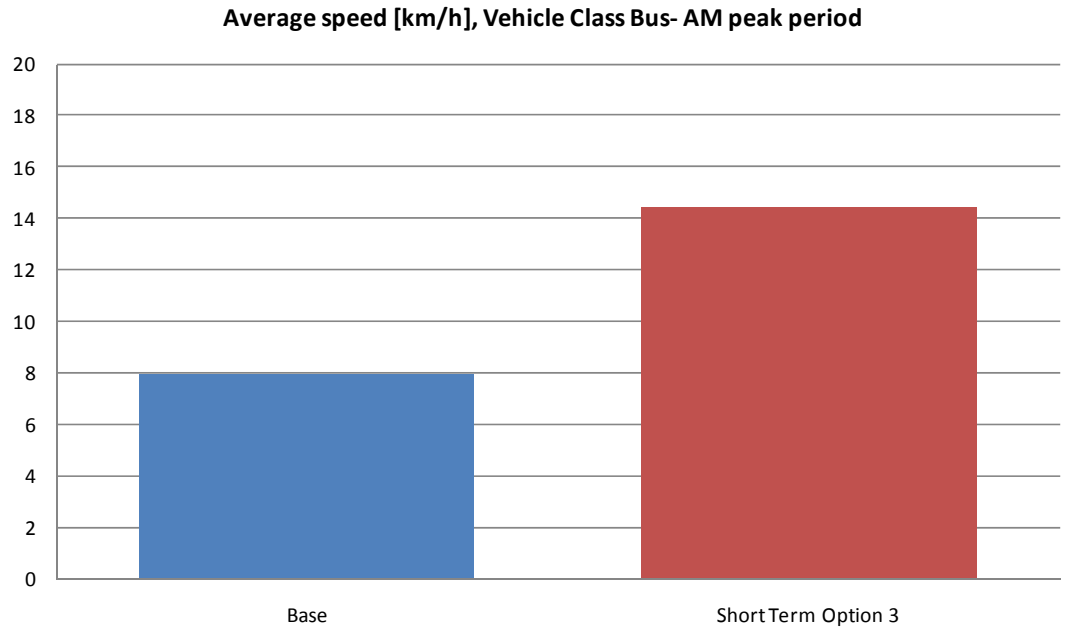


Figure 7.25: Comparison of bus journey delay, Short term option 3 vs Base- AM

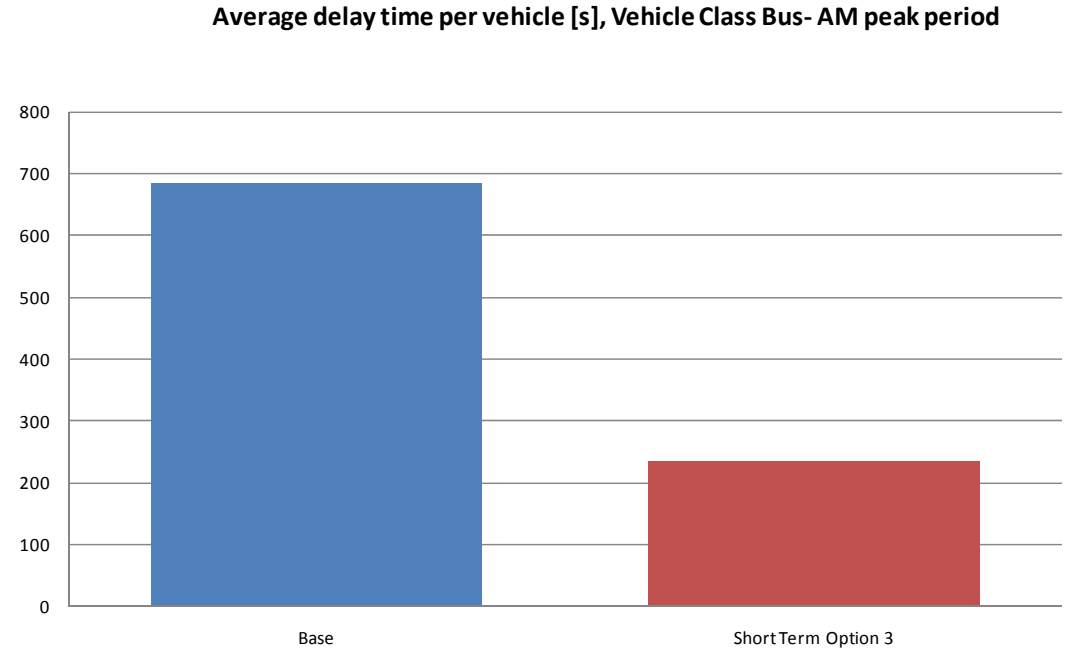
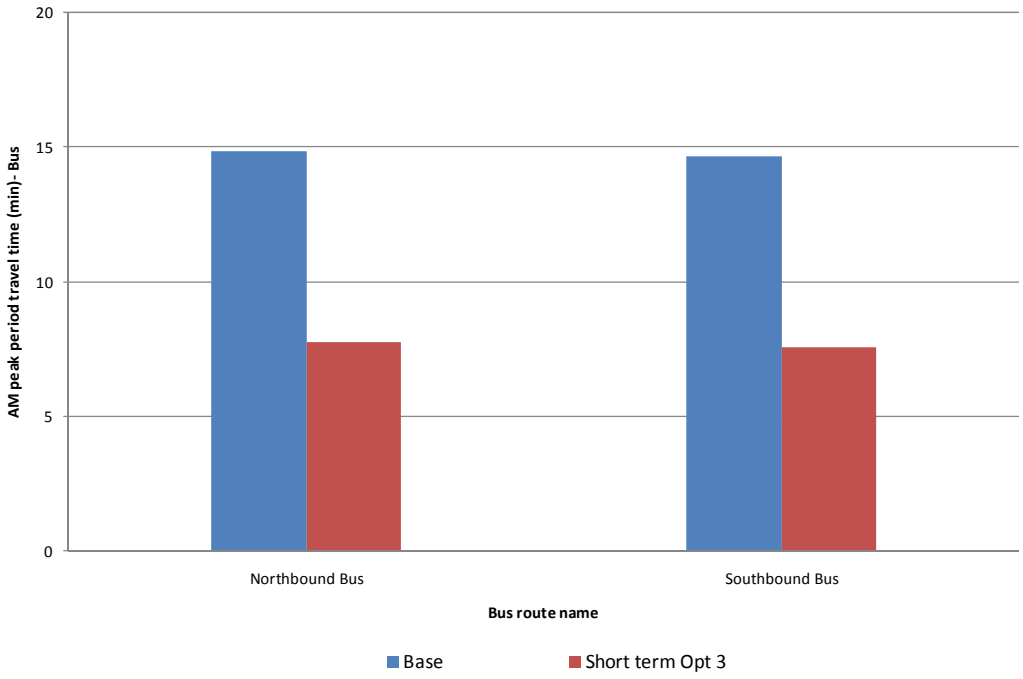


Figure 7.26: Comparison of bus travel time on Makariou Av, Base vs short term option 3-AM



7.5 Summary of the short term impacts

7.5.1 This section has described the assessments carried out of two short term options for Makariou/Kallipoleos and compared the impacts of these options with the short term impacts of implementing now the preferred longer term option, Option 3 (modified to obviate any need for carriageway widening on Makariou).

7.5.2 All options are shown to deliver benefits to buses. While Option 1 and Option 3 deliver the highest benefits to buses the differences are, in general, not substantial due to relatively smaller number of buses in use currently. Option 3 has the benefit of also improving general traffic flows and network throughput.

7.5.3 Option 1 is likely to have a bigger impact than Option 2 on the wider road network, in particular in terms of the displacement of traffic onto the network west of Makariou.

7.5.4 Option 3 does, therefore, represent the best short term option, provided any potential constraints to its implementation can be overcome or mitigated.

7.5.5 In terms of wider network issues, the short term options will be expected to have an impact on the same junctions as in the 2020 options. These junctions will include:

- Digeni Akrita/Nikis
- Kennedy Avenue/Nikis
- Grivas Digeni/Dimostheni Severi

The further studies CB/ALA is due to carry out will take into account any additional traffic at the Themistoklis Dervi junction and elsewhere.

7.5.6 In addition, the short term Option 3 will require the following traffic management measures:

- Improvements at the junctions of Digeni Akrita/Kallipoleos, Stasinou/Kallipoleos, Makariou/Digeni Akrita, and Makariou/Aglantzias
- New traffic signals at Kallipoleos/Ypatias and Digeni Akrita/Nikodimou Mylona
- One way streets on Theodotou, Chalkokondyli, Demokrotou and Doiranis and Klaridi and Damascanou

Implementing these measures, however, will only require minor works including changes to lane-markings and signal-plans. The most significant of these being the proposed new signals.

Other impacts

7.5.7 None of the short term options would be expected to have a material impact on road safety or on the accessibility of the area. In Section 6 Option 3 was shown to have a slight/moderate adverse environmental impact to be addressed over the longer term.

7.5.8 None of the short term options provide dedicated cycle lanes. However cyclists will benefit from access to the bus lanes.

7.5.9 Options 1 and 2 will have little impact on pedestrians. With Option 3 there will be scope to give pedestrians improved crossing facilities at junctions on Makariou, due to the reduction in the number of conflicting traffic movements.

8 Summary and conclusions

8.1 Overview

8.1.1 The Integrated Mobility Master Plan (IMMP) proposals for the Nicosia road network include converting Makariou Avenue and Kallipoleos Avenue to operate as a one way pair, primarily to create opportunities to reallocate road space to buses, cyclists and pedestrians. It also proposes that traffic, other than buses and cyclists, be excluded from the northern end of Makariou.

8.1.2 This study has assessed traffic management options for the Makariou/ Kallipoleos network, taking the IMMP as the starting point. Three options have been considered, all based on the concept of the one way radial pair. The first (Option 1) was based on the IMPP proposals, and included a northbound bus lane and a two way cycle lane on Makariou. Two further options were then developed to address issues identified with the impacts of the IMMP scheme. In Option 2 the pedestrianisation of the northern end of Makariou was omitted to mitigate some of the traffic impacts of Option 1, while in Option 3 a contra flow (southbound) bus lane was introduced in place of the cycle lane, to improve the accessibility of bus services.

8.1.3 These options have been assessed for their impacts on the operation of the road network; road safety; public transport; pedestrians and cyclists; accessibility to homes and businesses; and the environment. These assessments were carried out for the IMMP 'design year' 2020. All options were compared against a Reference Case (or 'do minimum') scenario for that year.

8.2 Option assessment

8.2.1 While Option 1 presents the most opportunity to enhance the pedestrian environment in the core retail area of Makariou, the displacement of traffic associated with it is predicted to give rise to major problems on Stasinou/Evagorou. These problems may be mitigated by proposed improvements to orbital corridors to the south, but these solutions are only likely to be delivered in the longer term.

8.2.2 Option 2 mitigates these traffic issues. However Option 2, as does Option 1, has a significant adverse impact on the accessibility of bus services to the Makariou corridor, as southbound services are diverted to Kallipoleos.

8.2.3 Option 3 mitigates this adverse impact on bus users by providing a contra flow bus lane on Makariou. The contra flow bus lane replaces the two way cycle lane so there is some adverse impact on cyclists compared to Options 1 and 2, who will share the bus lane instead of having a dedicated facility.

8.2.4 Option 3 is very similar to Option 2 in terms of traffic conditions.

8.2.5 With regards to road safety, there are no existing accident 'blackspots' in the study area. However, all three options may be expected to have some beneficial impact on safety through a reduction in the number of conflicting traffic movements. However they may have adverse safety impacts from an increase in traffic speeds on the major roads, unless mitigating measures are introduced.

8.2.6 All three options have an overall neutral impact on the accessibility by car to the Makariou retail areas and to adjacent residential areas, with access times increasing slightly for some journeys and reducing slightly for others.

8.2.7 All three are expected to give rise to increase in traffic in parts of the adjacent residential areas between Makariou and Kallipoleos, although overall the impact is slight or neutral. The Mylonas Street need to be signalised at both end to ensure enough capacity for the exiting traffic. All increase flows on Makariou and Kallipoleos.

8.2.8 In terms of the objectives for the study area, therefore, Option 3 is recommended as the most balanced option in terms of the improvements it delivers for sustainable transport. Pedestrianisation on Makariou may be retained as a longer term objective, probably in association with improvements to the strategic orbital road network to the south to reduce traffic on Stasinou.

8.2.9 Minor improvements at the following traffic signal junctions will be required with any of the three options assessed:

- Digeni Akrita/Kallipoleos
- Stasinou/E & A Theodotou/Kallipoleos
- Makariou/Digeni Akrita
- Kallipoleos/Makariou.
- Makariou/Aglantzias between Kallipoleos and Aglantzias

8.2.10 New traffic signals will be required at the Kallipoleos/Ypatias junction and at the Digeni Akrita/Nikodimou Mylona junction.

8.2.11 It should be noted that no cost estimates have been made

Wider impacts

8.2.12 The traffic forecasting undertaken for this study has highlighted traffic capacity issues on the road network away from the Makariou/Kallipoleos corridors, but which will be impacted upon by the measures proposed within those corridors. The most critical of these are at the Digeni Akrita/Nikis, Kennedy Avenue/Nikis and Grivas Digeni/Dimostheni Severi junctions. The traffic analyses undertaken here need to be extended to address these issues and identify appropriate mitigation.

8.3 Short term options

8.3.1 The three options described in 8.2 were formulated to deliver the objectives of the IMMP over a period up to 2020. Given the desire to implement more immediate measures to promote bus use, specific short term options requiring minimum highway changes, have also been assessed. These short term options would represent the first phase of the longer term traffic management plan for the area.

8.3.2 The first two short term options assessed both retain two way traffic on Makariou and Kallipoleos. Option 1 provides for bus lanes in both directions on Makariou, but with Makariou north of Digeni Akrita becoming one way northbound for general traffic to accommodate two bus lanes. In Option 2 bus lanes in each direction are still provided between Kennedy and Digeni Akrita, but to the north only a northbound bus lane is provide to allow the retention of two way working for general traffic.

8.3.3 In addition, there is a potential opportunity to implement the preferred longer term option, Option 3, over a shorter timescale in association with planned major works on Kallipoleos. The short term impacts of this option have also, therefore, been assessed with current demand levels.

8.3.4 Short term Options 1 and Option 3 deliver similar benefits to buses, and higher benefits to buses than Option 2. Option 3 also delivers significant benefits in terms of overall network capacity.

8.3.5 Option 3 represents the preferred short term option. It will require the following traffic management measures:

- Improvements at the junctions of Digeni Akrita/Kallipoleos, Stasinou/Kallipoleos, Makariou/Digeni Akrita, and Makariou/Aglantzias
- New traffic signals at Kallipoleos/Ypatias and Digeni Akrita/Nikodimou Mylona
- One way streets on Theodotou, Chalkokondyli, Demokrotou and Doiranis and Klaridi and Damascanou

Implementing these measures, however, will only require minor works including changes to lane-markings and signal-plans. The most significant of these being the proposed new signals.

8.3.6 In terms of wider network issues, the short term options will be expected to have an impact on the same junctions as in the 2020 options. These junctions will include:

- Digeni Akrita/Nikis
- Kennedy Avenue/Nikis
- Grivas Digeni/Dimostheni Severi

The further studies CB/ALA is due to carry out will take into account any additional traffic at the Themistoklis Dervi junction and elsewhere.

Appendix 1 - Trip Generation Model

Figure A 1: Trip Generation model, Comparison between enhanced and previous model

Trip Generation models

Enhanced Trip Generation Models

Trip Production					
Trip Purpose	**Explanatory Variables**	**Coeff**	**t-value**	**Sig**	**R Square**
HBW	Employment_Residents	1.52	93.57	0.00	98%
HBEdu	HH_Numbers	0.95	19.30	0.00	71%
HBShopping	HH_Numbers	0.48	23.50	0.00	78%
HB Other	Population_More than 16 yrs	0.52	42.78	0.00	92%
NHB	Num_of_Jobs	0.05	4.30	0.00	31%
	Local_Business_commercial_area	20.20	2.78	0.01	
	School_area_alltypes_hectare	18.91	3.29	0.00	

Trip Attraction					
Trip Purpose	**Explanatory Variables**	**Coeff**	**t-value**	**Sig**	**R Square**
HB Work	Job_Density_PerHectare	6.94	7.06	0.00	64%
	Activity area_SqM	0.01	9.62	0.00	
	Not_Town_CentreEmployment_Establishment	0.20	3.21	0.00	
HB Education	School area (km^2) in zone	45.88	7.79	0.00	44%
	Population density per hectare	1.32	5.27	0.00	
HB Shopping	Local_Business_commercial_area	31.68	6.28	0.00	41%
	Town_Centre	84.15	3.47	0.00	
	HH_Numbers	0.09	5.67	0.00	
HB Other	LocalBusiness_Area_SqM	0.04	2.97	0.00	17%
	HH_Numbers	0.31	2.73	0.01	
	ViewPoints_Area_SqM	0.003	2.06	0.04	
NHB	Num_of_Jobs	0.06	4.68	0.00	22%
	LocalBusiness_Area_SqM	0.01	1.66	0.10	
	School_area_alltypes_hectare	12.950	2.17	0.03	

Previous Model

Trip Production			
Trip Purpose	**Explanatory Variables**	**Coeff**	**t-value**
HBW	Population	1.56	-
HB Other	Population	0.84	-
NHB	Population	0.05	-

Trip Attraction			
Trip Purpose	**Explanatory Variables**	**Coeff**	**t-value**
All purposes	Employment position in the zone	2.65	-

Table A 1: Population projections and population growth factors for Lefkosia area

Municipalities, Communities	POPULATION		Growth from 2010 to 2020
	2010	2020	
Zone Name			
Lefkosia Municipality	48788	53667	1.15
Quarters			
Agios Andreas	5290	5819	1.10
Trypiotis	2026	2228	1.10
Nempetchane	179	197	1.10
Tampakchane	208	229	1.10
Faneromeni	456	502	1.10
Agios Savvas	534	587	1.10
Omerie	135	149	1.10
Agios Antonios	5340	5874	1.10
Agios Ioannis	265	292	1.10
Taktelkale	623	685	1.10
Chrysaliniotissa	116	128	1.10
Agios Kassianos	75	83	1.11
Kaimakli	11081	12189	1.10
Panagia	9482	10430	1.10
Agios Konstan. & Eleni	2590	2849	1.10
Agioi Omologitai	9820	10802	1.10
Arap Achmet	204	224	1.10
Geni Tzami	140	154	1.10
Omorfita	224	246	1.10
Agios Dometios	12246	12368	1.01
Quarters			
Agios Pavlos	2852	2880	1.01
Agios Georgios	9394	9488	1.01
Egkomi Lefkosias	18694	23370	1.25
Strovolos	66718	76058	1.14
Quarters			
Chryseleousa	18534	21130	1.14
Agios Dimitrios	11734	13377	1.14
Apostolos Varnavas &	13227	15079	1.14
Agios Makarios			0.00

Agios Vasileios	19490	22218	1.14
Ethnomartyras Kyrpianos	2206	2514	1.14
Stavros	1527	1740	1.14
Aglantzia	20470	22107	1.08
Lakatameia	33318	38982	1.17
Quarters			
Agios Mamas	1340	1565	1.17
Agia Paraskevi	13797	16139	1.17
Archangelos - Anthoupoli	13223	15479	1.17
Agios Nikolaos	4958	5799	1.17
Synoikismos Anthoupolis	2842	3325	1.17
Latsia	14877	18150	1.22
Quarters			
Agios Georgios	10486	12793	1.22
Agios Eleftherios	2696	3289	1.22
Archangelos Michael	1695	2068	1.22
Geri	8247	10556	1.28
Dali	7293	9116	1.25
Tseri	6605	8256	1.25
Kato Deftera	1883	2164	1.15
Pano Deftera	2250	2588	1.15

Appendix 2 – Committed Developments

Additional Traffic Generation

Ref. No.	Name of Devt.	Location	Land Uses	Total Floor space	Total Floor space	Weekday AM (07:00 - 08:00) Flows		Weekday PM (17:00 - 18:00) Flows	
				sq m	sq km	To	Frm	To	Frm
1	Esperidon Office Devt.	Esperidon	General Retail/Office	3634	0.004	13	0	33	64
2	Athalassias Devt.	Athalassias	General Retail/Office	4529	0.005	16	0	41	80
3	Tseriou Office Devt.	Tseriou	Office/General Retail/Restaurant	4900	0.005	30	0	29	97
4	Prodromou Office Devt.	Prodromou	General Retail/Office	2489	0.002	9	0	23	44
5	M&S Devt.	Lemesou	Retail/Office/Gallery	3180	0.003	12	0	34	120
6	Tseriou Retail Devt.	Tseriou	Retail	1917	0.002	0	0	78	68
7	Petevis Mixed-Use Devt.	Strovolou	Office/General Retail/Public Parking	5730	0.006	31	2	59	122
8	Strovolou Mixed-Use Devt.	Strovolou	General Retail/Office	1846	0.002	6	0	17	33
				7576	**0.008**	**37**	**2**	**76**	**155**
9	Kennedy Mixed-Use Devt.	Kennedy	General Retail/Office	2763	0.003	10	0	25	50
10	Troodos Office Det.	Sp. Kyprianou	Office	3180	0.003	18	0	4	52
11	Nikis Mixed-Use Devt.	Nikis	General Retail/Office	5200	0.005	18	0	46	92
12	Lemesou Office Devt.	Lemesou	Office	2200	0.002	10	0	2	30
13	G. Digeni Mixed-Use Devt.	G. Digeni	General Retail/Office	3675	0.004	13	0	34	66
14	Office Devt. On Lemesou	Lemesou	Office	1432	0.001	6	0	2	19
15	Aglantzia Carrefour Supermarket	Larnakos	Food Retail	2232	0.002	7	1	98	92
16	Aglantzia Orphanides Supermarket	Larnakos	Food Retail	2804	0.003	9	2	124	116
17	Aglantzia Mixed-Use Devt.	Aglantzia	Office/General Retail/Residential/ Restaurant/Public Parking	5442	0.005	32	10	56	99
18	Ay. Prokopiou Office Devt.	Ay. Prokopiou	Office	4890	0.005	22	1	5	65
19	Engomi Office Devt.	Engomi	Office	3690	0.004	17	0	4	49
20	Mikaland Tower Devt.	K. Matsi	Office/General Retail/Residential/ Public Parking	2800	0.003	96	7	32	93
21	Latsia Alfamega Supermarket	Arch. Makariou	Food Retail	2696	0.003	8	1	116	109
22	Lakatameia Shopping Mall	Lakatameia	Various	42500	0.043	0	0	466	412

23	IKON Leisure Devt.	Sp. Kyprianou	Cinema/Bowling/ Health Spa/ Restaurant/Office	33000	0.033	22	11	200	197
24	Alakati Mixed-Use Det.	Lakatameia	Residential/Hotel/ General Retail/Office /Restaurant	27000	0.027	126	212	362	522
25	GSP Square Devt.	Central Nicosia	Office/Retail/Restaurants/ Hotel	10000	0.010	24	2	54	108
26	Nicosia Tower Mixed-Use Devt.	G. Digeni	Residential/Hotel/ General Retail/Office	32000	0.032	47	39	226	289
27	Leventis Tower	Central Nicosia	Residential/Cultural Uses	7300	0.007	11	15	25	94
28	Jean-Nouvel Tower	Central Nicosia	Residential/General Retail/Office	4488	0.004	10	10	22	41
29	Deloitte Office Tower	G. Digeni	Office	3750	0.004	17	0	4	50
					0.036	**64**	**39**	**230**	**338**
30	Mixed-Use Devt. (Atkins)	G. Digeni	Residential/General Retail/Office	11000	0.011	32	14	64	136
31	Residential Devt. (Israeli)	Pallouriotissa	Residential	5000	0.005	4	20	18	13
32	Rotos Devt.	Pallouriotissa	Residential/Retail	4430	0.004	2	14	51	42
33	Rotos Devt. 2	Pallouriotissa	Residential	4000	0.004	3	16	14	10
34	Rotos Office Devt.	Severi	Office/General Retail	3150	0.003	10	0	33	58
35	Cyfield Office Devt.	Severi	Govt. Offices	8500	0.009	245	10	0	5
					0.012	**255**	**10**	**33**	**63**
36	Gavrielides-Chapo Mixed-Use Devt.	Central Nicosia	Residential/General Retail/Office/Leisure	20000	0.020	31	41	106	158
37	Ministry of Health		Govt. Offices						
38	Cyprus Cultural Centre	Th. Dervi	Various	21172	0.021	0	0	139	120
39	Govt. Offices at State Fair	Engomi	Govt. Offices	60382	0.060	603	23	0	0
40	Govt. Offices at Platy	Keryneias	Govt. Offices	82825	0.083	1293	53	0	0
						2863	503	2646	3813
							3367		6459

Appendix 3: Comparative Assessment of Options

Type of Criteria	Assessment Criteria	Option 1	Option 2	Option 3
Network Operation	**Total**	**6**	**7**	**7**
	Average travel time on the strategic network	0	0	0
	Average delay/vehicle – local area	2	2	2
	Average network delay per speeds – local area	1	2	2
	No. of vehicles leaving network (total network throughput)	2	2	2
	Journey times on key routes	1	1	1
Safety	**Total**	**1**	**1**	**1**
	Reductions in conflicts at key junctions	2	2	2
	Change in average speeds – major roads	-1	-1	-1
	Change in average speeds – minor roads	0	0	0
Accessibility	**Total**	**0**	**0**	**0**
	Change in average weighted travel times	0	0	0
Environmental	**Total**	**1**	**0**	**-2**
	Changes in vehicle/kms	0	0	-1
	Traffic flow on sensitive streets – major roads	0	0	-1
	Traffic flow on sensitive streets – other roads	1	0	0
Public Transport	**Total**	**2**	**2**	**4**
	Average bus speeds/delays	2	2	2
	Bus travel time on Makariou	0	0	2
	Bus passenger access times to bus stops	-2	-2	0
Pedestrians	**Total**	**5**	**3**	**2**
	Footway widening	2	0	-1
	Additional pedestrian crossings	1	1	1
	Improved crossing facilities at junctions	2	2	2
Cyclists	**Overall**	**4**	**4**	**2**
	Dedicated or shared space for cyclists	2	2	1
	Widths of dedicated or shared facilities	2	2	1

Impact thresholds

-	**Delays/journey times**	**Flow changes**	**Network throughput**
Neutral/slight	< +/- 5 mins.	< +/- 25%	< +/- 10%
Moderate	+/- 5 - 10 mins.	+/- 25% - 50%	+/- 10% - 20%
Large	> +/- 10 mins.	> +/- 50%	> +/- 20%

-	**Link speeds**
Neutral/slight	+/- 5 kph.
Moderate	+/- 5 – 10kph
Large	> +/- 10kph

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