Appendix A

SHOREHAM HARBOUR TRANSPORT MODEL REVIEW AND UPDATE TECHNICAL NOTE

Technical Note

Subject: Review of the SHTM Model

Date: 10 August 2012

Reference: MB1202

Author: Martin Bach

Version: 1.0

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1 Introduction

The SHTM model was developed originally by Peter Brett/Minnerva in 2010, and passed to Parsons Brinkerhoff in 2012 for application on a study in the Adur/Shoreham region. When applied on this study, trips were being 'lost' unexpectedly during the iterative process. An initial audit of the processing job by PB identified an error in one of the modelling scripts, but when corrected this did not make any difference to the model results.

Minnerva was then asked to undertake a more detailed audit of the model to understand why trips were being 'lost'.

In addition, the model was designed so that outputs from the Saturn Highway Assignment runs were passed back to the OmniTRANS Public Transport model so that PT assignments could use these 'congested' highway speeds. An important component of the multi-modal modelling structure, this link had been disabled for these model runs, and needed to be re-established.

A detailed account of the audit process follows in subsequent sections, but a summary of the key findings is presented here:

1. The basis of the mode split model is that it calculates incremental changes to the trip matrices between the base and forecast scenarios using cost differences (by mode) between the scenarios.

2. As with all incremental models, if there are no trips in the base scenario for a given zone i-j pair, but there are non-zero trips in the forecast scenario, action must be taken to ensure that zero trips are not produced for the forecast.

3. With the scenario run tested in the audit this situation was detected, but for a set of different reasons:

    a. the error in the script as identified by PB, when corrected, required the 2008 Base scenario to be re-run. This had not been done, with the result that in a forecast scenario run there were non-zero trips in cells where there were corresponding zero cells in the Base.

    b. the forecast matrices, as derived for this model application, have trips in cells which do not have trips in corresponding cells in the base. This has been observed both for zones which were 'dummy' in the base but have been used in this model, but also for 'existing' zones where base i-j cells have changed from zero to non-zero trips

4. A potential third reason exists: an apparent import error for the forecast scenarios has switched Home Based Other and Home Based Employers Business trip matrices. This could also give rise to non-zero cells in the Forecast Matrices with corresponding zero filled cells in the Base matrices. [Note: this condition has to be confirmed by PB]

5. A couple of additional minor corrections were made to the scripts, but after corrective action for the items noted in paragraph 3 above were made, a detailed audit of trip totals through the various processing stages showed that 'mechanically' the process is now correct; that is, trips are not lost during the mode split process.

6. The link between Saturn and OmniTRANS PT has been re-established, so more realistic highway speeds are used by the PT assignment.

Although the model can be shown to be working correctly in a 'mechanical' sense, there are several issues which require consideration to ensure that the model is behaving as expected. These issues are discussed in later sections, and summarised in Section 8 , below.

2 Audit Strategy

The model as supplied was in OmniTRANS V5 format, and when originally developed required the use of set of utility classes (MvDataTools) developed by Minnerva to operate. PB does not have a licence for these classes, so changes were made by PB to the model scripts to avoid use of these classes. This gave rise to a divergent set of job scripts for running the model.

Whilst having no reason to think that any of the divergent scripts were not correctly amended, the audit was undertaken reverting to the original scripts, with the one exception of the change noted in 3.a (above); this correction was made to the original scripts. By reverting to the original job set one potential source of 'error' was removed; thus avoiding the need to check the amendments in the amended scripts.

To enable the model to run, copies of the relevant MvDataTools classes used by the SHTM model have been placed in the Local_Classes directory of the model. This will enable the model to be run by anyone who does not have a licence for MvDataTools (see discussion in Section 9 below).

Having removed one source of potential error, the Audit Strategy adopted was:

a) to re-run the 2008_Base_Network_wth_Base_Demand_Scenario. This to re-establish the 2008 Base, but also to check that the trip matrix totals, as the processing progresses through the disaggregation of the input matrices, were as expected

b) to take the 2008 input data (matrices and planning data) and set up a 'dummy' scenario to run against the 2008 Base. As the data was identical, the generated matrices for one iteration of the model run, through the post-mode split stage to the production of the combined vehicle/pt-fare/pt-no-fare for the next iteration, was expected to be identical to the 2008 base.

c) repeat (b), but with input data taken from for one of the 2028 (PB) forecast runs, and to see what happened.

To assist in this audit, several jobs were updated so they generated an output, tab separated text file containing matrix totals by the various (PMTU) categories, suitable for opening in Excel and so facilitate the audit. Some other changes were made to the job scripts, the main ones noted below:

0606 - Import Trip Matrices. A switch has been put in here that distinguishes between importing OmniTRANS binary matrices (.odm) and text .CSV files as created by PB. Base 2008 matrices are imported using the .odm format, forecast matrices prepared by PB are imported as .csv.

0611 - Initial Decomposition of Trip Matrices to CA-NCA and User Classes. Output analysis file added.

0621 - Aggregation of Trip Matrices for Assignment. Comparison statistics against the Base matrices added

0628 - Run Mode Split Model per User Class. Output analysis file added, plus other revisions discussed later

For all model runs, highway assignment trip matrices generated by OmniTRANS were passed to PB for running in Saturn with the resulting loaded network and skim matrices passed back for processing.

It should be noted that as part of this audit, no checks have been made on the network structures or content, highways or public transport.

3 2008 Base_Network_with_Base_Demand

This scenario was re-run so that each step of the processing could be checked to ensure that the expected matrix totals were being generated, as well as to establish a new base given the correction to one of the scripts noted in 3.a above.

The re-run comprised running jobs 0605 - 0611 and 0621 - 0628 (all jobs run manually, not from the Scenario Manager).

An audit trail of matrix totals is presented in spreadsheet "*Audit Trail 2008 Base.xlsx"* which is stored in the directory *..\Model_Data\Model_Outputs\2008_Base_Network_with_Base_Demand.*

The results are given for the AM period and the spreadsheet shows how the original, input matrices are disaggregated, by mode, through the various stages of processing. (PM results are not shown as the mechanical process is identical as that for the AM)

[Note: in this and other spreadsheets generated for this analysis, trip totals may differ by very small number of trips due to rounding/truncation in the spreadsheet as no decimal places are shown)

During the course of this analysis, it was noted that the global variable for setting the HGV PCU factor was missing from the modelling scripts, resulting in a default factor of 1.0 being available. To remedy this, the variable $hgv_pcu_factor = 2.0 was set in 'Get_Scenario.rb'

An examination of the spreadsheet *Audit Trail 2008 Base.xlsx* shows that the set of matrices produced post-mode split, and then re-aggregated into matrices ready for the 'next' iteration (which does not happen in the Base scenario) are identical to the starting matrices.

The conclusion from this was that the matrix processing for the Base Scenario was (mechanically) correct.

4 Dummy Forecast 2009_Base_Network_with_Base_Demand

Although re-running the 2008 Base showed that trip totals generated at the end of the run were as expected, this was not testing the code for a separate forecast scenario against the base, so a dummy forecast (for 2009) was set up, using the same input data as that for the 2008 base.

When run through one iteration, to the point of re-aggregating matrices for the next iteration, the same results were obtained as running the 2008 Base, so the indication from this was that when forecast data was supplied to the model in the expected form, the model was behaving as expected.

5 2028 Forecast Run - 2028_Base_Network_with_Ref_Demand

Taking data from the 2028_Base_Network_with_Ref_Demand scenario, the model was re-run. However, this time the aggregate matrices generated for the 'next' iteration were **not** as expected, and although the trip total differences were not as large as those reported by PB when they ran the model, the differences were such that something was not correct.

Investigation showed that the discrepancy was generated in job 0628 - Run Mode Split Model per User Class.rb, where the OtChoice incremental mode split is used. This works in the following manner:

a) trip matrices by mode (highway/pt) for the Base Year are used to generate, on a cell- by-cell i-j zone basis, probabilities of using each mode

b) these probabilities are then used with cost difference matrices (forecast year - base year; per mode), to generate forecast probability matrices per mode.

c) these forecast probability matrices are then applied to the forecast total trip matrices to derive the forecast mode split matrices.

The way in which this class works, ***if there are no observed trips in the base year for a given i-j zone pair, the probabilities are set to zero.*** Consequently, if there are non-zero trips in the forecast year for that i-j zone pair, zero trips will be generated.

Although some additional issues were noted in the use of this class, this was the prime reason for trips 'disappearing'. As reported earlier, this condition arose because:

a) the base had (originally) not been re-run with the amended script (although this condition had been addressed in this run, it was present when PB ran the model)

b) i-j zone pairs, with zero trips in the Base Scenario, had non-zero trips in the Forecast Scenario; specifically in the highway pcu matrix.

c) the switching of the HBO and HBEmpBuisness trip matrices in the Forecast run (to be confirmed)

The combined effect of these conditions was to give a significant number of trips in cells which had no observed trips in the base. Consequently, for the reasons described above, the forecast year trips were being set to zero.

Some other minor changes were made to this script to improve on the output trips totals; a check was introduced to ensure that the generated probabilities summed to 1.0 (in some cases this was not the case to several decimal places, resulting in a few trips being lost when the probabilities were applied). The forecast probabilities were also applied to the forecast total trip matrix and not the base, as implied by the example given by the OtChoice manual.

To deal the main issue, a method is required to deal with those zones where there are zero trips in the base, but non-zero in the forecast. The original design intention had been that any dummy zones in the base matrices would be 'seeded' with trip (rates) to provide an 'observed' mode split, off which the forecast could pivot. These could be derived from TEMPRO, or could be the presumed car/pt mode split in the data used to establish the car trip rates for the new developments (probably from TRICS. If 'green field' sites, expected base year values could be used to indicate what would be happening in the base, given the base network configuration.

This was not possible for these tests, so a **temporary** section of code has been inserted in this job which takes the *forecast number* of trips by mode as the base values, if there are zero trips in the base, to calculate the initial probabilities. This ensures that a non-zero set of probabilities are calculated and forecast trip are generated for these i-j pairs. Whilst this may be satisfactory for the forecast development zones, it may be incorrect for 'existing non-development' zones as the forecast mode split is being imposed rather than that for the base.

The status of this temporary amendment is discussed below in Section 8 below.

When these various amendments were applied, the aggregated matrices produced at the end of the first iteration, ready for the next, produced trips totals which were as expected.

However, it should be noted that there *will be* differences in trip matrix totals, per iteration, as trips move between highway/pt modes. This is due to the effect of car occupancy. For example, given a car occupancy rate of say, 1.5. if 100 person trips move from PT to car, this will result in 100/1.5 = 67 Vehicle trips appearing in the highway matrix, an apparent loss of 33 trips.

The audit trail for the analysis of this model run is given in spreadsheet:

Audit Trail 2028 Ref Demand.xlsx

which is in .../*Model_Data\Model_Outputs\2028_Base_Network_with_Ref_Demand*

This spreadsheet is similar to that for the 2008 base analysis, but has an additional section at the bottom showing the results of the mode split analysis, and trips changing mode per purpose group.

Given the modal shifts, and the different car occupancy factors per purpose, a commentary is give non how each set of figures is obtained.

As an additional test, the second iteration was run through manually to the generation of matrices post-mode split. The results were sensible and there were no unexpected loss of trips.

As can be seen in the *Audit Trail 2028 Ref Demand.xls,* the modal shift is not very high for the first iteration, although for the second iteration the change is larger (no documented here). It is difficult to comment on why his should be the case given the various input data items which need review (see Section 8 below) but it is likely that the initial iteration is making a 'base' adjustment, with subsequent iterations (of which only one has been done) seeing the modelling interactions really taking effect.

6 Mapping the Saturn and OmniTRANS networks

A key feature of the model is the interaction between the highway and pt networks; that is, for the OmniTRANS pt assignment to use the highway speeds generated by Saturn. By doing so, any congestion in the network forecast by Saturn would be reflected in the run time for buses, which in turn would affect the generated pt skim matrices. As the skim matrices from both the highway and public transport models are inputs to the mode split model (as described above), this interaction is a vital component of the model.

This feature was disabled in the PB amended jobs for the model, but was re-instated for this audit analysis, and must be maintained for any further model runs.

7 An overview of the mapping process

The OmniTRANS and Saturn networks are, for the most part, topographically different, but the requirement exists, as noted above, to transfer data from the Saturn network to the OmniTRANS network.

Topographical differences between the two networks occur because:

- The OmniTRANS network was built using an imported NAVTEQ digital network. This includes all 'minor' roads, not present in the Saturn network
- The Saturn network is very 'abstract' for the outer study area whereas the OmniTRANS network is more detailed
- Within the 'Study Area', the Saturn network contains many 'abstract' simplifications, which are not present in the OmniTRANS network.

In areas of the network where the networks are topographically similar, a single Saturn link between nodes 'a' and 'b' may be represented by a series of OmniTRANS links; the intermediate nodes representing intersections with the 'minor' roads not present in the Saturn network.

The two networks also differ in that different node numbers are used for the same 'pint' in the network.

The challenge is then to 'map' the two networks together, recognising that there may be sections of the network where this is not possible. However, the expectation is that mapping will be successful in the parts of the network which 'matter' - that is, where the bus routes operate.

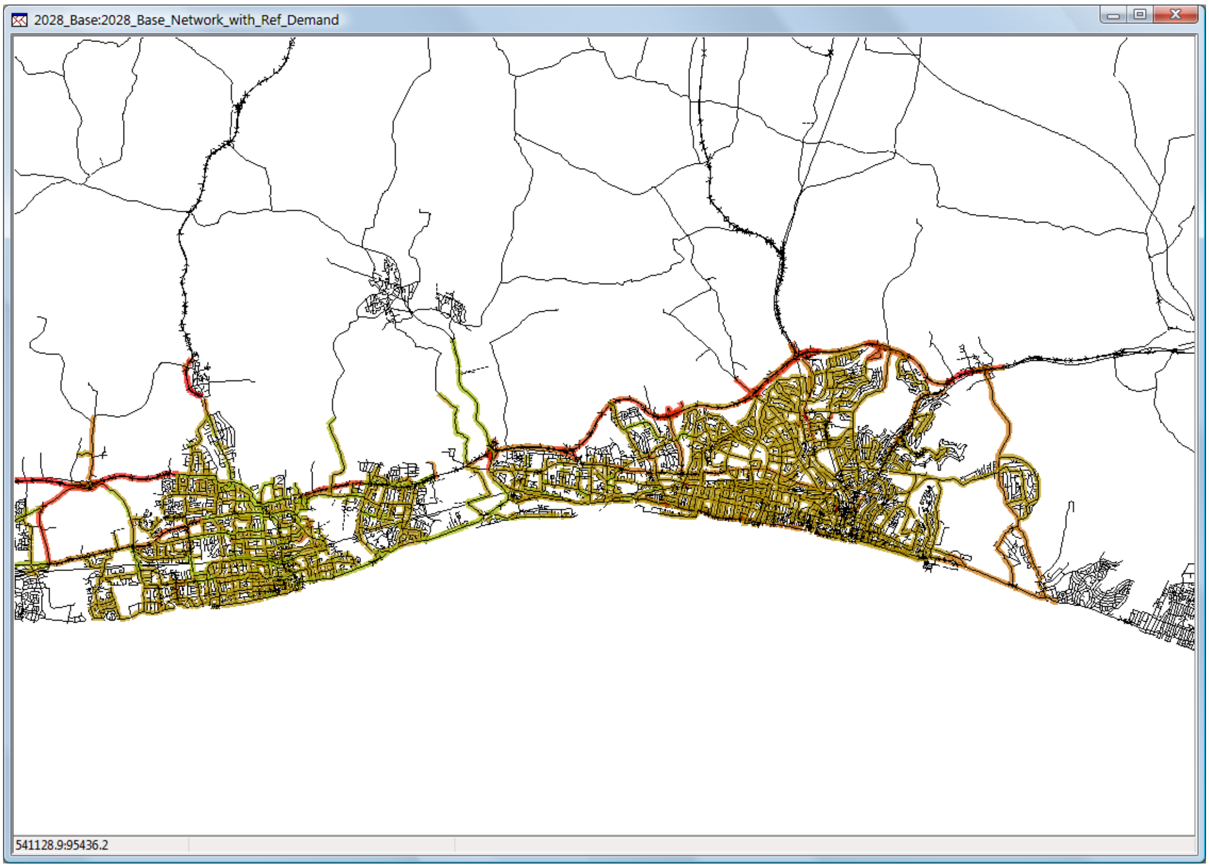
The mapping process is described as follows:

- first produce a node equivalence file between the two networks. Using grid coordinates, nodes in the two networks are 'mapped' to each other. When establishing a new forecast scenario, job *0605 - Map Forecast Year Saturn Network Nodes* **must** be run to establish the node equivalences, even if the Saturn network has not been changed from the base, or any other forecast run.

- using this node equivalence file, a link equivalence file is generated. For each link in the Saturn network, the equivalent single OmniTRANS link is found. If this does not exist, the shortest path between the two equivalent OmniTRANS nodes is built, and this set of links is equated to the Saturn link. This link equivalence file is used to transfer data from Saturn to OmniTRANS.

  When running the model, job *0624 - Import Saturn Link and Turn Times* does this mapping, and transfers both link and turn times from the loaded Saturn network to the OmniTRANS network; in turn these times are used by the pt assignment. Note that when this job is run, many apparent warning and error messages are generated. These relate to those parts of the network which cannot be mapped correctly.

  The image below shows the part of the network where speeds have been transferred across from Saturn to OmniTRANS:



[Bandwidth plot: SatDB Speeds [pmtu 1,1,21,24,1,1]

8 Conclusions and Recommendations

The audit of the model identified several issues which required addressing, and as stated, the model now appears to be running correctly in a 'mechanical' sense.

However, several issues have been noted relating to the data used for the 2028 forecasts, and it is recommended that these are reviewed. Specifically:

a. The input planning data spreadsheets appear to be identical to that for 2008. These spreadsheets contain Parking Costs and Car Availability Proportions by mode/purpose. Is it the intention that these are identical, especially parking costs?

b. Similarly, the proportion matrices used to split trips between pay/free|park/fare are identical. Is this intentional?

c. The initial input forecast vehicle pcu trip matrices should be reviewed to ensure that it is intended that there are i-j zone pairs which have non-zero trips in the forecast, but not in the base. (See job *Compare Base and PB 2028 matrices* which resides in *..\jobs\00_Utilities_Misc* to see which i-j pairs are found). If this is the intention, then action relating to the 'seeding' of the base matrices is required (discussed below)

d. The import of HBO and HBEmployers Business observed matrices. It would appear that these have been 'switched' (certainly for the 2028 forecast that was run). This needs checking.

e. Apparently the Saturn and OmniTRANS networks have not been changed from the base. Is this the intention, especially with reference to pt services which may (or indeed may not) be associated with the new developments?. If pt services, or network changes are intended for the forecast scenario then as currently stated, these will not be reflected in the mode split calculations.

A view needs to be taken on how to manage the seeding of i-j cells where there are zero trips in the base, but non-zero in the future. Options are:

a. where this occurs, to use the forecast trips to generate the base probabilities. This has been implemented as a pragmatic solution, but as discussed above could be argued to be technically incorrect in the case where more accurate base year values could be provided, based on TEMPRO/TRICS/Local trip rates. This leads to the next option:

b. to provide a mechanism that seeds candidate cells with data based on TEMPRO/TRICS/Local trip rates (by purpose, by time of day) which would give an accurate representation of potential mode split, were there trips for these zones. This could be done on a cell-by-cell basis, which might be onerous, or on a matrix wide basis using sets of 'default' rates.

c. re-organise the model structure, so that for each forecast year, a new reference base scenario is established. This would be similar in function to the 2008 Base in that any scenarios for that year would be pivoted off the base for the year. However, this only makes sense if there is no discrepancy between the matrices for the forecast year with zero/no-zero cells; otherwise we are back to the original problem.

Other than the implementation of (a), required to 'fix' the loss of trips, implementing options b or c are not achievable within the scope of this audit.

9 Model Requirements

The model in its current (post-audit) form is still in OmniTRANS V5 format, although as reported earlier it now includes the required MvDataTools classes for successful operation.

These classes are provided *gratis*, but no maintenance support is provided. Neither can they be used in any other model that PB or WSCC might construct.

If this model were to be used by any other organisation, they are unlikely to have (access to) OmniTRANS V5 and the model would have to be converted to OmniTRANS V6. It should be noted that this has several ramifications given changes between the two OmniTRANS versions:

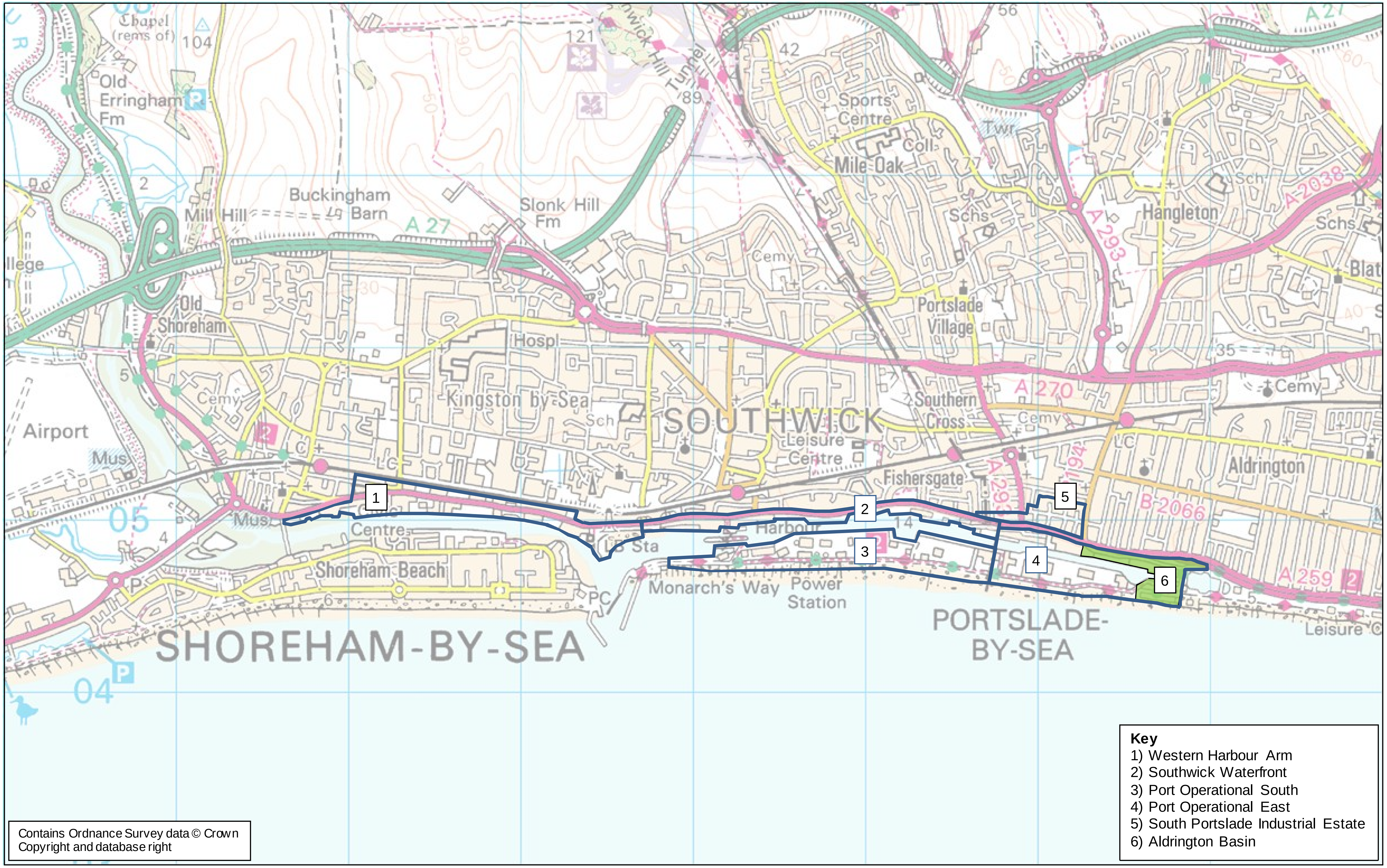
- The Scenario Manager requires re-writing as the class used to construct it is no longer supported by Omnitrans International. It would have to be replaced by using WxRuby as the successful operation of the Scenario Manager cannot be guaranteed

- As well as using MvDataTools, the V5 model used the Model Parameters Manager as developed by Minnerva. This creates the Managed Model Parameters file used in the scripts. Although the absence of the Model Parameters Manager does not preclude the running of the model as it stands, new features provided in OmniTRANS V6 render the Model

Parameters Manager obsolete. Consequently, the handling of the model parameters needs re-casting.

Appendix B

SHOREHAM HARBOUR TRANSPORT MODELLING AREAS BOUNDARY MAP



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CLIENT/PROJECT
Adur District Council
Transport Study of Strategic Development Options in Adur

TITLE
Indicative Locations of Shoreham Harbour Developments

DATE **26/11/2012**	PRODUCED **MSR**
	CHECKED **SP**
SCALE **Not to scale**	APPROVED **NW**

Appendix B

Appendix C

SHOREHAM HARBOUR SITE ALLOCATION TRIPS

Western Harbour Arm [1]

Loading Points

Note: Red circle(s) indicate development zone loading point(s).

Zone loading location	Estimate of current jobs (B2/B8)	Estimated new jobs			Total New jobs	Net increase in job number
		New office/light industrial B1	New B2/B8	New retail (A1)		
Western Arm	1279	361	0	236	598	598

Assumption: New jobs additional to existing jobs

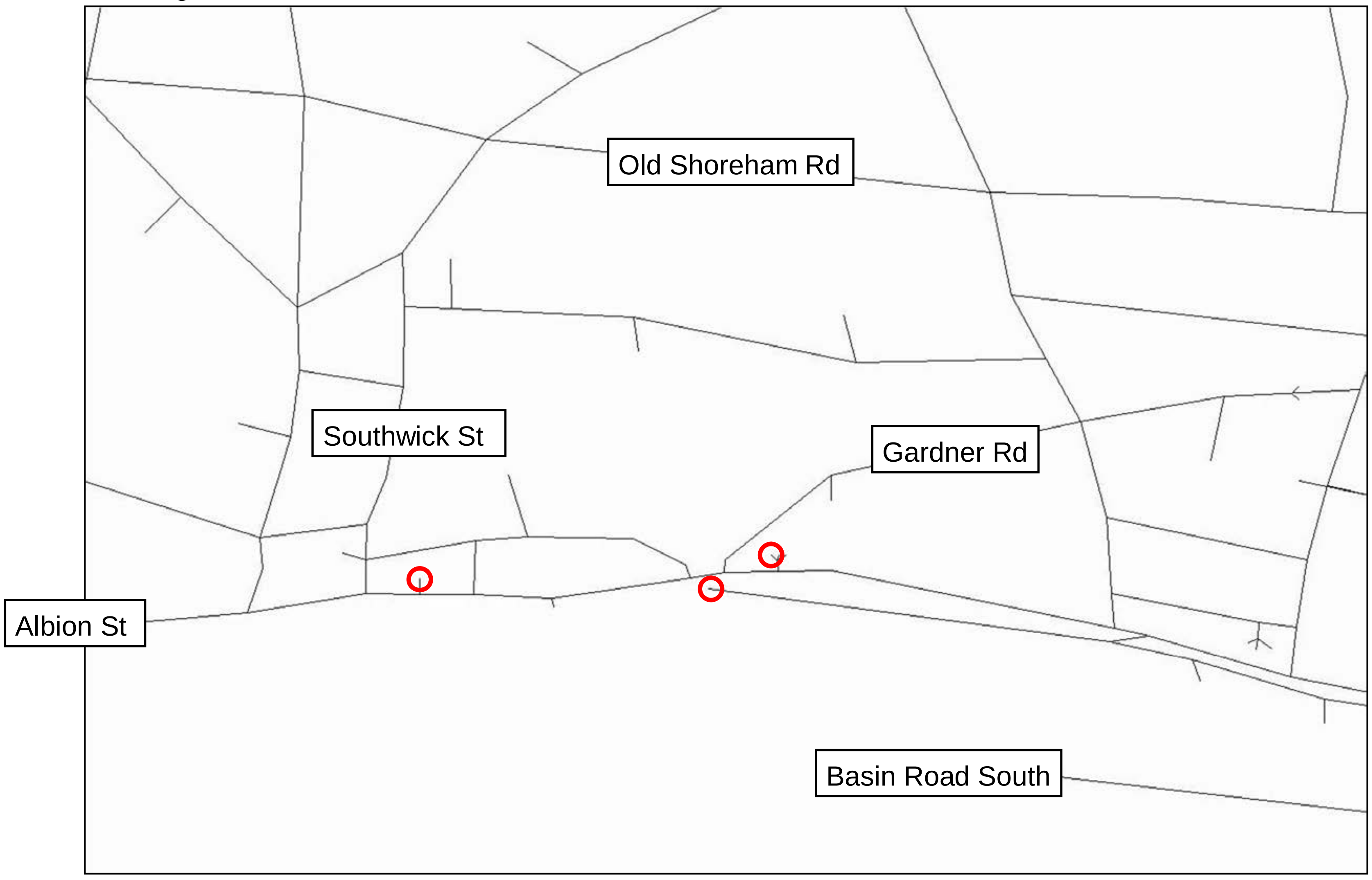
Departures (AM peak)
Net increase in departures: 235

Arrivals (AM peak)
Net increase in arrivals: 209

Method
New and existing trips will be added into the selected zones.

Southwick Waterfront [2]

Loading Points



Note: Red circle(s) indicate development zone loading point(s).

Zone loading location	Estimate of current jobs (B2/B8)	Estimated new jobs			Total New jobs	Net increase in job number
		New office/light industrial B1	New B2/B8	New retail (A1)		
Southwick Waterfront	470	340	0	0	340	340

Assumption: New jobs additional to existing jobs

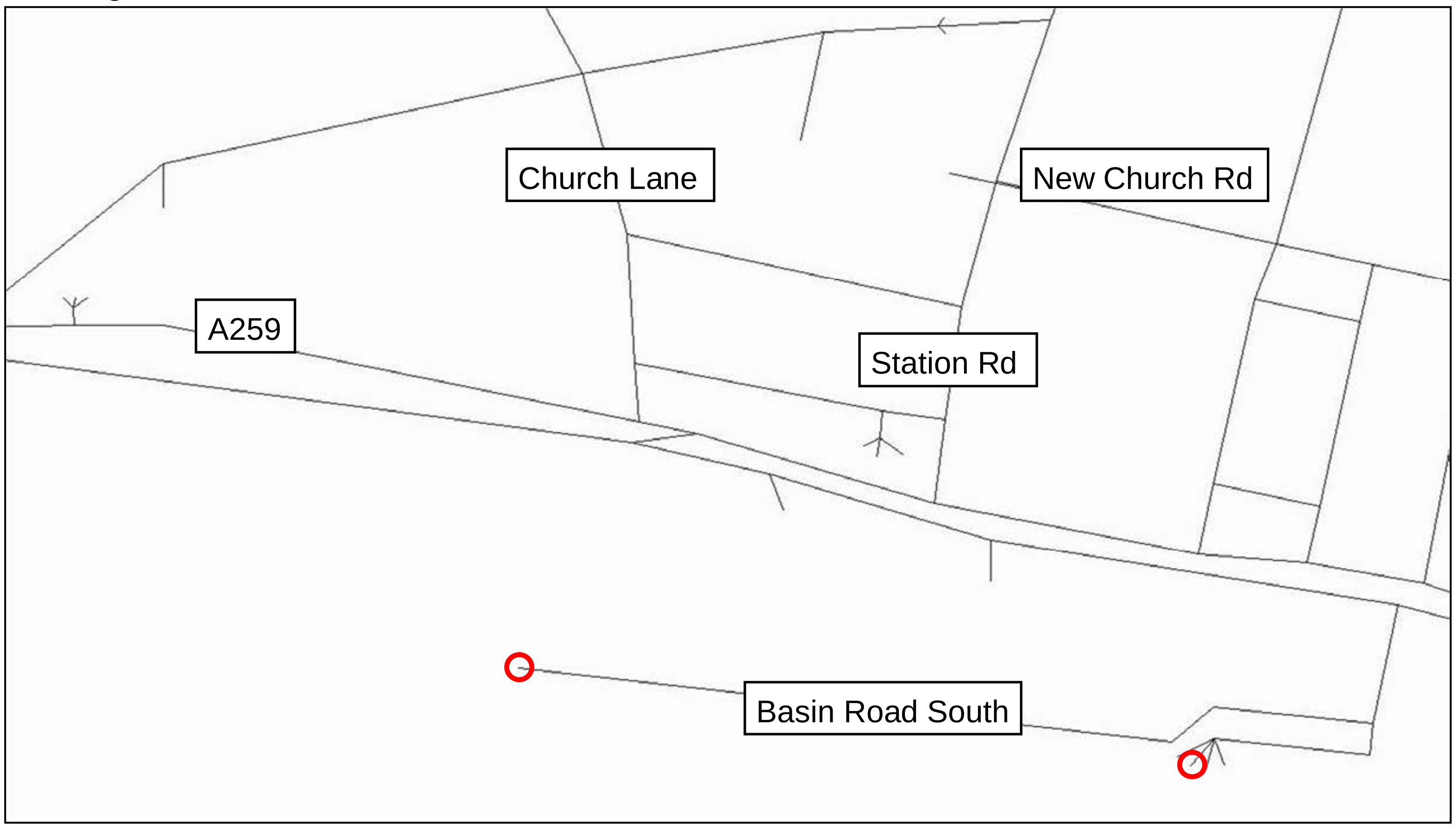
Departures (AM peak)
Net increase in departures: 11

Arrivals (AM peak)
Net increase in arrivals: 112

Method
New and existing trips will be added into the selected zones.

Port Operational South [3]

Loading Points



Note: Red circle(s) indicate development zone loading point(s).

Zone loading location	Estimate of current jobs (B2/B8)	Estimated new jobs			Total New jobs	Net increase in job number
		New office/light industrial B1	New B2/B8	New retail (A1)		
Port Operational South	470	0	0	0	0	0

Assumption: New jobs additional to existing jobs

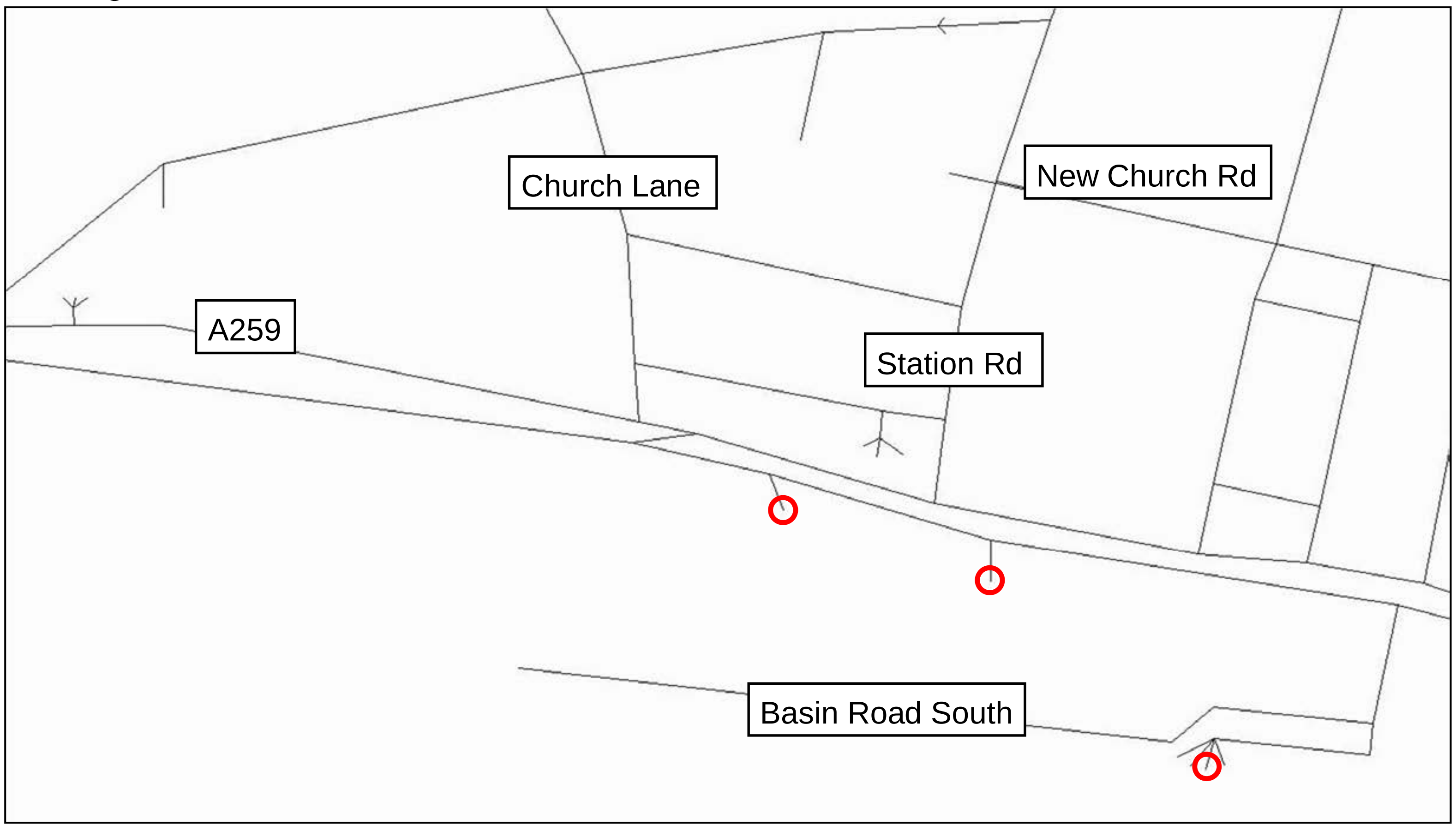
Departures (AM peak)
Net increase in departures: 0

Arrivals (AM peak)
Net increase in arrivals: 0

Method
New and existing trips will be added in to the selected zones.

Port Operational East [4]

Loading Points



Note: Red circle(s) indicate development zone loading point(s).

Zone loading location	Estimate of current jobs (B2/B8)	Estimated new jobs			Total New jobs	Net increase in job number
		New office/light industrial B1	New B2/B8	New retail (A1)		
Port Operational East	470	0	0	0	0	0

Assumption: New jobs additional to existing jobs

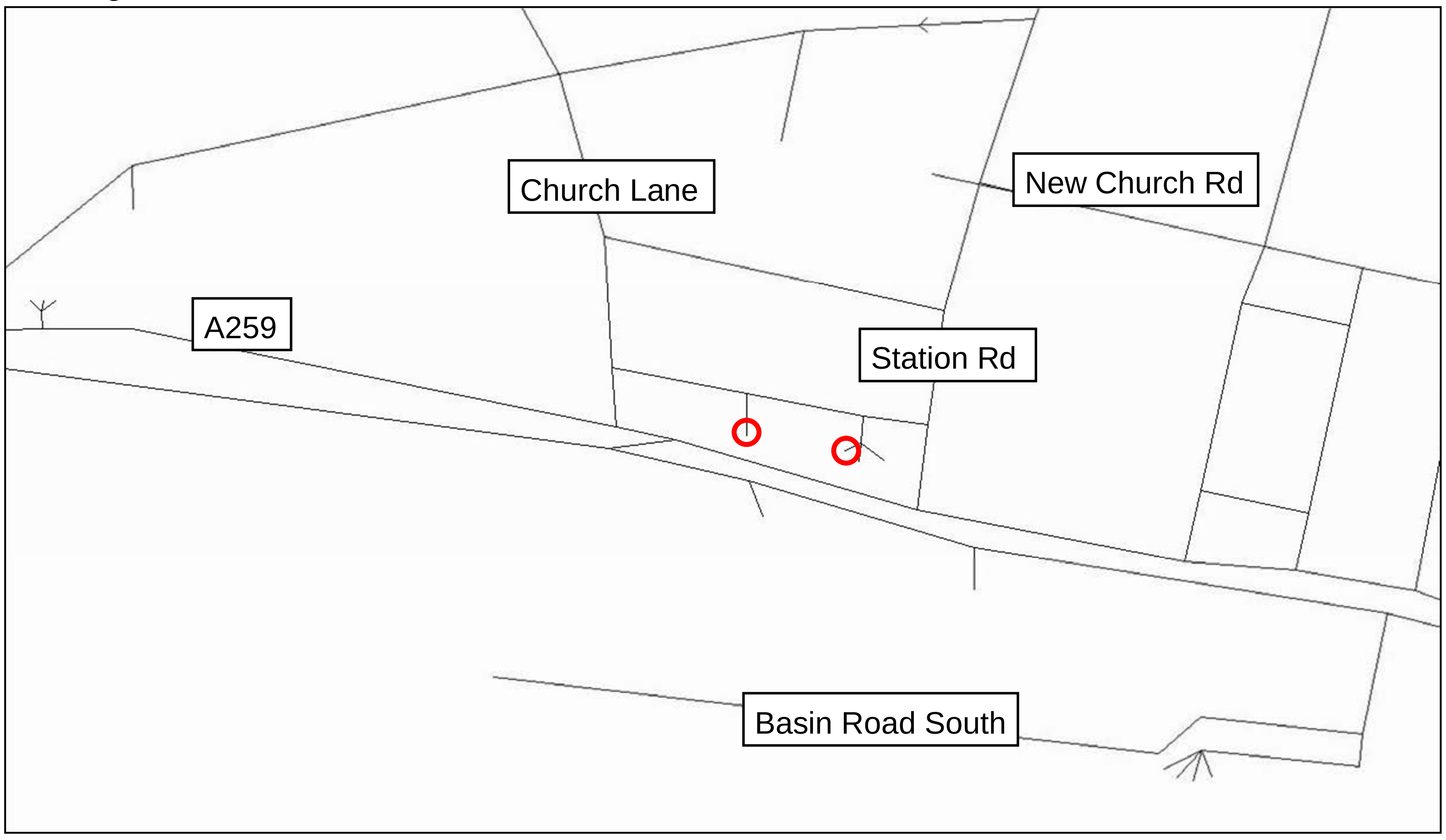
Departures (AM peak)
Net increase in departures: 0

Arrivals (AM peak)
Net increase in arrivals: 0

Method
New and existing trips will be added in to the selected zones.

South Portslade Industrial Estate [5]

Loading Points



Note: Red circle(s) indicate development zone loading point(s).

Zone loading location	Estimate of current jobs (B2/B8)	Estimated new jobs			Total New jobs	Net increase in job number
		New office/light industrial B1	New B2/B8	New retail (A1)		
South Portslade	728	638	0	0	638	638

Assumption: New jobs additional to existing jobs

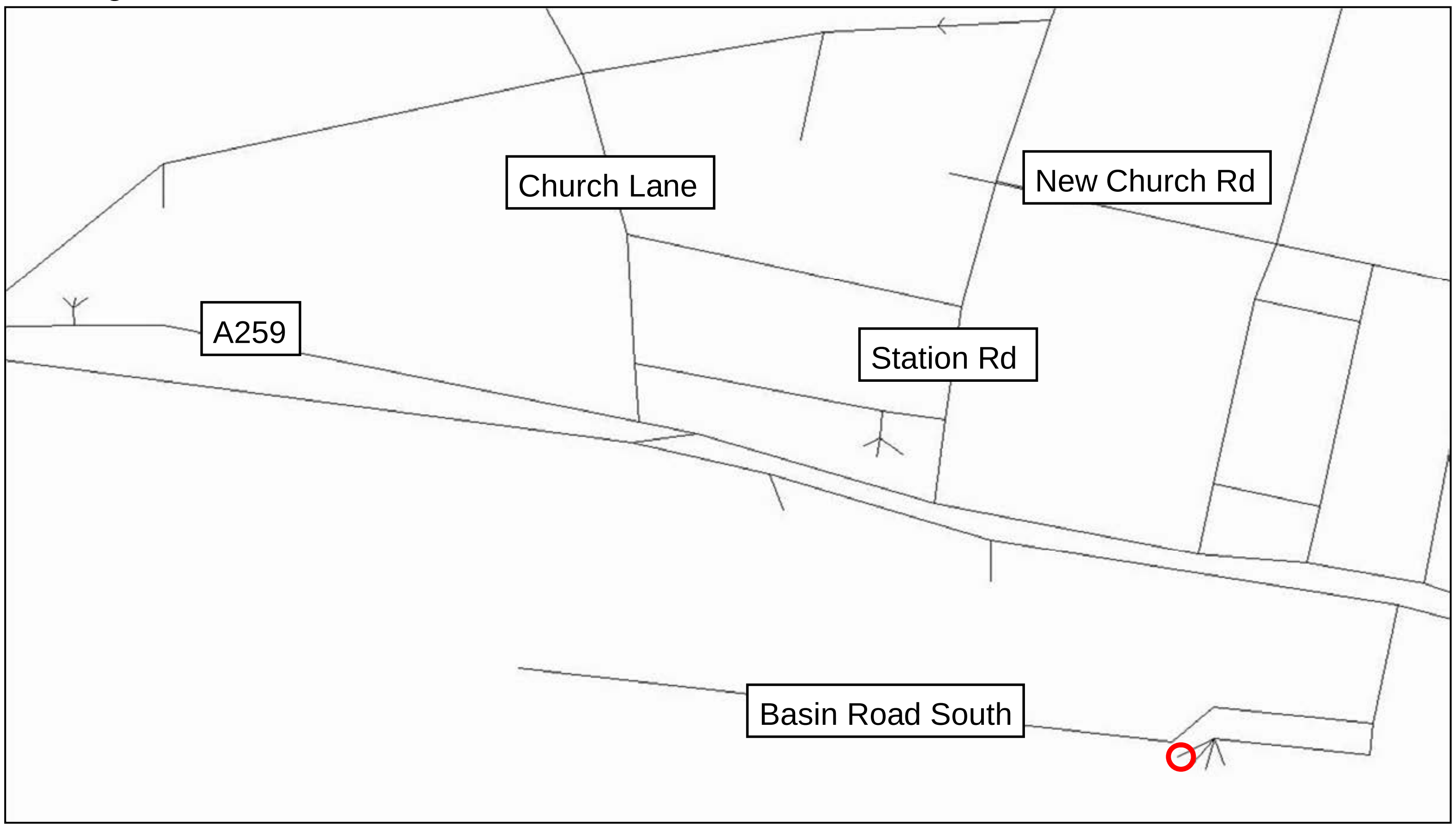
<u>Departures (AM peak)</u>
Net increase in departures: 21

<u>Arrivals (AM peak)</u>
Net increase in arrivals: 210

<u>Method</u>
New and existing trips will be added in to the selected zones.

Aldrington Basin [6]

Loading Points



Note: Red circle(s) indicate development zone loading point(s).

Zone loading location	Estimate of current jobs (B2/B8)	Estimated new jobs			Total New jobs	Net increase in job number
		New office/light industrial B1	New B2/B8	New retail (A1)		
Aldrington Basin	391	0	0	0	0	0

Assumption: New jobs additional to existing jobs

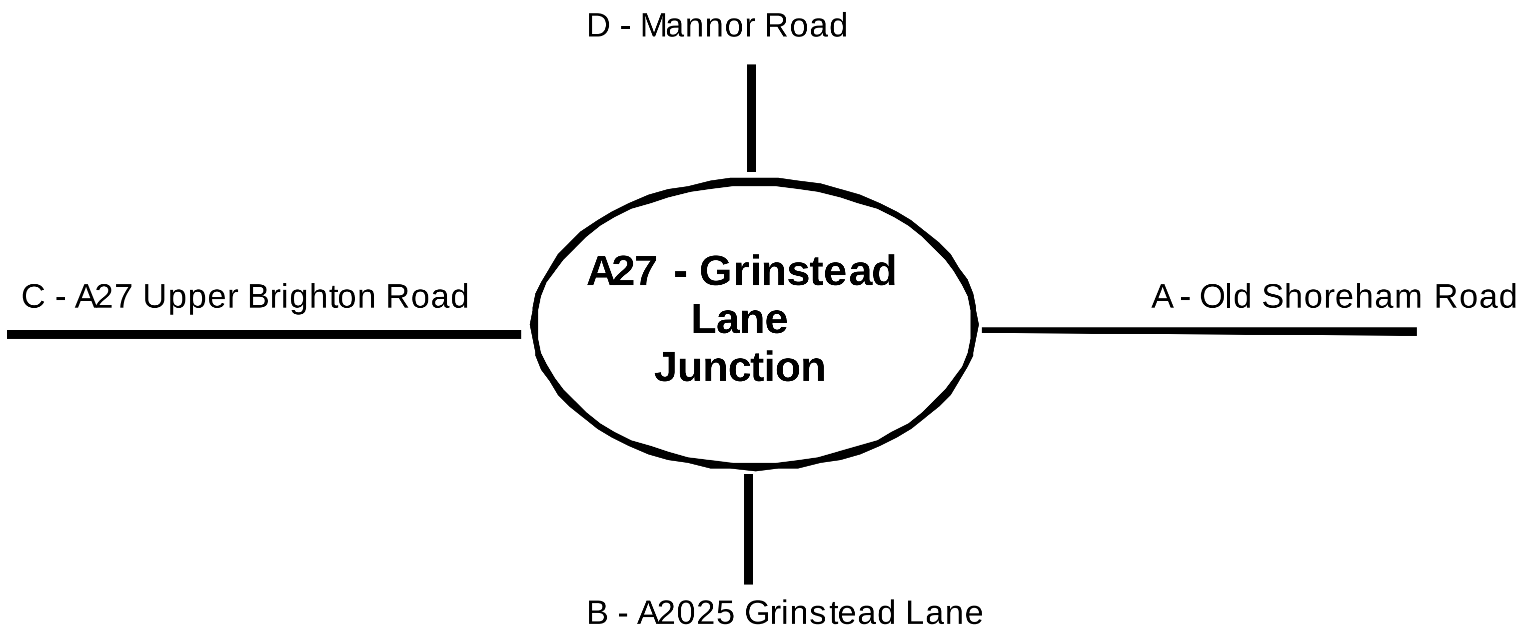
Departures (AM peak)
Net increase in departures: 66

Arrivals (AM peak)
Net increase in arrivals: 25

Method
New and existing trips will be added in to the selected zones. Previously tested scenarios included some additional employment in this area; this scenario looks at the impact of providing 300 dwellings.

Appendix D

JUNCTION TURNING FLOWS



Reference Case

	A	B	C	D
A	38	696	2228	69
B	839	0	0	7
C	2836	9	0	0
D	178	1	0	0

Initial Demands

Scenario C

	A	B	C	D
A	0	917	2345	82
B	958	0	20	76
C	3080	0	0	0
D	225	85	18	0

Demands with Mitigation

Scenario C

	A	B	C	D
A	0	926	2335	82
B	916	0	12	81
C	2982	0	0	0
D	220	80	18	0

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CLIENT/PROJECT

Adur Distric Council
Transport Study of Strategic Development Options in Adur

TITLE

AM Turning Flows - A27- A2025 Grinstead Lane Junction

DATE

28 July 2016

PRODUCED BY

MSR

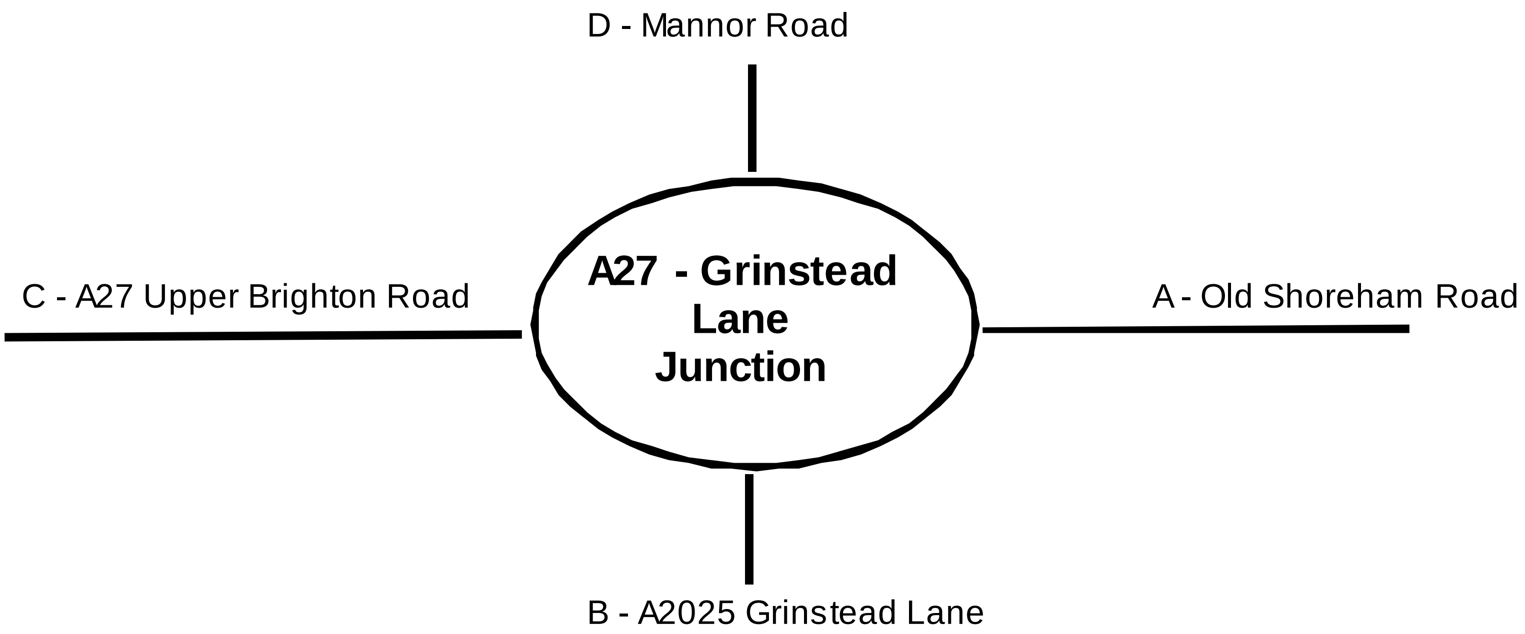
CHECKED BY

DH

APPROVED

DH

Figure D1



Reference Case

	A	B	C	D
A	1	725	3002	123
B	751	0	0	12
C	1833	202	11	0
D	76	12	18	0

Initial Demands

Scenario C

	A	B	C	D
A	1	821	3164	133
B	736	0	0	12
C	2038	125	11	0
D	117	12	19	0

Demands with Mitigation

Scenario C

	A	B	C	D
A	0	1011	3205	78
B	891	0	27	107
C	1942	22	0	0
D	43	78	22	0

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TITLE

PM Turning Flows - A27- A2025 Grinstead Lane Junction

DATE
28 July 2016

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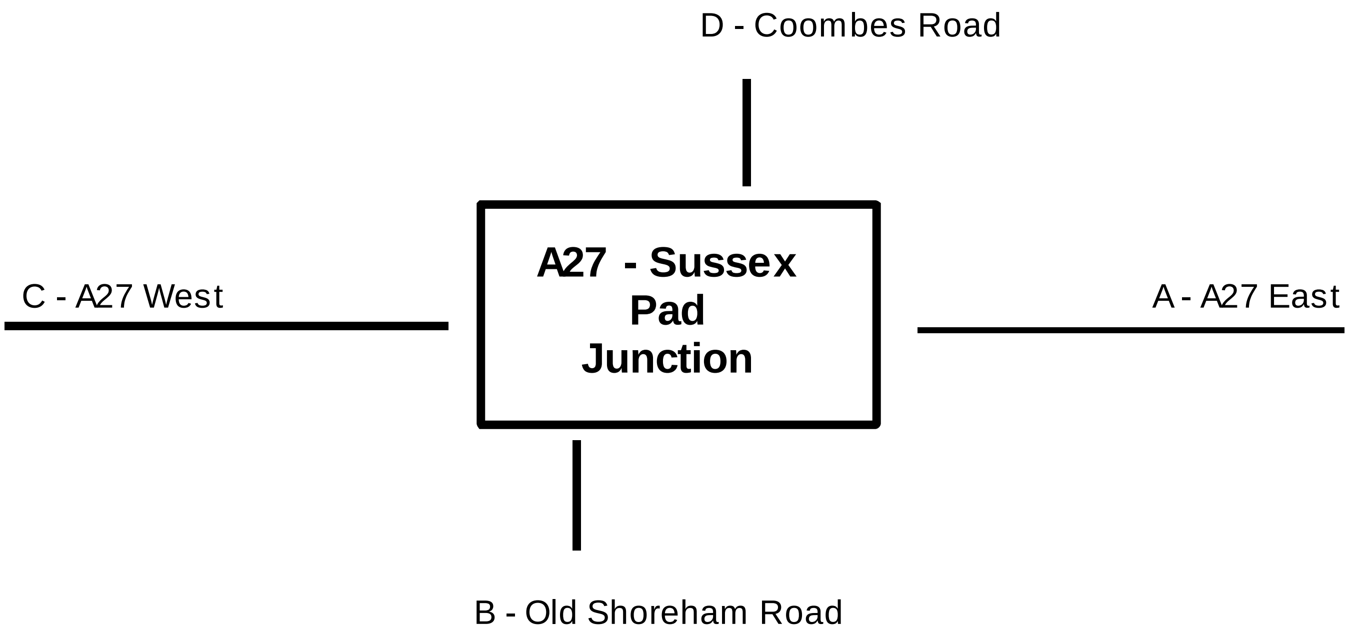
Figure D2



Reference Case

	A	B	C	D
A	0	90	2660	37
B	89	0	6	0
C	2736	94	0	100
D	6	0	8	0

Initial Demands

Scenario C

	A	B	C	D
A	0	136	3126	39
B	271	0	65	0
C	3846	271	9	136
D	6	0	9	0

Demands with Mitigation

Scenario C

	A	B	C	D
A	0	117	3138	38
B	264	0	57	0
C	3728	248	8	134
D	6	0	9	0

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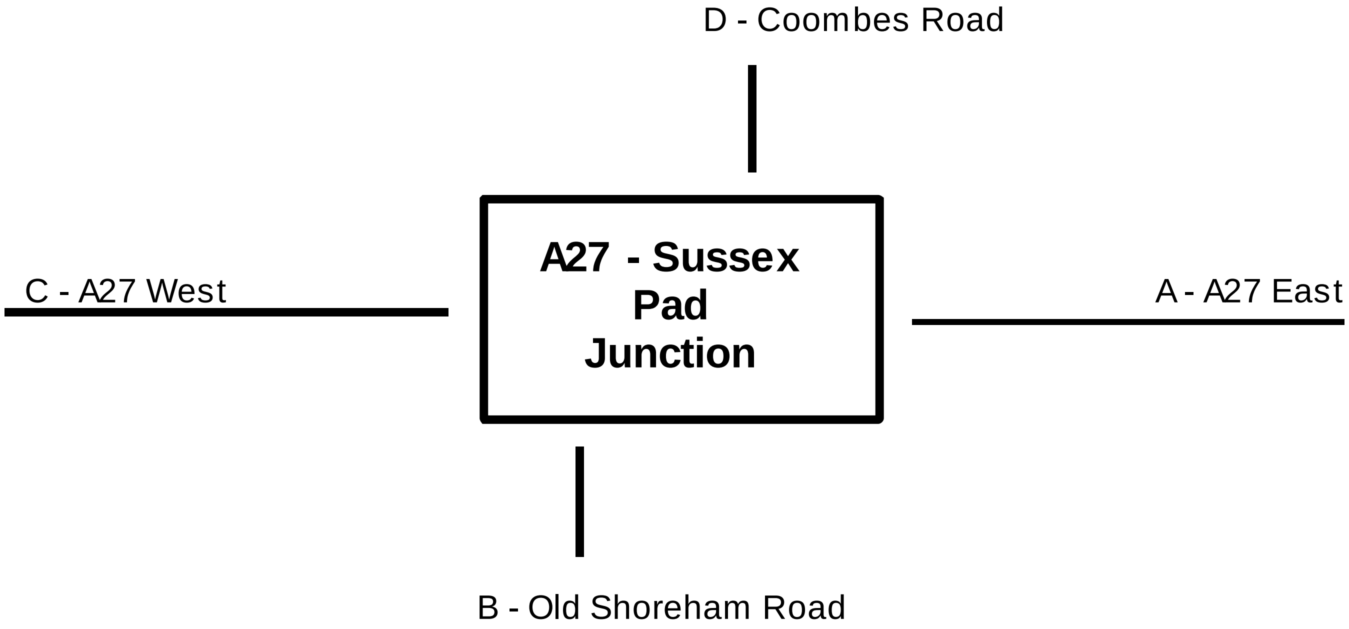
Figure D3



Reference Case

	A	B	C	D
A	0	232	2442	88
B	95	0	14	0
C	2522	27	0	12
D	87	1	12	0

Initial Demands

Scenario C

	A	B	C	D
A	647	360	3897	15
B	128	0	205	0
C	2651	192	37	12
D	11	0	13	0

Demands with Mitigation

Scenario C

	A	B	C	D
A	0	357	4043	15
B	85	0	234	0
C	2665	164	36	12
D	11	0	13	0

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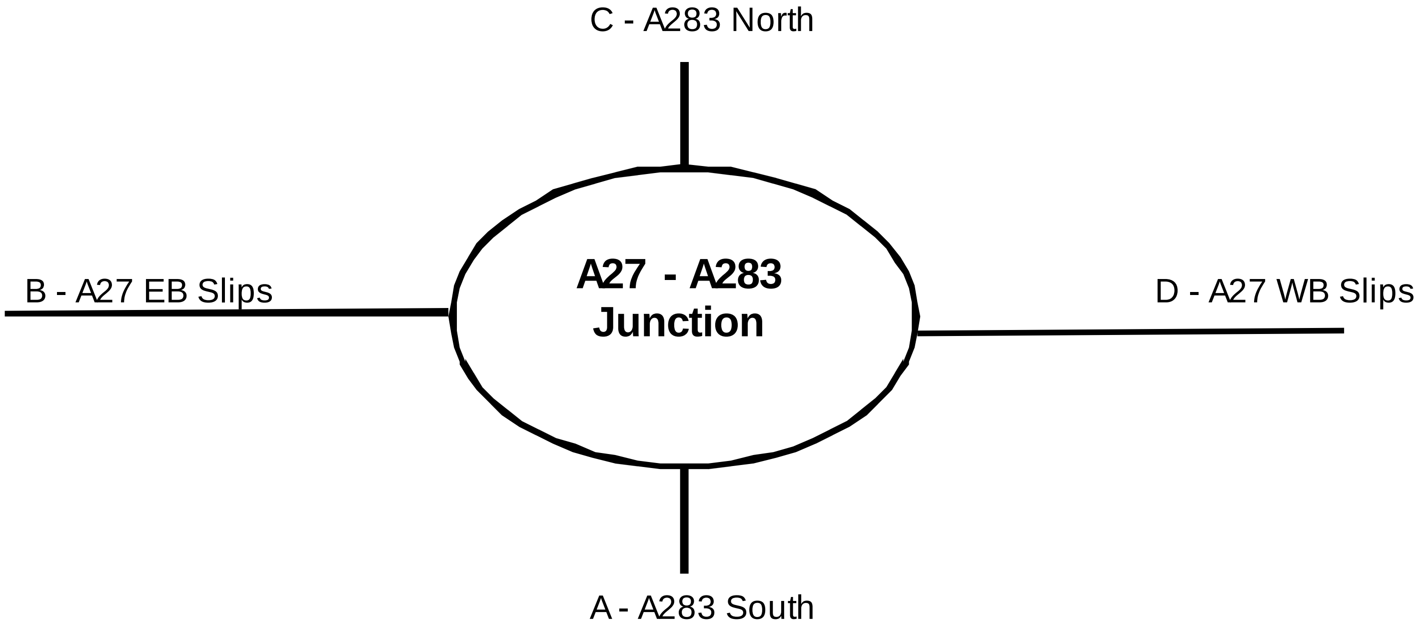
Figure D4



Reference Case

	A	B	C	D
A	0	489	522	224
B	335	0	1177	175
C	374	160	0	0
D	212	999	0	0

Initial Demands

Scenario C

	A	B	C	D
A	0	574	510	231
B	351	0	1146	247
C	476	192	0	0
D	275	923	0	0

Demands with Mitigation

Scenario C

	A	B	C	D
A	0	605	435	242
B	343	0	1174	282
C	321	140	0	0
D	240	846	0	0

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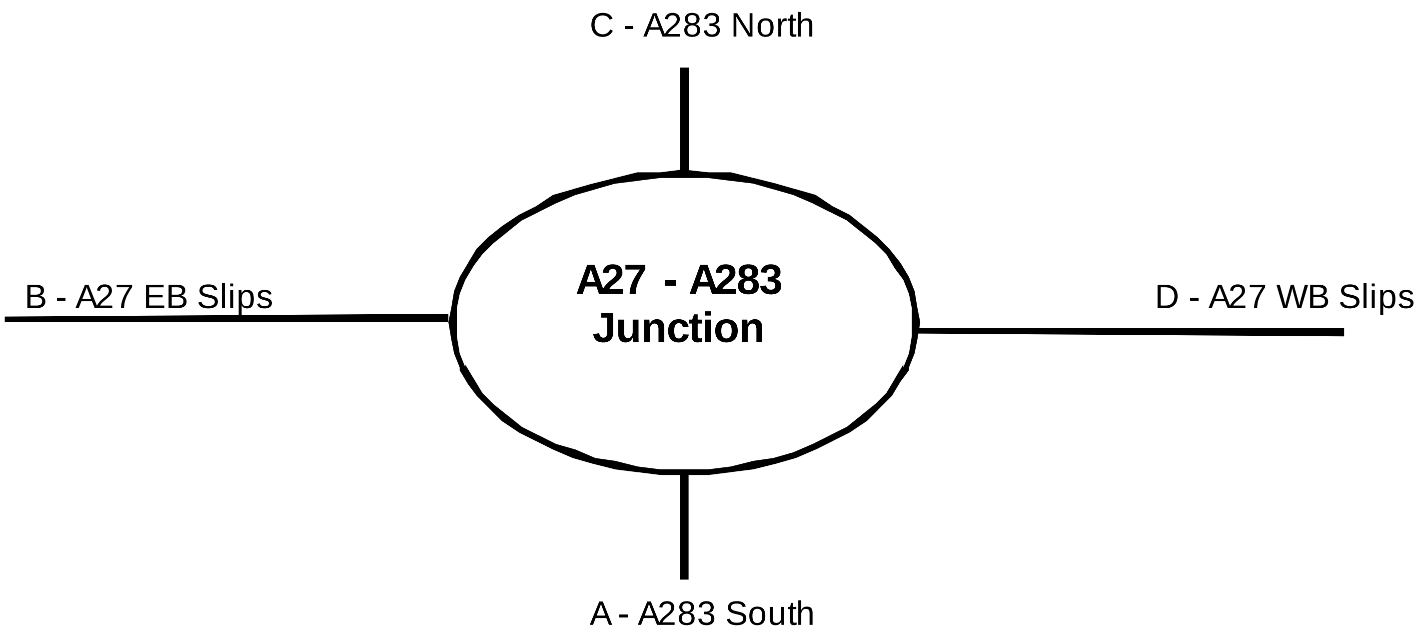
Figure D5



Reference Case

	A	B	C	D
A	0	1282	239	3
B	807	0	795	268
C	343	155	0	0
D	56	1405	0	0

Initial Demands

Scenario C

	A	B	C	D
A	0	1136	255	3
B	869	0	771	243
C	379	726	0	0
D	0	992	0	0

Demands with Mitigation

Scenario C

	A	B	C	D
A	0	437	465	198
B	507	0	711	582
C	259	86	0	0
D	290	1183	0	0

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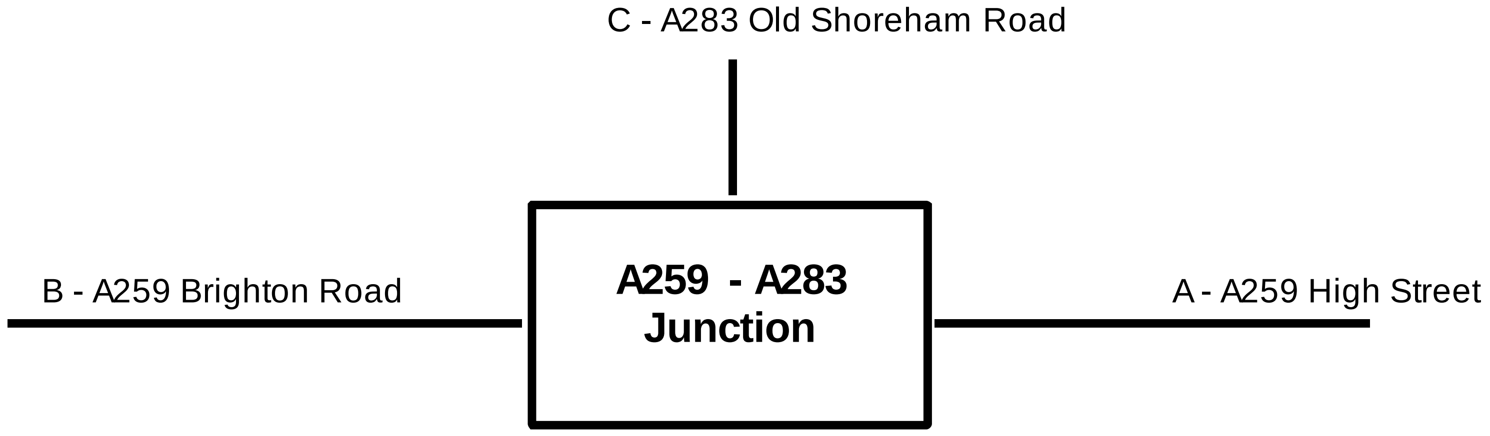
Figure D6



Reference Case

	A	B	C
A	0	1084	87
B	1311	0	537
C	85	535	0

Initial Demands

Scenario C

	A	B	C
A	0	967	140
B	1156	0	669
C	138	589	0

Demands with Mitigation

Scenario C

	A	B	C
A	0	954	132
B	1142	0	661
C	123	560	0

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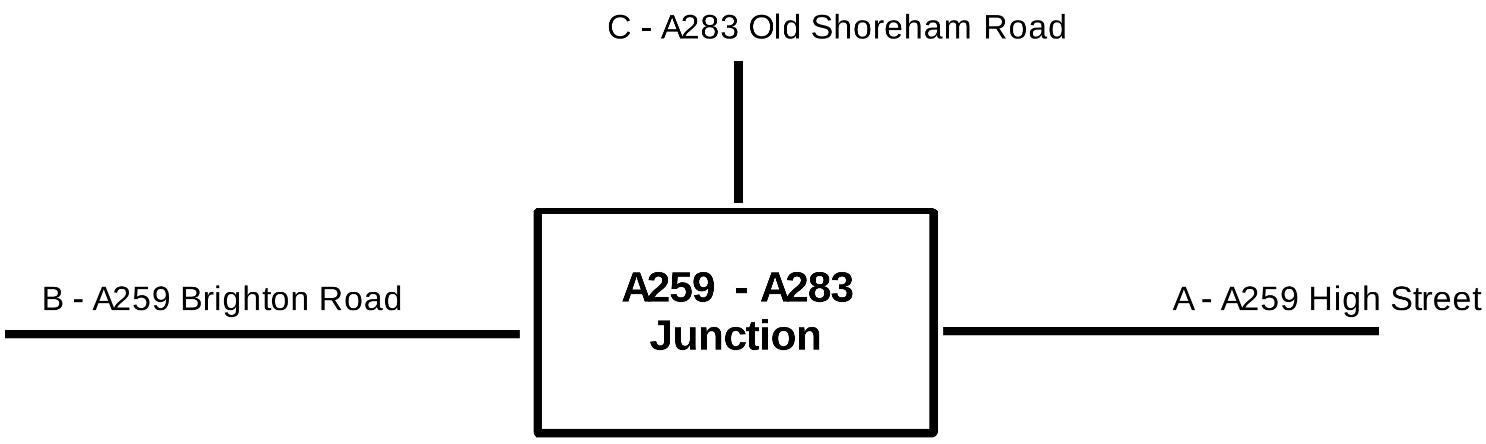
Figure D7



Reference Case

	A	B	C
A	0	998	0
B	777	112	456
C	21	1087	0

Initial Demands

Scenario C

	A	B	C
A	0	1109	0
B	788	114	504
C	27	1148	0

Demands with Mitigation

Scenario C

	A	B	C
A	0	1339	22
B	685	91	589
C	119	784	0

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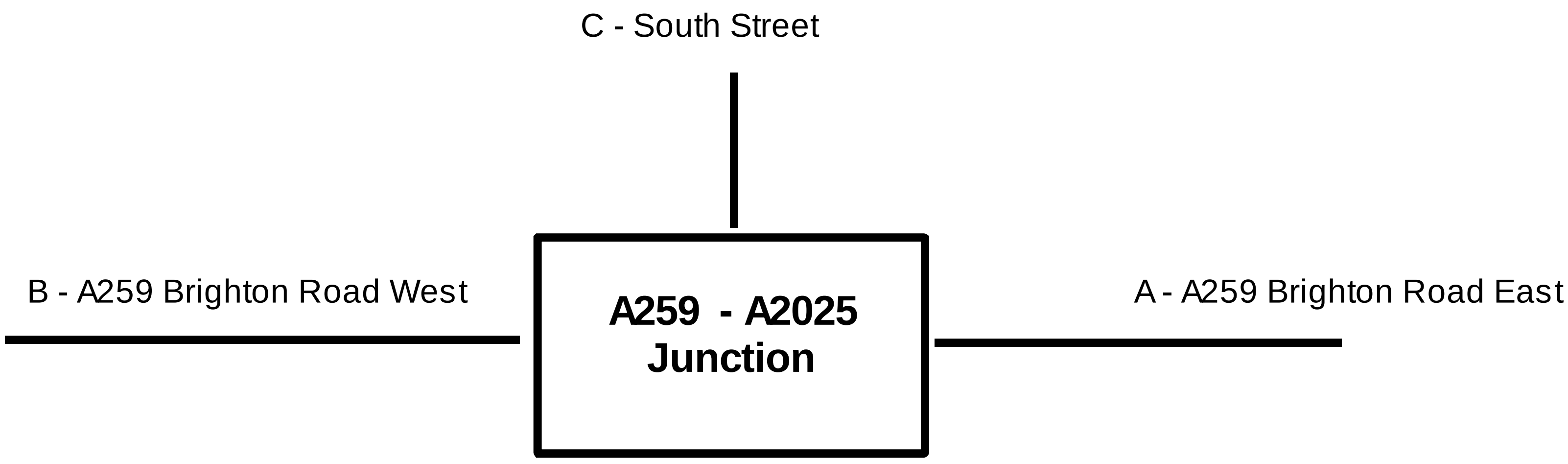
Figure D8



Reference Case

	A	B	C
A	0	847	0
B	1015	0	167
C	0	759	0

Initial Demands

Scenario C

	A	B	C
A	0	1194	0
B	1243	0	316
C	0	682	0

Demands with Mitigation

Scenario C

	A	B	C
A	0	1162	0
B	1226	0	313
C	0	705	0

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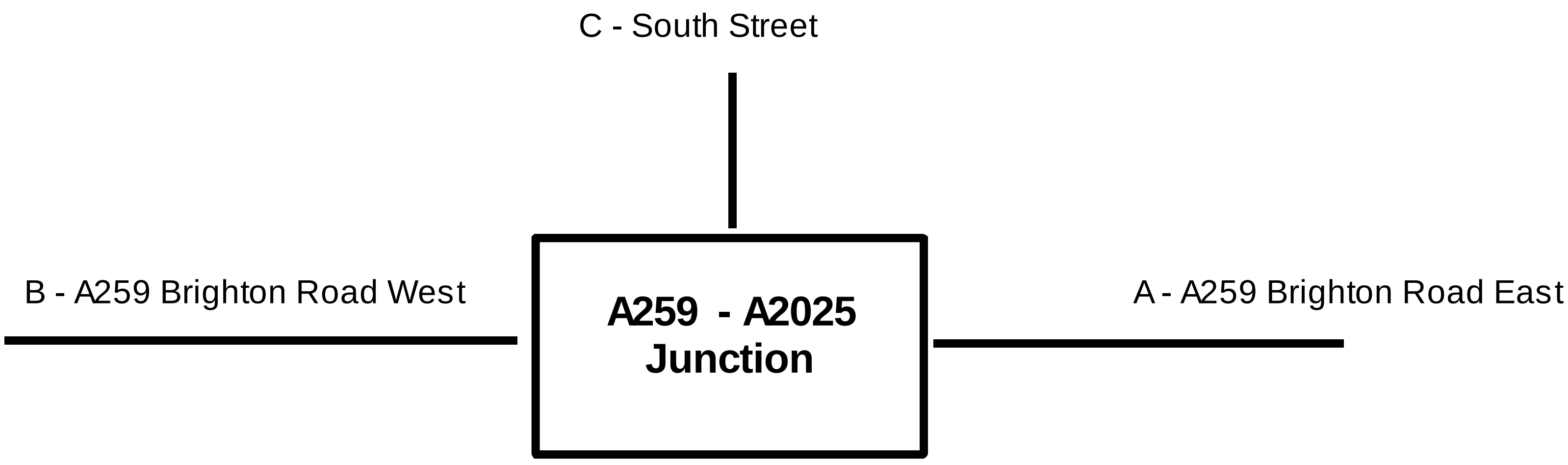
Figure D9



Reference Case

	A	B	C
A	0	879	0
B	758	0	289
C	0	912	0

Initial Demands

Scenario C

	A	B	C
A	0	933	0
B	737	0	311
C	0	991	0

Demands with Mitigation

Scenario C

	A	B	C
A	0	1364	0
B	775	0	558
C	0	848	0

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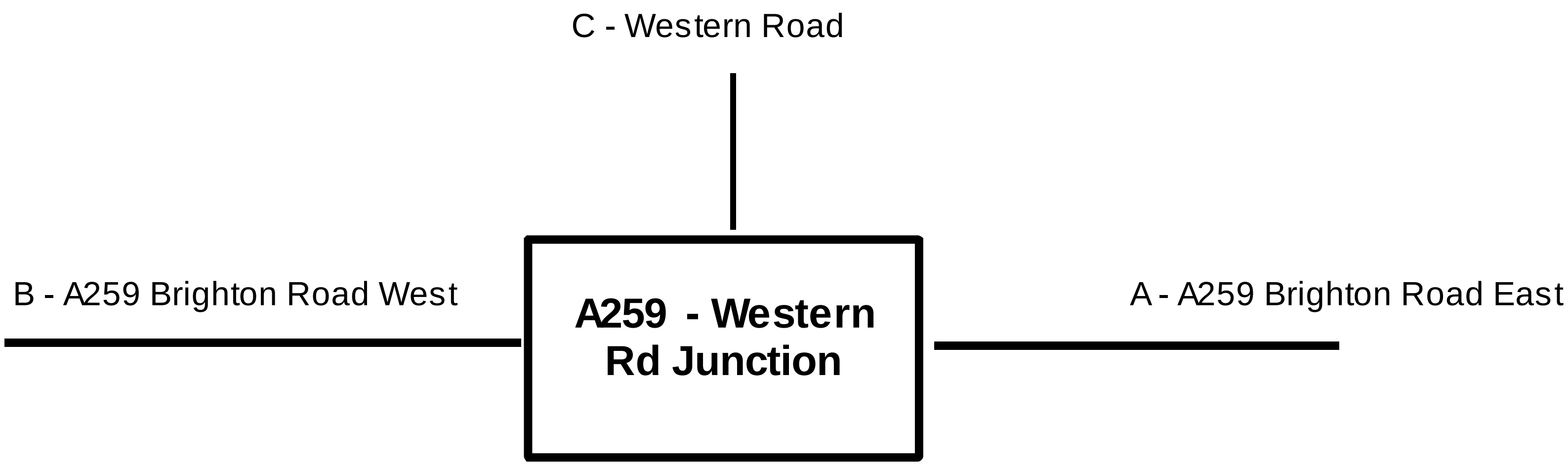
Figure D10



AM - Reference Case

	A	B	C
A	0	1348	0
B	1302	0	515
C	107	228	0

PM - Reference Case

	A	B	C
A	0	1426	0
B	830	0	539
C	19	210	0

AM - Scenario C

	A	B	C
A	0	1505	2
B	1364	0	446
C	91	213	0

PM - Scenario C

	A	B	C
A	0	1436	0
B	843	0	510
C	9	213	0

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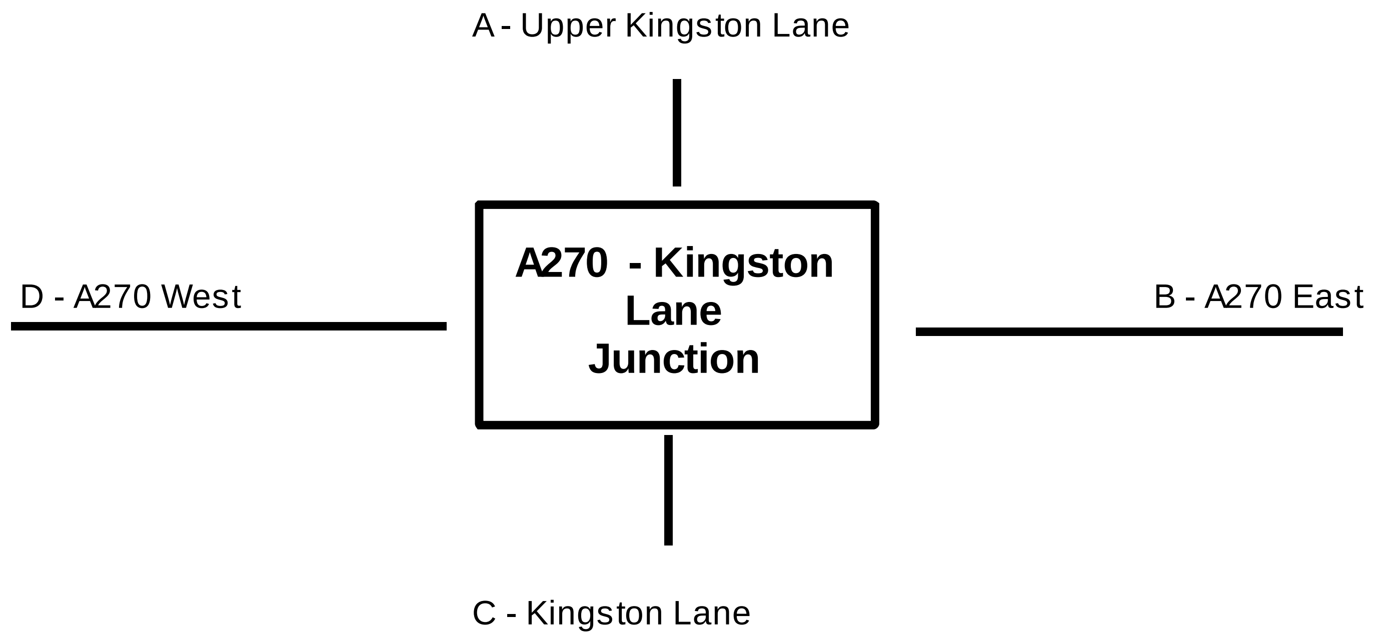
Figure D11



AM - Reference Case

	A	B	C	D
A	0	44	8	23
B	0	0	2	1470
C	76	29	0	126
D	4	1113	307	0

PM - Reference Case

	A	B	C	D
A	0	8	11	19
B	0	0	0	1530
C	72	109	0	137
D	17	895	201	0

AM - Scenario C

	A	B	C	D
A	0	44	7	24
B	0	0	13	1448
C	74	43	0	126
D	4	1139	327	0

PM - Scenario C

	A	B	C	D
A	0	8	11	20
B	0	0	0	1548
C	77	140	0	137
D	11	997	265	0

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Turning Flows - A270 Upper Shoreham Road / B2167 Kingston Lane

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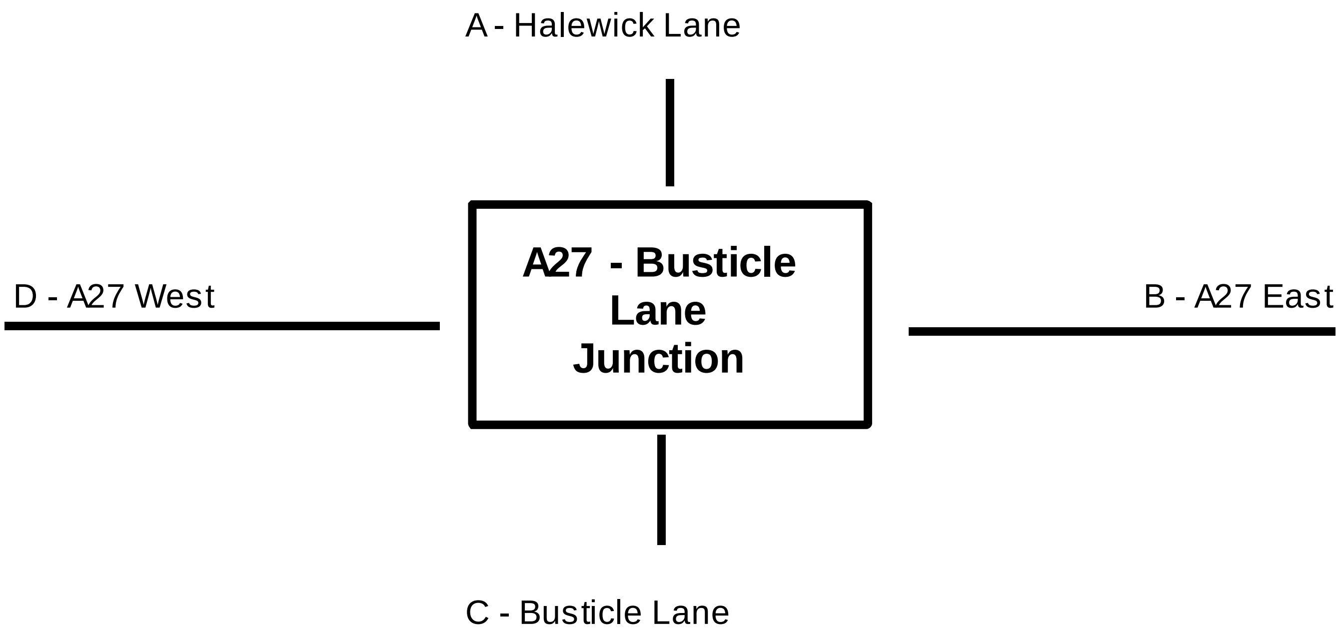
Figure D12



AM - Reference Case

	A	B	C	D
A	0	197	268	113
B	10	0	133	1770
C	165	90	0	208
D	16	1902	153	0

PM - Reference Case

	A	B	C	D
A	0	50	105	30
B	27	0	180	1448
C	238	141	0	114
D	81	1577	129	0

AM - Scenario C

	A	B	C	D
A	0	322	189	125
B	10	0	80	1971
C	200	114	0	179
D	4	2015	142	0

PM - Scenario C

	A	B	C	D
A	0	51	126	33
B	21	0	158	1512
C	252	128	0	99
D	99	1698	136	0

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Turning Flows -
A27 / Busticle Lane

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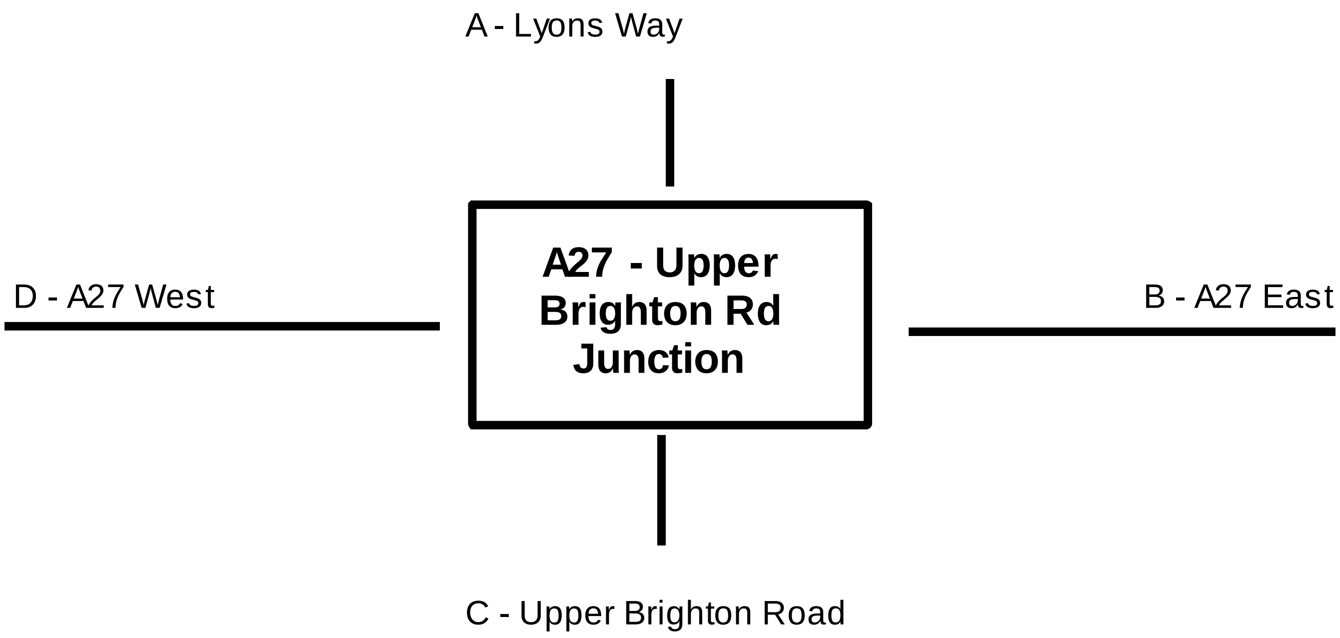
Figure D13



AM - Reference Case

	A	B	C	D
A	0	58	0	85
B	138	0	247	1502
C	45	233	0	194
D	0	1798	0	0

PM - Reference Case

	A	B	C	D
A	0	161	7	227
B	27	0	87	1431
C	63	198	0	102
D	0	1432	42	0

AM - Scenario C

	A	B	C	D
A	0	9	0	126
B	148	0	165	1689
C	34	426	0	216
D	0	1758	0	0

PM - Scenario C

	A	B	C	D
A	0	161	19	238
B	21	0	134	1407
C	78	365	0	83
D	15	1413	45	0

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Turning Flows - A27 Sompting Bypass / Upper Brighton Road

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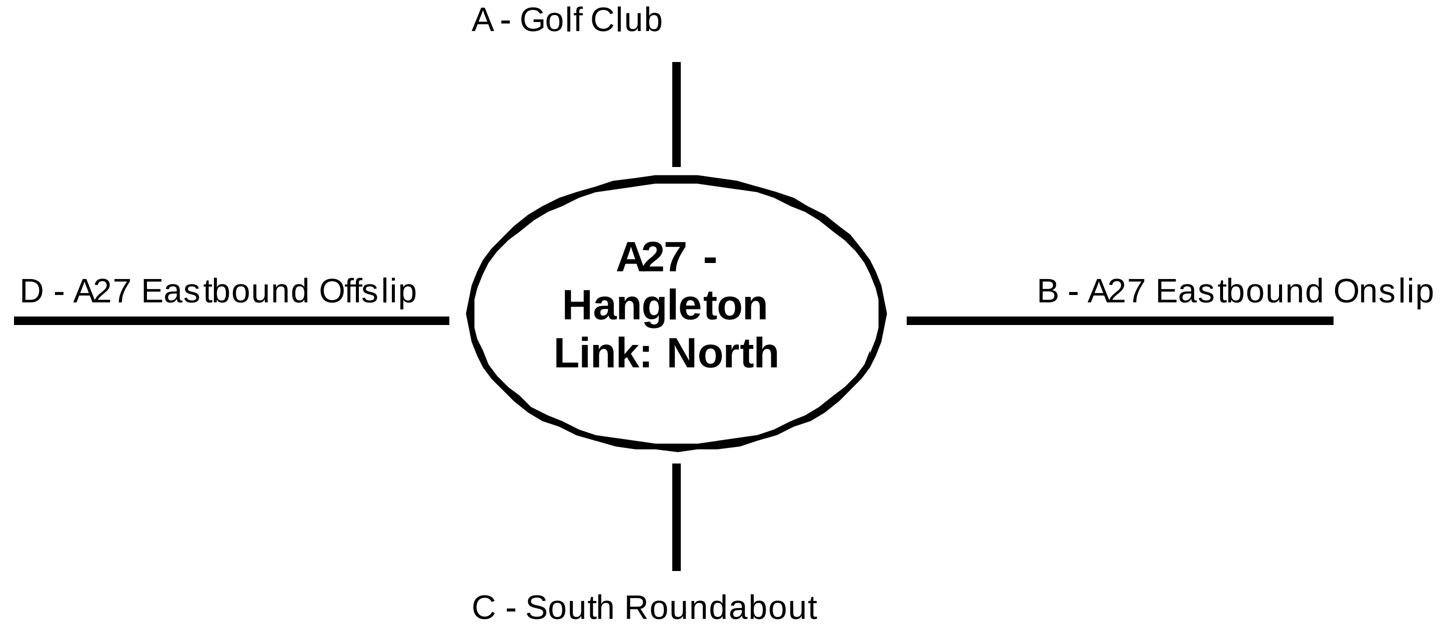
Figure D14



AM - Reference Case

	A	B	C	D
A	0	0	74	0
B	0	0	0	0
C	40	1302	0	0
D	94	325	380	0

PM - Reference Case

	A	B	C	D
A	0	7	86	0
B	0	0	0	0
C	14	1092	0	0
D	69	0	301	0

AM - Scenario C

	A	B	C	D
A	0	0	89	0
B	0	0	0	0
C	39	1231	0	0
D	98	0	215	0

PM - Scenario C

	A	B	C	D
A	0	7	90	0
B	0	0	0	0
C	22	1253	0	0
D	75	0	141	0

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Turning Flows - A27 / Hangleton Link North Roundabout

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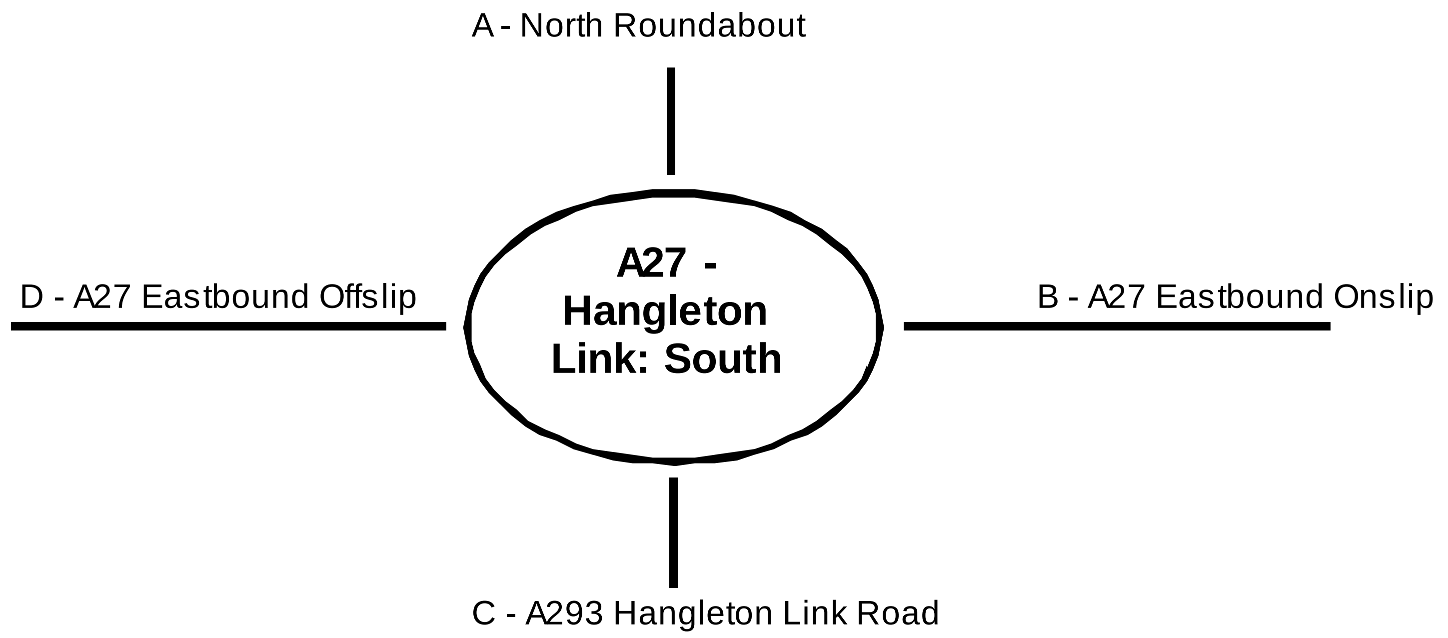
Figure D15



AM - Reference Case

	A	B	C	D
A	0	0	403	51
B	0	0	1040	0
C	1342	0	0	404
D	0	0	0	0

PM - Reference Case

	A	B	C	D
A	0	0	322	65
B	0	0	807	0
C	1167	0	0	684
D	0	0	0	0

AM - Scenario C

	A	B	C	D
A	0	0	248	56
B	0	0	1105	0
C	1270	0	0	502
D	0	0	0	0

PM - Scenario C

	A	B	C	D
A	0	0	167	65
B	0	0	845	0
C	1275	0	0	985
D	0	0	0	0

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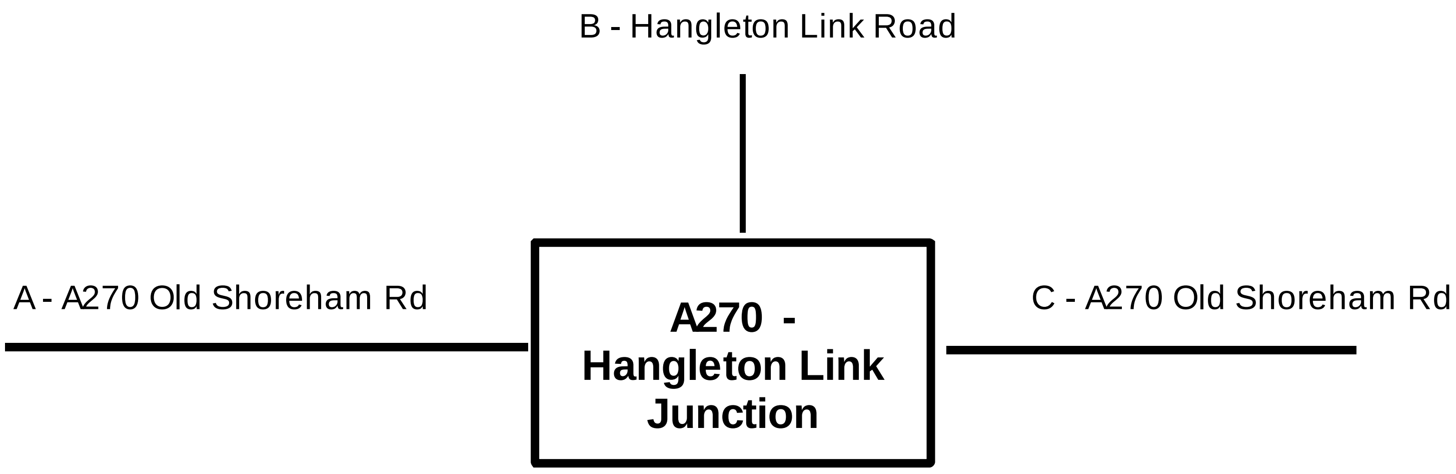
Figure D16



AM - Reference Case

	A	B	C
A	0	383	889
B	456	0	567
C	858	385	0

PM - Reference Case

	A	B	C
A	0	671	504
B	159	0	636
C	1072	247	0

AM - Scenario C

	A	B	C
A	0	404	892
B	470	0	512
C	875	387	0

PM - Scenario C

	A	B	C
A	0	654	652
B	178	0	484
C	1039	285	0

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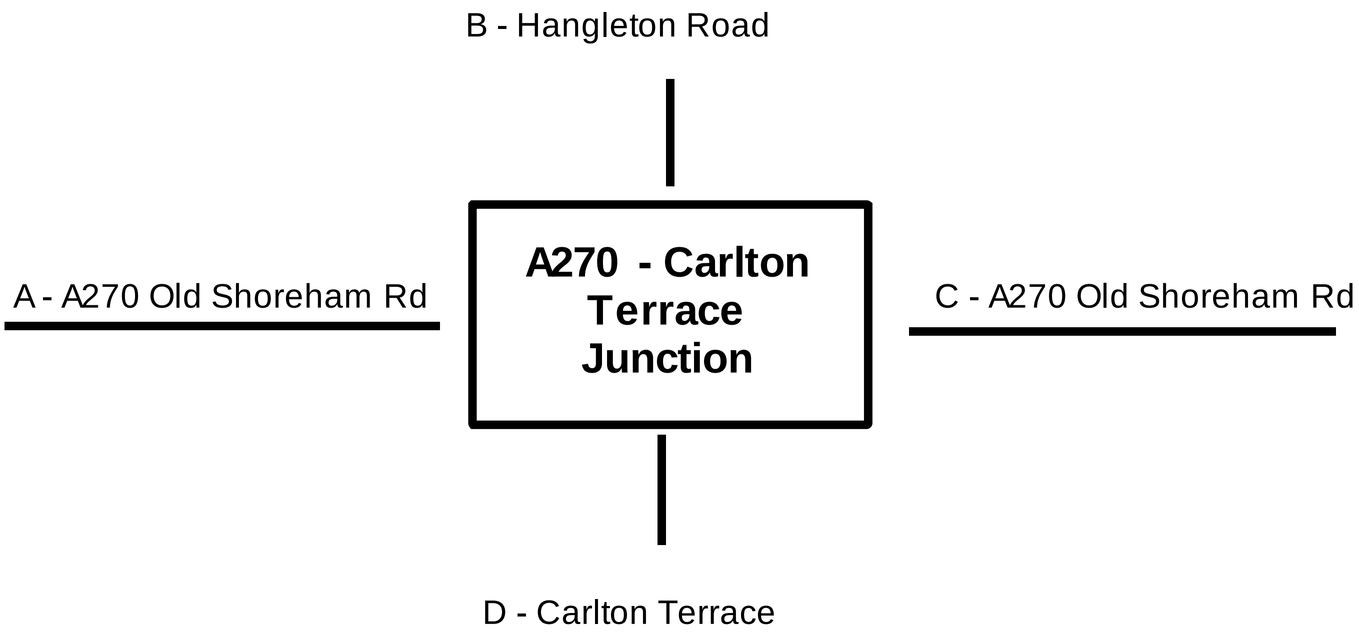

AM - Reference Case

	A	B	C	D
A	0	297	1018	141
B	63	0	0	269
C	908	78	0	37
D	272	328	160	0

PM - Reference Case

	A	B	C	D
A	0	209	782	149
B	264	0	0	225
C	1008	15	0	0
D	47	432	240	0

AM - Scenario C

	A	B	C	D
A	0	296	960	148
B	69	0	0	272
C	921	94	0	39
D	272	300	183	0

PM - Scenario C

	A	B	C	D
A	0	215	773	148
B	253	0	0	216
C	945	26	0	0
D	126	422	207	0

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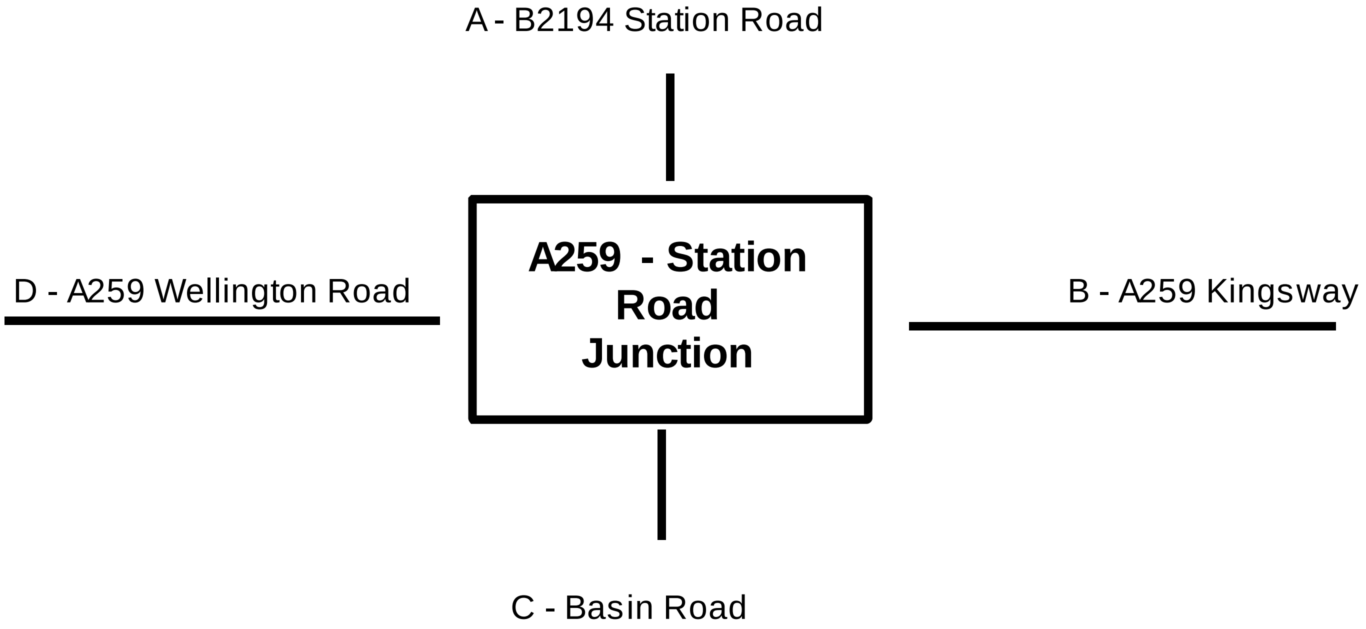
Figure D18



AM - Reference Case

	A	B	C	D
A	0	186	0	0
B	187	0	0	201
C	0	0	0	0
D	0	1185	0	0

PM - Reference Case

	A	B	C	D
A	0	94	0	0
B	95	0	0	433
C	0	0	0	0
D	0	928	0	0

AM - Scenario C

	A	B	C	D
A	0	183	0	2
B	179	0	0	180
C	0	0	0	0
D	20	1168	0	0

PM - Scenario C

	A	B	C	D
A	0	132	0	0
B	88	0	0	429
C	0	0	0	0
D	22	964	0	0

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Figure D19

Appendix E

MODELLED JOURNEY TIMES

APPENDIX E-1

JOURNEY TIME ROUTES MAP

Journey Time Routes:

1 - Western Road/Busticle Lane
2 - South Street/Grinstead Lane
3 - A283 Old ShorehamRoad /Steyning Road
4 - B2194 Station Road / A293
5- A27
6- A27/A270

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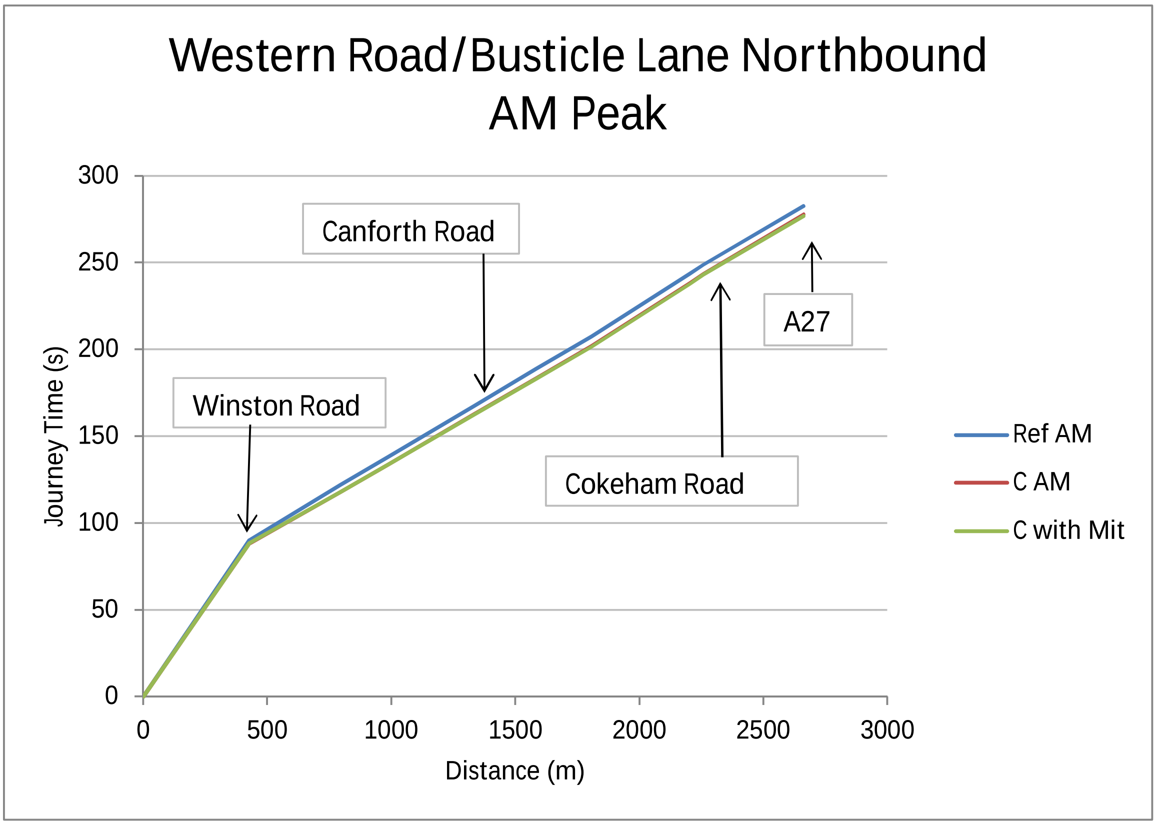
Appendix E

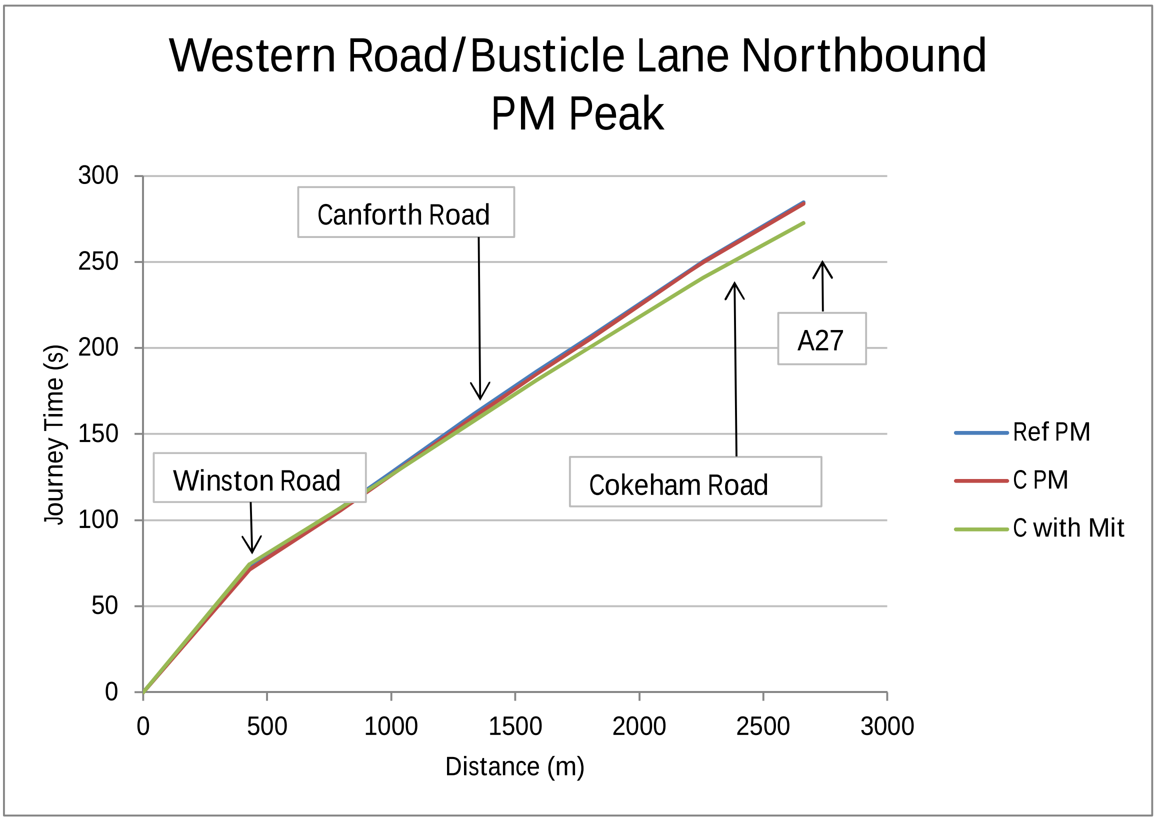
APPENDIX E-2

MODELLED JOURNEY TIME COMPARISON PLOTS

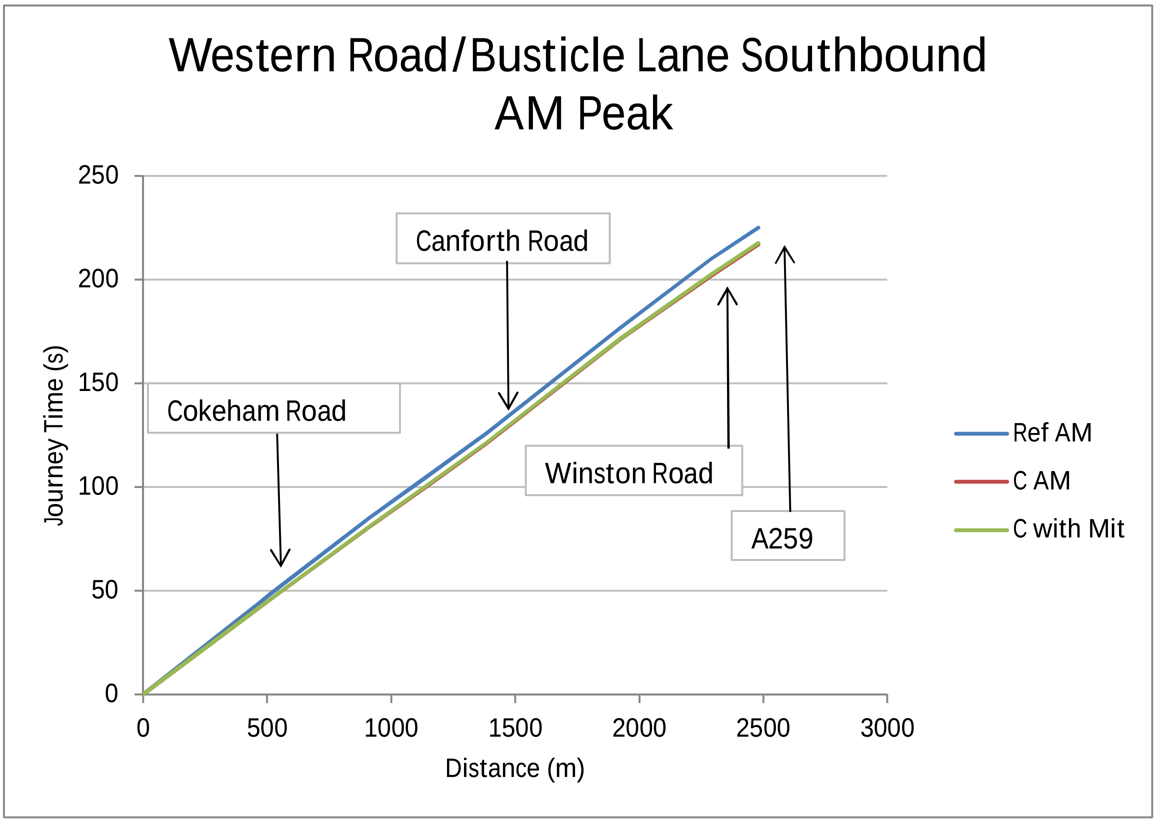
Route 1 - Western Road / Busticle Lane Northbound AM Peak



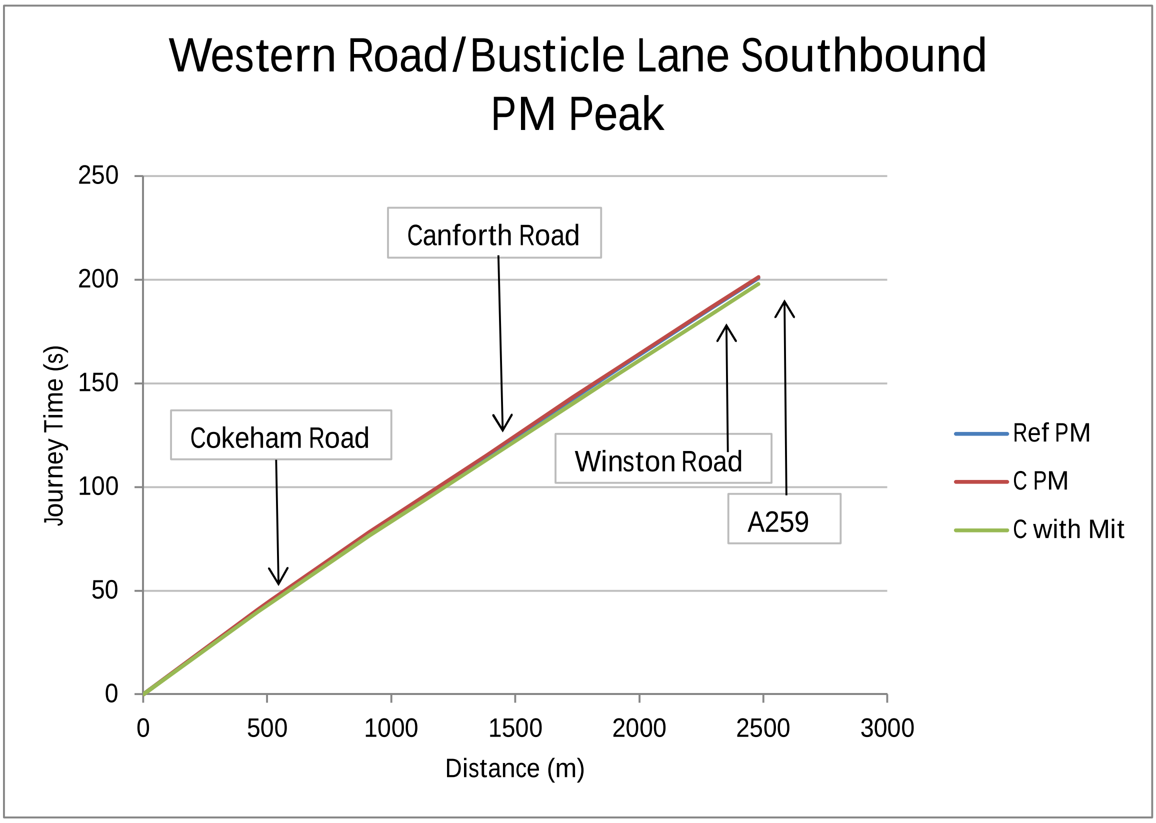
Route 1 - Western Road / Busticle Lane Northbound PM Peak



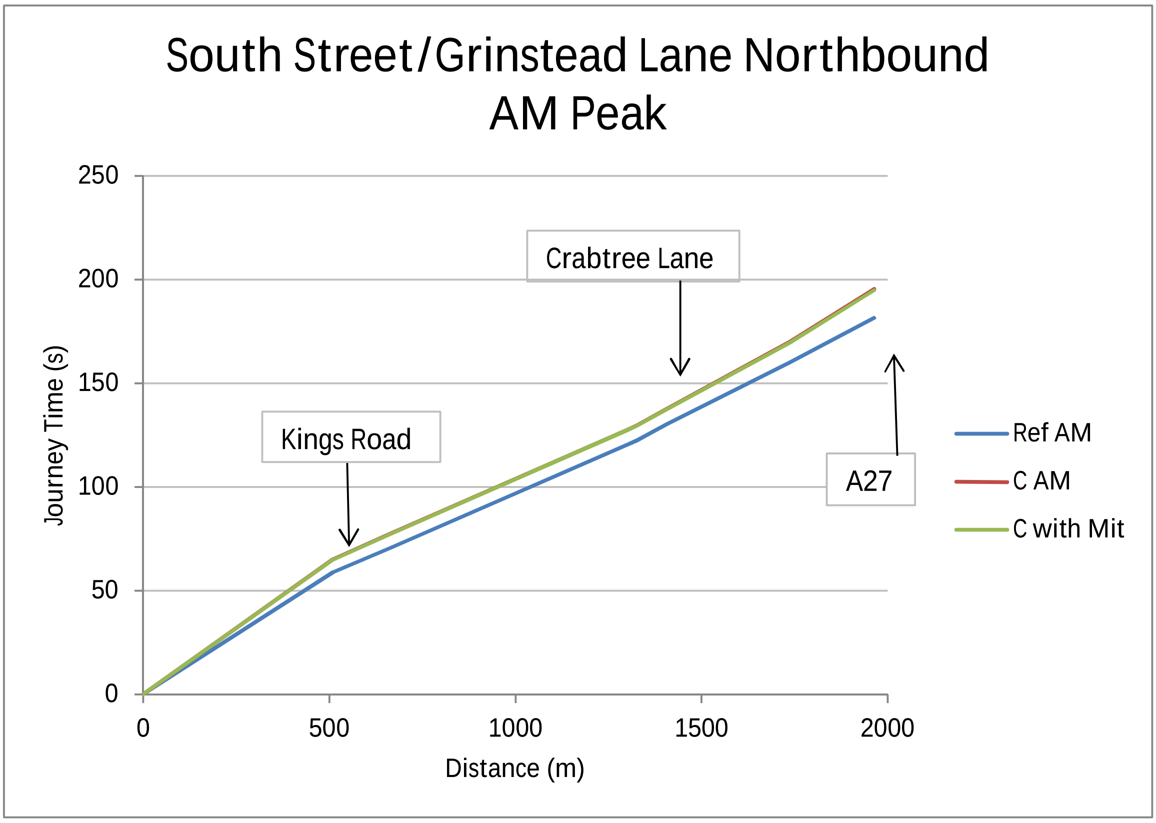
Route 1 - Western Road / Busticle Lane Southbound AM Peak



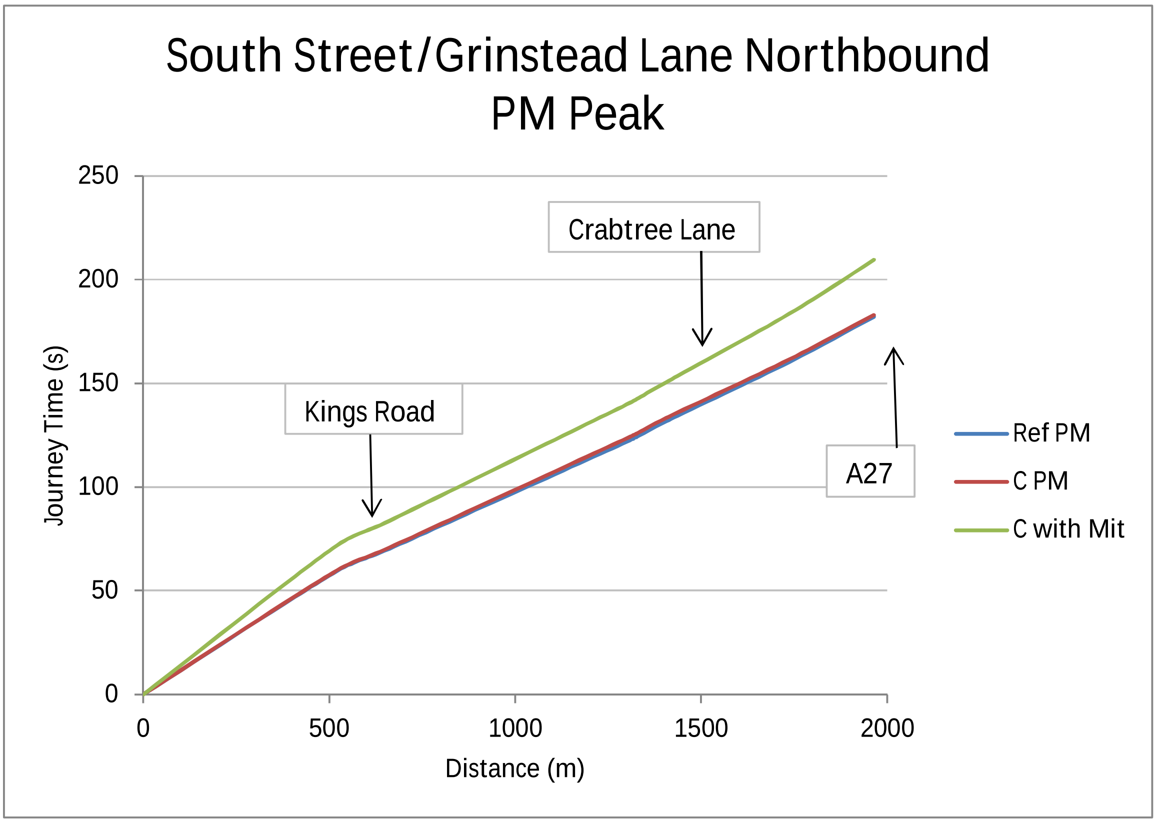
Route 1 - Western Road / Busticle Lane Southbound PM Peak



Route 2 - South Street / Grinstead Lane Northbound AM Peak

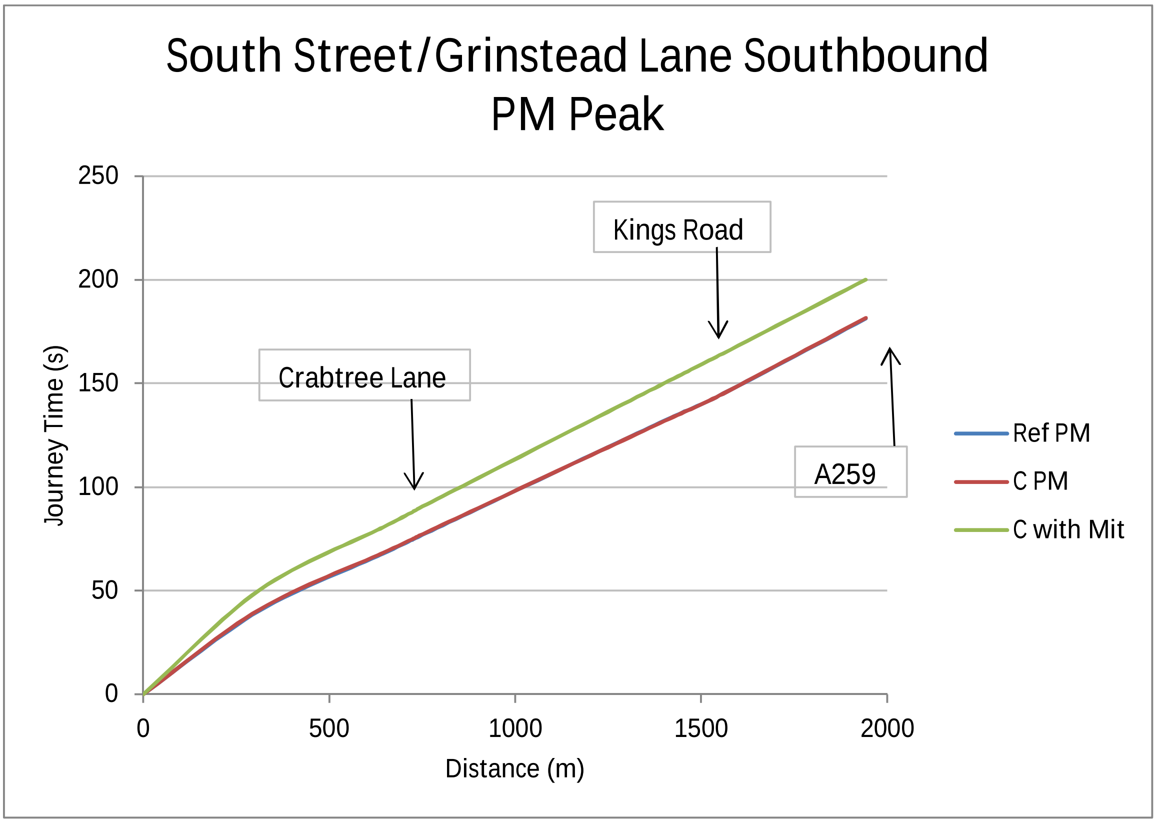


Route 2 - South Street / Grinstead Lane Northbound PM Peak

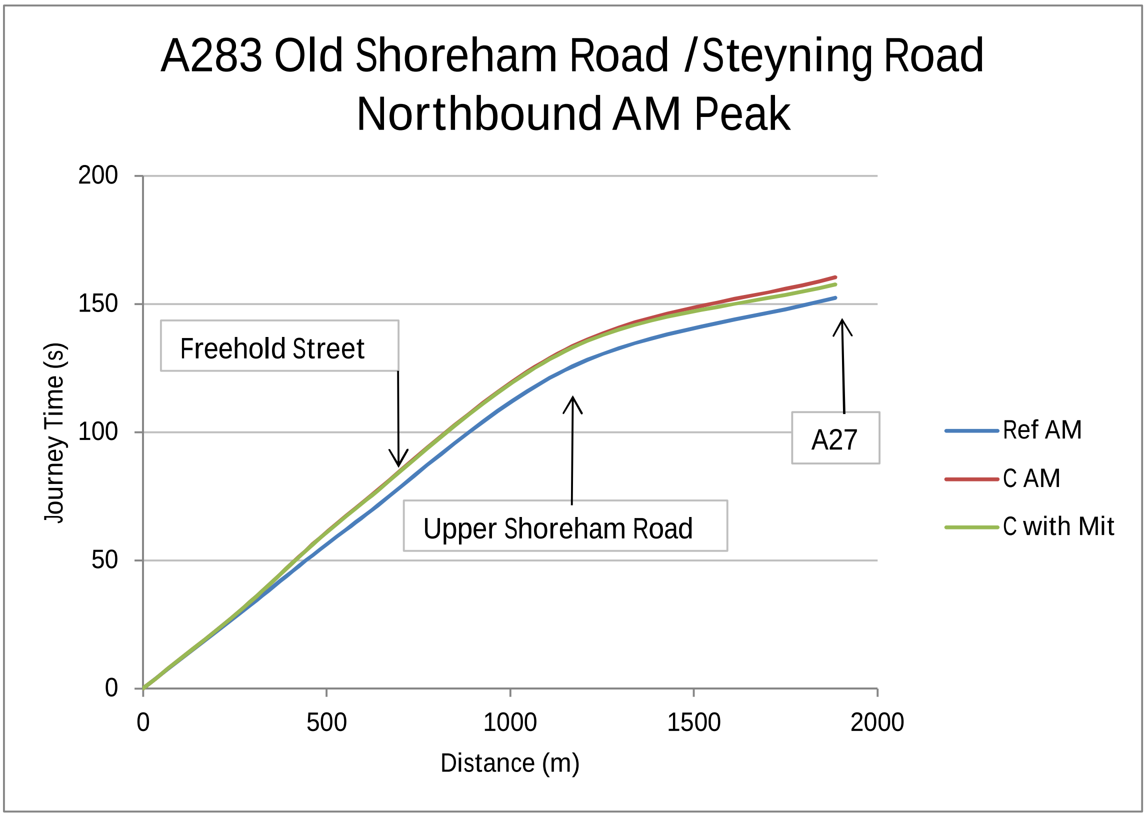


Route 2 - South Street / Grinstead Lane Southbound AM Peak

Route 2 - South Street / Grinstead Lane Southbound PM Peak



Route 3 - A283 Old Shoreham Road / Steyning Road Northbound AM Peak



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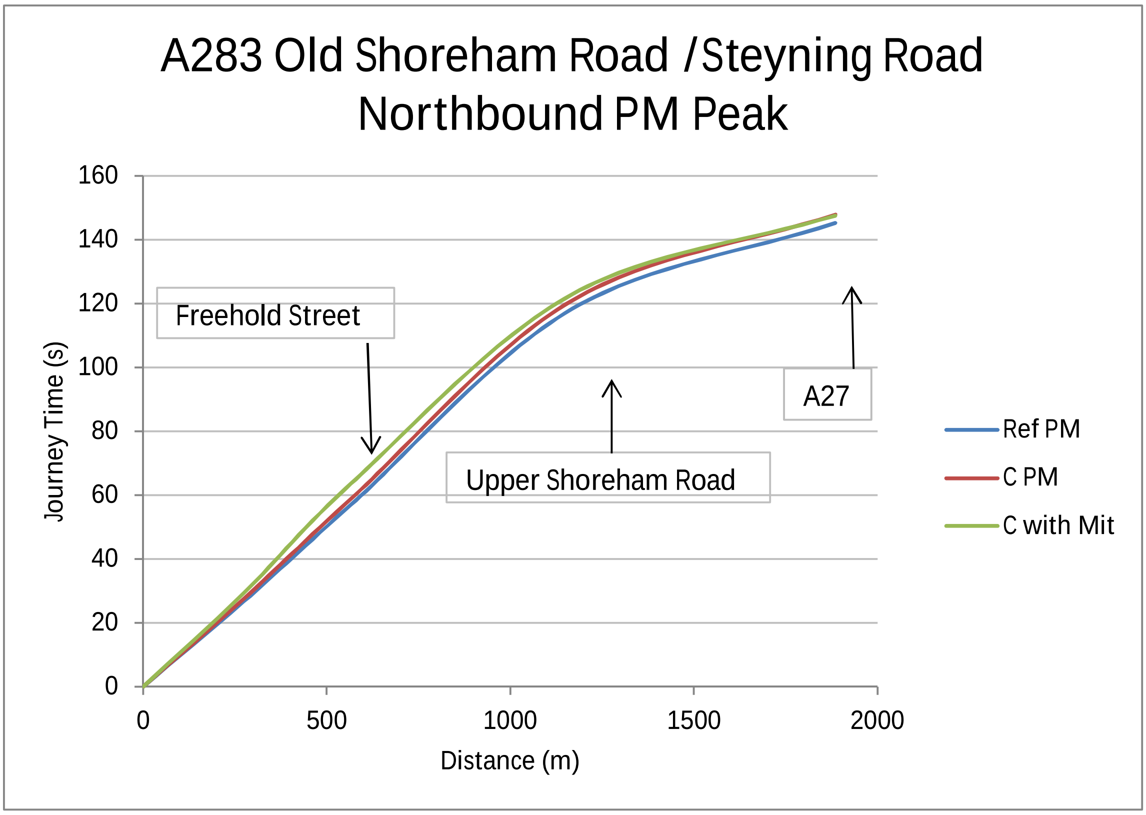
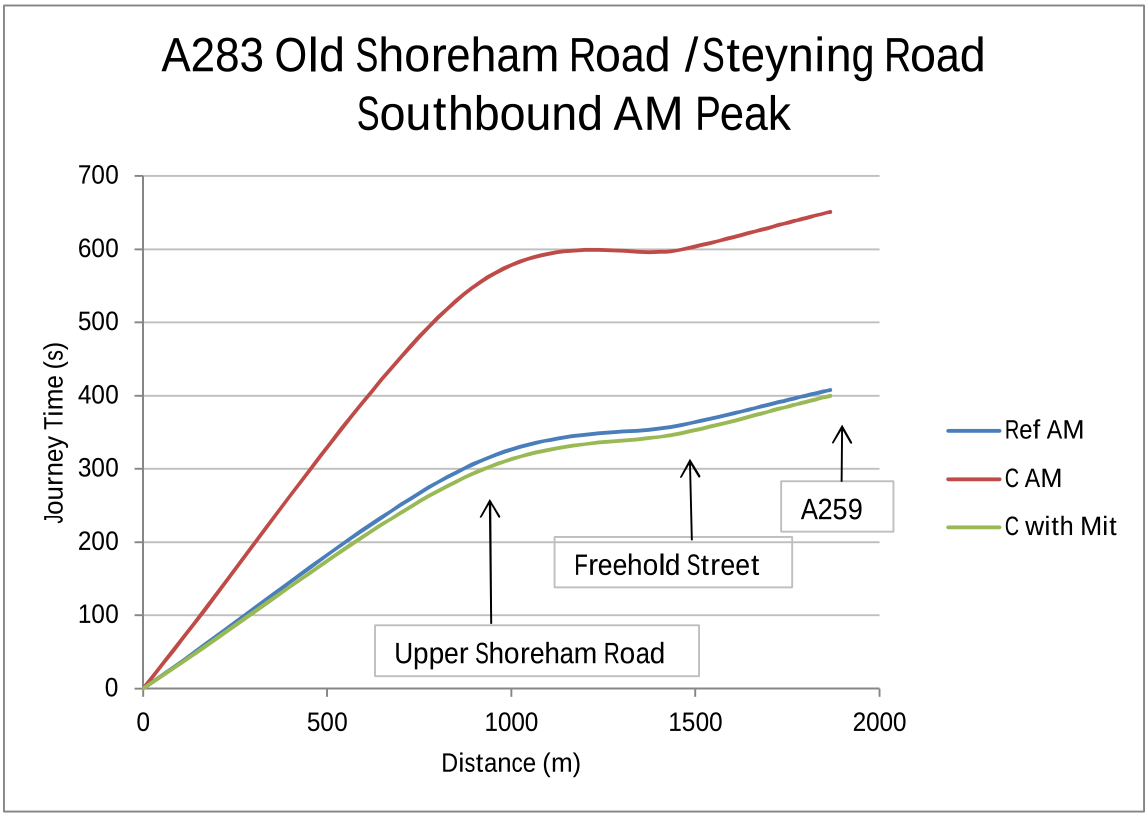
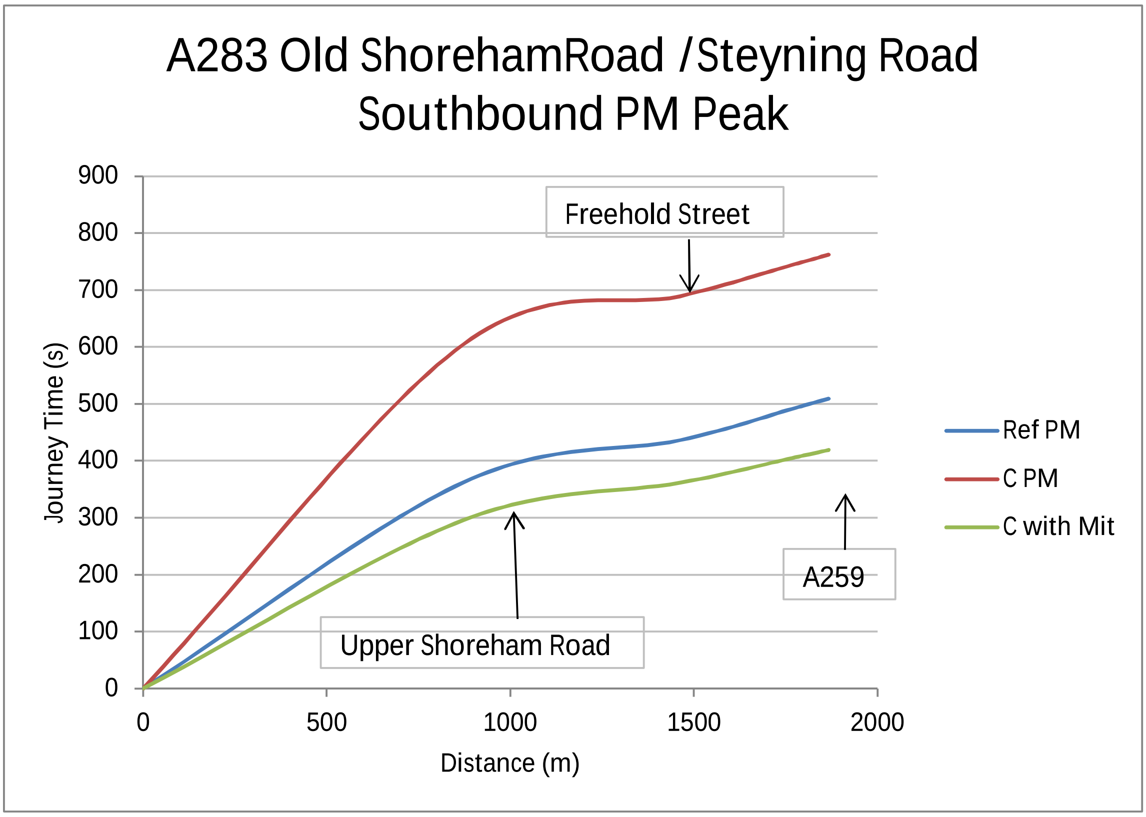


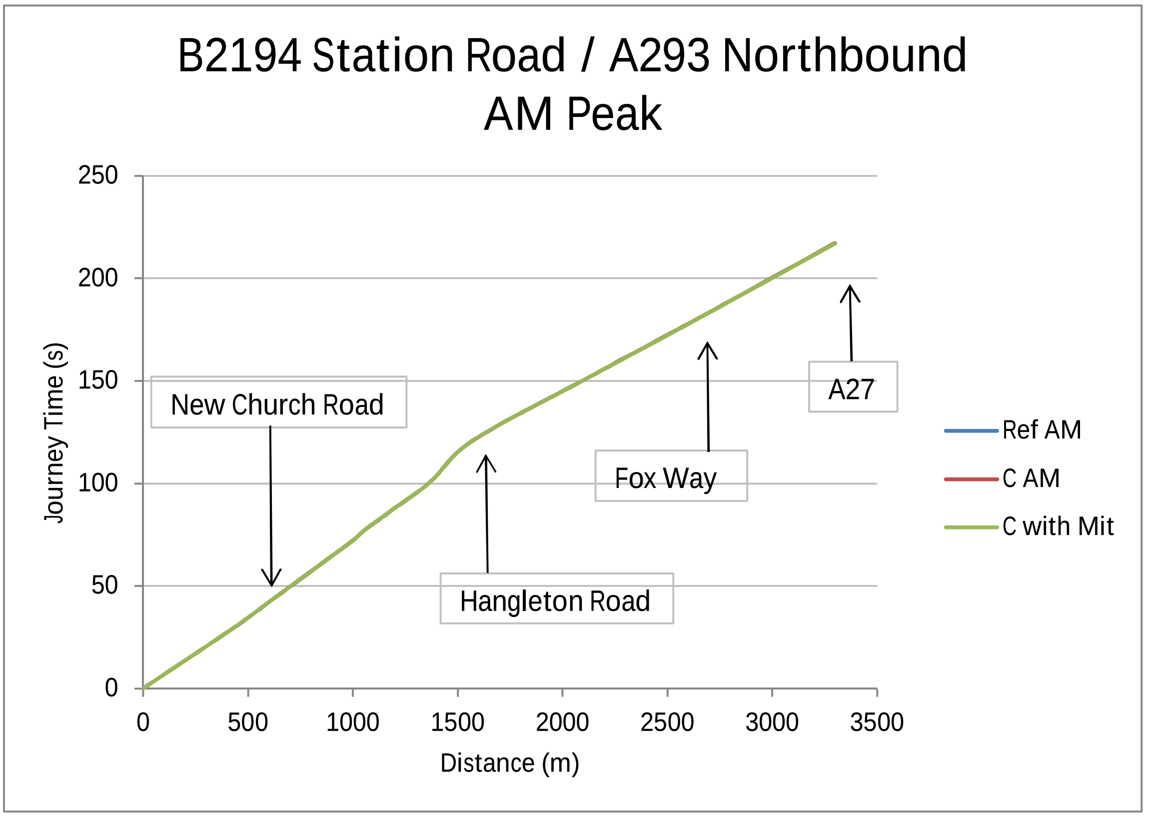
Route 3 - A283 Old Shoreham Road / Steyning Road Southbound AM Peak



Route 3 - A283 Old Shoreham Road / Steyning Road Southbound PM Peak



Route 4 - B2194 Station Road / A293 Northbound AM Peak



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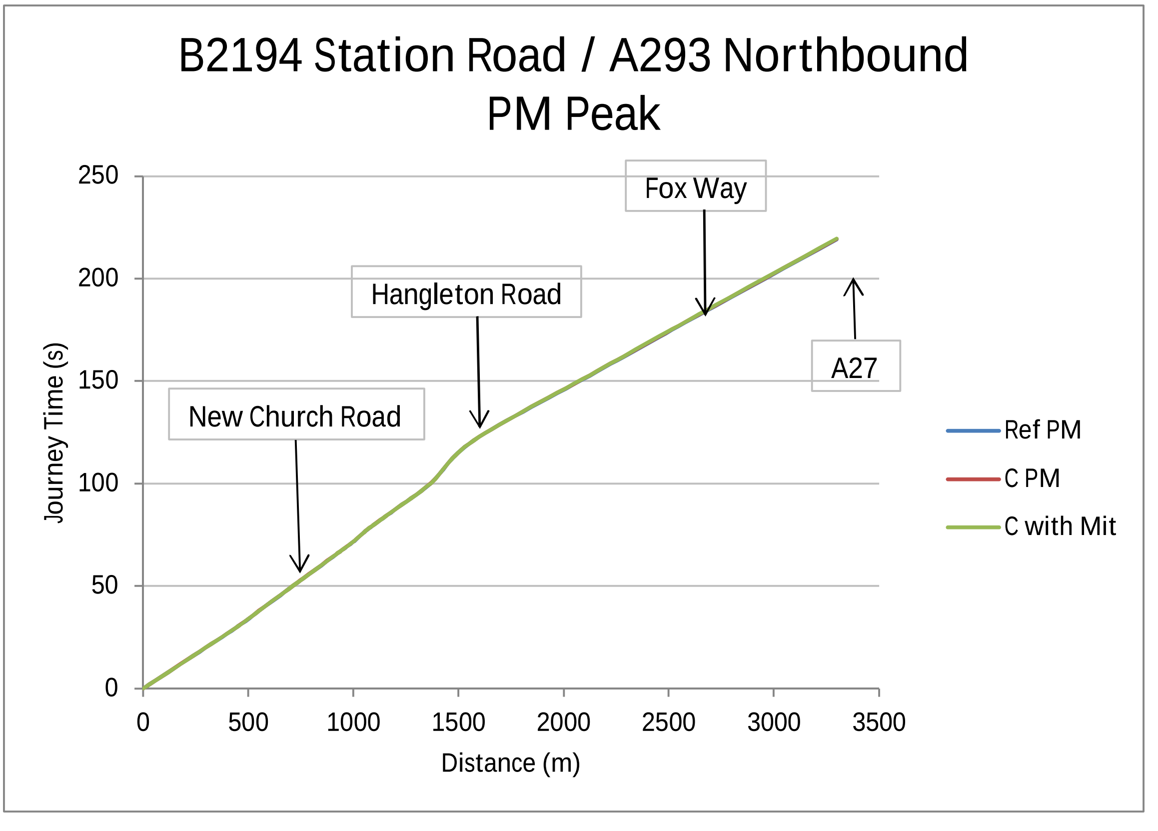

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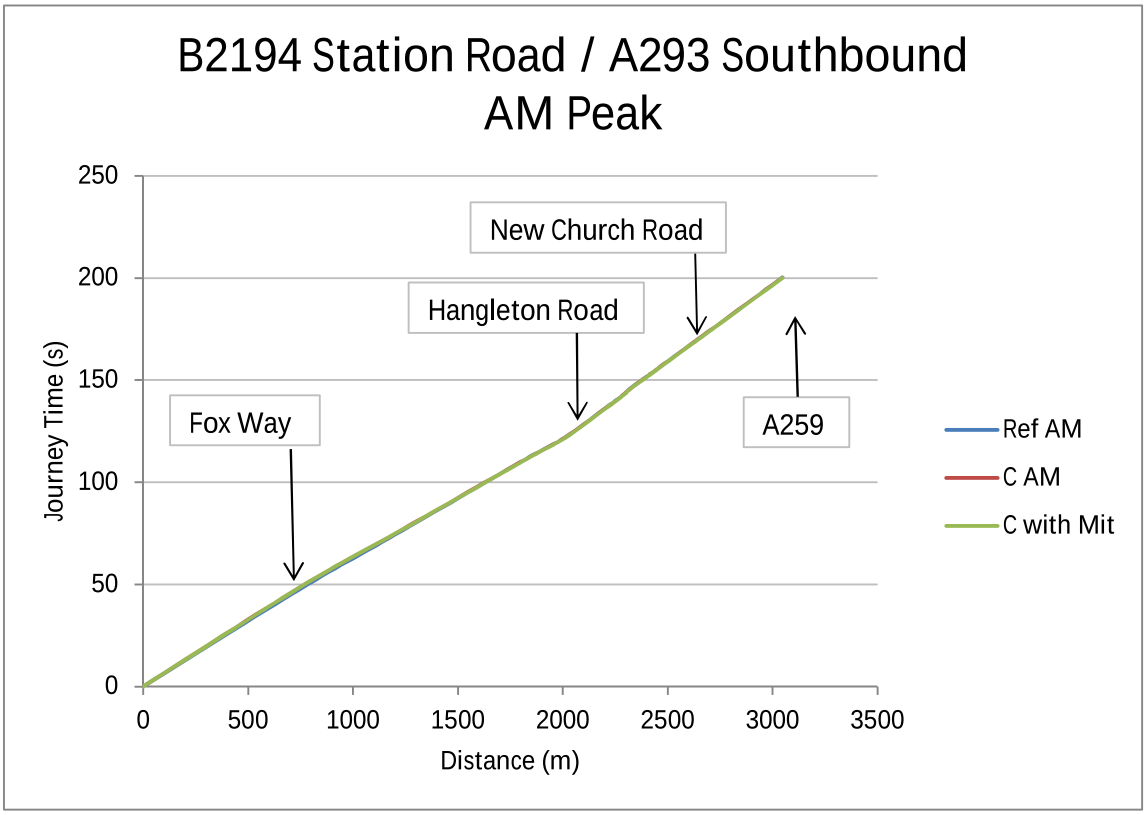
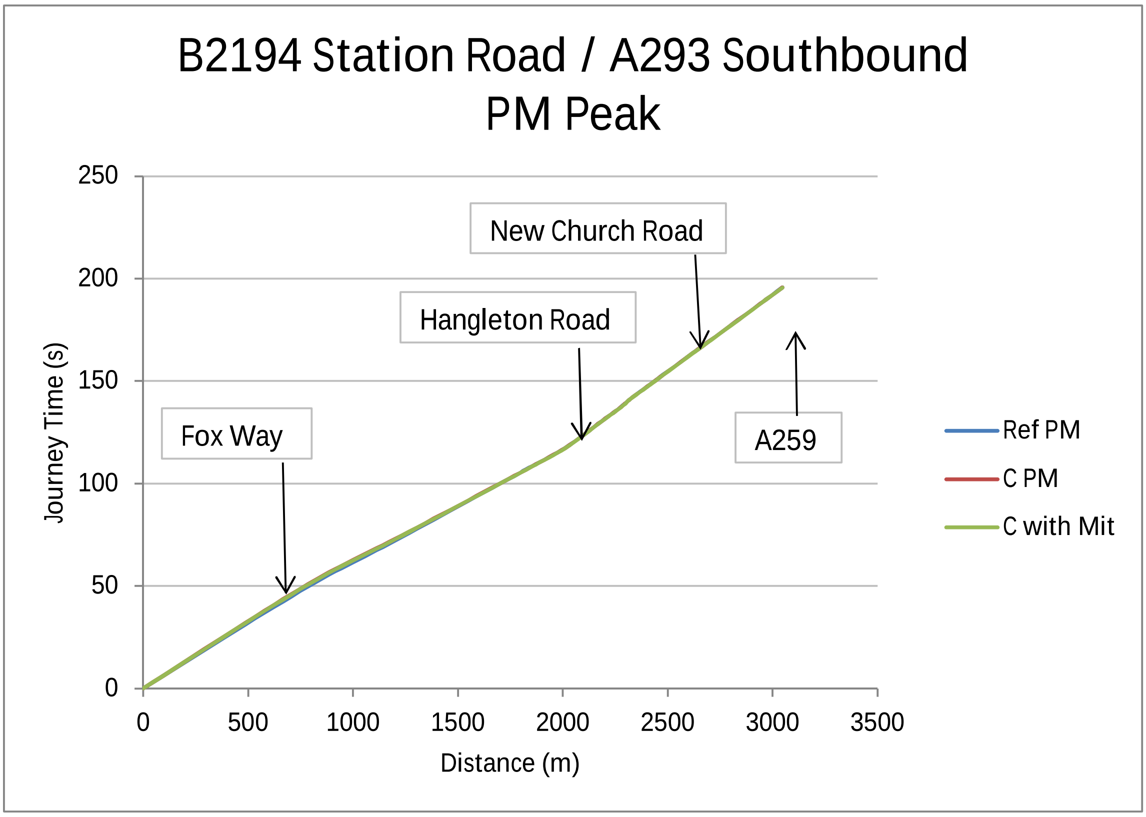
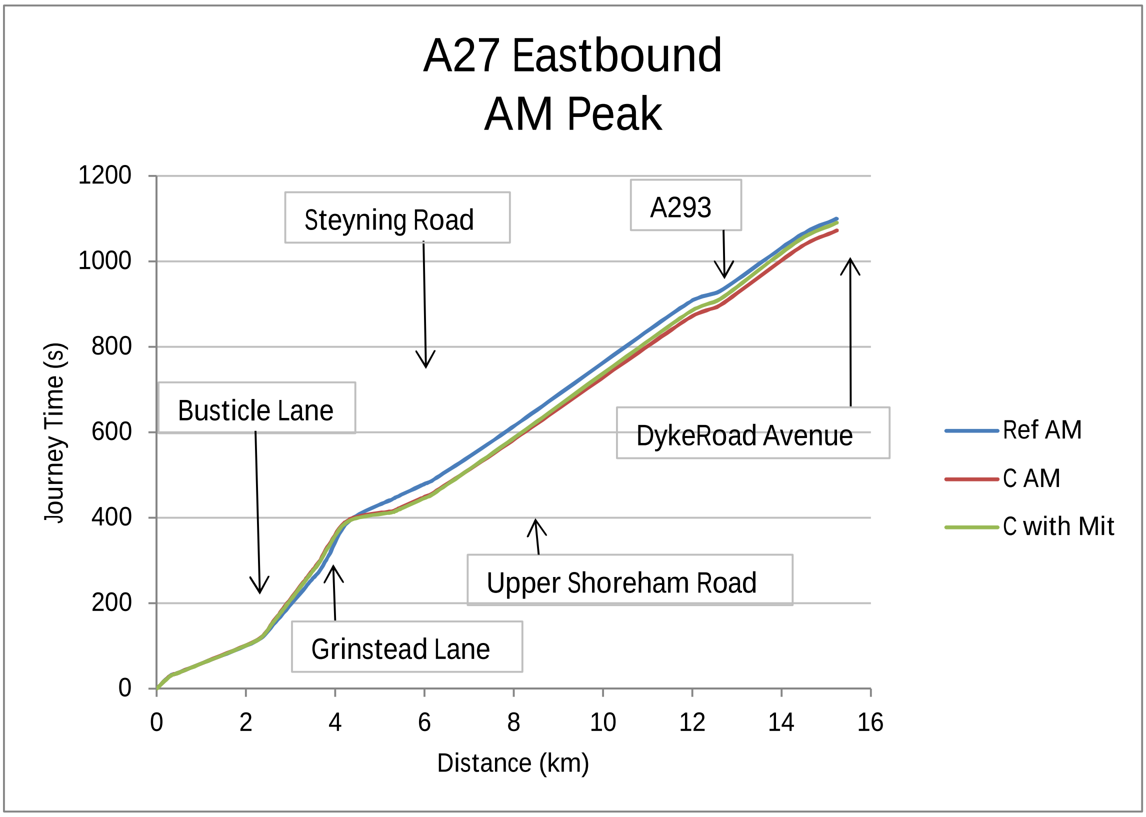


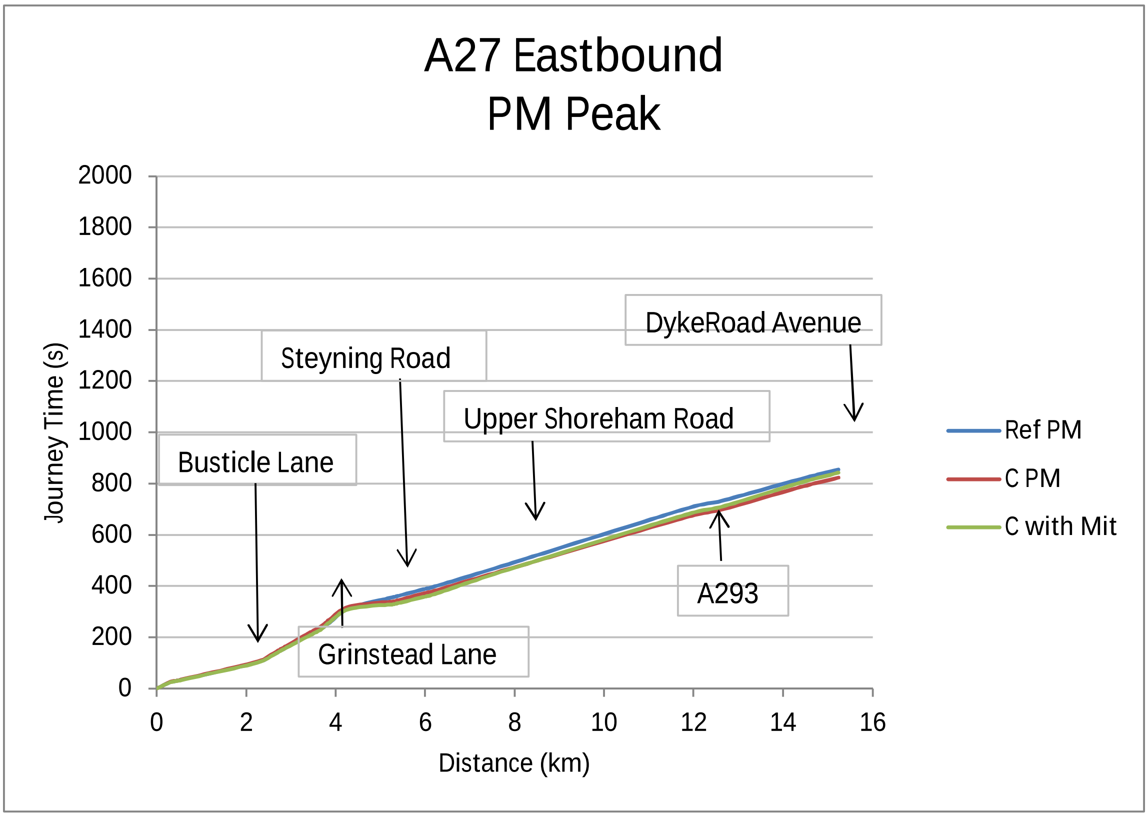
Route 4 - B2194 Station Road / A293 Southbound PM Peak



Route 5 - A27 Eastbound AM Peak



Route 5 - A27 Eastbound PM Peak



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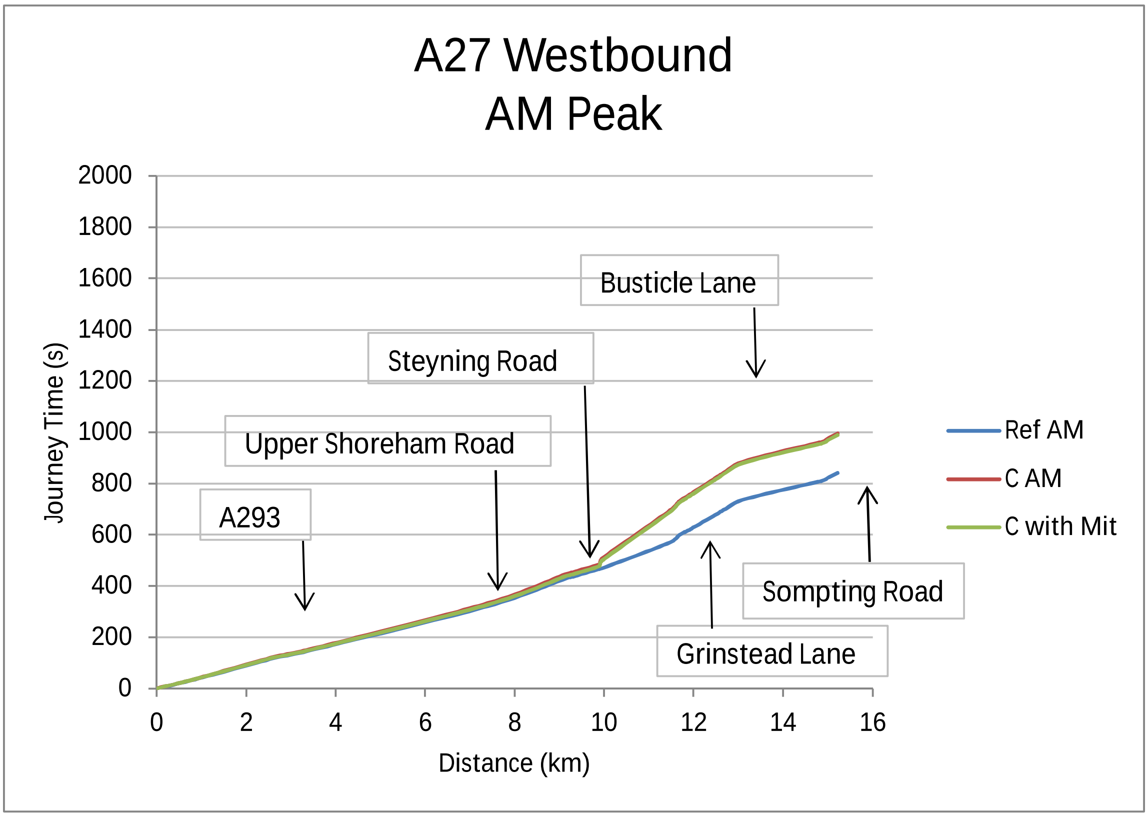

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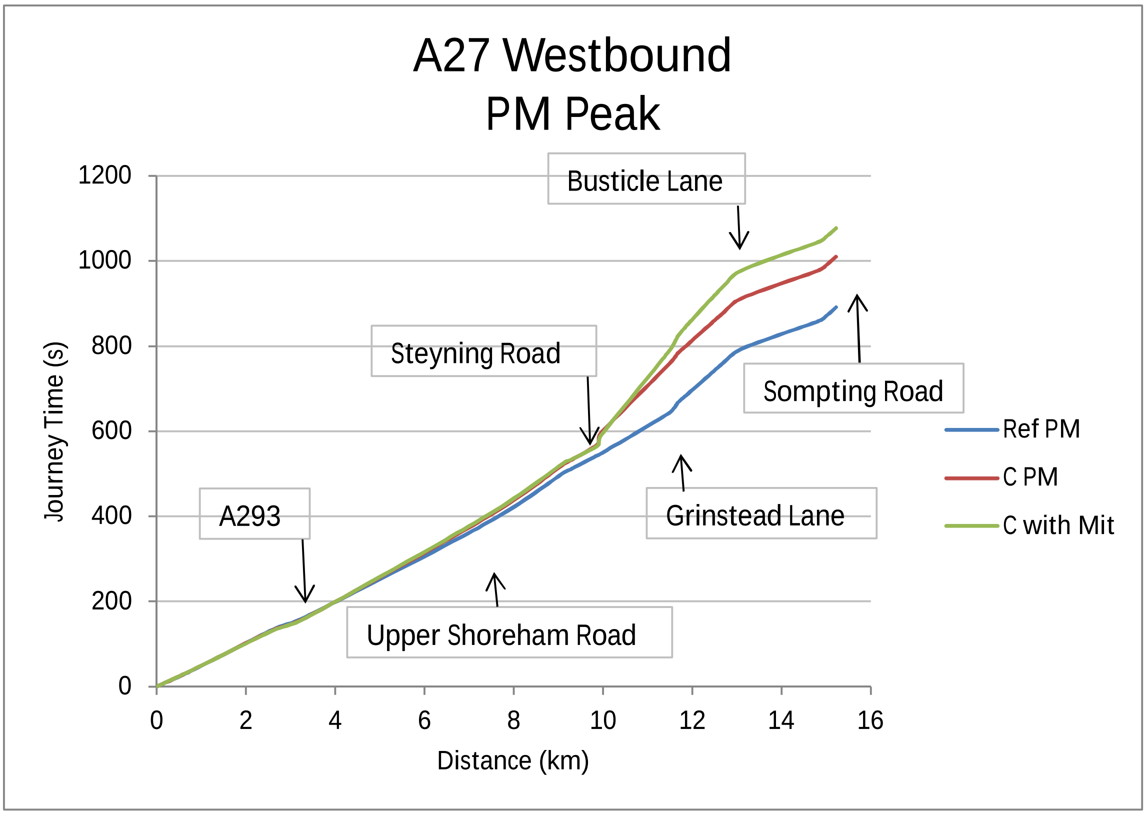
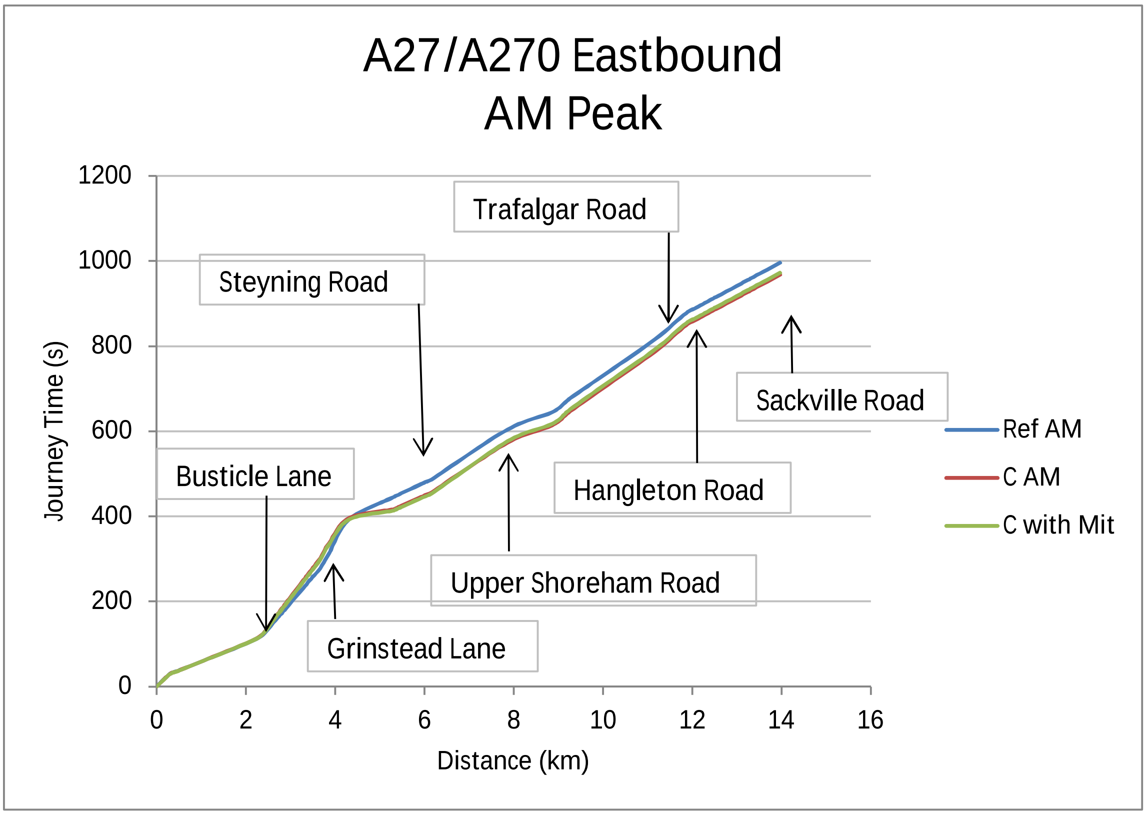


Route 6 - A27 / A270 Eastbound AM Peak



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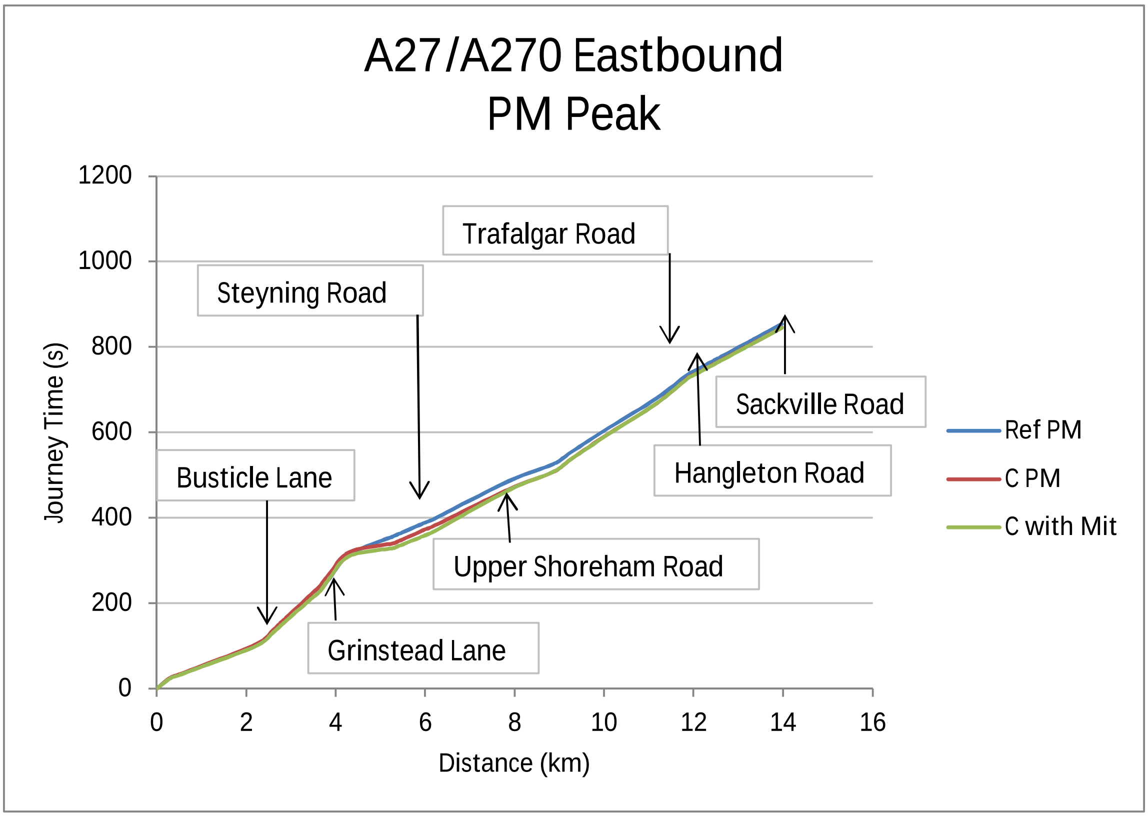

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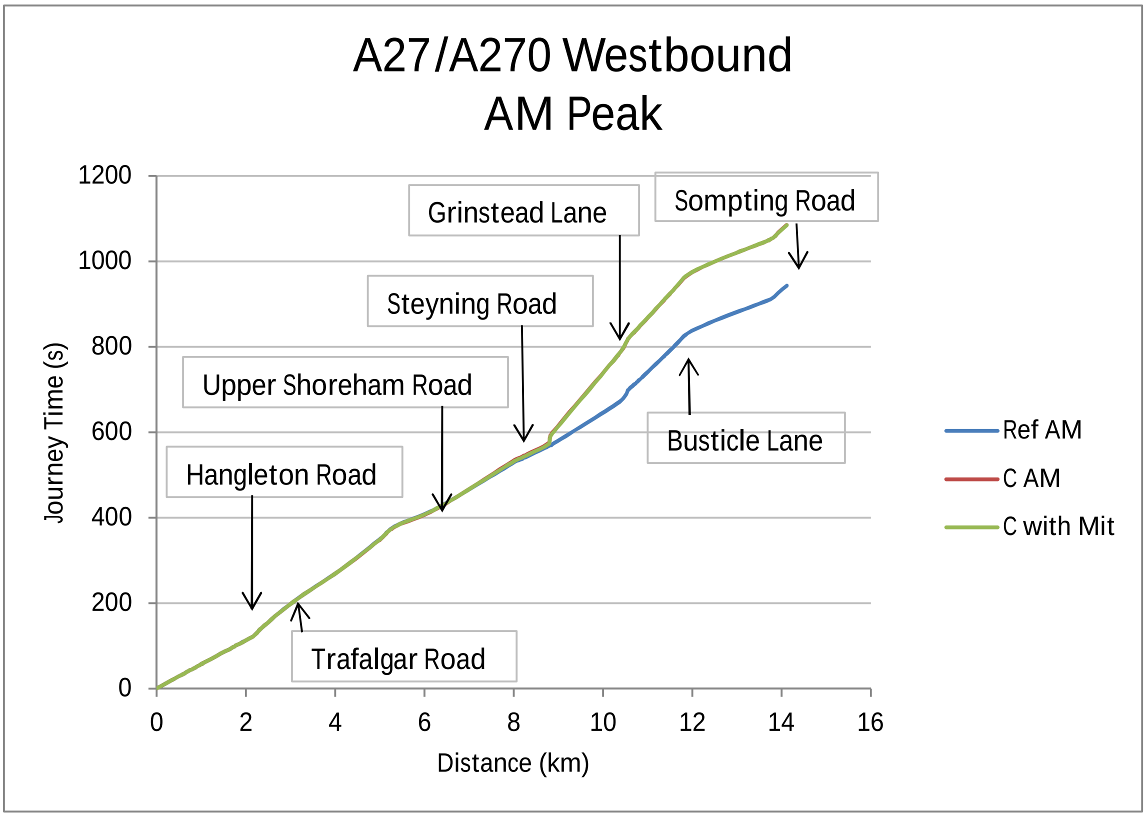

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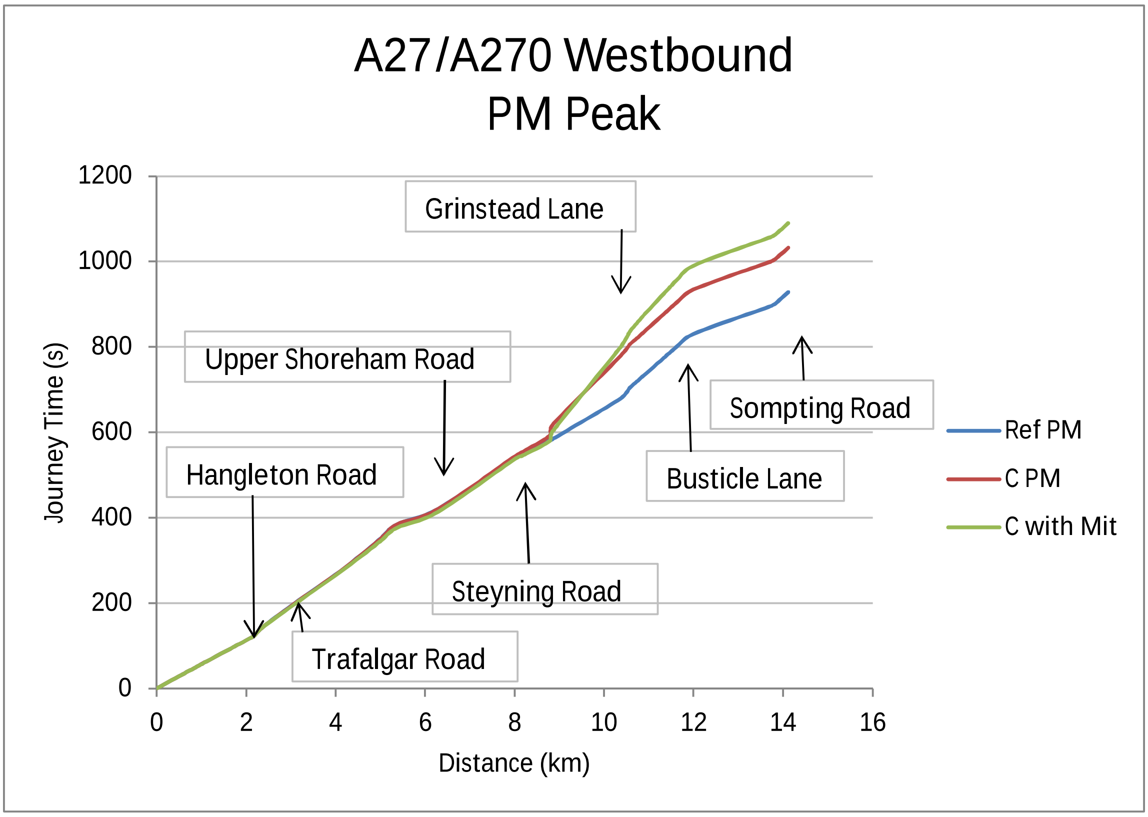

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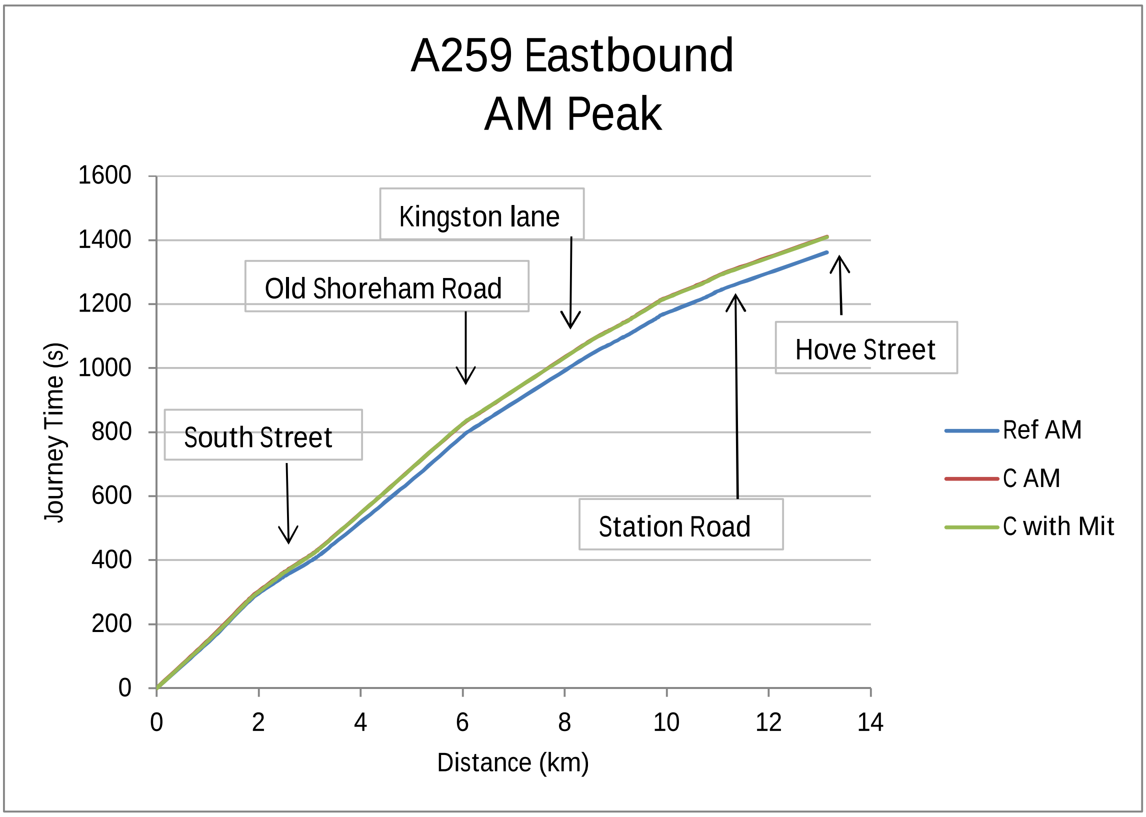

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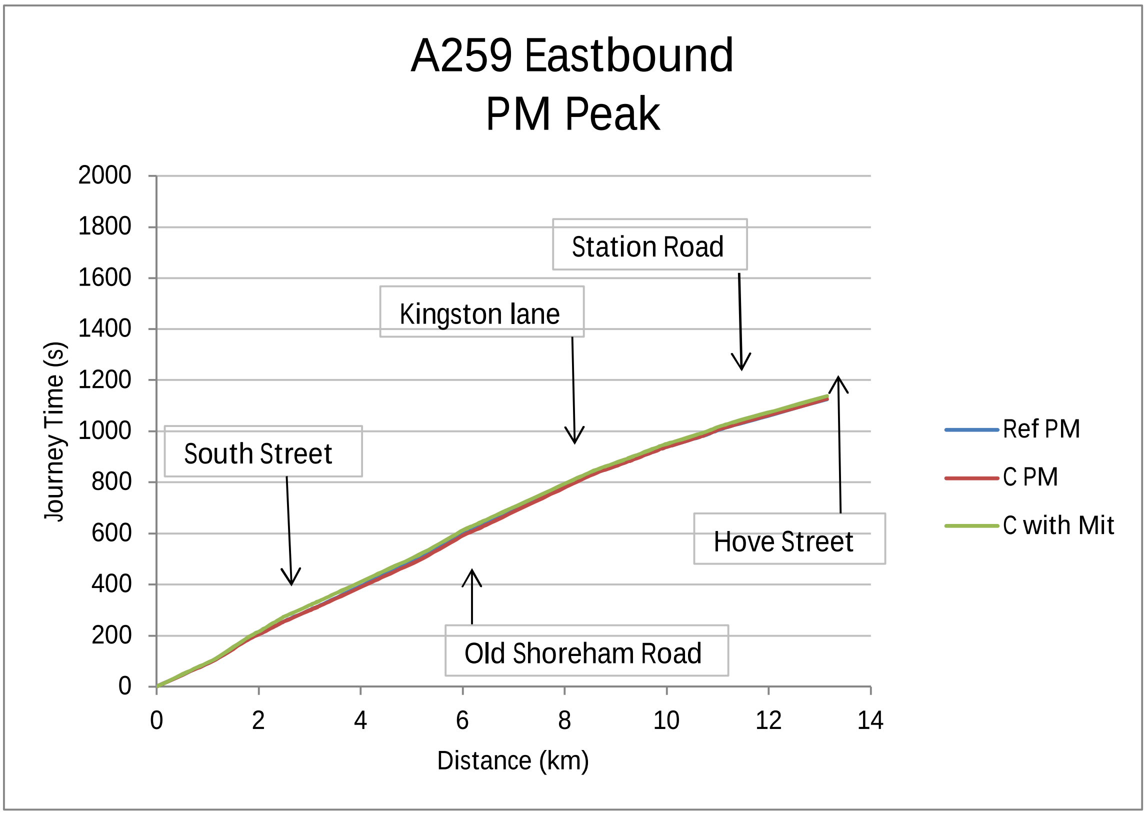

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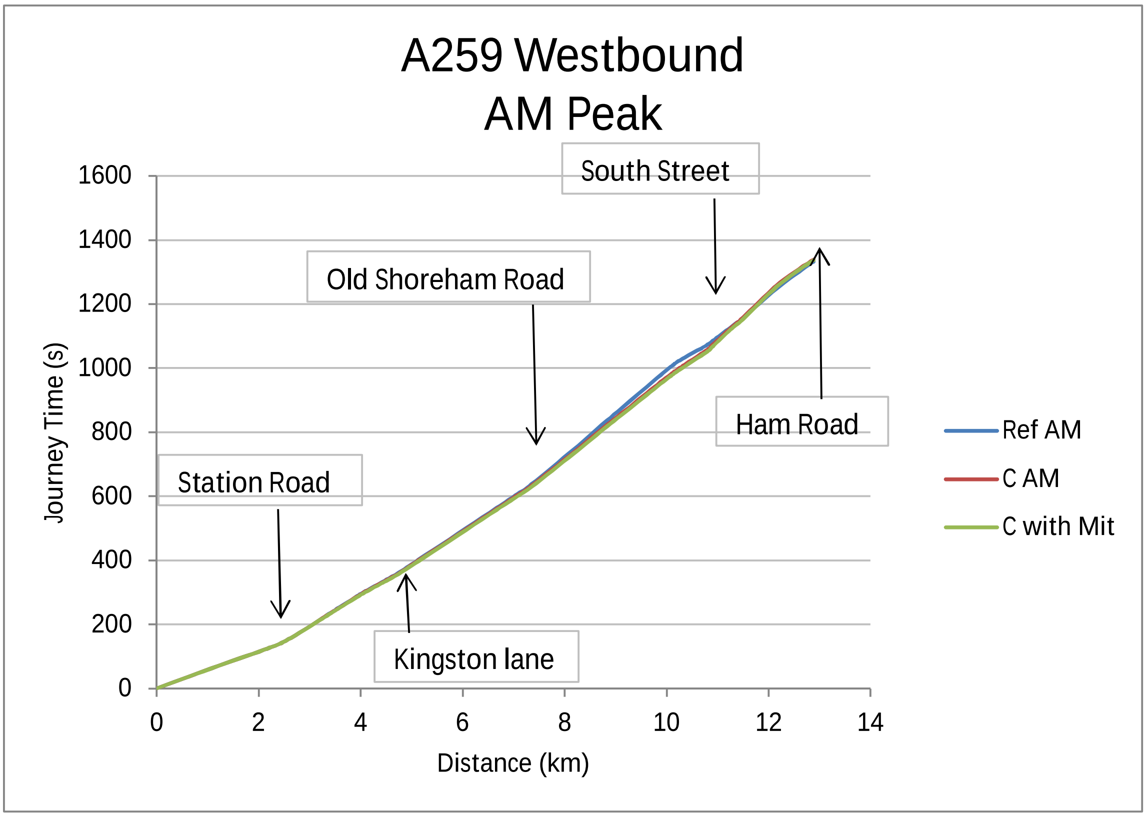
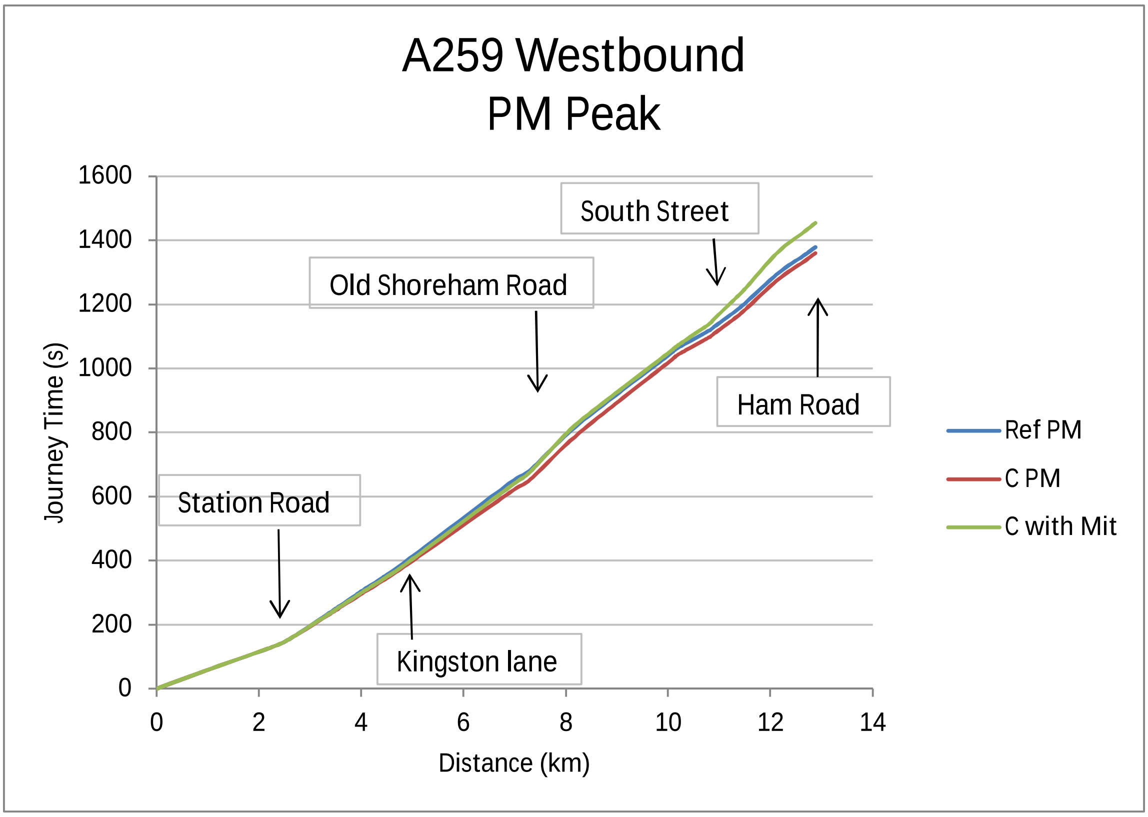


Route 7 - A259 Westbound PM Peak



Appendix F

GLOSSARY OF TERMS

Appendix F – Glossary of Terms

General Terms

The Passenger Car Unit (PCU) is a means of standardising traffic flow that considers the impact a mode of transport has compared to a single car. Larger vehicles such as buses and heavy goods vehicles are assigned multiple PCUs to reflect their increased length and so additional space required when using the highway network.

Actual flow is the number of vehicles observed passing through a junction or other given point in a network within the modelled period. Any vehicles heading to that point, but unable to complete the counted movement within the modelled period due to congestion or queuing upstream or at the junction itself are not counted in the actual flow.

Demand flow wanting to pass through a junction or other given point in a network within the modelled period. It can be equal to or higher than the actual flow depending on congestion within the network. If the network is free flowing, with no queuing, the demand flow will be equal to the actual flow. If congestion exists in the network that has delayed one or more vehicles upstream of the observation point, the demand flow will be higher.

Saturation flow is an expression of the volume of traffic (often expressed in PCU) that could be expected to pass a stop line (or observation point in the network) in normal free flowing conditions with no opposing traffic.

Capacity is the volume of traffic that can pass a stop line within the allocated green time (at traffic signal controlled junctions) or can enter a roundabout in the gaps left by circulating traffic during a given period.

Modal shift is an assessment of whether people travelling on one mode of transport (such as private cars, buses, cycling etc.) would change to an alternative mode in response to changes in the cost and journey time of one (or more) mode compared to the others available. Estimating the patronage of a new transport option, perhaps following the introduction of a new bus service, also relies on mode shift calculations when assessing the likelihood of travellers to switch onto it.

ARCADY Modelling

ARCADY is a piece of junction modelling software for estimating the capacity of give-way controlled roundabouts. The capacity of each entry to the circulatory is estimated from the geometric layout of the junction, based on academic research into driving behaviour at roundabouts. The expected vehicle demand is also entered and compared by the software to the calculated capacity of each entry.

The performance results are calculated for each time interval, usually 15 minute periods, with the highest values from the modelled hour reported. The main performance statistics reported are the ratio of flow to capacity (RFC), the average queue and delay per vehicle.

- Max RFC (ratio of flow to capacity). The RFC is the ratio of traffic flow to the calculated capacity of each entry to the roundabout. The normal practical maximum RFC value is 0.85, above which there is an increased risk of excessive queues and delays. The maximum RFC from each set of six results was recorded;
- Max Average Queues (PCUs). A predicted value for the expected queue length. The highest average queue from each of the modelled time intervals is recorded for each arm of the junction.

Furnessing

The Furness balancing technique is used when a travel demand matrix is to be factored to meet target row and column totals. In the context of this study, the targets are the forecasted total number of trips departing from or arriving at individual zones. These include existing traffic as well as new development-generated traffic. With Furness a factor is applied to match row totals, then the variation against column targets is used to apply a factor to match those. This continues in a sequential process until both the row and column totals match the targets.

LinSig Modelling

LinSig is a piece of junction modelling software for estimating the capacity of traffic signal controlled junctions. The capacity of each lane of all modelled stop lines can be entered directly from survey data or estimated from the geometric layout. Traffic signal set-up information such as the phases, staging, intergreens, phase delays etc. is entered for use in calculating the capacity of each stop line over the modelled period. The expected vehicle demand is also entered and compared by the software to the calculated capacity of each entry.

The performance results are calculated for the whole modelled period, usually an hour, with the reported results representing the average for the whole period. The main performance statistics reported are:

- Degree of saturation (DoS). This is the ratio of the arriving traffic flow on a given link to the link's capacity, usually expressed as a percentage. A DoS value of 100% indicates that the demand flow exactly matches the capacity and no additional traffic could be accommodated. A DoS value of over 100% indicates that the link is over-saturated, and queues and delays will increase with time. In practice, a DoS value of 90% is normally used as the 'practical' upper threshold because, above this value, there is a higher risk of excessive queues and delays, mainly due to random fluctuations in vehicle arrival rates;
- Mean maximum queues (MMQs) in PCUs. The mean maximum queue is the average, over the modelled hour, of the maximum number of vehicles within a discharging queue, when the rearmost vehicle begins to move away. At high degrees of saturation, actual maximum queues on site, could be significantly longer than the average values predicted by LinSig (particularly later in the period);

- Average delay per PCU (in seconds). LinSig calculates an average value for the modelled hour. At high degrees of saturation, LinSig may significantly underestimate the actual maximum delays which could be experienced;
- Practical reserve capacity (PRC) is an indication of the potential spare capacity of a junction. The PRC value is the percentage change in traffic required to return the busiest stop line within the junction to 90% DoS. A positive PRC value indicates spare capacity, a value of zero no spare capacity and a negative value indicates that the junction has insufficient capacity. The PRC will be zero if the maximum DoS value on any of the links is 90%.

OmniTRANS Modelling

OmniTRANS is a transport modelling software platform allowing the integration of multiple transport modes (such as bus routes, rail services, walking and cycling) and a mode choice model into the assignment process. For this study, a mode choice model has been used to determine the shift of demand between car and public transport trips to estimate the likely level of future demand on the highway network in the study area.

SATURN Modelling

SATURN is a traffic modelling software platform focused on highway network assignment models. The highway travel demand from the OmniTRANS mode choice model was passed to SATURN to assess the likely route choice for each trip and the cumulative effect of all trips on traffic flow volumes, journey times, link and junction delays, total vehicle kilometres etc.

The highway assignment model in SATURN reports the V/C ratio for each modelled link and all allowed turns at the modelled junctions. This compares the traffic volume assigned to each link or turn (V) with the calculated capacity for that movement (C) and is similar to the RFC and DoS used in junction models.

TRANSYT Modelling

TRANSYT is also a piece of junction modelling software used for the assessment of capacity at traffic signal controlled junctions. It is produced by a rival software company to LinSig and is based on the same principles and research, producing directly comparable results.

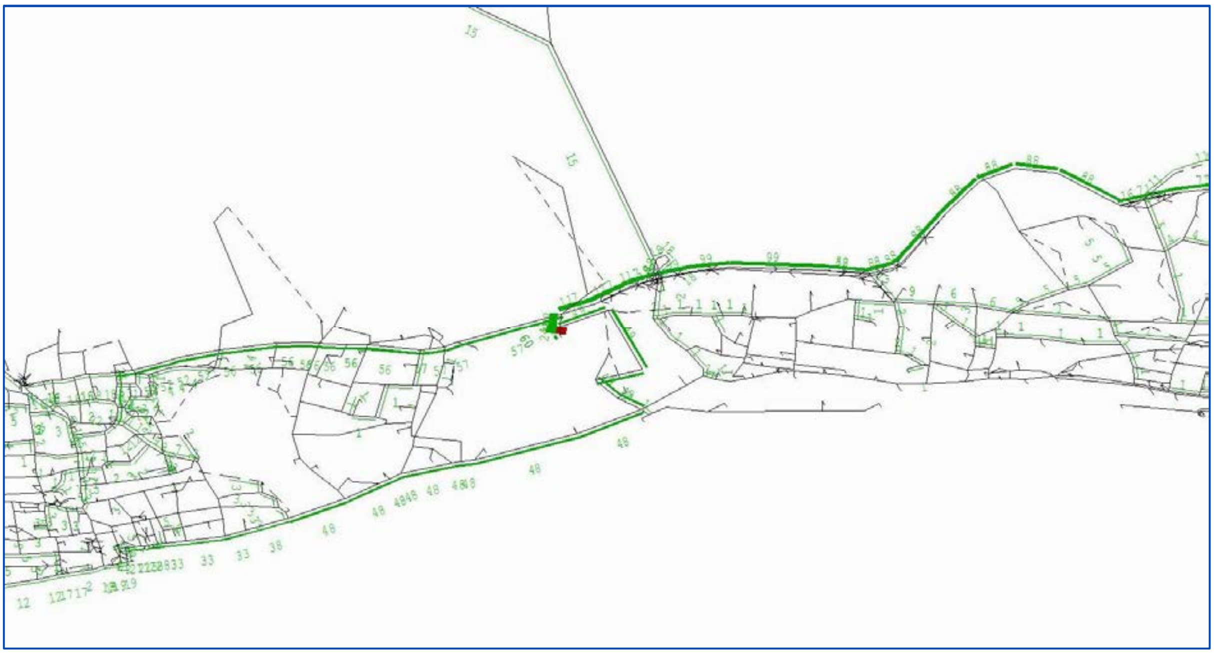
Appendix G

SELECT LINK PLOTS FOR SITE ALLOCATIONS

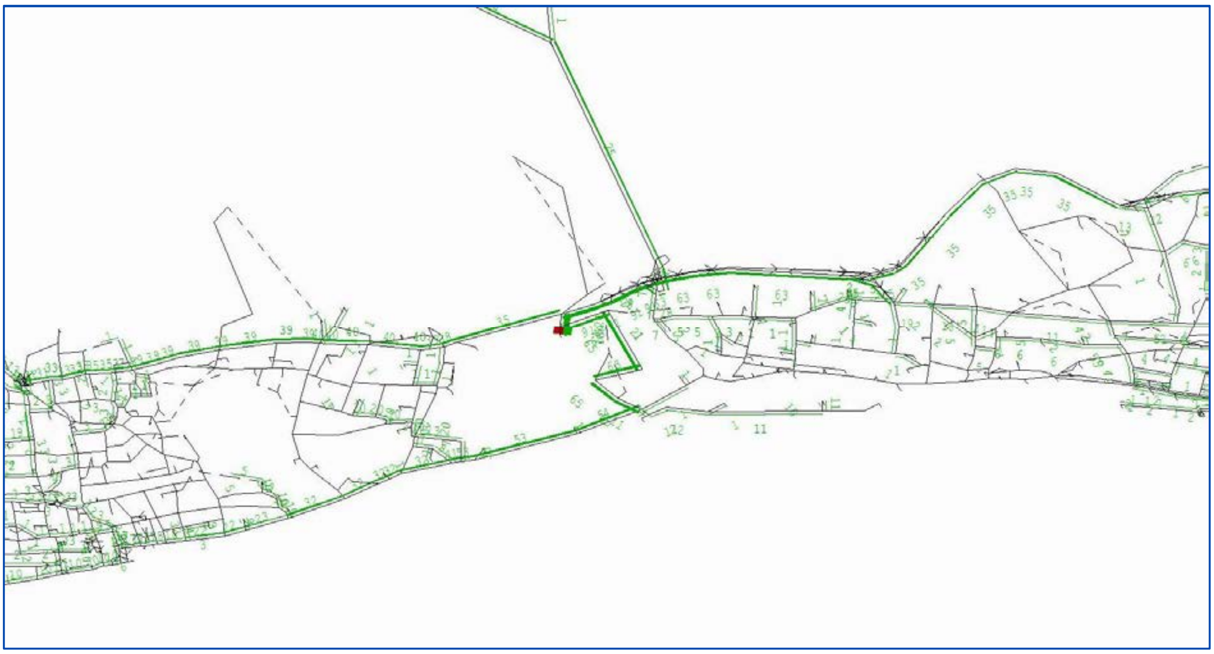
KEY

- The numbers on each plot relate to the number of vehicle trips to or from a specific development named in individual plots.
- The thickness of the green band next to each road increases as the volume of traffic on that road becomes greater.
- Red marks on each plot represent the key access / egress links relating to a specific development.

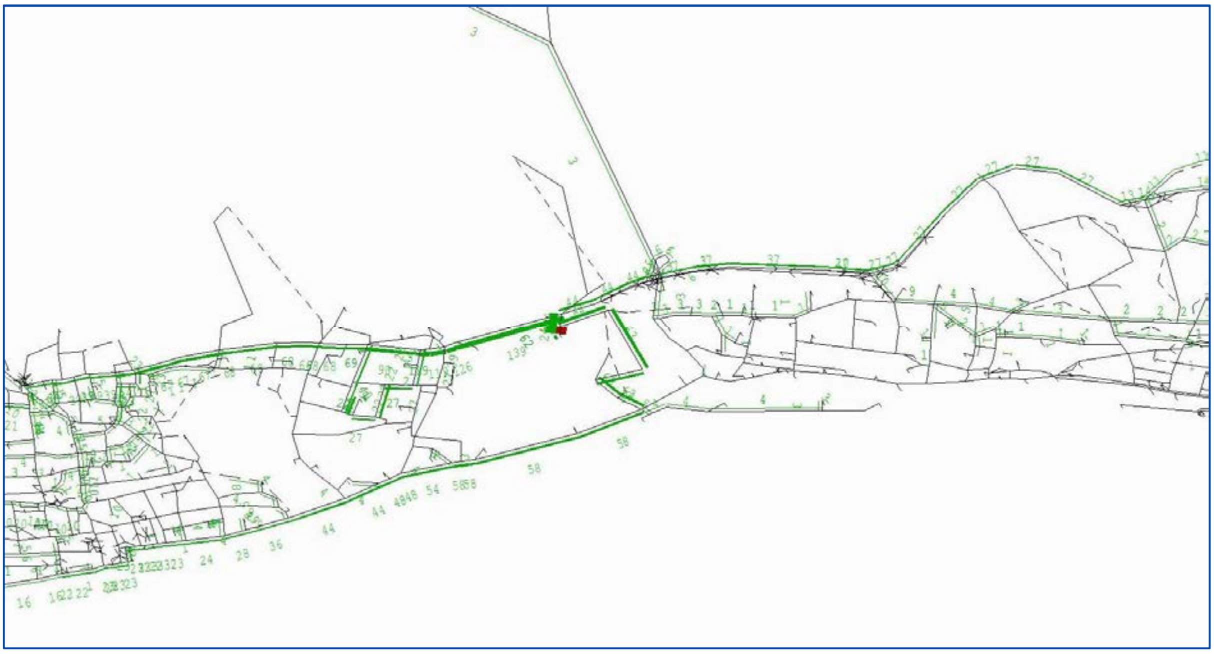
Trips from New Monks Farm, Scenario C AM



Trips to New Monks Farm, Scenario C AM

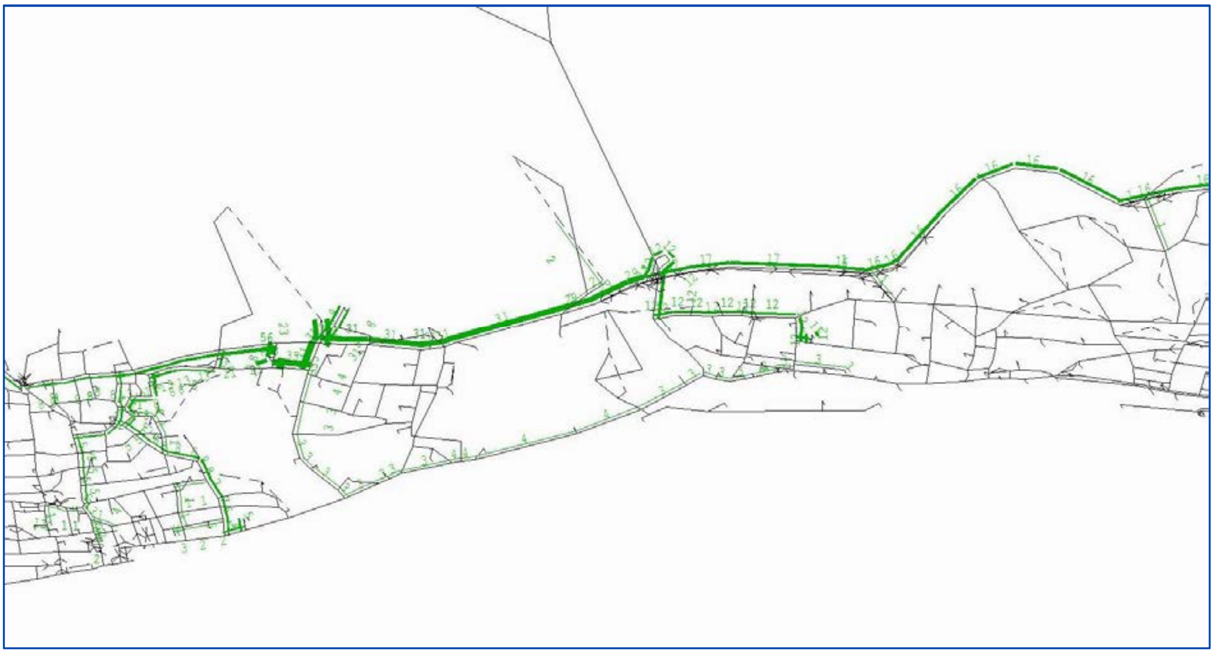


Trips from New Monks Farm, Scenario C PM



Trips to New Monks Farm, Scenario C PM

Trips from Sompting North, Scenario C AM

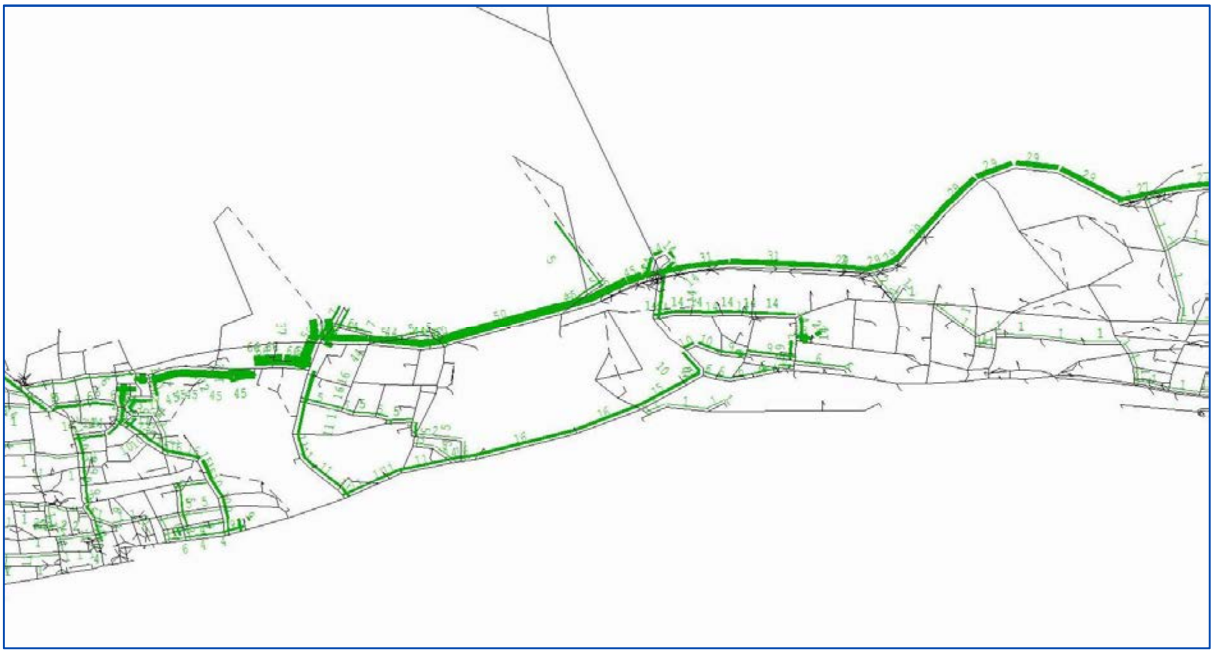


Trips to Sompting North, Scenario C AM

Trips from Sompting North, Scenario C PM

Trips to Sompting North, Scenario C PM

Trips from West Sompting, Scenario C AM



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Trips from West Sompting, Scenario C PM

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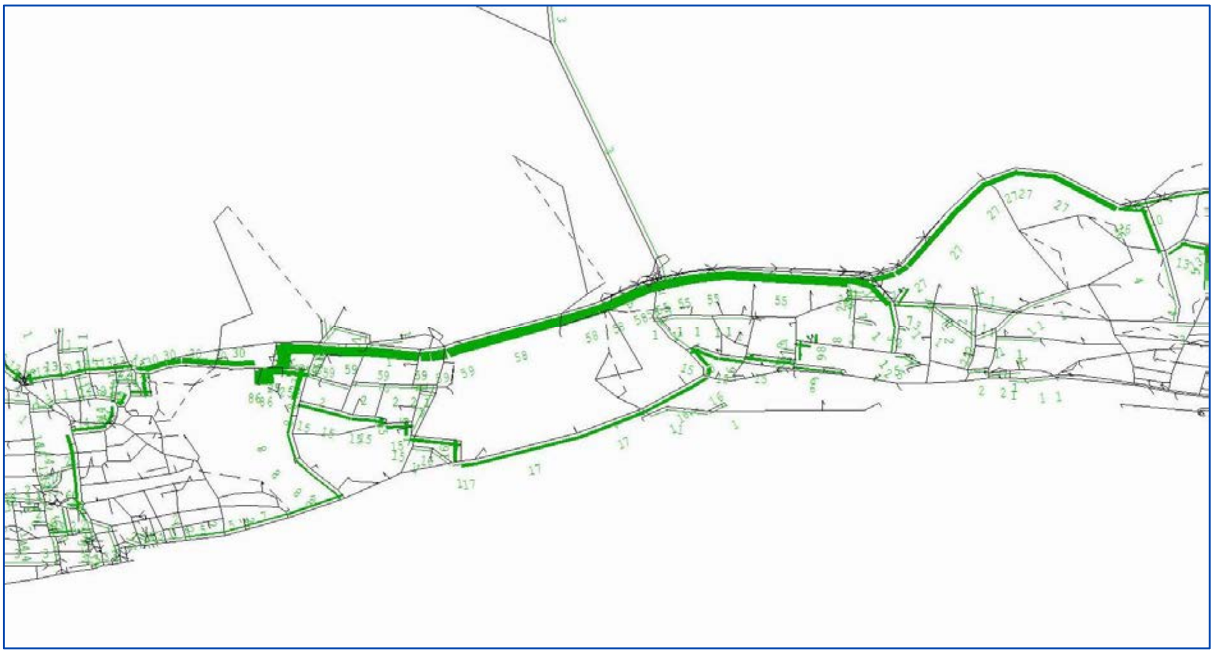

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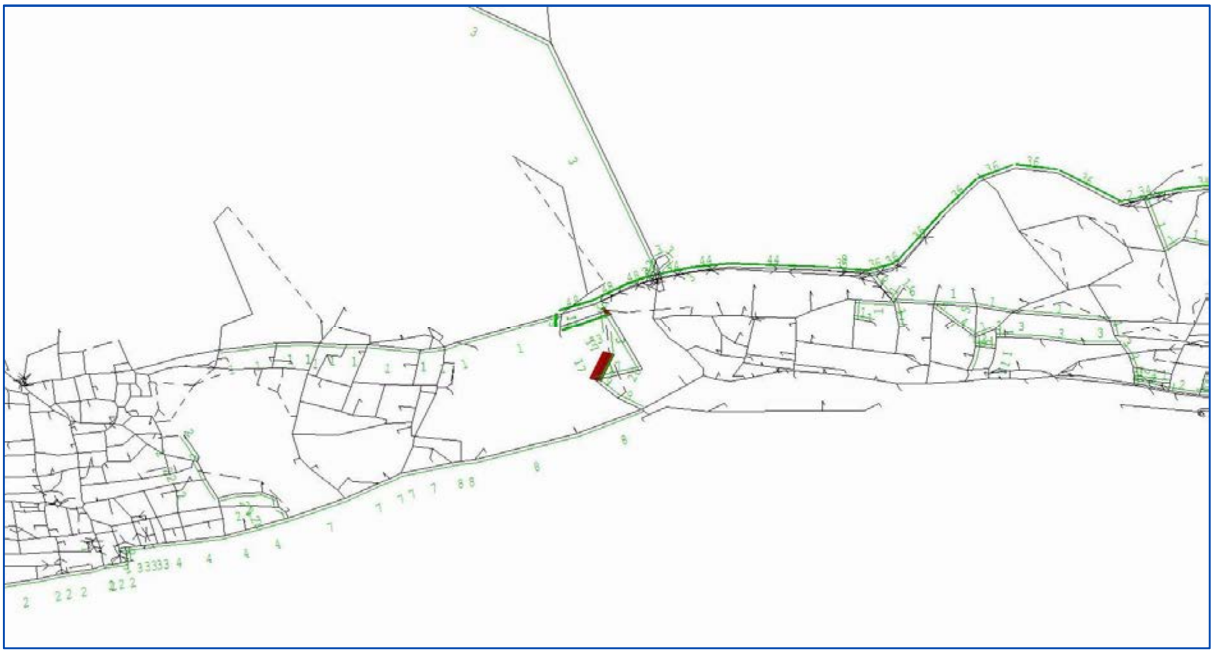

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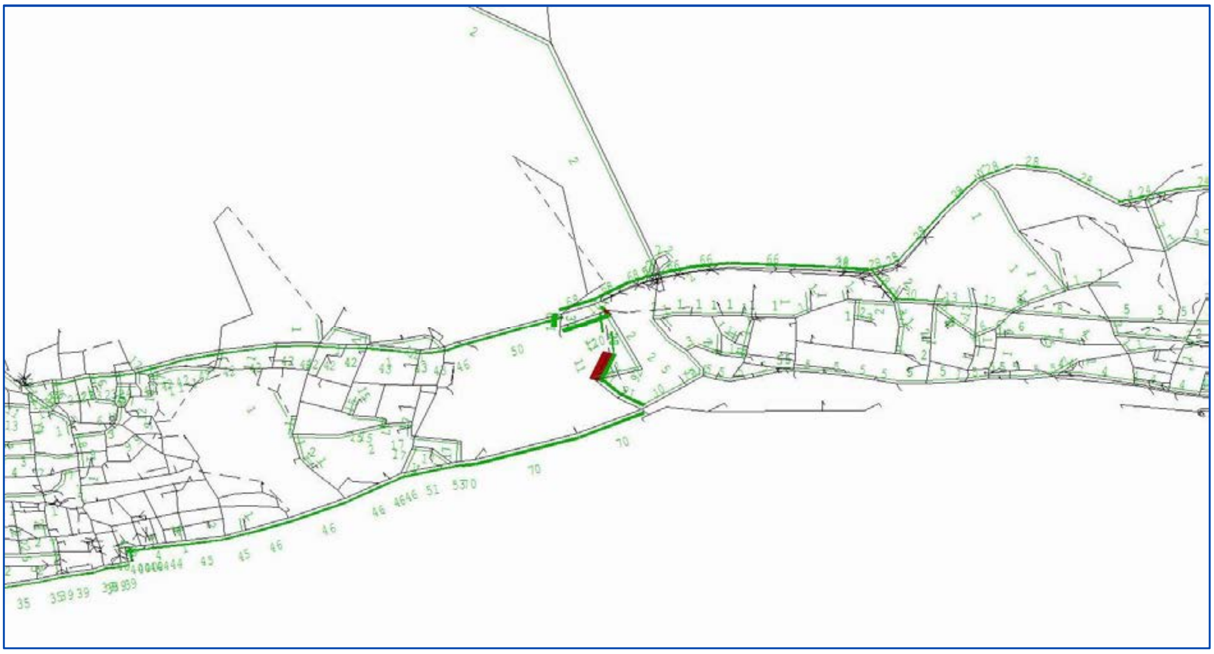
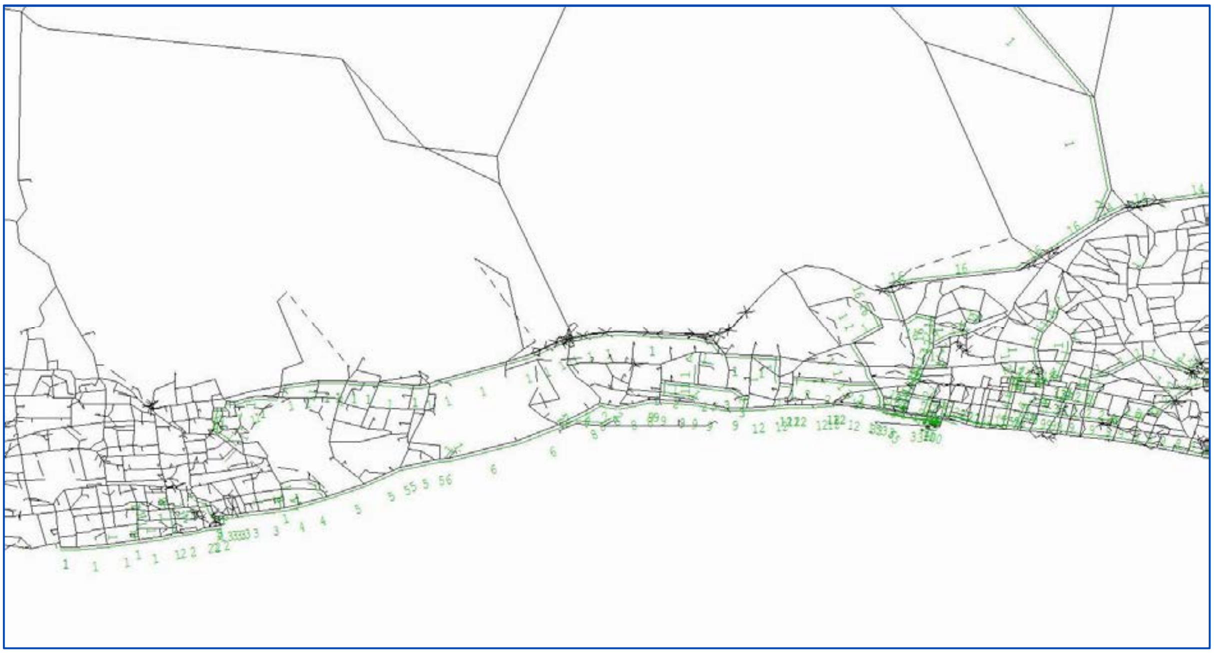
Trips from Shoreham Airport, Scenario C PM



Trips to Shoreham Airport, Scenario C PM

Trips from Aldrington Basin, Scenario C AM



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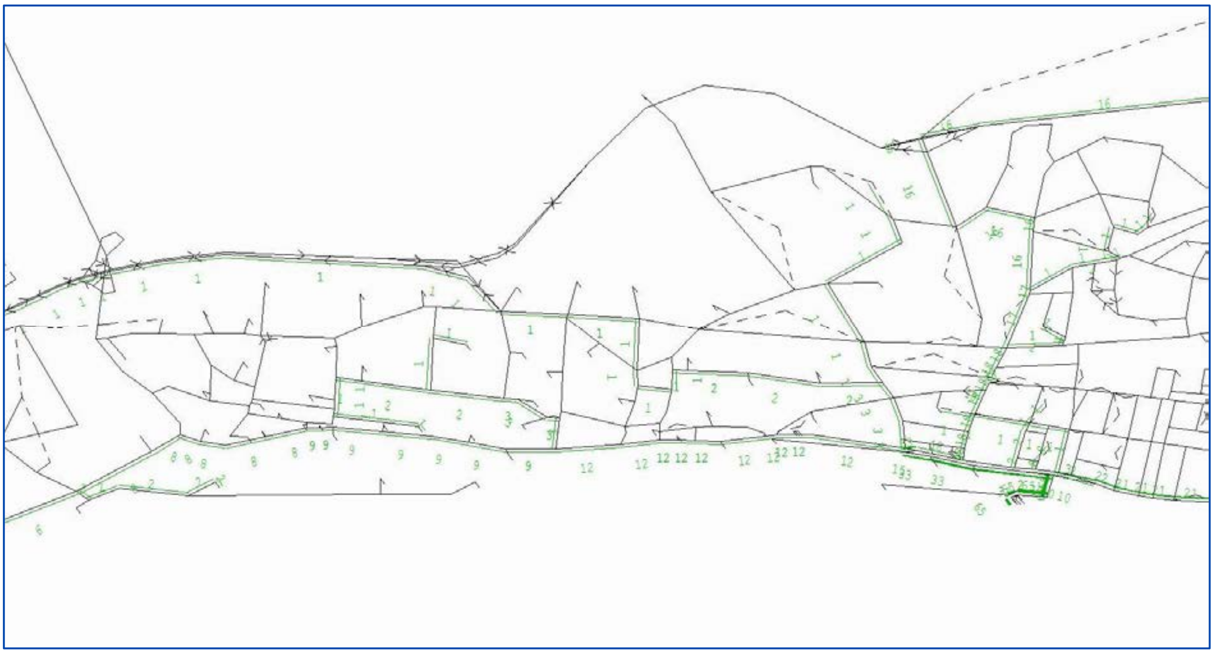

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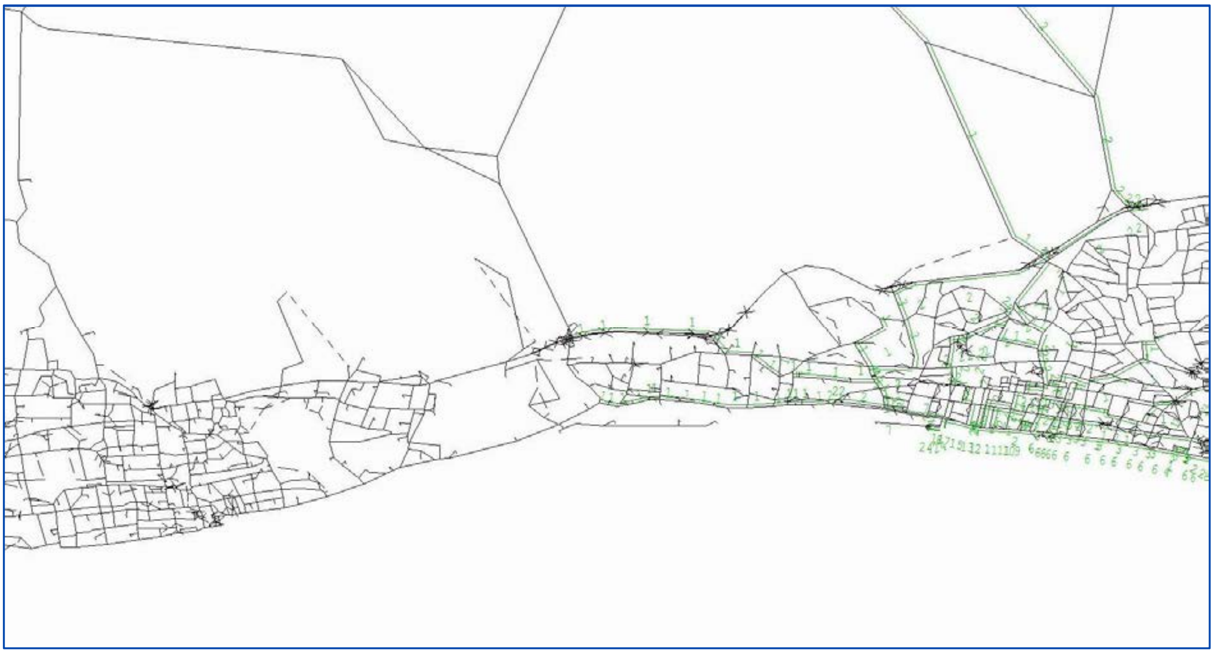

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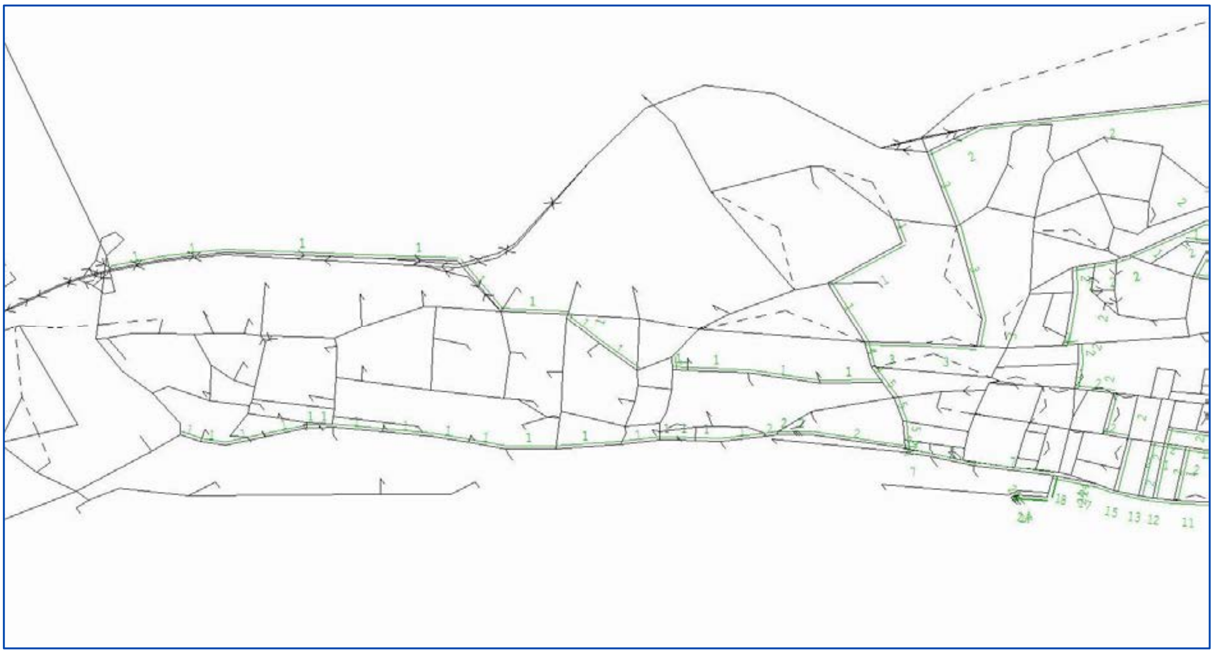
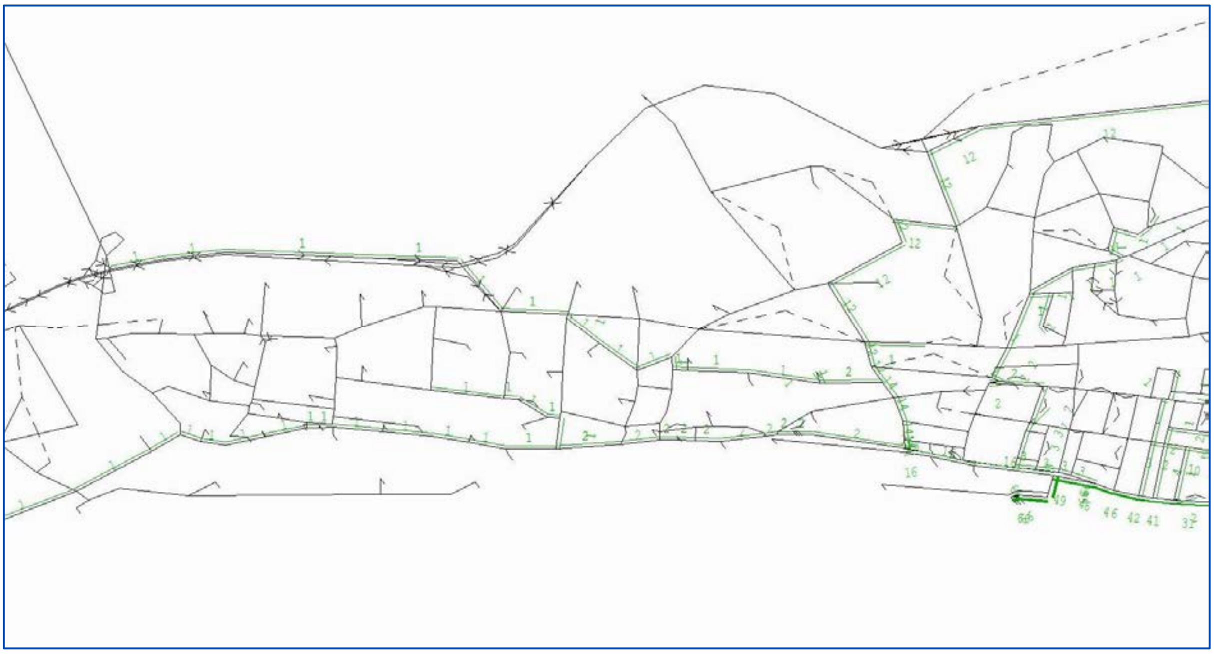


Trips from Aldrington Basin, Scenario C PM

Trips from Aldrington Basin, Scenario C PM

Trips to Aldrington Basin, Scenario C PM

Trips to Aldrington Basin, Scenario C PM



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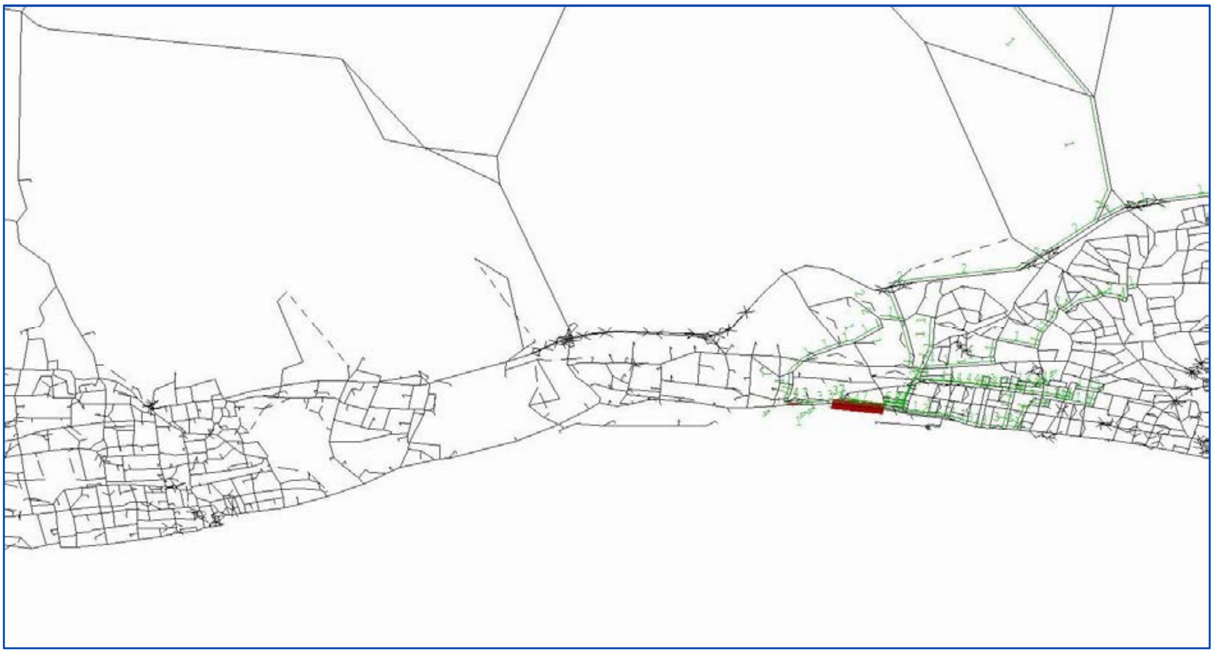

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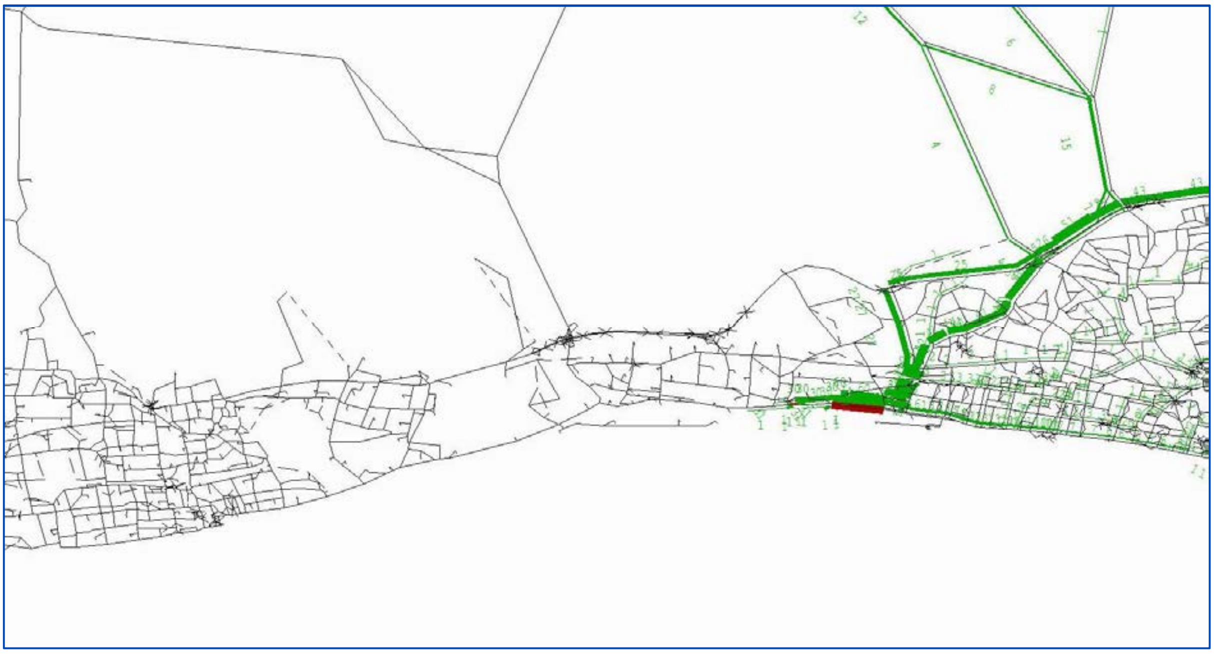
Trips to Southwick Waterfront, Scenario C AM

Trips to Southwick Waterfront, Scenario C AM

Trips from Southwick Waterfront, Scenario C PM



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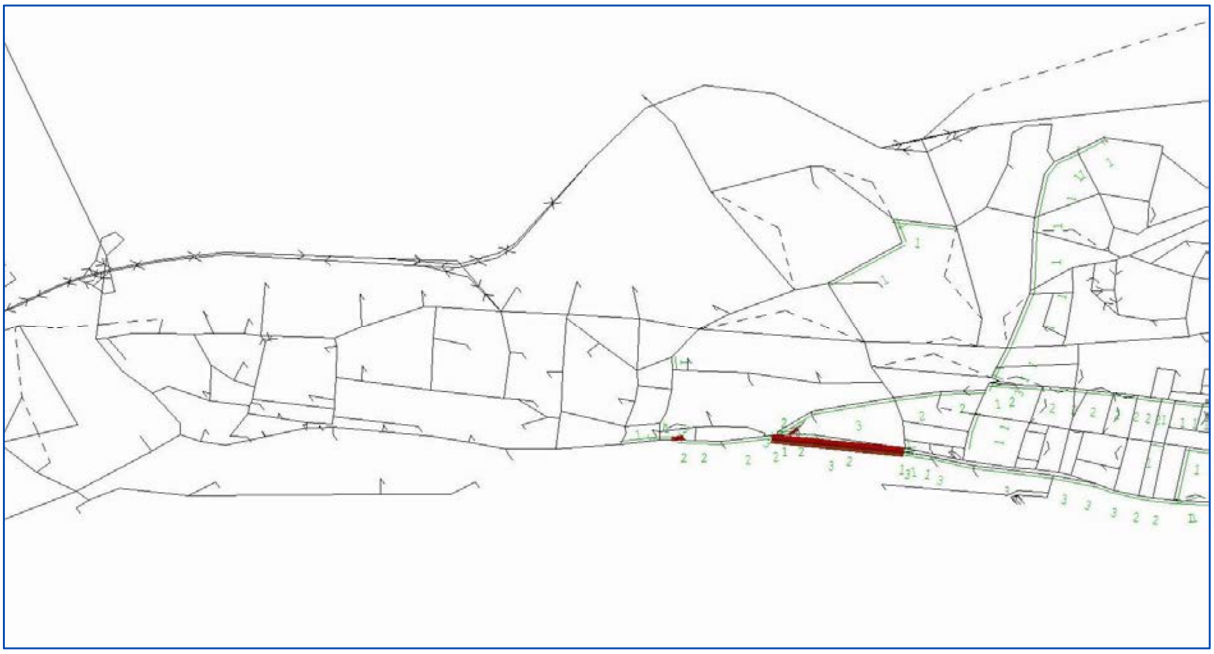
Trips to Southwick Waterfront, Scenario C PM

Trips to Southwick Waterfront, Scenario C PM

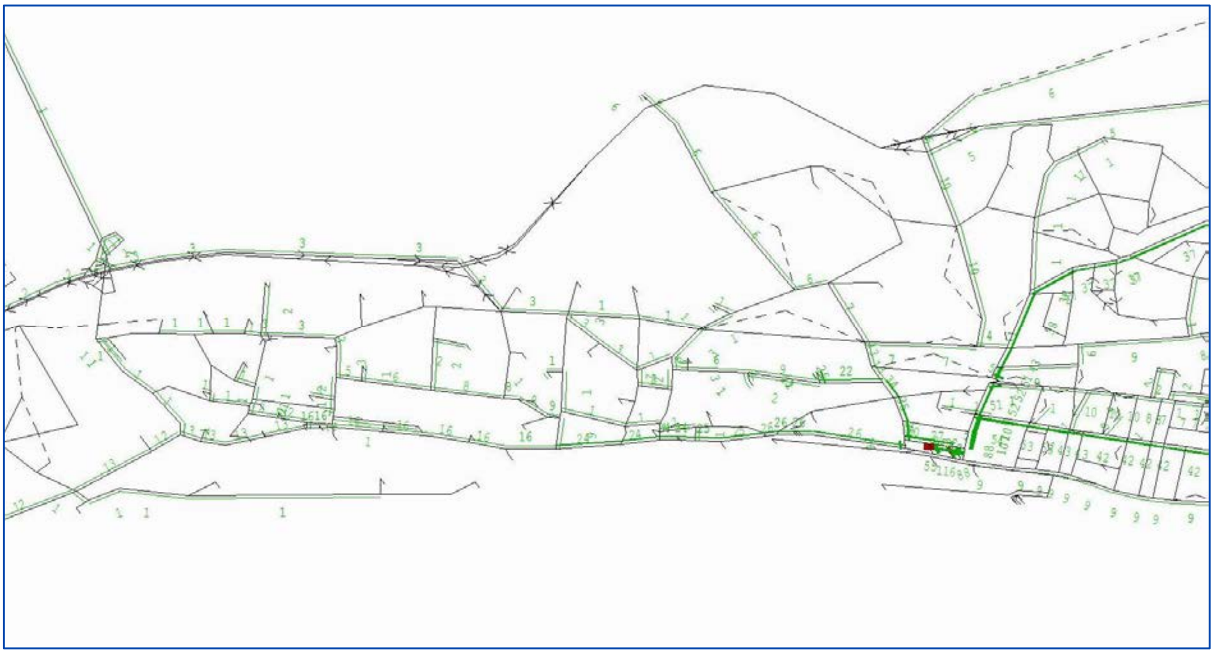


Trips from South Portslade, Scenario C AM

Trips from South Portslade, Scenario C AM

Trips to South Portslade, Scenario C AM

Trips to South Portslade, Scenario C AM



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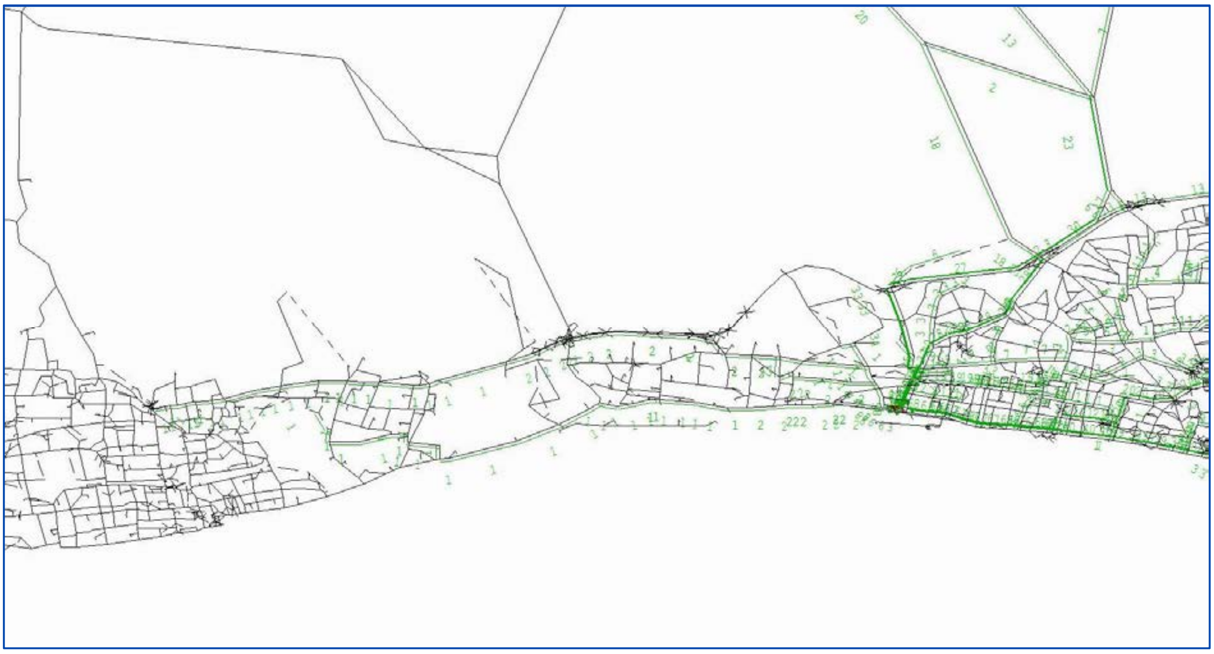

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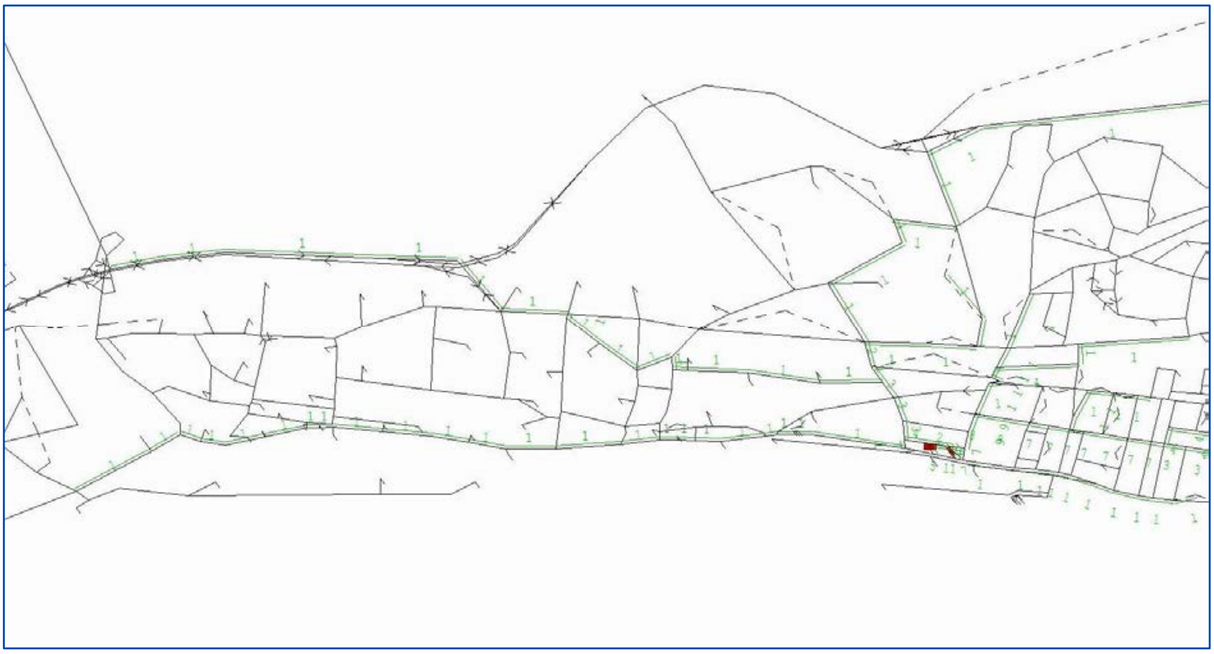
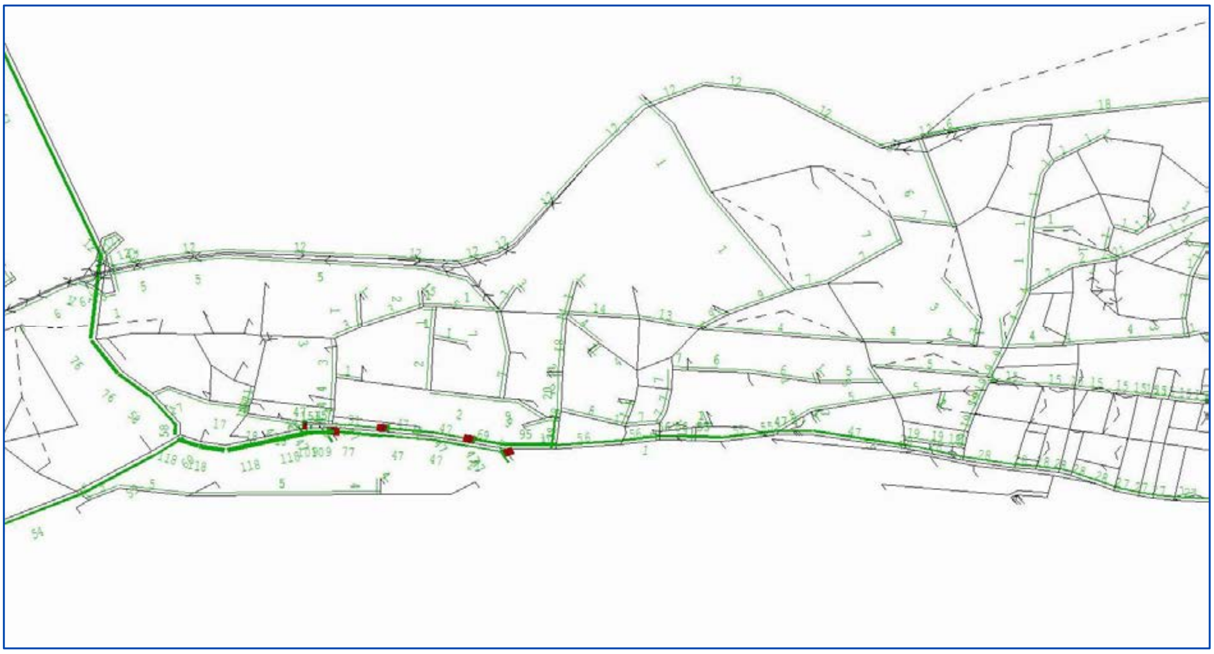


Trips from Western Harbour Arm, Scenario C AM

Trips from Western Harbour Arm, Scenario C AM



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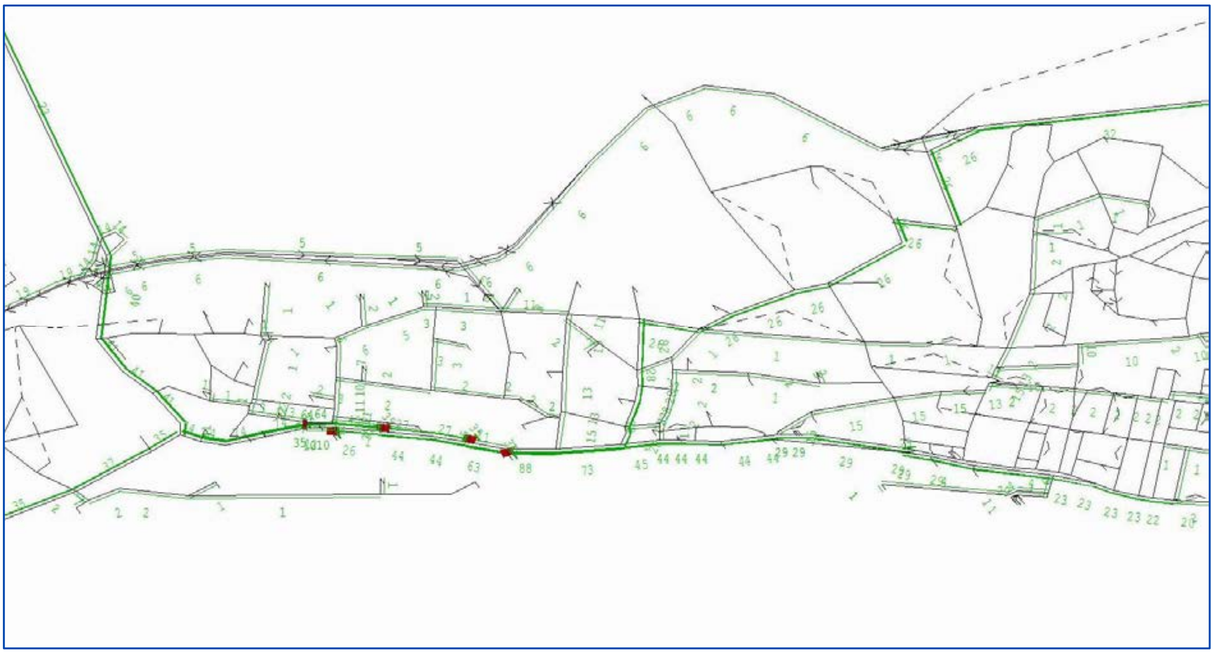
Trips to Western Harbour Arm, Scenario C AM



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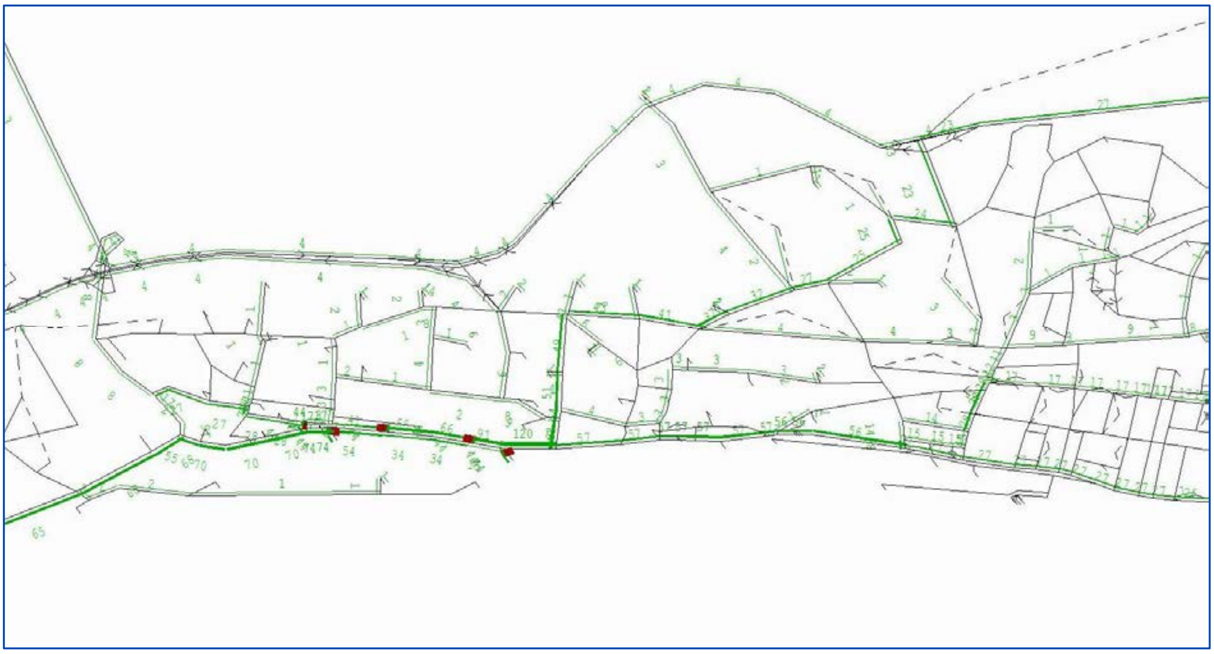
Trips from Western Harbour Arm, Scenario C PM



Trips to Western Harbour Arm, Scenario C PM

Trips to Western Harbour Arm, Scenario C PM