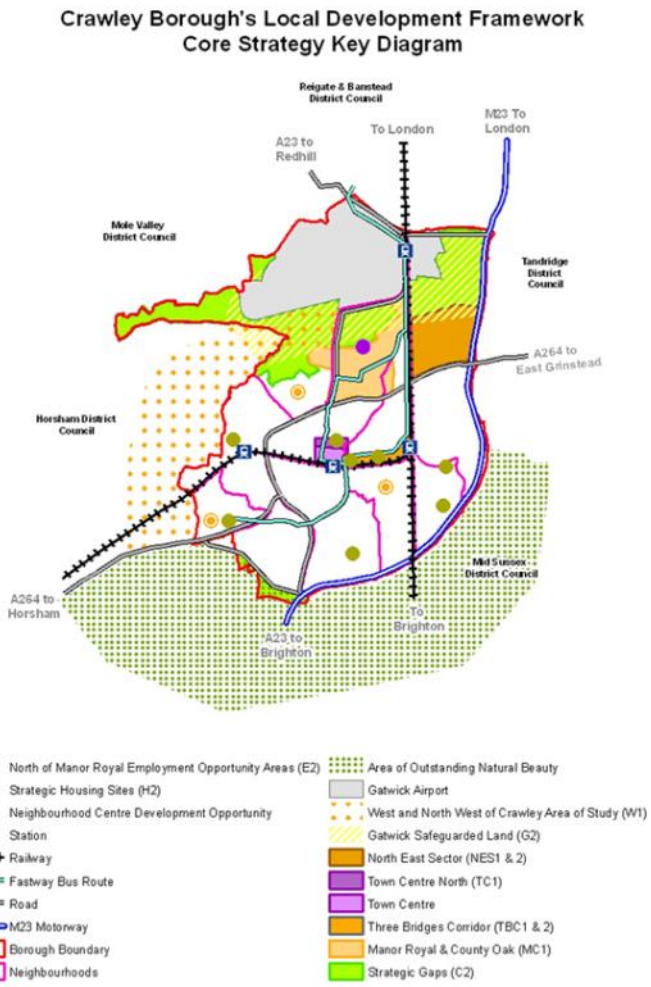
Crawley Borough Council
Local Plan Transport Strategy

LPTS Stage-1 Interim Report

Document reference: CBCLPTS01

Revision: 2

Issued: 20th August 2012



Document Control Sheet

Project Name:	Crawley Local Plan Transport Strategy
Project Number:	CO03022434
Document / Report Title:	LPTS Stage-1 Interim Report
Document / Report Number:	CBCLPTS01

Issue Status/Amendment	Prepared	Reviewed	Approved
Issue 01	Name: Tim Lynn Signature: Date: 20.08.12	Name: (print) Signature: Date:	Name: (print) Signature: Date:
(Enter Details of Amendment)	Name: (print) Signature: Date:	Name: (print) Signature: Date:	Name: (print) Signature: Date:
(Enter Details of Amendment)	Name: (print) Signature: Date:	Name: (print) Signature: Date:	Name: (print) Signature: Date:
(Enter Details of Amendment)	Name: (print) Signature: Date:	Name: (print) Signature: Date:	Name: (print) Signature: Date:

Executive Summary

Stage 1 of the Local Plan Transport Strategy has examined the implications of three land use development options in Crawley Borough and compared them with a baseline situation. We have used the West Sussex County Transport Model to assess the transport impacts at a coarse, strategic, level, at AM peak 2029. Impacts have been considered for car and public transport modes.

Development scenarios have been differentiated by changing the housing and employment assumptions in the National Trip End Model, for Crawley and, thereby, varying the trip movement forecasts, using TEMPRO. Trip patterns have not been calculated at a detailed site-specific level. The respective stage-1 development options 1-3 represented a significant proportionate increase in planning allocations within Crawley, compared with the baseline situation, from 2006 to 2029.

We have checked the validity of the multi-modal SATURN / CUBE strategic model within Crawley and found it to be not very accurate. Nevertheless it was used, rather than the local model, because it offered the most reliable means of assessing development impacts at a county-wide level. We consider that the Crawley Town Centre Model should be used for stage-2 of the study, when it will be more important to test and understand localised outcomes within Crawley.

The stage-1 model assignments have been made using a future year 'do-minimum' highway and public transport network, which excludes any impact mitigation schemes.

At a county level, there would be minimal difference in the impact of the various stage-1 forecast scenarios, relative to the baseline, in terms of trip volume, journey distance, travel time and proportion of trips uncompleted. There would be a substantial increase in queuing delay in all options.

We have assessed option impacts at a more local level in Crawley. Total highway trips would increase by 14%, 15% and 16% with options 1, 2 and 3, respectively. Uncompleted trips that remain stuck in congestion after the AM peak hour would increase by 178%, 188% and 196% in options 1, 2 and 3, respectively, compared with the baseline, amounting to upwards of 5,000 trips. Likewise, queuing delay would rise considerably by 339%, 344% and 361% in options 1, 2 and 3.

Link flow changes of more than +/- 10%, relative to the baseline, were predicted to arise in Crawley as follows:

- Option 1: 12 links with increase; 7 links with decrease;
- Option 2: 13 links with increase; 4 links with decrease;
- Option 3: 14 links with increase; 4 links with decrease.

We also examined link and junction Ratios of Flow to Capacity. In respect of road links with RFC of more than 95%, in Crawley, the following pattern emerged:

- Baseline: 1 link;
- Option 1: 3 links;
- Option 2: 3 links;
- Option 3: 3 links.

This suggests that there would be no difference between options in terms of heavily congested road links.

With regard to road junctions in Crawley, with RFC greater than 100% on the busiest approach, findings were as follows:

- Baseline: 6 junctions;
- Option 1: 5 junctions;
- Option 2: 8 junctions;
- Option 3: 8 junctions.

Results suggest that option 1 would have a less detrimental impact in Crawley, than either of options 2 or 3. Across the wider modelled area, there are 11 junctions where RFC would exceed 100% at AM 2029 in the baseline and in all development options 1-3. There are two junctions where RFC would fall just below 100% in the baseline, but exceed 100% with all options.

No traffic increases of more than 250 vehicles AADT were predicted to occur on A22, A275, A26 or B2110, through Ashdown Forest, with any of the development options, indicating that air quality in the Special Area of Conservation would not be adversely affected.

Stage-1 outcomes indicate that the strategic development options for Crawley would have a similar, adverse, impact upon wider-area highway network performance at AM peak 2029. However, many of the congestion problems would also be present in the baseline. On the Crawley network, Option 1 would entail fewer congestion and queuing delay problems, relative to the baseline, than either of options 2 or 3, as measured in terms of: trip volume increase; uncompleted trips; queuing delay; link flow change; and junction RFC exceeding 100%.

The stage-1 travel demand predictions are an underestimate of likely traffic volumes, when compared with the potential stage-2 trip rate forecasts, at a site-specific level. Therefore, it may be prudent to restrict the strategic development allocations in Crawley to at, or below, the magnitude envisaged for option 1.

Contents

Appendix F

Junction Average Delay on Busiest Approach

Appendix G

Junction Average Delay Differences from Baseline on Busiest Approach

Appendix H

Impact of Strategic Plan Scenarios on Ashdown Forest

Appendix I

Highway Network Links and Junctions for Analysis (Figures 2 and 3)

List of Figures

List of Tables

1. Introduction

1.1. Overview

1.1.1. Crawley Borough Council (CBC), in 2012, aimed to determine an optimum land use development strategy for their draft Local Plan. Amey was commissioned to assess the transport implications of various development options and to recommend a preferred strategy. The preferred selection was to be based on achieving the least impact with the most acceptable strategy of transport interventions as mitigation. West Sussex County Council (WSCC) provided technical advice to CBC on the transport appraisal aspects of the study.

1.1.2. In scope, the project required a multi-modal transport model to appraise the impacts of development and test the performance of the highway and public transport systems, with and without remedial schemes. Two models were available for application in the study, namely the West Sussex County Transport Model (WSCTM) and the Crawley Town Centre Model (CTCM).

1.1.3. Both of these models comprise a SATURN highway component, interfaced with a CUBE bus and rail component and linked via a mode and trip destination choice model. The models operate by loading a 'matrix' of trip movements, differentiated by highway and public transport (PT) modes and trip purposes, on to the respective transport networks. It then determines choice of routes, modes and destinations according to the cost of travel for each zone to zone journey.

1.1.4. Assessments were produced for the weekday AM peak situation at forecast year 2029. The commission comprised two stages. Stage-1 is a broad appraisal of the scale of housing and employment that could be accommodated within Crawley Borough, given the likely transport facilities available at 2029. Stage-2, to be undertaken in due course, is a more detailed tailoring of site-specific development, under the most favourable strategies determined from stage-1 and taking into account remedial interventions.

1.1.5. This is an interim report of the findings from stage-1 of the Crawley study. Stage-1 consisted of a baseline demand scenario, together with three alternative development options (1 – 3), all of which were tested using a transport network with only committed interventions in place and no remedial, impact mitigation, schemes.

1.2. Approach

1.2.1. Here, we give an outline of the approach used to undertake stage-1 of the Crawley study.

1.2.2. The focus of the study is Crawley Borough. The Borough boundary is shown in Figure 1.

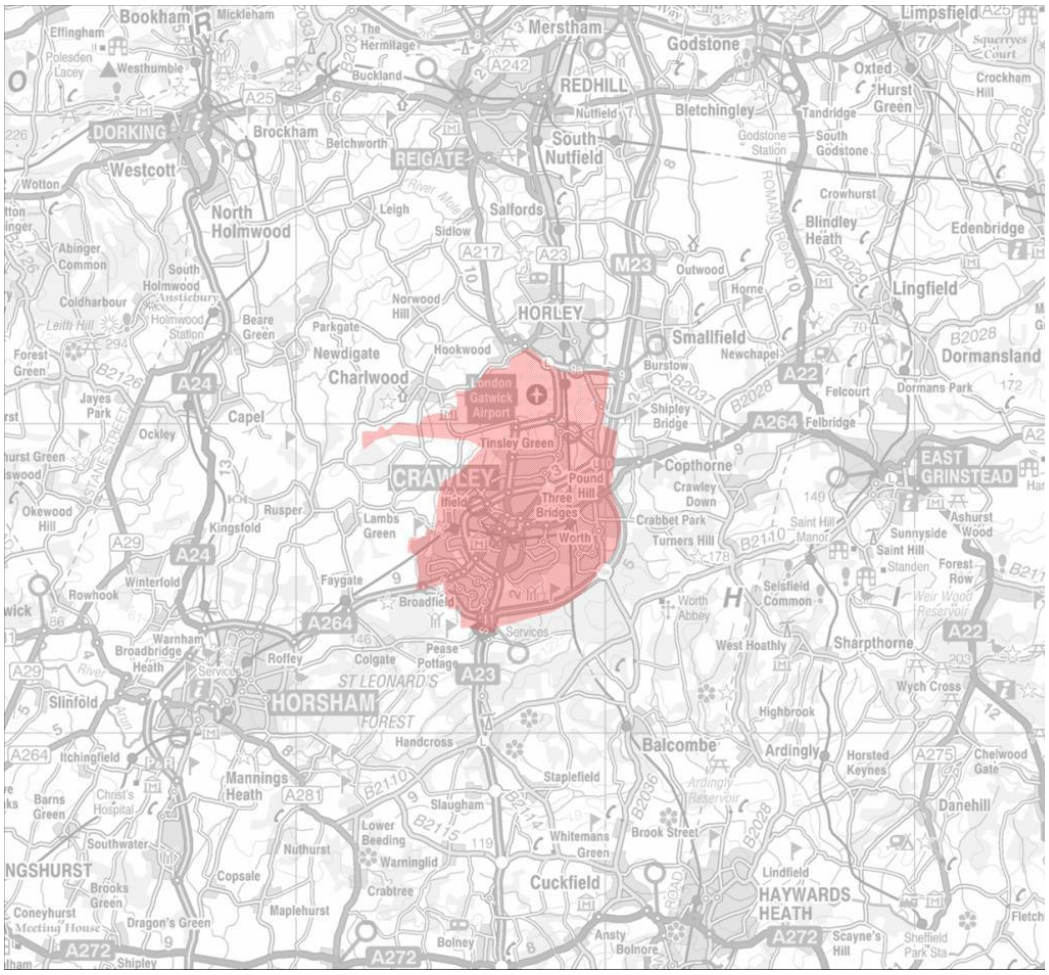


Figure 1: Crawley Borough Boundary

1.2.3. For the purpose of transport assessment, the county model (WSCTM), rather than the town model (CTCM), was judged to be the best tool for stage-1 of the study, because:

- It would provide a more reliable picture of how the strategic development options in Crawley would impact upon the wider area transport network, outside Crawley;
- The coarseness of the model network and zoning in WSCTM is commensurate with the coarse specification of the stage-1 development options (i.e. the specified housing and employment in options 1 – 3 would be spread evenly across Crawley Borough and not allocated to specific sites).

1.2.4. It was considered that CTCM should be used for stage-2 of the study, when it would be more important to test and understand localised outcomes within Crawley.

1.2.5. The WSCTM had previously been assembled to give an accurate validation against observed travel patterns, at 2008 AM peak, across the county. Further tests were carried out on the WSCTM 2008 base year model, for stage-1, to determine its accuracy and reliability for representing travel patterns within and around Crawley. Outcomes are described below.

1.2.6. Model scenarios for stage-1, at AM peak 2029, were defined as broad allocations of Borough-wide development, in the form of additional households and jobs, spread evenly across model zones. Trip growth associated with each development scenario was calculated using district-level data from the National Trip End Model (NTEM version 6.2) and TEMPRO version 6.2 software. Growth factors were then applied to all model zones representing the NTEM 'Crawley Main' district. Derivation of trip growth factors is discussed further below.

1.2.7. There are 16 trip origin / destination (O-D) zones in the WSCTM, which constitute the Crawley Main district (i.e. the Borough) in NTEM.

1.2.8. Multi-modal model assignments were undertaken for each development scenario and outcomes analysed in terms of scenario impact upon network performance. Findings are summarised in this report.

1.3. Accuracy of the WSCTM

1.3.1. Checks were made to determine if the strategic transport model was suitable for predicting development impacts in Crawley.

1.3.2. Reliability of the WSCTM highway element, within Crawley, was checked by comparing modelled traffic flows with observed flows from the most recent CTCM base model report (PBA LMVR Update August 2008). To do this, observed and modelled flows were extracted, across the following Crawley route sections:

- Outer cordon – roughly, lying outside the A264 / M23 route on the south and east sides and lying around the edge of the urban area on the west and north sides (south of Gatwick airport);
- Inner cordon – roughly, lying inside the A23 / A2011 route on the west and north sides and lying north of Tilgate Park and east of the railway on the south and east sides;
- North-south screen-line – roughly cutting all north / south routes accessing Crawley, in an arc around the north of the town, between Faygate Lane in the west and M23 in the east.

1.3.3. Matrix estimation (ME) was also used in SATURN, to improve the match between all available observed counts and modelled flows, with the following conditions:

- ME has only been applied to non-strategic zone movements, within, to and from, Crawley;
- ME has been constrained to a low adjustment factor, to prevent large changes to individual zone trip ends.

1.3.4. We checked the accuracy of the traffic flow validation after ME, using a Department for Transport (DfT) target of 85% of links with a 'GEH' value less than 5.0 as the main criterion, with the following results:

- Crossing the outer cordon, both ways – 68% links have GEH <5.0 (target 85%);

- Crossing the inner cordon, both ways – 56% links have GEH <5.0 (target 85%);
- Crossing the north / south screen-line, both ways – 50% of links have GEH <5.0 (target 85%);
- All cordons and screen-lines together – 60% of links have GEH <5.0 (target 85%);
- All wider-area West Sussex county model screen-lines together – 78% of links have GEH <5.0 (target 85%).

1.3.5. It was clear that the WSCTM traffic flow validation within Crawley was poor, although better than without strategic freezing, with a higher ME factor, or without any ME. The validation across the county, however, remained fairly accurate.

1.3.6. On balance, we decided to use the WSCTM as it stood, after matrix estimation, because it remained reliable outside Crawley and because the poor validation within Crawley would not compromise the stage-1 outcomes, given the coarseness of the development assumptions. It was not feasible to refine further the WSCTM model zones and network, because it would be too onerous to use the CTCM matrices to split the WSCTM zones.

1.3.7. We judged that it would not be worthwhile to try to improve the validation of the WSCTM within Crawley, using selected counts in ME and slight adjustments to network and zone access details, as there would be no certainty of success. Also we did not adopt CTCM for stage-1, despite its superior validation within Crawley, because it was unlikely to provide reliable outcomes across the wider area and it would not give more robust results within Crawley when development allocations were only coarsely defined.

1.3.8. Since the WSCTM validation outside Crawley was reasonably accurate, no changes were made, at stage-1, to improve precision within Crawley.

1.4. Scope of Report

1.4.1. The remainder of the report consists of the following sections. Section 2 describes how the various demand components were assembled for each forecast scenario. Section 3 notes the committed transport interventions that were included in the forecast model and summarises the findings from the model assignments for each demand scenario. Finally, section 4 provides a summary and conclusions from the stage-1 appraisal.

2. Stage 1 Travel Demand Forecasts

2.1. Overview

2.1.1. This section summarises the steps taken to assemble the Stage-1 travel demand forecasts, defined as zone-to-zone origin to destination (O-D) trip movements, for all travel modes combined, at weekday AM peak, 2029.

2.2. Demand Scenarios

2.2.1. There are four demand scenarios that have been compiled for Stage-1, namely:

- Baseline;
- Development Options 1, 2 and 3.

2.2.2. The baseline consists solely of TEMPRO trip growth forecasts, derived from current planning allocations in the NTEM database. Development options 1 – 3 represent revised growth forecasts. These revisions are based on adjustments to the household and job data for Crawley Main district in NTEM, to reflect varying magnitudes of strategic development build.

2.2.3. CBC specified the scope of development options 1 – 3, for the period 2014 to 2029. The scale of development increases with each option, as indicated in Table 1.

Table 1: Strategic Land Use Change in Development Options 1 – 3

	Additional Development Build 2014 to 2029	
Development Option	**Employment Gross Floor Area (sqm)**	**No. Households per annum**
Option 1	145,500	300
Option 2	145,500	400
Option 3	145,500	500

2.2.4. Certain assumptions have been made in order to assemble the demand scenarios, namely:

- NTEM planning data has been adjusted for development options 1 – 3 by removing existing households and jobs and replacing with CBC strategic alternatives;
- CBC specification of employment gross floor area (GFA) has been converted to net internal area (NIA) using a typical ratio of NIA/GFA recorded by Mid Sussex District Council; i.e. 87%;
- The employment NIA values have been converted to an equivalent number of jobs, for inclusion in NTEM, using CBC recorded value of 20sqm NIA per employee;

- Existing NTEM is understood to include strategic development during the period 2006 to 2016, which would be replaced by CBC strategic allocations over the period 2014 to 2029; therefore, to ensure consistency between the baseline and development options, the forecast period has been taken as 2006 to 2029;
- For application of future growth, it is reasonable to assume that WSCTM base year 2008 is equivalent to and has the same traffic patterns as forecast base year 2006;
- Development options 1 – 3 have been assembled to include completed and committed residential and employment allocations, as specified by CBC, in addition to strategic plans;
- The household forecasts in development options 1 – 3 already include strategic plan allocation for Crawley North East Sector, which is also a committed site; therefore reductions are required to the planned households in Table 1, to remove double-counting;
- Allowance has been made for committed land use at Kilnwood Vale (West of Bewbush) in NTEM 'Horsham Rural' district, when assembling development options 1 – 3;

2.3. Demand Forecasting Method

2.3.1. Planning data contained in existing NTEM for Crawley Main and Horsham Rural districts, at 2006 and 2029, together with the unit change that has to be removed for development options 1 – 3, is as shown in Table 2.

Table 2: NTEM 6.2 Existing Planning Forecasts

		2006 Base		2029 Forecast		Unit Change 2006 - 2029			
NTEM District	District Ref	No. Households	No. Jobs	No. Households	No. Jobs	Change in Households	% Change in Households	Change in Jobs	% Change in Jobs
Crawley Main	45UE1	39983	99736	44183	104275	4200	10.5%	4539	4.6%
Rural Horsham	45UF0	12542	16517	14944	17476	2402	19.2%	959	5.8%

2.3.2. It can be seen that the base level of land use in Crawley, in NTEM at 2006, is considerable, amounting to about 40,000 households and 100,000 jobs. The strategic development to be removed from NTEM in order to assemble development options 1 – 3 amounts to about 4,200 households and about 4,550 jobs.

2.3.3. For comparison, the additional plan allocations to be included in development options 1 – 3 are summarised below.

2.3.4. The strategic development in options 1 – 3 is as shown in Table 3.

Table 3: Development Option 1 – 3 Strategic Plan Allocation in Crawley Main

	Additional Units 2014 – 2029			
Development Option	**No. Households**	**Employment Gross Floor Area (sqm)**	**Employment Net Internal Area at 87% of GFA (sqm)**	**No. Jobs at 20sqm per Employee**
Option 1	4,500	145,500	126,585	6,329
Option 2	6,000	145,500	126,585	6,329
Option 3	7,500	145,500	126,585	6,329

2.3.5. The ratio of net internal floor area to jobs, for the employment allocations, was calculated from data provided by CBC. We assumed that 'occupied employment floor space' was equivalent to the 'net internal area' of premises. Excluding the self-employed, Government trainees and HM forces, we derived a figure of (1,576,000sqm / 78,200 jobs) = 20sqm (net internal area) per employee.

2.3.6. Equivalent data from Mid Sussex DC, for combined B1, B2 and B8 land use classes, gave a similar ratio of 24sqm (net internal area) per employee. A ratio of 19sqm per employee was recorded for A1 retail use. The average Crawley figure of 20sqm per employee was judged to be comparable and therefore applicable for stage-1.

2.3.7. Overall plan allocations for development options 1 – 3 were assembled as follows:

- Remove current planning data (households and jobs) from NTEM for the period 2006 to 2029;
- Add in planning completions, 2006 to 2011, taken from CBC LDF Annual Monitoring Report 2010-11 (residential) and CILLA reports for Crawley 2006-11 (employment);
- Add in planning commitments, 2011 onwards, taken from CBC residential listing (13 sites) and from CILLA report for Crawley 2010-11 (employment);
- Subtract Crawley North East Sector commitments from the strategic allocations specified by CBC for development options 1 – 3;
- Add in strategic planning alternatives, 2014 to 2029, taken from CBC brief for options 1 – 3, exclusive of North East Sector.

2.3.8. Further adjustments were made to avoid double-counting of housing completions included in the CBC listing and the LDF monitoring report at the following sites:

- Leisure Centre (Haslett Avenue);
- Stone Court (Balcombe Road);
- Lucerne Drive (Balcombe Road).

2.3.9. These sites comprise 1,065 dwellings. A further 1,243 completions have been identified from planning records, between 2006 and 2012, giving an overall total of 2,308 housing completions.

2.3.10. Employment completions have also been accounted for, amounting to 4,096 jobs, once site gross floor areas have been converted to net internal areas and equivalent jobs using land-use specific employee ratios. These ratios have been derived from Mid Sussex records and also from Employment Densities Guide – 2nd Edition (Drivers Jonas Deloitte, 2010). Ratios by land use were as shown in Table 4.

Table 4: Employment Floor Area to Jobs Ratios

Employment Land Use	Net Internal Area per Employee (sqm)
A1: Retailing	19
A2: Financial/Professional Services	16
B1a: Offices	12
B1b: Research/Development	12
B1c: Light Industry	47
B1: Mixed Uses	10
B2: General Industry	36
B8: Storage & Distribution	70
C1: Hotel	2 (rooms per employee)
D2: Leisure	70

2.3.11. All residential and employment commitments have been handled at Stage-1 in terms of adjustments to planning data in NTEM and not as site-specific trip movements, because the model zones are currently too coarse for sites to be meaningfully allocated to specific zones. Housing commitments included in stage-1 are as shown in Table 4.

Table 5: Crawley Committed Housing Allocations

CBC Planning Ref	Site Location	No. Households	Equivalent NTEM District to be Adjusted
CR/2010/0313/FUL	Russell Way, Three Bridges	270	Crawley (main)
CR/1998/0039/OUT	North East Sector, north of Pound Hill	1,900	Crawley (main)
DC/10/1612	Kilnwood Vale, west of Bewbush	2,500	Rural (Horsham)
CR/2009/0352/OUT	Ifield Road, West Green	218	Crawley (main)
CR/2006/0339/OUT	Ifield Community College, Lady Margaret Road	170	Crawley (main)
CR/2008/00971/OUT	Dorsten Square, Bewbush	160	Crawley (main)

Table 5: Crawley Committed Housing Allocations			
CBC Planning Ref	**Site Location**	**No. Households**	**Equivalent NTEM District to be Adjusted**
Ashdown Drive	Thomas Bennett School, Tilgate	200	Crawley (main)
North East Sector Residual land	North of Pound Hill	600	Crawley (main)
Town Centre, North	Northgate	120	Crawley (main)
All Committed Crawley Main Sites		3,638	
All Committed Horsham Rural Sites		2,500	

2.3.12. We derived a total for housing commitments in Crawley Borough of 3,638 households, together with 2,500 households in Horsham District.

2.3.13. Committed employment allocations were predicted to entail a total of 10,017 jobs in Crawley Borough, plus 698 jobs in Horsham District.

2.3.14. The specified strategic allocations for development options 1 – 3, from Table 3, were adjusted to exclude commitments of 1,900 households and 292 jobs in North East Sector. The resulting strategic totals were as follows:

- Option 1 – 2,600 households and 6,037 jobs;
- Option 2 – 4,100 households and 6,037 jobs;
- Option 3 – 5,600 households and 6,037 jobs;

2.4. Future Year Demand Outcomes

2.4.1. The land use components of each of the stage-1 demand scenarios were assembled to give housing and employment allocations as shown in Table 6.

Table 6: Stage-1 Demand Scenario Plan Allocations										
	2006 Base		2029 Forecast							
			Baseline		Option 1		Option 2		Option 3	
NTEM District	**No. House-holds**	**No. Jobs**	**No. House-holds**	**No. Jobs**	**No. House-holds**	**No. Jobs**	**No. House-holds**	**No. Jobs**	**No. House-holds**	**No. Jobs**
Crawley Main	39983	99736	44183	104275	48529	119886	50029	119886	51529	119886
Rural Horsham	12542	16517	14944	17476	15042	17476	15042	17476	15042	17476

2.4.2. The scenarios represent a percentage change in plan allocations, from base year 2006, as summarised in Table 7.

Table 7: Stage-1 Demand Scenario Percentage Change in Allocations from 2006

	2029 Forecast							
	Baseline		Option 1		Option 2		Option 3	
NTEM District	No. House-holds	No. Jobs	No. House-holds	No. Jobs	No. House-holds	No. Jobs	No. House-holds	No. Jobs
Crawley Main	10.5%	4.6%	21.4%	20.2%	25.1%	20.2%	28.9%	20.2%
Rural Horsham	19.2%	5.8%	19.9%	5.8%	19.9%	5.8%	19.9%	5.8%

2.4.3. It can be seen from Table 7 that, over the stage-1 forecast period, the percentage increase in households with the development options ranges from 21% in option 1 to 29% in option 3, compared with 11% in the baseline. The percentage increase in jobs is consistent through the development options at 20%, compared with 5% in the baseline.

2.4.4. The plan forecasts discussed above were converted to equivalent O-D zone to zone trips, using the following method:

- NTEM planning data was adjusted to reflect the household and job projections in each stage-1 scenario;
- TEMPRO was used to derive production and attraction trip end growth factors, by journey purpose for AM peak 2006 to 2029, from the adjusted planning data;
- Growth was applied by purpose to the trip matrices from the 2008 WSCTM base model, segmented by car-available and non-car-available journeys and by purpose;
- The resulting forecast 2029 scenario matrices were assigned (alongside heavy goods vehicles) in the multi-modal model, in an iterative process that includes mode and destination choice adjustments, to derive final travel demand by highway and PT modes.

2.4.5. Resulting trip patterns for zones constituting Crawley Borough were analysed. Table 8 shows total trips produced by and attracted to Crawley Borough, under the stage-1 demand scenarios.

Table 8: Stage-1 Forecast Trip Movements at Crawley Zones in WSCTM (AM Peak, All Modes except HGV)						
Demand Scenario	**No. Trips Produced (Origins)**	**Change in Trip Productions from Base Year 2008**	**% Change from Base Year in Trips Produced**	**No. Trips Attracted (Destinations)**	**Change in Trip Attractions from Base Year 2008**	**% Change from Base Year in Trips Attracted**
Base Year 2008	19148	N/A	N/A	25219	N/A	N/A
Baseline 2029	21577	2429	12.7%	26795	1576	6.3%
Option 1 2029	23577	4429	23.1%	30773	5554	22.0%
Option 2 2029	24156	5008	26.2%	30788	5569	22.1%
Option 3 2029	24735	5587	29.2%	30804	5585	22.1%

2.4.6. The zone productions and attractions in Table 8 include some duplication of trips because a trip that both starts and ends in any of the 17 Crawley zones will appear twice in the table. It is reasonable to take the number of trip productions as a good approximation of the total trips added by each forecast scenario.

2.4.7. The trip totals in Table 8 do not include through movements in Crawley, which start and end in zones outside the borough but which travel on the Crawley transport network.

2.4.8. In Table 8, the comparative change in Crawley trips, from base year, broadly mirrors the percentage change in Crawley Main planning allocations, in Table 7, but is slightly greater owing to the duplication referred to above.

2.4.9. The increase in trip productions (Table 8) corresponds with the change in households (Table 7), which generate AM journey departures, in each scenario as follows:

- Baseline – 13% increase in trip productions / 11% increase in households;
- Option 1 – 23% increase in trip productions / 21% increase in households;
- Option 2 – 26% increase in trip productions / 25% increase in households;
- Option 3 – 29% increase in trip productions / 29% increase in households.

2.4.10. The increase in trip attractions (Table 8) corresponds with the change in jobs (Table 7), which generate AM journey arrivals, in each scenario as follows:

- Baseline – 6% increase in trip attractions / 5% increase in jobs;
- Option 1 – 22% increase in trip attractions / 20% increase in jobs;
- Option 2 – 22% increase in trip attractions / 20% increase in jobs;
- Option 3 – 22% increase in trip attractions / 20% increase in jobs.

2.4.11. The above comparisons indicate that the planning assumptions for the respective stage-1 demand scenarios have been reliably converted into trip movements in the transport model.

3. Stage 1 Model Assignment Outcomes

3.1. Overview

3.1.1. This section considers the outcomes from the stage-1 transport model assignments.

3.2. Future Transport Networks

3.2.1. The modelled transport network for stage-1 has been defined as a 'do-minimum' situation, comprising committed interventions only and no unconfirmed, development-dependent, schemes.

3.2.2. Highway interventions that have been included in the do-minimum situation comprise all schemes represented in the established future year WSCTM, as documented in the Forecasting Report (Amey / WSCC, 22nd July 2011, Table 3.1). Key schemes that are relevant to the Crawley area are as follows:

- A23 Handcross to Warninglid highway improvement;
- A272 Haywards Heath Relief Road;

3.2.3. The A23 scheme entails on-line widening from all-purpose dual two-lane to dual three-lane carriageway, in both directions over about 4km. It involves closure of all direct accesses along the trunk road, provision of a new local access road along the western side and junction enhancement to provide dual two-lane slip roads and over-bridges and dumbbell roundabouts at both Handcross and Warninglid junctions.

3.2.4. The A272 scheme involves completion of Haywards Heath Relief Road stages 5 and 6, around the southern edge of the town. Stages 1 – 4 are already in place. The scheme entails new or improved highway links and junctions between A273 at Bolnore and A272 at Hurstwood Lane.

3.2.5. Certain committed development access improvements have, however, been omitted from the do-minimum highway network. The proposed accesses for the North East Sector and for Kilnwood Vale (West of Bewbush) have been excluded, because for stage-1 of the Crawley study, these developments have been represented in terms of changes to NTEM planning data at a Borough-wide level rather than as site-specific allocations where trip movements would be concentrated.

3.2.6. In addition, the do-minimum situation includes the following recent changes to the PT network:

- Increases in train capacity on First Capital Connect rail services between Brighton and Bedford;
- Extension of peak period Gatwick Express trains to start and end at Brighton, with corresponding reduction in Brighton – Clapham Junction services;
- Additional platform provision at Gatwick Airport rail station.

3.3. Overall Scenario Impact in West Sussex

3.3.1. Multi-modal model assignment outputs from the WSCTM stage-1 scenarios have been extracted and analysed, with respect to the following:

- Overall volume and modal split of trips, at county level;
- Components of highway trip movements at county level, in terms of total passenger car units (PCU), number of trips within zones that are not assigned to the network, number of queued trips that do not complete during the modelled period and number of congested links;
- Overall network performance, for highway and PT, in terms of travel time and distance at county level;
- Elements of highway operation at county level, comprising traffic queues, average speeds, fuel consumption and carbon emissions; and
- Equivalent highway performance statistics for a localised cordoned area covering Crawley Borough.

3.3.2. Table 9 shows network travel demand statistics for the county level, as a whole, by scenario and travel mode.

3.3.3. For highway and PT trips combined, the county-wide increase from the 2029 AM baseline to option 1 (2,091 trips), option 2 (2,683 trips) and option 3 (3,275 trips), mirrors the increase in trip productions from baseline shown in Table 8 for Crawley. This indicates that the trips associated with strategic planning options have been correctly transferred into the WSCTM.

3.3.4. It is notable that the change in trips, county-wide, is very small between the baseline and options 1, 2 and 3 (0.9%, 1.2% and 1.4%, respectively), which suggests that the impact of Crawley development on overall network performance will not differ substantially between scenarios.

3.3.5. The proportion of total trips undertaken by PT in each scenario is consistently small at about 8%. This is unchanged from the base year and reflects the lack of detail with regard to PT services and trip movements in the WSCTM CUBE model within Crawley. Conversely, the proportion of trips undertaken by car is consistently high at about 92% in all scenarios. The scale of development in Crawley does not, in the strategic model, significantly alter the mode share. Detailed mode choice outcomes could be more accurately assessed using the CTCM in stage-2 of the study.

Table 9: Stage-1 County-Wide Travel Demand Statistics

Model Parameter	Travel Mode	Measure-ment	Base Year 2008	Base-line 2029	% Change from Base Year	Option 1 2029	% Change from Base-line	Option 2 2029	% Change from Base-line	Option 3 2029	% Change from Base-line
Total Network Trips	Highway	Persons	186660	211305	13.2%	213500	1.0%	214060	1.3%	214620	1.6%
	PT	Persons	16939	18967	12.0%	18863	-0.5%	18895	-0.4%	18927	-0.2%
	Combined	Persons	203599	230272	13.1%	232363	0.9%	232955	1.2%	233547	1.4%
	% Highway Trips	%	91.7%	91.8%		91.9%		91.9%		91.9%	
	% PT Trips	%	8.3%	8.2%		8.1%		8.1%		8.1%	
Road Trip Total Demand	Highway	PCU	147290	167305	13.6%	168974	1.0%	169407	1.3%	169869	1.5%
Road Trip Intra-Zone Demand	Highway	PCU	8498	9696	14.1%	9885	1.9%	9925	2.4%	9965	2.8%
Road Trip Inter-Zone Demand	Highway	PCU	138792	157609	13.6%	159089	0.9%	159482	1.2%	159904	1.5%
No. Road Trips Uncompleted	Highway	PCU	3730	5584	49.7%	6834	22.4%	6767	21.2%	6862	22.9%
Road Trips Uncompleted	Highway	%	2.7%	3.5%		4.3%		4.2%		4.3%	
Congested Links	Highway	No. Roads	111	137	23.4%	143	4.4%	143	4.4%	145	5.8%

3.3.6. Table 9 also shows various aspects of the predicted highway trip demand from the SATURN model, specifically:

- The total trip demand in PCU including intra-zone movements that don't appear on the modelled network and inter-zone movements that do.
- The number of PCU trip that are held up in queued traffic as a result of network congestion and which, consequently, do not complete their origin to destination journey during the AM peak hour;
- The number of congested highway links and turns on which traffic queues arise as a result of demand exceeding capacity (i.e. not as a consequence of traffic control e.g. signals and give-ways);

3.3.7. At a county level, the proportion of highway trips that remain uncompleted after the AM peak hour is low, amounting to 2.7% at base year. This increases slightly to 3.5% in the baseline at 2029 and to about 4.3% in each of the Crawley development options 1-3.

3.3.8. Table 10 shows some county-wide network performance statistics taken from the multi-modal model.

3.3.9. It is evident that, in terms of most performance statistics, the scale of change between the forecast baseline and options 1-3 is very small by comparison with the change between base year and baseline. This suggests that there is little to differentiate the development options at the strategic level.

3.3.10. Overall distance travelled, on highway, increases by less than 0.5% in all options and on PT decreases by about 1.5% in all options, relative to the baseline. Similarly, overall travel time on highway increases by less than 3.0% in all options and on PT decreases by less than 1.5% in all options.

3.3.11. Over-capacity queuing delay on the highway network, which occurs where demand exceeds capacity, is predicted to increase by about 25% in options 1 and 2 and by 27% in option 3, compared with the baseline. However, the magnitude of these increases is less significant than the change from base year to 2029 baseline of 60%. Hence the impact of each forecast scenario on highway performance will tend to show as very similar to the baseline at 2029.

Table 10: Stage-1 County-Wide Network Performance Statistics											
Model Parameter	**Travel Mode**	**Measure-ment**	**Base Year 2008**	**Base-line 2029**	**% Change from Base Year**	**Option 1 2029**	**% Change from Base-line**	**Option 2 2029**	**% Change from Base-line**	**Option 3 2029**	**% Change from Base-line**
Total Network Travel Distance	Highway	PCU-Kms	3690921	4215508	14.2%	4224529	0.2%	4231424	0.4%	4237921	0.5%
	Bus	Person-Kms	51377	58088	13.1%	57795	-0.5%	57883	-0.4%	57984	-0.2%
	Rail	Person-Kms	539123	618424	14.7%	608542	-1.6%	608550	-1.6%	608579	-1.6%
	All PT	Net Kms	590500	676512	14.6%	666337	-1.5%	666434	-1.5%	666563	-1.5%
Total Network Travel Time	Highway	PCU-Hrs	48428	57374	18.5%	58714	2.3%	58797	2.5%	58990	2.8%
	Bus	Person-Hrs	2000	2260	13.0%	2249	-0.5%	2252	-0.4%	2256	-0.2%
	Rail	Person-Hrs	9317	10683	14.7%	10518	-1.5%	10519	-1.5%	10521	-1.5%
	All PT	Net Hrs	11317	12943	14.4%	12767	-1.4%	12771	-1.3%	12777	-1.3%
Transient Queues	Highway	PCU Hrs/Hr	3630	4826	32.9%	4972	3.0%	4973	3.0%	4989	3.4%
Over-Capacity Queues	Highway	PCU Hrs/Hr	2340	3741	59.9%	4656	24.5%	4656	24.5%	4762	27.3%
Link Travel Time	Highway	PCU Hrs/Hr	42458	48806	15.0%	49086	0.6%	49168	0.7%	49239	0.9%
Average Vehicle Speed	Highway	kph	76.2	73.5	-3.5%	72.0	-2.0%	72.0	-2.0%	71.8	-2.3%
Total Fuel Consumption	Highway	Litres/Hr	114697	130314	13.6%	131768	1.1%	131978	1.3%	132179	1.4%
CO2 Emissions	Highway	kg	115306	131174	13.8%	132680	1.1%	132874	1.3%	133082	1.5%

3.4. Overall Scenario Impact in Crawley

3.4.1. In view of the inconclusive outcomes in Tables 9 and 10, we have tried to focus on Crawley Borough to understand better the localised impacts of the development options. We have cordoned down the highway element of WSCTM, to extract summary statistics for all of Crawley on its own. The limits of the cordoned area have been defined by the following routes, in clockwise order around the Borough perimeter:

- B2114 south of M23 J11, Pease Pottage;
- A23 south of M23 J11, Pease Pottage;
- A264 west of A2220 junction, Bewbush;
- Gossops Drive accessing A23 Crawley Avenue from Gossops Green / Bewbush;
- Ifield Wood, accessing Ifield Avenue, north west of A23 Crawley Avenue;
- Ifield Road, accessing Ifield Avenue, north west of A23 Crawley Avenue;
- Lowfield Heath Road, west of A23 London Road;
- A23 London Road, north west of Gatwick Airport;
- B2036 Balcombe Road north of Fernhill Road;
- M23 north of J9;
- B2037 Antlands Lane, east of B2036 Balcombe Road;
- Copthorne Bank east of Shipleybridge Lane;
- A264 Copthorne Common Road, east of A2220 and M23 J10;
- Copthorne Hotel, accessing A2220 / A264 Copthorne Roundabout;
- Turners Hill Road, east of B2036 Balcombe Road; and
- B2036 Balcombe Road, south of M23 J10a.

3.4.2. Table 11 shows summary cordon network performance statistics extracted from the SATURN model for AM peak 2029. It can be seen from Table 11 that, at a local level, the traffic forecast for the development options will have a significantly greater incremental impact over the baseline than was shown at a county level in Tables 9 and 10. Total Crawley travel demand, including through traffic, at AM peak 2029 will be around 14% greater than baseline in option 1, 15% greater in option 2 and 16% greater in option 3.

3.4.3. By contrast with the county-wide model statistics, the Crawley highway cordon outcomes indicate that each of the development options will have a severe impact relative to the forecast baseline. This in turn suggests that none of the scales of strategic development could be easily mitigated and that planning aspirations within Crawley may need to be reduced accordingly.

Table 11: Stage-1 Crawley Cordon Highway Network Performance Statistics										
Model Parameter	**Measure-ment**	**Base Year 2008**	**Base-line 2029**	**% Change from Base Year**	**Option 1 2029**	**% Change from Base-line**	**Option 2 2029**	**% Change from Base-line**	**Option 3 2029**	**% Change from Base-line**
Total Trip Demand	PCU	32505	35516	9.3%	40477	14.0%	40903	15.2%	41263	16.2%
Intra-Zone Trips	PCU	1140	1244	9.1%	1463	17.6%	1492	19.9%	1522	22.3%
Inter-Zone Trips	PCU	31365	34272	9.3%	39014	13.8%	39411	15.0%	39741	16.0%
No. Trips Uncompleted	PCU	1327	1788	34.7%	4970	178.0%	5141	187.5%	5285	195.6%
% Trips Uncompleted	%	4.2%	5.2%		12.7%		13.0%		13.3%	
Congested Links	No. Roads	24	31	29.2%	41	32.3%	39	25.8%	41	32.3%
Network Travel Distance	PCU-Kms	322305	350586	8.8%	375836	7.2%	377505	7.7%	380094	8.4%
Network Travel Time	PCU-Hrs	5392	6202	15.0%	10723	72.9%	10799	74.1%	11029	77.8%
Transient Queues	PCU Hrs/Hr	637	795	24.8%	994	25.0%	984	23.8%	993	24.9%
Over-Capacity Queues	PCU Hrs/Hr	863	1148	33.0%	5037	338.8%	5098	344.1%	5288	360.6%
Link Travel Time	PCU Hrs/Hr	3893	4259	9.4%	4692	10.2%	4716	10.7%	4747	11.5%
Average Speed	kph	60	57	-5.5%	35	-38.1%	35	-38.1%	35	-38.9%
Fuel Consumption	Litres/Hr	16676	17783	6.6%	20798	17.0%	20938	17.7%	21100	18.7%
CO2 Emissions	kg	16825	17994	6.9%	21058	17.0%	21194	17.8%	21360	18.7%

3.4.4. The number of uncompleted trips that become stuck in network congestion, in the development options, will amount to: 4,970 PCU in option 1; 5,141 PCU in option 2; and 5,285 PCU in option 3. These are equivalent to about 13% of trips on the highway network in each option, but represent a large increase from baseline of 178% in option 1, 188% in option 2 and 196% in option 3.

3.4.5. In terms of queuing delay, caused by demand exceeding highway capacity, the forecast congestion will increase considerably relative to the baseline, by 339% in option 1, 344% in option 2 and 361% in option 3. Overall highway network travel time would rise by 73% in option 1, 74% in option 2 and 78% in option 3.

3.4.6. Components of modelled highway trips within the WSCTM Crawley cordon are as shown in Table 12.

Table 12: Stage-1 Crawley Cordon Highway Trip components

Trip Component	Unit	Base Year 2008	Base-line 2029	Change from Base Year	Option 1 2029	Change from Base Line	Option 2 2029	Change from Base Line	Option 3 2029	Change from Base Line
Total	PCU	32505	35516	3011	40477	4961	40903	5387	41263	5747
	%	100%	100%	9%	100%	14%	100%	15%	100%	16%
Inter-Zone	PCU	31365	34272	2907	39014	4742	39411	5139	39741	5469
	%	96%	96%	9%	96%	14%	96%	15%	96%	16%
Internal - Internal	PCU	5293	6044	751	7106	1062	7252	1208	7396	1352
	%	16%	17%	14%	18%	18%	18%	20%	18%	22%
Internal - External	PCU	7131	7996	865	11121	3125	11359	3363	11581	3585
	%	22%	23%	12%	27%	39%	28%	42%	28%	45%
External - Internal	PCU	12152	12681	529	14007	1326	13976	1295	13923	1242
	%	37%	36%	4%	35%	10%	34%	10%	34%	10%
External - External	PCU	7929	8795	866	8243	-552	8316	-479	8363	-432
	%	24%	25%	11%	20%	-6%	20%	-5%	20%	-5%
Intra-Zone	PCU	1140	1244	104	1463	219	1492	248	1522	278
	%	4%	4%	9%	4%	18%	4%	20%	4%	22%

3.4.7. It can be seen from Table 12 that options 1-3 would be similar in terms of the magnitude of various highway trip components, travelling within, from, to, or through Crawley. In all options, the biggest change from the baseline would be in the number of internal to external trips leaving Crawley in the AM peak, ranging from a 39% increase in option 1, to 42% in option 2 and 45% in option 3. By contrast, there would be a change in the number of external to external trips passing through Crawley, amounting to a 6% decrease in option 1 and a 5% decrease in options 2 and 3, relative to the baseline. This decrease reflects increased travel time on some of the through routes, especially the A23.

3.4.8. The pattern of trips would remain similar in all options 1-3, at about 18% within, 27% from, 35% to and 20% through, Crawley. However, in all options there would be a slight increase in trips starting inside Crawley and a decline in trips starting outside Crawley, relative to the baseline, in all scenarios

3.5. Forecast Network Traffic Flow and Capacity

3.5.1. The performance of key highway links and junctions on parts the strategic county network and on the local Crawley network has been assessed, in terms of traffic flow volumes and ratios of flow to capacity (RFC). In particular, outputs have been extracted with respect to the following:

- Assigned highway link flows and differences from baseline;
- Link RFC;
- Overall junction RFC for all approaches combined, at key intersections; and
- Maximum RFC from any approach at key junctions.

3.5.2. We have selected key parts of the highway network, including Crawley, for which to extract model outputs. The focus of interest has been defined broadly as the area bounded by A24 to the west, (between A272 and Horsham), A275 to the east, (between A272 and East Grinstead), A237 / A264 to the north (between Horley and East Grinstead) and A272 to the south, (between A24 and A275).

3.5.3. Highway links for which assignment outputs have been analysed are as shown numbered in Figure 2.

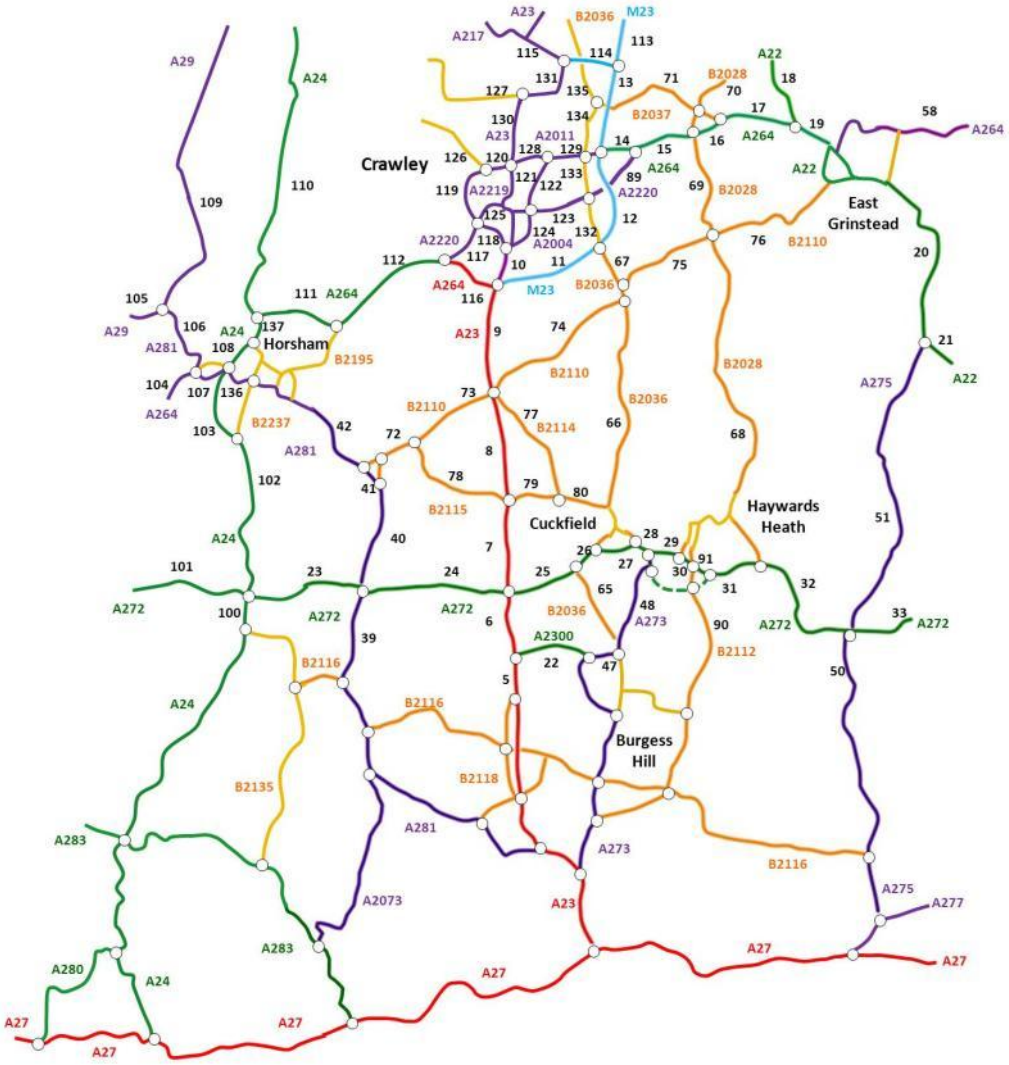


Figure 2: Highway Links For Stage-1 Analysis

3.5.4. Similarly, highway junctions for which assignment outputs have been analysed are shown numbered in Figure 3.

3.5.5. Full page copies of Figures 2 and 3 are also attached in Appendix I.

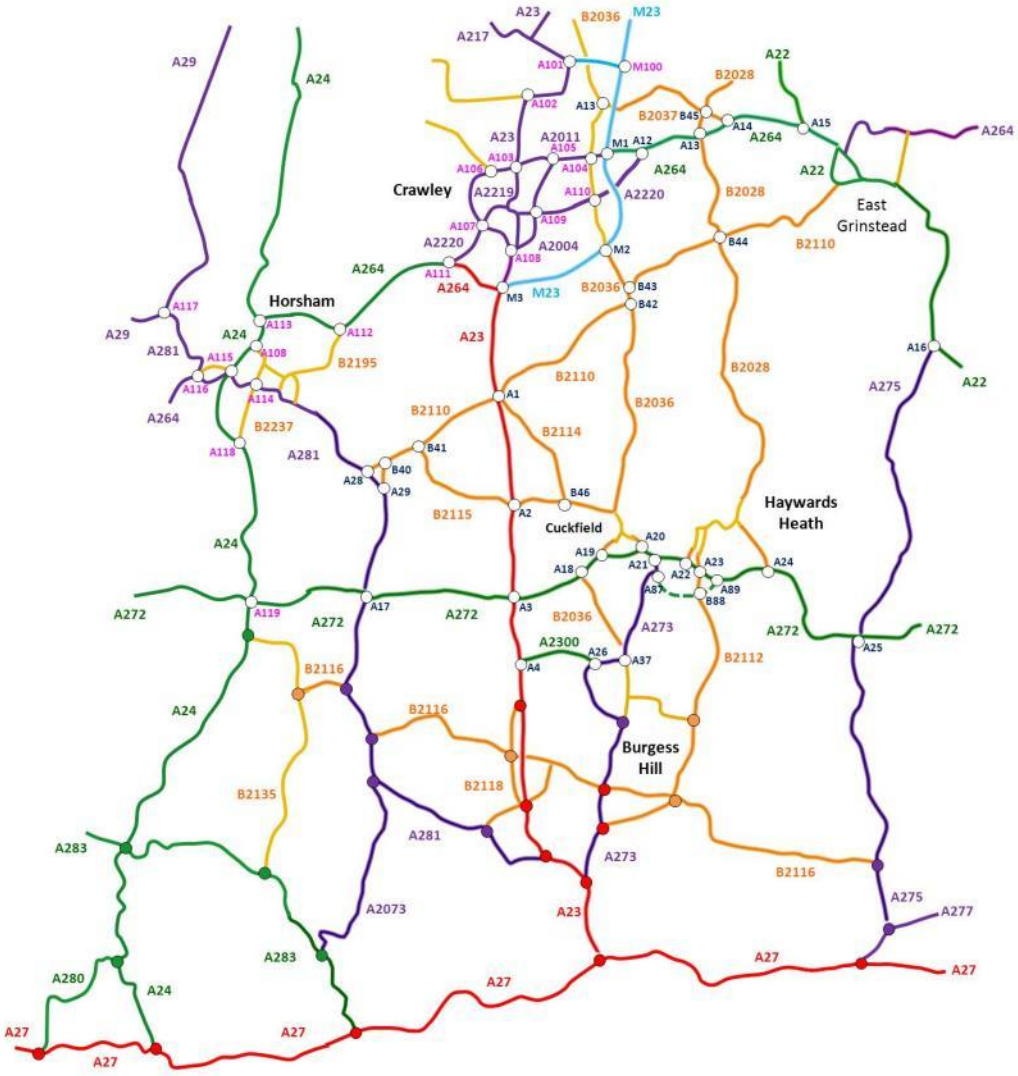


Figure 3: Highway Junctions For Stage-1 Analysis

3.5.6. A summary of assigned link traffic flows, for AM peak 2029, is given in Appendix A, for each forecast scenario. Link flow differences with each development option, relative to the baseline, are shown in Appendix B.

3.5.7. Routes where traffic flows are predicted to increase by more than 10% with all of the the development options are as follows:

- A264 westbound between A22 East Grinstead and B2037 Effingham Park;
- A272 westbound between Haywards Heath Relief Road and B2112;
- B2036 northbound between B2110 and M23 J10A;
- B2037 westbound between B2038 and B2036 Balcombe Road;

- B2110 northeast bound between A23 and B2036;
- B2114 northbound between B2115 and B2110;
- A23 northbound between A2011 and Manor Royal;
- A2004 northbound and southbound between A2220 and A2011;
- A2219 southbound between A2011 and A2220;
- A2220 northeast bound between A23 and B2219;
- A2220 southwest bound between B2036 and A2004;
- B2036 northbound between M23 J10A and A2220;
- B2036 southbound between B2037 and A2011; and
- Lowfield Heath Road eastbound between Charlwood and A23.

3.5.8. There are also a number of links in the development options where flows will decrease by more than 10% relative to the baseline, owing to changes in trip destinations or traffic re-routing to avoid congestion.

3.5.9. We have counted the number of links within or accessing Crawley, in each development scenario, that are predicted to have a flow increase or decrease of more than 10%. The results within the cordon area boundary, identified earlier, are as follows:

- Option 1: 12 links with >10% flow increase; 7 links with >-10% flow decrease;
- Option 2: 13 links with >10% flow increase; 4 links with >-10% flow decrease;
- Option 3: 14 links with >10% flow increase; 4 links with >-10% flow decrease;

3.5.10. On these terms, there is a slight worsening of link impact with successive options 1-3.

3.5.11. Key highway links have also been analysed to measure their ratio of flow to capacity (RFC), under the forecast scenarios at AM peak 2029. Findings are shown in Appendix C. Links that are predicted to experience a RFC of more than 100% are as follows:

- A264 eastbound and westbound between A2220 Copthorne and B2028, in all scenarios;
- A272 eastbound between A273 Bolnore and B2028 Haywards Heath, in all scenarios;
- A2220 northeast bound between A23 and A2219, in options 1, 2 and 3;
- B2036 southbound between B2037 and A2011, in option 3 only.

3.5.12. We have counted the number of links within or accessing Crawley, in each development scenario, that are predicted to have a RFC of more than 95%. The results within the cordon area boundary, identified earlier, are as follows:

- Baseline: 1 link with RFC >95%;
- Option 1: 3 links with RFC >95%;

- Option 2: 3 links with RFC >95%;
- Option 3: 3 links with RFC >95%;

3.5.13. It is apparent that the development options would not have a significant impact on network link performance, in terms of RFC, in the study area. However, satisfactory operation of the highway network depends more upon junction RFC than link RFC.

3.5.14. Performance of key junctions has been assessed in two respects, first in terms of average RFC at each junction, whereby total inflow is divided by total capacity across all approaches and second, in terms of highest RFC on the busiest approach at each junction. Appendix D contains a summary of junction average RFC, whilst Appendix E shows highest approach RFC at each junction.

3.5.15. In terms of junction average RFC there would not be a significant problem in any of the forecast scenarios, except at the following locations where RFC would exceed 90%:

- M23 J11 at Pease Pottage average RFC: 101% in baseline; 103% in options 1, 2 and 3;
- A2220 / B2036 Balcombe Road average RFC: 100% in baseline; 101% in option 1; 102% in option 2; and 103% in option 3;
- A272 / B2036 Ansty average RFC: 89% in baseline; 90% in options 1, 2 and 3;
- A2011 / A2004 / Hazelwick Avenue average RFC: 99% in baseline and options 1, 2 and 3;
- A24 / B2237 south of Horsham average RFC: 91% in baseline and options 1, 2 and 3.

3.5.16. There would be a more significant congestion problem in terms of highest RFC on the busiest arm at key junctions. Locations within and accessing Crawley, where flows would exceed capacity (i.e. RFC >100%) are as follows:

- M23 J11 Pease Pottage Max RFC: >105% in baseline and options 1, 2 and 3;
- A264 / A2220 Copthorne Max RFC: >105%% in baseline and options 1, 2 and 3;
- B264 / B2028 Snow Hill Max RFC: 99% in baseline and option 1; 100% in option 2; and 101% in option 3;
- A2011 / A2004 Hazelwick Max RFC: 102% in baseline; 103% in options 1 and 2; 104% in option 3;
- A23 / Ifield Avenue Max RFC: 103% in baseline and options 1 and 2; 104% in option 3;
- A23 / A2220 Cheals roundabout Max RFC: 87% in baseline; 99% in option 1; 100% in options 2 and 3;
- A2004 / A2220 Haslett Avenue Max RFC: >100% in baseline and options 2 and 3, but not option 1;

- A2220 / B2036 Balcombe Road Max RFC: >105% in baseline and options 1, 2 and 3.

3.5.17. We have counted the number of junctions within and accessing Crawley where maximum RFC would exceed 100%, in each forecast scenario. The outcomes were as follows:

- Baseline: 6 junctions with Max RFC >100%;
- Option 1: 5 junctions with Max RFC >100%;
- Option 2: 8 junctions with Max RFC >100%;
- Option 3: 8 junctions with Max RFC >100%.

3.5.18. Across the wider impact analysis area, as defined earlier, there would also be congestion problems at the following road junctions.

- A264 / A22 Felbridge Max RFC: 105% in baseline and options 1, 2 and 3;
- A272 / A281 Cowfold Max RFC: 104% in baseline and options 1, 2 and 3;
- A272 / B2026 Haywards Heath Max RFC: 99% in baseline; 100% in options 1, 2 and 3;
- A272 / B2111 Haywards Heath Max RFC: 102% in baseline and options 1, 2 and 3;
- B2112 / Haywards Heath Relief Road Max RFC: 105% in baseline and options 1, 2 and 3;
- B2028 / B2037 Effingham Park Max RFC: 100% in baseline; 101% in options 1 and 2; and 102% in option 3;
- B2110 / B2028 Turners Hill Max RFC: 120% in baseline; 121% in options 1, 2 and 3;
- B2114 / B2115 Slough Green Max RFC: 98% in baseline; 100% in options 1, 2 and 3;
- A264 / B2195 Horsham Max RFC: 104% in baseline; 105% in options 1, 2 and 3;
- A24 / A264 Horsham Max RFC: 104% in baseline and options 1, 2 and 3;
- A24 / B2237 Horsham Max RFC: 102% in baseline; 103% in options 1, 2 and 3;
- A29 / A281 Rowhook Max RFC: 106% in baseline and options 1, 2 and 3;
- A24 / A272 Buck Barn Max RFC: 104% in baseline and options 1, 2 and 3.

3.5.19. Overall, there would be a substantial number of junctions around Crawley that would experience congestion, queuing and delay on at least one junction approach at AM peak 2029. However, the severity of problems with development options 1, 2 and 3 would be just as bad in the baseline at most locations, except for the following junctions where congestion would be marginally worse with the development options:

- B264 / B2028 Snow Hill;
- A2011 / A2004 Hazelwick;
- A23 / Ifield Avenue;
- A23 / A2220 Cheals roundabout.

3.5.20. There are a few junctions that would operate satisfactorily in one development option, but not in others. These are as follows:

- B264 / B2028 Snow Hill: RFC >100% in option 3 only;
- A23 / A2220 Cheals roundabout: RFC >100% in options 2 and 3 only;
- A2004 / A2220 Haslett Avenue: RFC >100% in options 2 and 3 only.

3.5.21. Overall, in terms of junction operation within capacity, option 1 is predicted to perform marginally better than options 2 and 3.

3.6. Forecast Network Traffic Delay

3.6.1. We have also examined the performance of key highway links and junctions in terms of traffic delays. Specifically the following model details have been extracted:

- Average delay per vehicle on the busiest approach at key junctions; and
- Change in delay per vehicle on the busiest junction approach, relative to the baseline.

3.6.2. Delays in seconds per vehicle on the busiest junction arms are summarised in Appendix F, whilst differences in highest delays between scenarios and the baseline are contained in Appendix G. The outcomes from the junction delay analysis are inconclusive, because no junction in any of the development options 1-3 is predicted to have a delay increase of more than 60 seconds per vehicle (i.e. 1 minute).

3.7. Forecast Traffic Impact on Ashdown Forest

3.7.1. Finally, an assessment has been made of the likely impact of traffic flows associated with the Crawley stage-1 strategic plan scenarios upon Ashdown Forest Special Area of Conservation (SAC), east of Crawley and to the south east of East Grinstead. The impact assessment uses annual average daily traffic (AADT) flow predictions as an indicator of changes in air quality in this environmentally sensitive area.

3.7.2. In the WSCTM output analysis we have included key roads that access or cross Ashdown Forest, namely:

- A275 (Lewes – East Grinstead);
- A22 (Uckfield – East Grinstead);
- A26 (Uckfield – Crowborough);
- B2110 (East Grinstead – Royal Tunbridge Wells);

- B2188 (Maresfield – Groombridge);
- B2026 (B2188 – B2110);
- Coleman's Hatch road (East – West through Ashdown Forest).

3.7.3. As the WSCTM is a strategic model and Ashdown Forest is positioned on the north east periphery of the network, we cannot derive meaningful flow assignments for B2188, B2026 or Coleman's Hatch Road. However, we have assessed future traffic impacts on A275, A22, A26 and B2110, which pass by, or through, Ashdown Forest. The assessment represents a 'worst case' for these routes, which are modelled as carrying additional traffic that might otherwise travel on B2118, B2026 and Coleman's Hatch Road, within the SAC.

3.7.4. The threshold for determining significant traffic impact is defined in the Habitats Regulations Assessment, using the Department for Transport's Design Manual for Roads and Bridges (DMRB). The criteria for defining an affected road specify that a flow increase of 1,000 vehicles or more AADT, 2-way, will constitute a significant impact.

3.7.5. We have applied representative local flow factors to convert the forecast AM peak hour model outputs, at 2029, to an AADT equivalent. The resulting AADT flows on the Ashdown Forest routes, for Crawley development options 1-3, have been compared with the baseline for the respective years. Results from the analysis are provided in Appendix H.

3.7.6. Table 13 gives a summary of the AADT flows predicted around Ashdown Forest under the forecast scenarios.

Table 13: Forecast 24-Hour AADT 2-Way Flows on Roads Through Ashdown Forest

Highway Link	Base Year 2008	Baseline 2029	Option 1 2029	Option 2 2029	Option 3 2029
A275	5229	6061	6083	6019	6016
A22	4883	5881	6106	6104	6117
A26	3410	4002	3998	3933	3931
B2110	2235	2546	2533	2535	2541

3.7.7. Table 14 shows AADT flow change, with the forecast scenarios, from base year.

Table 14: Forecast 24-Hour AADT 2-Way Flow Change from Base Year Through Ashdown Forest

Highway Link	Base Year 2008	Baseline 2029	Option 1 2029	Option 2 2029	Option 3 2029
A275	-	832	854	790	787
A22	-	998	1223	1221	1234
A26	-	592	588	523	520
B2110	-	311	299	301	306

3.7.8. Table 15 indicates the equivalent flow change with the development options, from baseline at 2029.

Table 15: Forecast 24-Hour AADT 2-Way Flow Change from Baseline Through Ashdown Forest

Highway Link	Base Year 2008	Baseline 2029	Option 1 2029	Option 2 2029	Option 3 2029
A275	-	-	21	-42	-45
A22	-	-	225	223	236
A26	-	-	-4	-69	-71
B2110	-	-	-12	-10	-5

3.7.9. It can be seen that the maximum 2-way AADT flow change from the baseline at 2029, around Ashdown Forest, would be on the A22, amounting to 236 vehicles in option 3, 223 vehicles in option 2 and 225 vehicles in option 1, on A275.

3.7.10. AADT changes on the remaining routes, A275, A26 and B2110 would be negligible and mostly reduced flows relative to the baseline.

3.7.11. It is evident that the Crawley strategic development options would not cause significant traffic flow impacts, or reductions in air quality, on routes through Ashdown Forest.

4. Stage 1 Summary and Conclusions

4.1.1. This section draws out the main findings from the Crawley stage-1 appraisal.

4.1.2. Stage 1 of the Local Plan Transport Strategy has examined the implications of three land use development options in Crawley Borough and compared them with a baseline situation. We have used the West Sussex County Transport Model to assess the transport impacts at a coarse, strategic, level, at AM peak 2029. Impacts have been considered for car and public transport modes.

4.1.3. Development scenarios have been differentiated by changing the housing and employment assumptions in the National Trip End Model, for Crawley and, thereby, varying the trip movement forecasts, using TEMPRO. Trip patterns have not been calculated at a detailed site-specific level.

4.1.4. The strategic WSCTM was used, rather than the Crawley Town Centre Model, because it offered the most reliable means of assessing development impacts at a county-wide level. However, checks on its validity within Crawley revealed it to be not very accurate at a local level, even after some refinement, by comparison with Department for Transport guidelines (60% links achieved acceptable accuracy, compared with a target of 85%). After making the small changes to improve accuracy within Crawley, the wider-area model achieved 78% of links with acceptable accuracy, compared with a target of 85%.

4.1.5. The respective stage-1 development options 1-3 represented a significant proportionate increase in planning allocations within Crawley, compared with the baseline situation, from 2006 to 2029. In the options 1-3, the percentage increase in households ranged from 21%, through 25%, to 29%, compared with the baseline increase of 11%. Similarly, in the options 1-3, the percentage increase in jobs was consistent at 20%, compared with the baseline increase of 5%. These changes were mirrored closely by the increases in predicted trip movements starting and ending within Crawley Borough.

4.1.6. However, in absolute terms, the above land use variations are less significant increases, when considered in the context of the 2006 existing land use allocation of 40,000 households and 100,000 jobs, in Crawley.

4.1.7. Stage-1 residential and employment growth, as input to NTEM, has been converted into equivalent Crawley trips, using TEMPRO. This gives a considerable underestimate of movements, when compared with site-specific trip calculations that would be derived from a source such as TRICS, as proposed in stage 2 of the study. This is because NTEM and TEMPRO operate with all of Crawley as a single zone and they predict trips between Crawley and surrounding districts. They ignore the considerable volume of local trips within Crawley that would arise at a site-specific level.

4.1.8. Our stage-1 method does apply TEMPRO growth to all modelled zones within Crawley, but the growth factors are low, because they omit trip growth that is retained wholly within the Borough. Therefore, in stage 2, we would be likely to predict substantially more trips and greater transport impact, for a given residential or employment allocation, than in stage 1.

4.1.9. The stage-1 model assignments have been made using a future year 'do-minimum' highway and public transport network. This includes committed transport interventions, most notably A23 Handcross to Warninglid and A272 Haywards Heath Relief Road improvements. However, the network excludes any impact mitigation schemes.

4.1.10. At a county level, there would be minimal difference in the impact of the various stage-1 forecast scenarios. The change in total trips, by car and PT, from baseline would be 0.9%, 1.2% and 1.4% in options 1, 2 and 3, respectively. The modal share would be predominantly car, comprising 98% of trips.

4.1.11. Similarly, the difference between the options and baseline, in terms of journey distance, travel time and proportion of trips uncompleted, owing to congestion, would be very small at county level. There would be a substantial increase in queuing delay, of over 25% relative to the baseline, where highway demand exceeds capacity. However, this impact with the options is small, when compared with the 60% predicted increase between base year and 2029 baseline.

4.1.12. We have assessed option impacts at a more local level in Crawley, by extracting cordon information from the highway model at AM 2029. The outputs include external traffic movements passing through and around Crawley. Here, the outcomes suggest that the development options would have a considerable impact relative to the baseline, with the severity of impact increasing successively through options 1-3 in line with the magnitude of development. Total highway trips would increase by 14%, 15% and 16% with options 1, 2 and 3, respectively.

4.1.13. The cordoned highway trip total for Crawley predicted in the strategic model would be substantially lower at base year 2008 (32,505 PCU) than in the Crawley Town Centre Model at base year 2006 (61,420 PCU). We judge the shortfall to be a consequence of the county model not containing as many zones and hence, short distance trips, as the town centre model.

4.1.14. Uncompleted trips that remain stuck in congestion after the AM peak hour would increase by 178%, 188% and 196% in options 1, 2 and 3, respectively, compared with the baseline, amounting to upwards of 5,000 trips. Likewise, queuing delay would rise considerably by 339%, 344% and 361% in options 1, 2 and 3.

4.1.15. Wider area highway model outputs were analysed, within an area bounded by A24, A217, A275 and 272, to understand how the development options would impact upon network performance. We then reduced the impact area of interest to match that used in the Crawley cordon analysis. Link flow changes of more than +/- 10%, relative to the baseline, were predicted to arise in Crawley as follows:

- Option 1: 12 links with increase; 7 links with decrease;

- Option 2: 13 links with increase; 4 links with decrease;
- Option 3: 14 links with increase; 4 links with decrease.

4.1.16. These outcomes suggest that option 1 would have a slightly less adverse impact than options 2 and 3, in terms of flow change.

4.1.17. We also examined link and junction Ratios of Flow to Capacity. In respect of road links with RFC of more than 95%, in Crawley, the following pattern emerged:

- Baseline: 1 link;
- Option 1: 3 links;
- Option 2: 3 links;
- Option 3: 3 links.

4.1.18. This suggests that there would be no difference between options in terms of heavily congested road links. We found that there would be one link where RFC would exceed 100% in the development options 1, 2 and 3, but not in the baseline, namely:

- A2220 northeast bound between A23 and A2219.

4.1.19. Also, there would be one link where RFC would exceed 100% in option 3 but not in other scenarios, namely:

- B2036 southbound between B2037 and A2011.

4.1.20. With regard to road junctions in Crawley, with RFC greater than 100% on the busiest approach, findings were as follows:

- Baseline: 6 junctions;
- Option 1: 5 junctions;
- Option 2: 8 junctions;
- Option 3: 8 junctions.

4.1.21. Results suggest that option 1 would have a less detrimental impact in Crawley, than either of options 2 or 3. We have identified several junctions where RFC would exceed 100% with certain development options, namely:

- A23 / A2220 Cheals roundabout Max RFC: 87% in baseline; 99% in option 1; 100% in options 2 and 3;
- B264 / B2028 Snow Hill Max RFC: 99% in baseline and option 1; 100% in option 2; and 101% in option 3;
- A2004 / A2220 Haslett Avenue Max RFC: >100% in baseline and options 2 and 3, but not option 1;
- A2011 / A2004 Hazelwick Max RFC: 102% in baseline; 103% in options 1 and 2; 104% in option 3;

- A23 / Ifield Avenue Max RFC: 103% in baseline and options 1 and 2; 104% in option 3.

4.1.22. At the selected junctions listed above, option 1 would have marginally less adverse impact than either of options 2 or 3. These are key locations where further operational analysis and potential intervention may be required, in order to mitigate adverse impacts of development.

4.1.23. Across the wider modelled area, there are 11 junctions where RFC would exceed 100% at AM 2029 in the baseline and in all development options 1-3. There are two junctions where RFC would fall just below 100% in the baseline, but exceed 100% with all options.

4.1.24. Potential effects of the Crawley development options upon air quality in Ashdown Forest were assessed in terms of change in annual average daily traffic flow of more than 1,000 vehicles, 2-way, relative to the baseline situation at 2029. No traffic increases of more than 250 vehicles AADT were predicted to occur on A22, A275, A26 or B2110, with any of the development options, indicating that air quality in Ashdown Forest would not be adversely affected.

4.1.25. In conclusion, the overall stage-1 outcomes indicate that the strategic development options 1-3, for Crawley, would have a similar, adverse, impact upon wider-area highway network performance at AM peak 2029. However, many of the predicted congestion problems would also be present in the baseline scenario. On the more localised Crawley network, Option 1 would entail marginally fewer congestion and queuing delay problems, relative to the baseline, than either of options 2 or 3, as measured in terms of:

- Trip volume increase;
- Uncompleted trips, stuck in queues;
- Queuing delay;
- Link flow change;
- Junction RFC exceeding 100%.

4.1.26. The stage-1 travel demand predictions, for the respective scenarios, are believed to be an underestimate of likely traffic volumes, when compared with the potential stage-2 trip rate forecasts, at a site-specific level. The stage-1 demand is also derived in the strategic multi-modal model, which underestimates the existing volume of trips within Crawley, when compared with the town centre model. Therefore, for stage 2, it may be prudent to restrict the strategic development allocations in Crawley to at, or below, the magnitude envisaged for option 1.

Appendix A

Highway Link Flows

Appendix B

Highway Link Flow Differences from Baseline

Appendix C

Highway Link Ratio of Flow to Capacity (RFC)

Appendix D

Junction Average Ratio of Flow to Capacity (RFC)

Appendix E

Junction Highest Ratio of Flow to Capacity (RFC) on Busiest Approach

Appendix F

Junction Average Delay on Busiest Approach

Appendix G

Junction Average Delay Differences from Baseline on Busiest Approach

Appendix H

Impact of Strategic Plan Scenarios on Ashdown Forest

Appendix I

Highway Network Links and Junctions for Analysis (Figures 2 and 3)