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Stafford Borough Council Core Strategy

Preferred Option Testing for M6 Junctions 13 and 14

Transport Evidence Base - Final Report

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Introduction

This is a technical transport evidence base report in response to the emerging Stafford Borough Local Development Framework (LDF), and in particular the key document within it, the Core Strategy Development Plan Document (DPD). The report is a technical assessment of the additional traffic that may be generated by further planned development within Stafford, and, an assessment if there is any detrimental impact upon the Strategic Road Network (SRN). If this proved to be the case then how this could be allayed through identifiable and tested mitigation measures.

The Highways Agency (HA) manages, maintains and improves the SRN on behalf of the Secretary of State for Transport.

This report is to assist its partners – Stafford Borough Council (as the Local Planning Authority, or LPA) and Staffordshire County Council (as the Local Highway Authority, or LHA) - in the LDF plan-making process. The report sets out the:

- Purpose and objectives of the technical assessment;
- Approach and methodology;
- Findings and conclusions.

The critical consideration for the HA is that the larger residential and employment developments that will in time be proposed within the Core Strategy (as Strategic Development Locations) or in a subsequent Allocations DPD, can be expected to generate additional traffic on the SRN.

The impact of such traffic, together with the normal increase in 'background traffic' that can be expected over the many years of the plan period, can be measured and analysed through traffic modelling. This technical work has formed the basis of the Study.

The HA, and its partners (the LPA and LHA), need this level of information to assist in informing the plan making process from a transportation perspective–led 'contribution strategy' (under-pinned by a firm spatial planning policy, and ideally enshrined within an adopted Development Plan Document). In such cases, the HA's role is to ensure that any proposed scheme can be fully justified though suitable evidence, and can be considered deliverable in terms of practicable impact and estimated cost.

Given these objectives, VISSIM was selected as the most appropriate modelling tool for JMP (the HA's transport planning consultant) to employ on the basis that its 'micro-simulation' of future traffic scenarios is the optimum means of demonstrating how additional vehicles will interact on an existing network. VISSIM (Verkehr in Stadten Simulation) translates to 'Traffic in Towns Simulation' and is ideal for this application as it accurately simulates urban traffic flow including pedestrians, cyclists and motor vehicles. A calibrated and validated VISSIM model that successfully replicates the existing conditions provides a base upon which future year models can be developed to help assess the impact of development traffic on the network. The model determines network and spare capacity, produces a technical assessment of the capacity of junctions and links, and provides a reliable base for testing mitigation options.

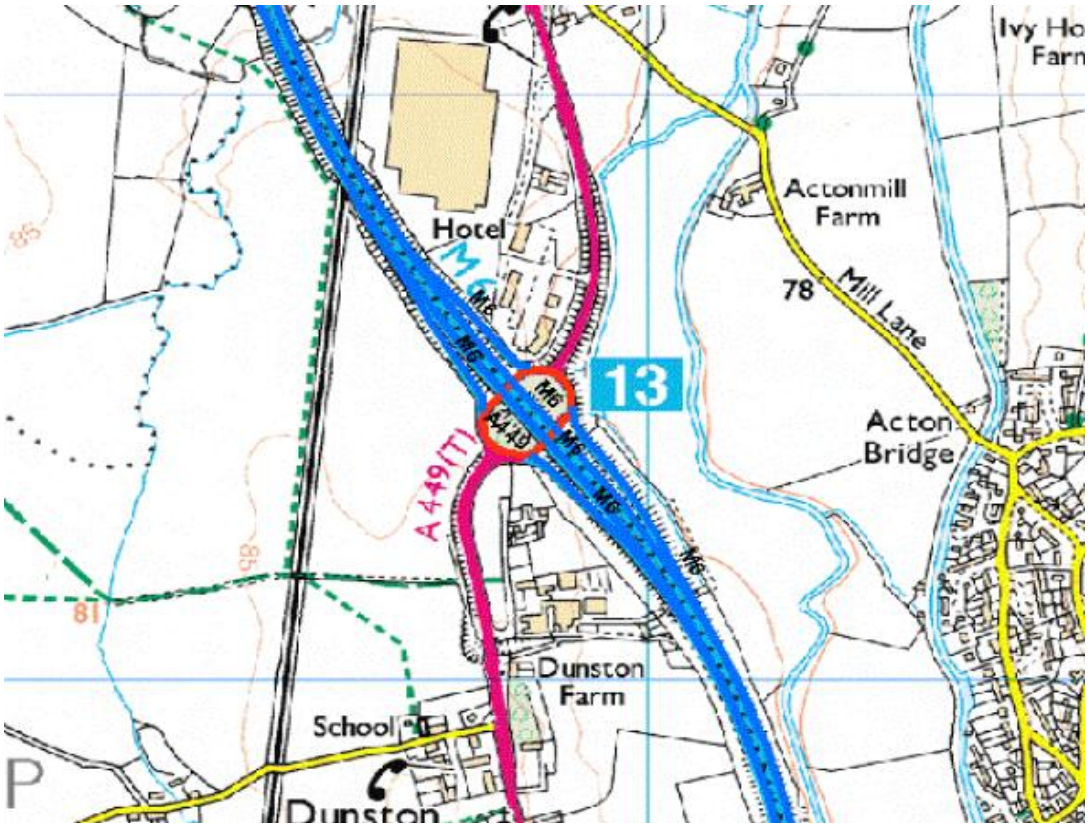
Current Traffic Conditions

The Strategic Road Network in the Stafford context consists of two motorway junctions – M6 Junctions 13 and 14.

The M6 motorway is designated as a route of national strategic importance directly linking the major metropolitan areas in the West Midlands and the North West and onwards towards London and the South East via a connection with the M1.

M6 Junction 13 is a grade separated, priority controlled junction. The HA is responsible for the mainline carriageway, slip roads and the circulatory (indicated blue and red on Figure 1).

Figure 1 M6 Junction 13

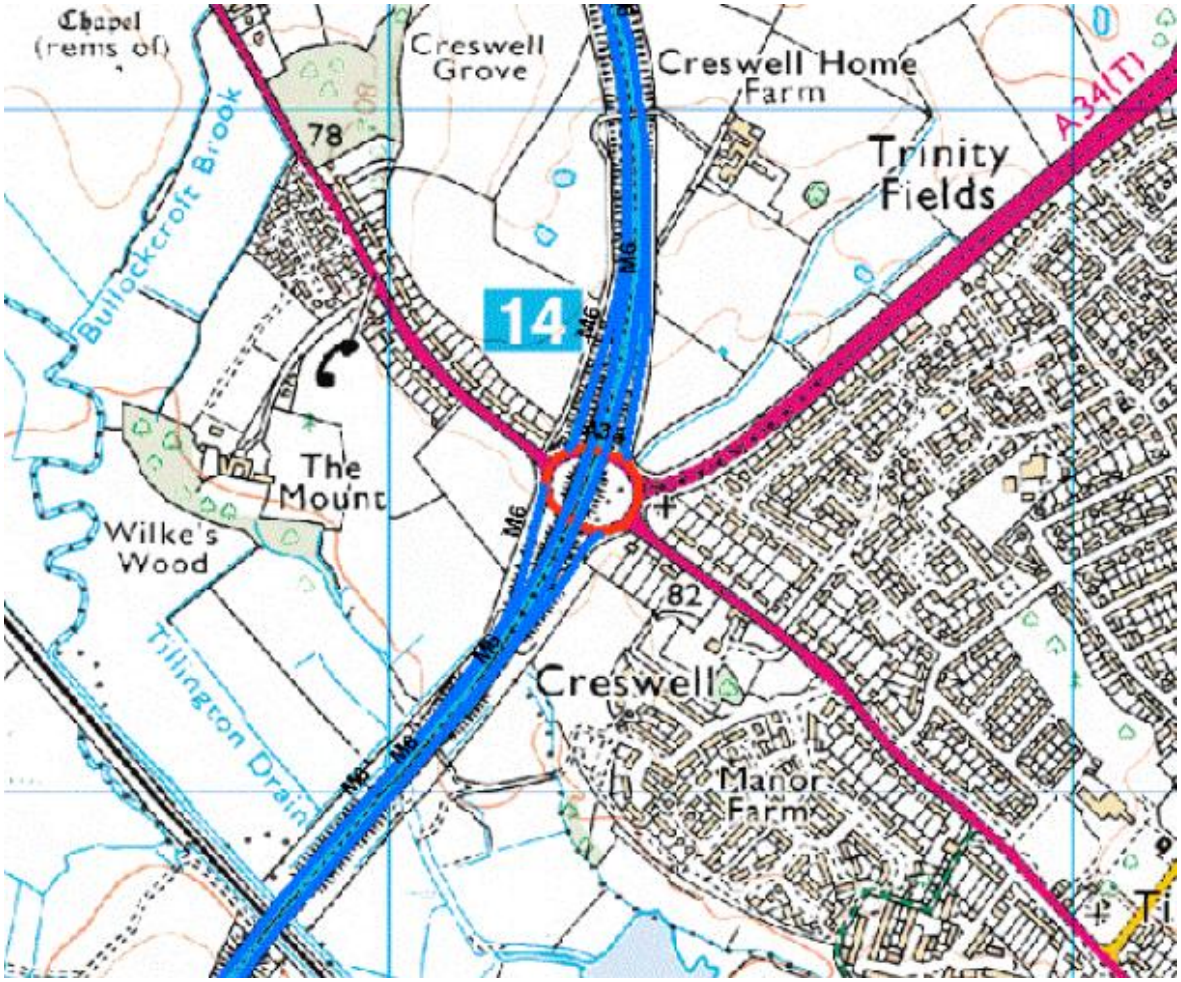


M6 Junction 14 is a grade separated, part signalised junction. The HA is responsible for the mainline carriageway, slip roads and the circulatory (indicated blue and red on Figure 2).

In 2011 a scheme was implemented which signalised both motorway 'off slips' at the junction. The result has been a much improved operation of the junction, particularly in managing the shorter northbound 'off slip' traffic.

A copy of the indicative scheme layout is provided at Annex 2.

Figure 2 M6 Junction 14



Planning Context

The purpose of the Report is to inform the plan-making process and ensure that the outcome of any future development proposals do not create safety issues or have a severe operational impact on the SRN.

The Agency has developed a three-way relationship with Stafford Borough Council (SBC) and Staffordshire CC (SCC). SBC have provided the HA with information as to the spatial options under consideration, and sought the HA's views.

These options are based on the most recent LDF consultation in 2012.

As explained in the following section, the Study relied on certain assumptions with regard the location and quantum of development in order to develop a suitable and realistic model of traffic growth and movement. These were adopted from the housing and employment figures set out in the Council's Core Strategy consultation documents, as published.

Modelling Scope and Methodology

Introduction

The purpose of this report is to understand the effect of the residential and employment allocations proposed as part of the Stafford Core Strategy on M6 Junctions 13 and 14. The Study is a technical assessment of the additional traffic that may be generated by further planned development and, if necessary, how any detrimental impact upon the SRN could be alleviated through appropriately tested and costed mitigation measures.

The basis for this assessment has been to use the industry standard modelling packages SATURN and VISSIM.

The SATURN model is under the ownership of SCC and has a 2007 base year. Forecast years of 2016 and 2031 have been constructed to test the effects of the Core Strategy Preferred Options, contained within the Plan for Stafford Borough. This SATURN model was developed by Atkins (SCC's term consultants) in partnership with Stafford Borough Council and the HA, who both participated in the study Steering Group.

The HA has used a microsimulation modelling tool known as VISSIM for M6 Junctions 13 and 14.

Junction 13

The Junction 13 model has been built using SCC's SATURN 2007 base model and is not calibrated or validated by any observed counts. The base year SATURN model was, however, calibrated at this location. SCC provided cordoned matrices for the model from the 2007 base SATURN model. Based upon this data, the VISSIM model was built for the following peak periods

- AM Peak: 0800-0900; and
- PM Peak: 1700-1800

The 2007 demand matrices were updated to 2012 demand matrices using TEMPRO growth factors. TEMPRO 6.2 data has been used for obtaining growth factors. As per WebTAG guidance, the TEMPRO growth factors have been adjusted with 2009 National Traffic Model (NTM) data. The following growth factors were derived from TEMPRO and applied to the junction arms:

Table 1 Growth Factors

Approach Arm	Road Category	Level	Area	AM	PM
NB off Slip	Motorway	41UG3	Stafford (Main)	1.03742	1.043927
A449 (west)	Trunk	41UG3	Stafford (Main)	1.029341	1.035797
SB off Slip	Motorway	41UG3	Stafford (Main)	1.03742	1.043927
A449(East)	Trunk	41UG3	Stafford (Main)	1.029341	1.035797

The model was run for 10 independent seeds. Link flows and turning flows were collected from the models and compared against the 2012 demand flows. The AM peak and PM peak results have been shown below in Table 2 and Table 3.

Table 2: Turning Flow Comparison

Approach	Exit	AM					PM				
		Assigned Flow	Modelled Flow	Difference	% Difference	GEH	Assigned Flow	Modelled Flow	Difference	% Difference	GEH
NB off Slip	A499 West	8	6	-1.7	-21.3	0.6	17	15	-2	-13.5	0.6
	NB On slip	0	0	0	0.0	0.0	0	0	0	0.0	0.0
	A499 East	553	568	15.2	2.7	0.6	360	354	-6	-1.7	0.3
	Total	561	575	13.5	2.4	0.6	377	369	-9	-2.3	0.4
A449 West	NB On slip	432	485	53.4	12.4	2.5	380	422	42	10.9	2.1
	A499 East	372	351	-21	-5.6	1.1	424	414	-10	-2.4	0.5
	SB on Slip	13	10	-2.9	-22.3	0.9	13	10	-3	-20.0	0.8
	Total	817	847	29.5	3.6	1.0	817	846	29	3.5	1.0
SB off Slip	A499 East	51	50	-0.7	-1.4	0.1	72	75	3	3.9	0.3
	SB on Slip	0	0	0	0.0	0.0	0	0	0	0.0	0.0
	A499 West	337	355	17.8	5.3	1.0	348	349	1	0.1	0.0
	Total	388	405	17.1	4.4	0.9	420	423	3	0.8	0.2
A449 East	SB on Slip	524	541	16.9	3.2	0.7	459	483	24	5.3	1.1
	A499 East	235	228	-7.2	-3.1	0.5	339	332	-8	-2.2	0.4
	NB On slip	116	112	-4.5	-3.9	0.4	53	48	-5	-9.4	0.7
	Total	875	880	5.2	0.6	0.2	851	863	12	1.4	0.4

Table 3: Link Flow Comparison

Location	AM					PM				
	Assigned Flow	Modelled Flow	Difference	% Difference	GEH	Assigned Flow	Modelled Flow	Difference	% Difference	GEH
A449 (West) EB	817	817	0	0.0	0.0	817	819	2	0.2	0.1
A449 (West) WB	580	594	14	2.3	0.6	704	711	7	0.9	0.2
NB On slip	548	547	-1	-0.2	0.1	433	437	4	0.9	0.2
SB Off slip	388	395	7	1.9	0.4	420	427	7	1.6	0.3
A449 (East) EB	976	1017	41	4.2	1.3	856	857	1	0.1	0.0
A449 (East) WB	875	881	6	0.7	0.2	851	861	10	1.1	0.3
SB on slip	537	537	0	0.1	0.0	472	475	3	0.7	0.2
NB Off slip	561	603	42	7.6	1.8	377	379	2	0.4	0.1
M6 (north of J13) SB	4143	4181	38	0.9	0.6	4317	4356	39	0.9	0.6
M6 (north of J13) NB	4314	4310	-4	-0.1	0.1	4211	4249	38	0.9	0.6
M6 (south of J13) NB	4327	4373	46	1.1	0.7	4155	4194	39	0.9	0.6
M6 (south of J13) SB	4292	4318	26	0.6	0.4	4369	4402	33	0.7	0.5

The results show that the assigned flows were able to complete their trips and the models are calibrated effectively.

Junction 14

The VISSIM micro-simulation model for M6 junction 14 was built by JMP for the HA in 2010. To develop the base model scenario, historic junction flow data collected in 2008 was utilised.

This model was used to test the previous growth options for Stafford Borough. It is important to note that the existing signalisation of the motorway 'off' slips was not in place at the time. The base model has since been updated with the signals in order to represent an accurate reflection of the existing network operating conditions.

The original testing also used 2026 development flows (derived from SCC's SATURN model) to illustrate the impact on the junction. These were revised to reflect the 2031 scenario required as part of this report.

Using the SATURN model, SCC undertook an exercise to understand the traffic generation and distribution from SBC's preferred growth options. Annex 1 illustrates the latest spatial development options and the scenarios used for this evidence base.

SCC used the model to illustrate how the network would look in 2031 (the end of CS plan period) with all the suggested development in place.

Staffordshire Council provided 2031 cordon demand matrices for M6 J13. These were entered directly into the HA Junction 13 VISSIM model to create the 2031 VISSIM model. Two vehicle types were modelled, Lights and HGVs.

2031 VISSIM models have been developed for the AM (0800 – 0900) and PM (1700 – 1800) peak periods. Both periods have a 15 minute warm up period.

No changes were made to the junction for the future year model; hence the network was tested as it is in the 2012 base model.

Testing M6 Junction 13

The model was run for 10 independent seeds and the outputs were summarised and compared against the base year model

Table 4 Link Flows Comparisons between base and 2031 model

Location	AM				PM			
	Base Flow	2031 Flows	Difference	Growth Factors	Base Flow	2031 Flows	Difference	Growth Factors
A449 (West) EB	817	949	132	1.16	819	962	143	1.17
A449 (West) WB	594	606	12	1.02	711	784	74	1.10
NB Onslip	547	520	-27	0.95	437	552	115	1.26
SB Offslip	395	412	17	1.04	427	462	36	1.08
A449 (East) EB	1017	1210	193	1.19	857	1142	285	1.33
A449 (East) WB	881	1053	172	1.20	861	1082	221	1.26
SB Onslip	537	756	219	1.41	475	665	190	1.40
NB Offslip	603	677	74	1.12	379	642	263	1.70
M6 (north of J13) SB	4181	4913	732	1.18	4356	5201	845	1.19
M6 (north of J13) NB	4310	4912	602	1.14	4249	5111	861	1.20
M6 (south of J13) NB	4373	5065	691	1.16	4194	5197	1003	1.24
M6 (south of J13) SB	4318	5250	932	1.22	4402	5404	1002	1.23

The average traffic growth between the base and 2031 for AM and PM is 15%% and 26% respectively.

A comparison between SATURN 2031 and VISSIM 2031 traffic flow was done to examine the validity of the model. Table 5 summarises the results.

Table 5 Link Flow Comparisons between 2031 SATURN and 2031 VISSIM Models

Location	AM					PM				
	Saturn Flows (2031)	VISSIM (2031)	Diff.	% Diff.	GEH	Saturn Flows (2031)	VISSIM (2031)	Diff.	% Diff.	GEH
A449 (West) EB	972	949	-22.6	-2.3%	0.7	959	962	2.8	0.3%	0.1
A449 (West) WB	621	606	-15.4	-2.5%	0.6	775	784	9.3	1.2%	0.3
NB Onslip	532	520	-12.0	-2.3%	0.5	550	552	1.6	0.3%	0.1
SB Offslip	425	412	-12.7	-3.0%	0.6	450	462	12.2	2.7%	0.6
A449 (East) EB	1235	1210	-25.4	-2.1%	0.7	1139	1142	2.9	0.3%	0.1
A449 (East) WB	1067	1053	-13.7	-1.3%	0.4	1078	1082	4.0	0.4%	0.1
SB Onslip	769	756	-12.9	-1.7%	0.5	673	665	-7.9	-1.2%	0.3
NB Offslip	693	677	-15.7	-2.3%	0.6	640	642	1.8	0.3%	0.1
M6 (north of J13) SB	4983	4913	-70.4	-1.4%	1.0	5158	5201	42.8	0.8%	0.6
M6 (north of J13) NB	4989	4912	-77.2	-1.5%	1.1	5063	5111	47.8	0.9%	0.7
M6 (south of J13) NB	5150	5065	-85.4	-1.7%	1.2	5154	5197	42.8	0.8%	0.6
M6 (south of J13) SB	5327	5250	-76.5	-1.4%	1.1	5371	5404	32.7	0.6%	0.4

The results showed that the VISSIM model has very similar link flows to the SATURN model. Turn flows at each approach were compared between the VISSIM base and 2031 model. The results are provided in Table 6.

Table 6 Turning Flows Comparisons between base and 2031 VISSIM Models

		AM				PM			
Approach	Exit	Base Year	2031	Difference	Growth Factors	Base Year	2031	Difference	Growth Factors
NB Offslip	A499 West	6	10	3	1.5	15	21	6	1.4
	NB Onslip	0	0	0	0.0	0	0	0	0.0
	A499 East	568	688	120	1.2	354	620	266	1.8
	Total	575	698	123	1.2	369	641	273	1.7
A449 West	NB Onslip	485	477	-9	1.0	422	480	58	1.1
	A499 East	351	482	131	1.4	414	466	52	1.1
	SB Onslip	10	15	5	1.5	10	17	7	1.7
	Total	847	973	127	1.1	846	963	117	1.1
SB Offslip	A499 East	50	70	20	1.4	75	55	-20	0.7
	SB Onslip	0	0	0	0.0	0	0	0	0.0
	A499 West	355	354	-1	1.0	349	407	58	1.2
	Total	405	424	19	1.0	423	462	39	1.1
A449 East	SB Onslip	541	756	216	1.4	483	648	164	1.3
	A499 East	228	258	31	1.1	332	357	25	1.1
	NB Onslip	112	56	-56	0.5	48	72	24	1.5
	Total	880	1071	190	1.2	863	1076	213	1.2

The proportions of traffic are similar in both the base and 2031 model.

To understand the change between base and future queue conditions, queue data was collected at four locations. The queue data comparison between the base and 2031 model are summarised in Table 7.

Table 7 Queue Lengths Comparisons between base and 2031 models

	Average Maximum Queue lengths in Meters			
Approach	AM Base	AM 2031	PM Base	PM 2031
SB Offslip (length approx. 200m)	47	123	32	81
A449 (East)	101	127	50	131
NB Offslip (length approx.200m)	48	54	35	71
A449 (West)	91	223	19	233

The queue length comparison shows that the queue lengths are higher in 2031 compared to the base, which is as expected. However, these increased queue lengths do not seem to cause any issues on the functioning of the junction

As shown in Table 7 the queues at slip roads are higher in 2031 than the base, however the slip roads have sufficient holding capacity (approx 200m length for each slip road) to accommodate the queuing vehicles and thus the mainline is not affected by the off slip queues in either time periods.

The observation made during the model run suggests that the only issue that may affect the performance of the junction is the long queue of vehicles for eastbound traffic on A449 on the western approach of the Junction. This is observed for both peak periods. Traffic on this arm does not come to a standstill, however, the approach is noted to be congested most of the time and traffic speeds also reduce substantially.

The overall network performance for base and 2031 is given in Table 8.

Table 8 Network Performance Comparisons for Base and 2031 Models

Parameter	**AM Base**	**AM 2031**	**PM Base**	**PM 2031**
Average delay time per vehicle [s], All Vehicle Types	6.90	11.70	5.03	11.92
Average number of stops per vehicles, All Vehicle Types	0.12	0.19	0.06	0.20
Average speed [km/h], All Vehicle Types	84.72	80.27	87.11	79.98
Total delay time [h], All Vehicle Types	20.09	39.18	14.60	42.16
Number of vehicles in the network, All Vehicle Types	236.90	286.30	222.30	290.60
Number of vehicles that have left the network, All Vehicle Types	10238.30	11672.80	10221.50	12441.30
Total travel time [h], All Vehicle Types	229.04	276.06	222.68	295.00

The average delay time per vehicle increases from 6.90 seconds to 11.70 seconds in the AM, and from 5.03 seconds to 11.92 seconds in the PM. The total delay time for all vehicles increased from 20.09 hours to 39.18 hours in the AM and from 14.60 hours to 42.16 hours in PM.

The average speed reduces from 84.72 km/h to 80.27 km/h in AM and from 87.11 km/h to 79.98 km/h in PM.

It is apparent from the above table that the overall network performance deteriorates in 2031. The speeds reduce, and the delays and travel times increase.

It is expected that in 2031 the junction won't operate as effectively as the base. However, traffic in 2031 is moving and there are no standstill queues or queues blocking back observed, therefore the results do not show any severe congestion issues.

In any case, the base year model was not calibrated to observed queue lengths on the A449. Recent observations by SCC indicate that queues on the A449 approaches are generally over estimated in the base year model, giving some confidence that queue levels will not reach the levels predicted in 2031.

Conclusion of M6 Junction 13 Testing

The model results show that M6 Junction 13 performs satisfactory with 2031 with all development traffic.

Testing M6 Junction 14

As previously mentioned, JMP on behalf of the HA developed a 2008 validated base model and undertook the following option tests on Stafford's previous growth options:

- 2026 Do minimum: 2026 Forecast flows with the (then) existing junction layout
- 2026 Do Something: 2026 Forecast flows with northbound 'off' slip signalised

The aim of this exercise was to compare the previous work carried out testing M6 Junction 14 with the latest growth options and observe the net difference between the two.

Forecast flows were supplied by SCC.

SCC provided the HA with their latest SATURN forecasting model results based upon the 2012 preferred options for an assessment year of 2031.The previous assessment year was 2026 and so this had to be revised.

Total 2031 development flows were derived by calculating the difference between SATURN 2007 base and 2031 forecast model flows. The base SATURN flows were subtracted from 2031 SATURN forecast flows to obtain growth between 2007 and 2031. The growth is then added to 2008 VISSIM flows. It was assumed that there is no growth between 2007 and 2008.

When subtracting the flows, the results showed some negative numbers. This was possibly due to traffic rerouting in the SATURN model or as a result of modal shift after the demand model run. However, the negative growth in traffic movements has been replaced by zero to make the analysis more robust.

Table 9: AM Peak Flow Comparison in PCU

Junction Approach	2007 SATURN	2026 SATURN with Redhill	2031 SATURN	Difference	2008 VISSIM	2026 DS2 VISSIM	2031 VISSIM	Difference	% Changes
	1	2	3	4 = (3-1)	5	6	7 = (5+4) adjusted	8 = (7-6)	9
Eccleshall Road (W)	746	876	956	210	698	867	948	81	9.34%
M6 Off-Slip SB	522	485	506	-16	484	486	492	6	1.23%
A34	908	1028	1189	281	887	1121	1218	97	8.65%
Eccleshall Road (E)	624	609	574	-50	527	590	575	-15	-2.54%
M6 Off-Slip NB	920	1077	1081	161	810	967	971	4	0.41%
Total	3720	4075	4306	586	3406	4031	4204	173	4.29%

Table 10: PM Peak Flow Comparison in PCU

Junction Approach	2007 SATURN	2026 SATURN with Redhill	2031 SATURN	Difference	2008 VISSIM	2026 DS2 VISSIM	2031 VISSIM	Difference	% Changes
	1	2	3	4 = (3-1)	5	6	7 = (5+4) adjusted	8 = (7-6)	9
Eccleshall Road (W)	446	596	616	170	450	603	621	18	2.99%
M6 Off-Slip SB	433	399	326	-107	398	398	398	0	0.00%
A34	942	1187	1218	276	976	1250	1286	36	2.88%
Eccleshall Road (E)	785	810	778	-7	721	834	858	24	2.88%
M6 Off-Slip NB	899	1066	1145	246	811	1047	1126	79	7.55%
Total	3505	4058	4083	578	3356	4132	4289	157	3.80%

Conclusion of M6 Junction 14 Testing

The comparative analysis illustrates the difference in flows between the previous Stafford preferred growth options with that of the latest.

The percentage change in the figures suggests that further detailed VISSIM model testing is not required for Junction 14 and that the Junction performs satisfactorily in 2031 without the need for further mitigation.

Sustainable Transport Measures

In line with current DfT policy guidance as set out within the Circular 02/2007 (at time of writing 02/2007 is currently under review), the HA fully encourage the promotion and inclusion of mechanisms to encourage use of alternatives to the car.

Smarter choice initiatives are aimed at persuading people to alter their travel behaviour using initiatives such as travel plans; personalised travel planning; public transport marketing; and travel awareness campaigns.

Successful implementation of smarter choice and demand management measures can provide a further opportunity for further development where otherwise available capacity would be limited.

Whilst not applicable in this instance for the SRN, they may also impact upon the scale and detail of other hard transport interventions (junction/road widening for example).

It is important to note that the current junction(s) model testing undertaken does not take into account further deductions in the levels of residual development traffic associated with the implementation of smarter choice/ demand management measures and is therefore reflective of a robust assessment of the developments proposed. It is noteworthy that both Staffordshire County Council and Stafford Borough Council strongly support the provision and promotion of smarter choice initiatives.

Indeed Stafford has recently been awarded some £4.2m from the Local Sustainable Transport Fund and in the period to 2015, the successful implementation of the interventions contained within the proposal should significantly affect travel behaviour in the County Town.

All development proposals will be expected to be accompanied by a package of infrastructure and a travel planning regime to make them acceptable in transport terms.

Summary of Findings and Conclusion

This report has produced by the HA in order to assist its partners Stafford Borough Council and Staffordshire County Council in the LDF plan-making process.

The Study reflects the Highways Agency's policy and the approach set out in the Department for Transport's Circular 02/2007 Planning and the Strategic Road Network. This policy is currently under revision (September 2012).

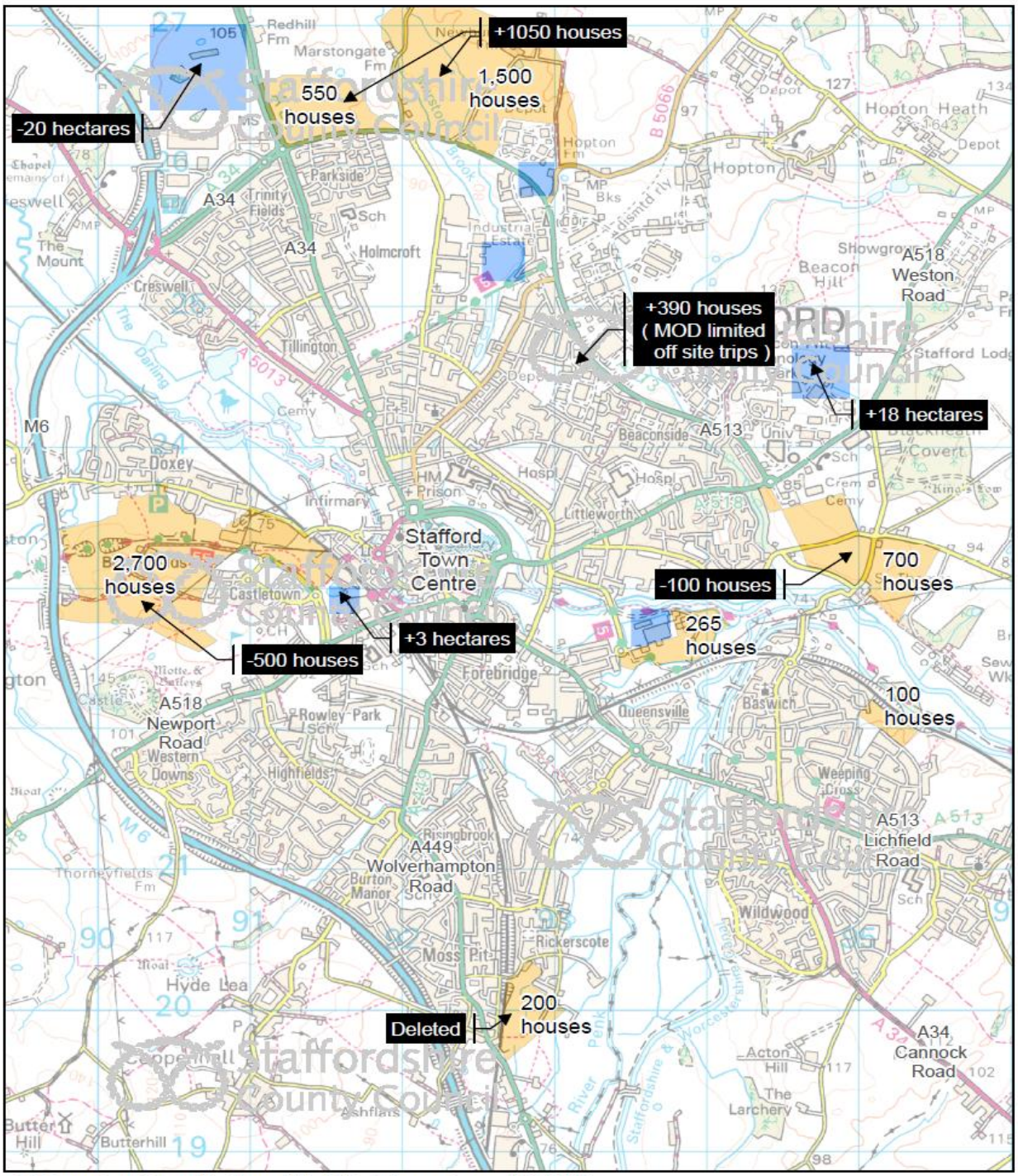
The results of this exercise are presented as evidence that the transport effects of the proposed Stafford Core Strategy development growth aspirations have been considered for the SRN Furthermore this exercise demonstrates the both M6 Junctions 13 and 14 operate to a satisfactory level throughout the plan period with all the proposed development (as set out in Annex 1) in place.

Any additional development over and above what has formed part of this report however, will need to undergo additional testing and may require additional mitigation measures to offset any adverse operational impacts.

Annex 1: Stafford Land Use Allocations 2006-2031

Stafford Western Access Improvements
Land Use Scenario Assumptions 2006 - 2031

Modelled Housing Sites Modelled Employment Sites



Annex 2: Indicative Layout for M6 Junction 14 Scheme (Implemented 2011)