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Warwickshire County Council
**Stratford-on-Avon Strategic
Transport Assessment**
Studley HGV Scenario Analysis

232815-07.R001

Issue | 11 April 2014

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 232815-07

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1 Introduction

The purpose of this report is to set out the findings from additional testing the impacts of an allocation of growth within the area of Winyates Green/Gorcott Hill (henceforth referred to as WG) as part of Stratford on Avon District Council's (SDC's) emerging Core Strategy. This work is intended to build upon the analysis set out during the previous phase of testing undertaken, as part of the Phase 2 Strategic Transport Assessment, by Arup on behalf of Warwickshire County Council (WCC) and SDC.

1.1 Overview

The objective of this stage of the assessment is to further understand the potential implications of allocating approximately 28 hectares of land at Winyates Green Triangle and Gorcott Hill for employment use. This Report builds upon the results of the *Stratford-on-Avon Strategic Transport Assessment Phase 2: Studley Scenario Analysis (July 2013)* Report.

The objectives of this stage of analysis are as follows:

- To understand the implications of the allocation of the land at Winyates Green/Gorcott Hill employment site when HGV movements are also included;
- To assess, in detail, the likely impact on the AQMA within Studley, of the assignment of additional vehicular demands as a result of the allocated site.

Demands within the existing 2028 Studley Reference Case have been developed through the forecasting of the existing model demands with factors derived from the TEMPRO database.

2 Development Demand Assumptions

The following section is intended to outline some of the key assumptions attributed to the allocation of HGV trip generation values for the Winyates Green/Gorcott Hill employment development scenario (WG/GH) referred to in Table 1 below.

Trip rates for HGVs associated with the development were estimated using TRICS 2013(a) (v6.11.2 edge of town sites) and were adjusted to account for the expected distribution of land to office, industrial and warehouse employment.

Table 1: Key units

Item	Quantity	Units
Site gross area	28	hectares
coverage	40%	
net site area	11.2	hectares
net site area	1120	100m ²
B1 proportion	50%	
B1 net site area	560	100m ²
B2 proportion	30%	
B2 net site area	336	100m ²
B8 proportion	20%	
B8 net site area	224	100m ²

The hourly trip generation attributed to the development are outlined within the Table 2 below. In total the development is assumed to generate 94 and 34 trips during the AM and PM peak periods respectively.

Table 2: Land At Winyates Green/Gorcott Hill Net Trip Generation (HGVs)

Time	In	Out
0700 to 0800	8	16
0800 to 0900	16	18
0900 to 1000	16	21
Total	94	
1600 to 1700	10	4
1700 to 1800	9	5
1800 to 1900	3	2
Total	34	

Traffic counts, undertaken Thursday 9th December 2010, were provided by WCC at the Icknield Street Drive/ Washford Drive roundabout (Figure 1). This count was used as a proxy to determine the relevant split of HGV trips generated by the development which would exit the site and travel southwards along the A435 through the Studley area. This was then applied to the aforementioned trips generated by the new employment area. The existing traffic distributions are shown in Table 3.

Figure 1: Location of Icknield Street Drive/Washford Drive roundabout.



Table 3: Existing distribution of traffic to/from Studley AQMA area

Existing traffic distribution	% to Studley AQMA	% from Studley AQMA
07:00-08:00	20%	33%
08:00-09:00	40%	21%
09:00-10:00	55%	8%
16:00-17:00	14%	19%
17:00-18:00	25%	21%
18:00-19:00	25%	0%
Total AM	42%	19%
Total PM	21%	18%

The resulting new HGV trips which were added to the network during the AM and PM peak hours are shown below.

Table 4: Additional HGV trips on the network

	Arrivals	Departures	Total
07:00-08:00	2	5	7
08:00-09:00	6	4	10
09:00-10:00	8	2	10
16:00-17:00	1	1	2
17:00-18:00	2	1	3
18:00-19:00	1	0	1

The additional trips were redistributed to the network following the existing distribution of traffic to/from zone 202 within the PARAMICS model. This zone was chosen as it is the same zone as was used to assign all existing and forecast vehicle demands via the A435 to the north east of Studley. It is from this location that it is envisaged that the majority of HGV trips will enter into the study area. In order that a more reflective routing pattern was retained within the assignment matrix, the northern zones were removed from this distribution and the assignment of HGV trips was focussed to the south to ensure that the trips that did enter the study area travelled across the model network. This reflects the fact that it is unlikely that a HGV would enter via the A435 and travel towards the A441 area. It is more likely that trips of this nature would travel through Redditch via the A4189.

2.1 Total demands

Table 5 shows the total demand for the three tested scenarios during the AM and PM peak periods. It can be seen that there is a 2-3% increase in demand volumes between the Winyates Green/Gorcott Hill and Reference Case Scenario. Further, the HGV scenario demand volumes are 0.01-0.02% higher than for the Winyates Green/Gorcott Hill scenario.

Table 5: Total demand for the 3 scenarios in the AM and PM peak periods

Demand	AM (07:00 to 10:00)	PM (16:00 to 19:00)
2028 Ref	29,062	30,124
2028 WG/GH	29,959	30,790
2028 WG/GH + HGV	29,985	30,797

It should be noted that the forecasting of HGV trips within the background matrices has already been undertaken through interrogation of the 2009 to 2028 NTEM forecast tables, using the All Roads factor, thus there is a chance that the additional HGV trips loaded in to the model as a result of the development may have already been accounted for within the initial forecasting process. The impacts of any double counting of this nature are unlikely to be significant and, as a result, no adjustments have been made in this respect.

3 Network Wide Performance Measures

The first stage of assessment is to review the performance of each of the key scenarios against the following network-wide statistics:

- **Average Journey Time (seconds)** – The average travel time of a completed trip during the model simulation period.
- **Average Distance (Km)** – The average distance travelled by a vehicle that completed their journey during the model simulation period.
- **Average Speed (Km/h)** – The average speed travelled by all vehicles that completed a journey during the model simulation period.
- **Completed Trips (vehicles)** – The number of completed trips recorded during the model simulation.

3.1 Network Wide Statistics

The following sets out the changes in network wide statistics between the 2028 Reference Case and the two development scenarios, the original scenario as was previously reported as well as the latest HGV scenario.

3.1.1 Average Journey Time (Seconds)

Analysis of the average journey time, in seconds, within each scenario, across the entire AM and PM model periods, is presented within Figure 2 on the following page.

Analysis of the difference in average journey time across the scenarios, presented within Figure 2, indicates that, during the AM period, there is approximately a 20% increase in the average journey time for the Winyates Green Scenarios when compared to the Ref Case. This is attributable to the inclusion of the additional trips on the network as a result of the developments.

The HGV Scenario results in slightly shorter delays when compared to the Winyates Green/Gorcott Hill scenario but significantly longer delays when compared to the reference case during the AM peak period. In the evening, the Winyates Green/Gorcott Hill and HGV scenario result in equal delays as expected.

The analysis of the impact on average journey times that is likely to occur as a result of the adoption of the various scenarios indicates that, within the PM, demand levels proposed by the 2028 WG and the WG +HGV scenarios result in a substantial increase in delay. This is to be expected as it is these scenarios which allocate the highest levels of demand to the network.

3.1.2 Average Journey Speed

Analysis of the average journey speed (km/h) within the two scenarios, across the entire AM and PM model periods, is presented within the following Figure 3 on the following Page.

Figure 2 : Average Journey Time (Seconds) 2028 Studley Core Strategy Scenarios

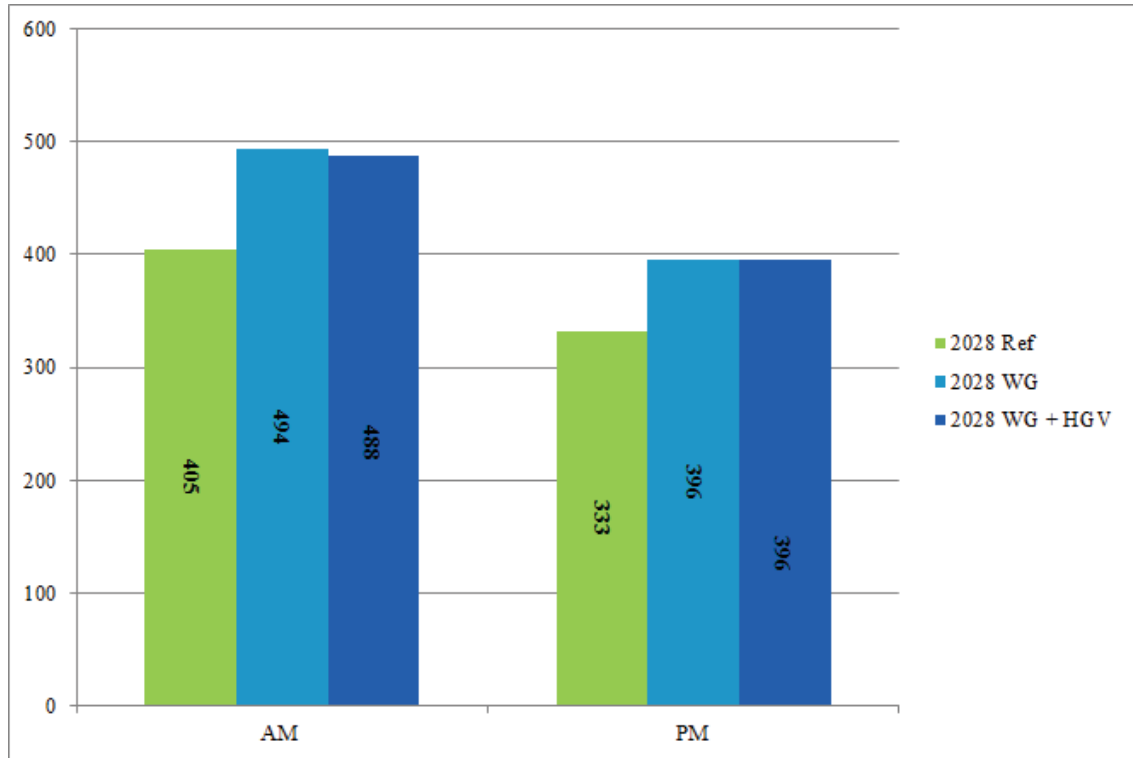
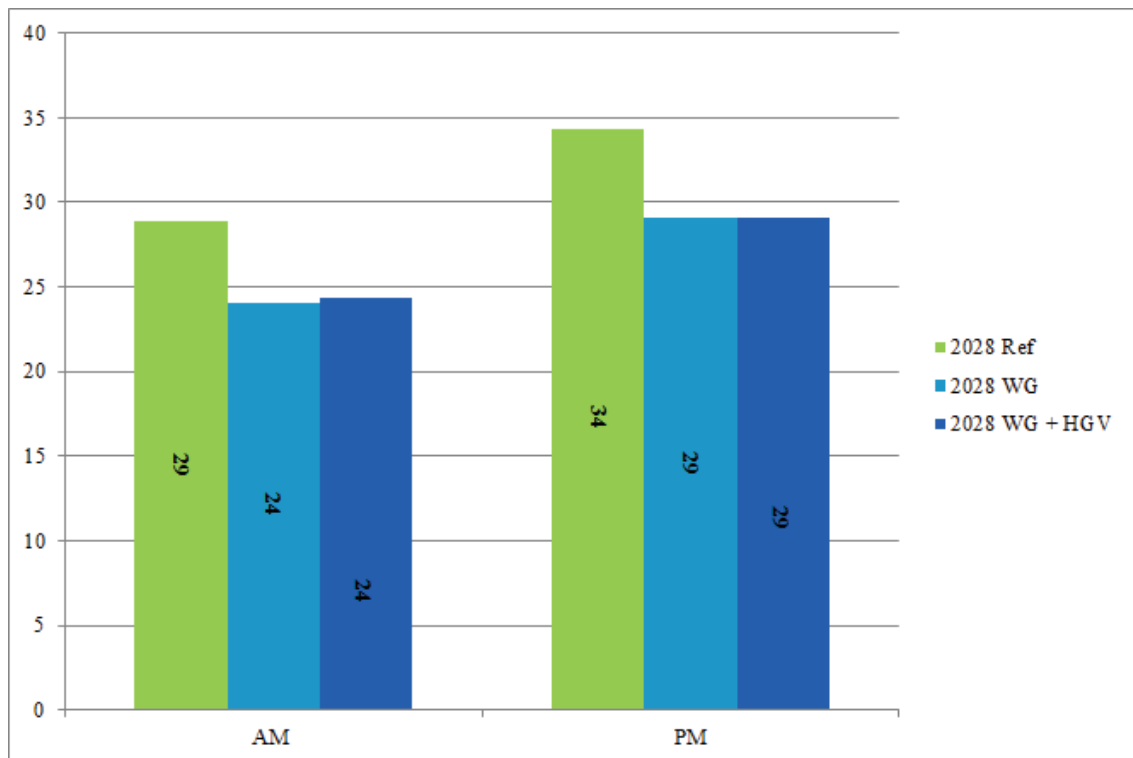


Figure 3: Average Journey Speed (Kmh-1) 2028 Studley Core Strategy Scenarios



The previous Figure 3 demonstrates that the differences in the average speeds that vehicles are able to travel at throughout each scenario network correlates to the data presented within the analysis of the average journey times. Analysis reveals that when compared to the 2028 Ref Case, the 2028 WG and WG+ HGV scenarios suffer a notable drop in average speeds. Ultimately, there is a very

minimal difference in average vehicle speed expected between the Winyates Green/Gorcott Hill and HGV scenarios.

Allocating additional demand is inevitably going to result in a drop in the overall average speed that vehicles are able to travel at within the network due to increased friction therein. However, the 2028 WG/ WG + HGV scenarios suffer substantial drops in the average speeds across both AM and PM periods which should be considered indicative of the impacts incurred as a result of the assignment of additional demands in those scenarios.

3.1.3 Average Journey Distance

Analysis of the average journey distance within each scenario, across the entire AM and PM model periods is presented within the following Table 6.

Table 6: Average Journey Distance (Km) 2028 Studley Core Strategy Scenarios

	2028 Ref	2028 WG	2028 WG + HGV
AM	3.2	3.3	3.3
PM	3.2	3.2	3.2

Analysis of the previous table reveals very little difference in the average distances that vehicles travel within each of the scenarios. This indicates that the propensity for vehicles to switch onto alternative routes when faced with increased delay and congestion is likely to be limited. This is to be expected given the limited number of routes through Studley.

3.1.4 Completed Trips

Analysis of the total number of completed trips within each scenario, across the entire AM and PM model periods, is presented within Figure 4 on the following page.

Analysis of Figure 4 reveals very little difference in the overall level of trip completion across each scenario. In most cases the number of trips that have completed within the respective model runs has increased. This is to be expected given the increase in the level of assigned demand.

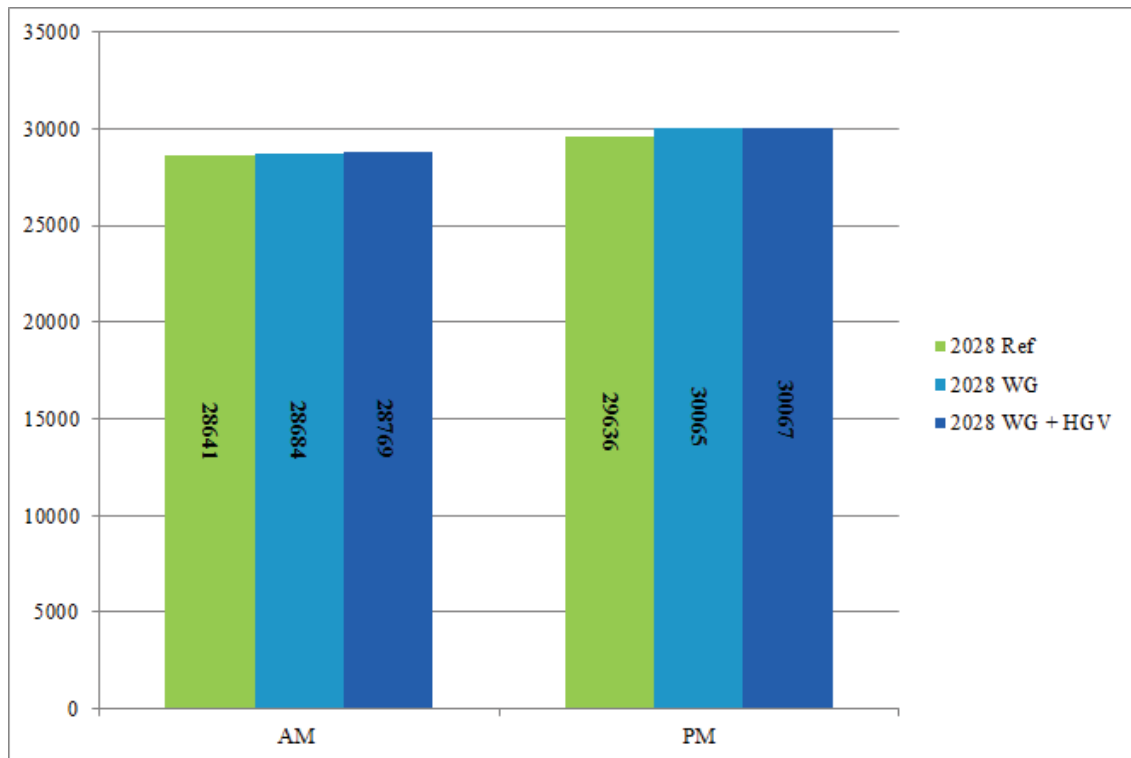
To understand how much demand is either unreleased or left on the network at the end of the simulation period the number of completed trips has been compared against the total demand levels assigned within the model. This information has been presented within Table 7.

Table 7: Completed Trips Analysis 2028 Studley Core Strategy Scenarios

	AM (07:00 to 10:00)			PM (16:00 to 19:00)		
	Demand	Completed Trips	Completed %	Demand	Completed Trips	Completed %
2028 Ref	29,062	28,641	98.55%	30,124	29,636	98.38%
2028 WG	29,959	28,684	95.75%	30,790	30,065	97.64%
2028 WG + HGV	29,985	28,769	95.94%	30,797	30,067	97.63%

The previous Table illustrates that, as a proportion of the demand assigned, the proportion of trips that are completed during the AM model period, drops for the Winyates Green/Gorcott Hill scenarios (slightly less for the HGV scenario). During the PM peak period, the proportion of trips completed is slightly lower for the Winyates Green/Gorcott Hill and Winyates Green/Gorcott Hill HGV scenario. This indicates that, despite the minor impact on delay and speeds that occur during the PM peak period, the demands within this scenario, are largely accommodated within the current network.

Figure 4: Completed Trips (Vehicles) 2028 Studley Core Strategy Scenarios



There is largely no difference in completed trips expected between the Winyates Green/Gorcott Hill and HGV scenarios.

3.2 Average Maximum Queue Length Analysis

One of the most useful indicators of the overall level of network performance that has been adopted within the analysis is the impact on Average Maximum Queue lengths across the entire model periods.

At this stage the analysis of queue lengths has been based on the average hourly maximum queue length. Results presented for each junction are based on the worst performing single approach. The hourly maximum for each individual model run has been calculated and then the average of all runs has been calculated for each hour. The average of these values, across all model hours, is reported as the periodic average maximum queue length and is reported in vehicles.

The maps which are referred to within the following analysis are presented within **Appendix A** of this report. Comparative plots have been produced which compare queue lengths within the Winyates Green/Gorcott Hill and Winyates Green/Gorcott Hill + HGV scenarios with the original 2028 Reference Case

queuing levels. The scenarios have been compared against the Ref Case, by period, and have been presented separately within the following plots:

- MQ001 & MQ002 – Land at Winyates Green/Gorcott Hill AM & PM
- MQ003 & MQ004 – Land at Winyates Green/Gorcott Hill + HGV AM & PM

The junctions for which average hourly maximum queue lengths have been calculated and compared are illustrated within Figure 5 on the following page.

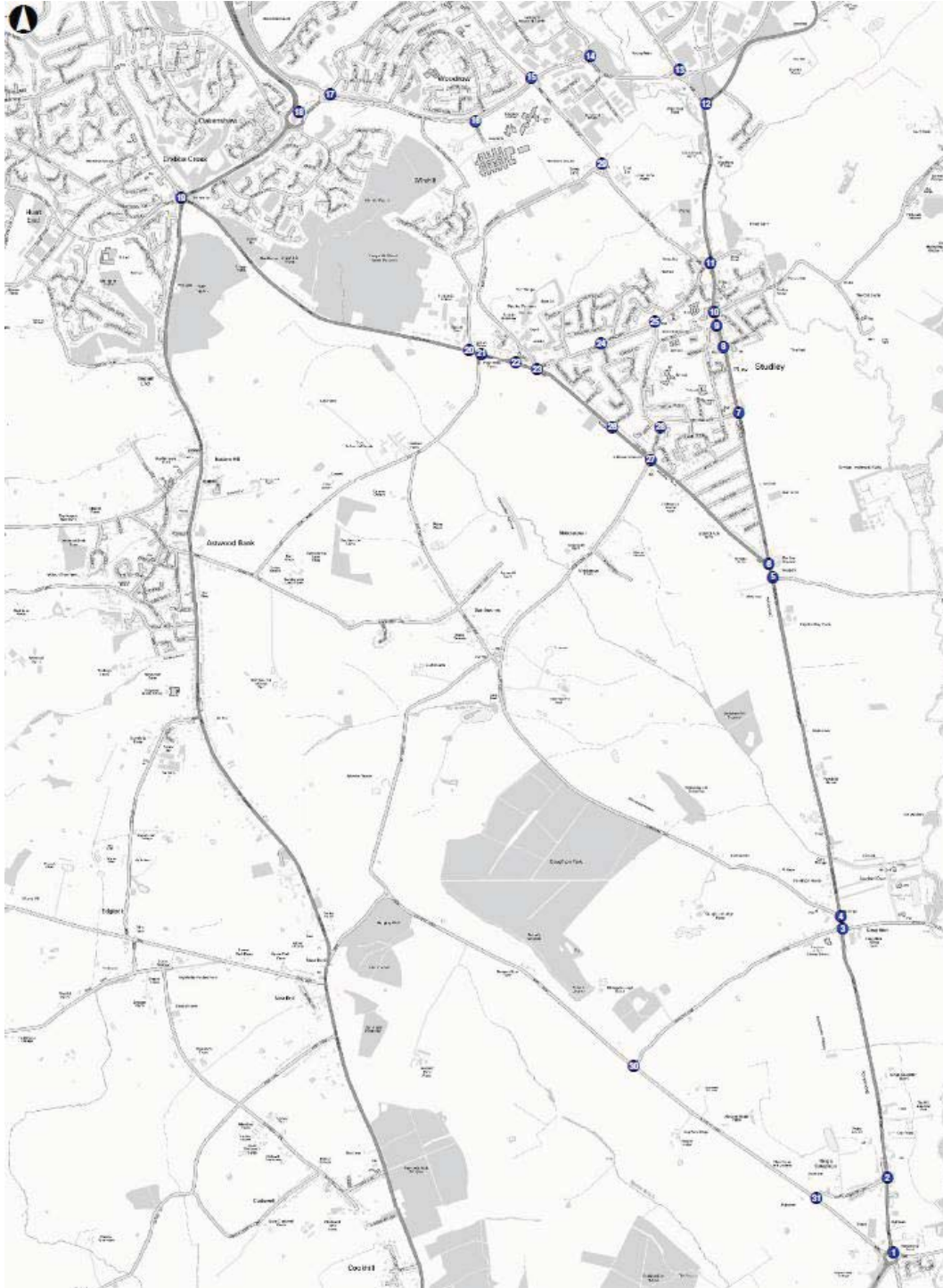
Junctions where queue differences have not been plotted on the maps simply represent junctions which did not trigger any of the assessment criteria across any one approach.

At this stage these results simply identify areas where further attention is required. A queue length increase of 50 vehicles does not necessarily mean that a scheme will not work, it may indicate that further optimisation of the layout or any signal times are required. Furthermore it may not account for improvements on other arms of the same junction which, when investigated further, may contain additional capacity which could be unlocked to reduce the queue length on the offending approach.

The classification of differences used within the queue length analysis is outlined as follows:

- **Queue Reduction** (a reduction in queue lengths of greater than 5 vehicles)
- **Moderate Increase** (an increase in queue lengths of between 15 and 25 vehicles)
- **Severe Increase** (an increase in queue lengths of between 25 and 50 vehicles)
- **Very Severe Increase** (an increase in queue length of over 50 vehicles)

Figure 5: Queue Assessment, Junction Locations



3.2.1 Winyates Green/Gorcott Hill / Winyates Green/Gorcott Hill + HGV Queuing Level Analysis (MQ001, MQ002 and MQ003, MQ004)

When comparing the differences during the AM peak period (MQ001 and MQ0017), and the PM peak period (MQ002 and MQ0018) it can be seen there are a few slight changes in the queue lengths expected for the Winyates Green/Gorcott Hill and HGV scenarios. Notable these changes are:

- Washford Drive/ Old Forge Drive (no change under the Winyates Green/Gorcott Hill scenario, queue reduction expected under the HGV scenario in the AM peak period)
- A448/ Bromsgrove Road/ Middletown Lane/ Littlewood Green (moderate increase under the Winyates Green/Gorcott Hill scenario, no change expected under the HGV scenario in the AM peak period)
- Sambourne Lane/ Birmingham Road (moderate increase under the Winyates Green/Gorcott Hill scenario, queue reduction expected under the HGV scenario in the AM peak period)
- Alcester Road/ New Road (no change under the Winyates Green/Gorcott Hill scenario, moderate increase expected under the HGV scenario in the AM peak period)
- Washford Drive/ Old Forge Drive (moderate increase under the Winyates Green/Gorcott Hill scenario, no change expected under the HGV scenario in the PM peak period)
- Icknield Street Drive/ B447/ Birmingham Road (no change under the Winyates Green/Gorcott Hill scenario, moderate increase expected under the HGV scenario in the PM peak period)
- Alcester Road/ New Road (no change under the Winyates Green/Gorcott Hill scenario, moderate increase expected under the HGV scenario in the PM peak period)

3.3 Summary

Whilst more detailed analysis is still required to determine any localised impacts that are likely to occur as a result of the delivery of one or all of the potential development sites, the initial analysis set out within the previous section of this report reveals the following:

- The WG and WG+HGV scenarios result in an approximate 20% increase in journey times as compared to the reference case
- The WG and WG+HGV scenarios result in an approximate 20% decrease in journey speeds as compared to the reference case
- There are negligible changes in the journey distances for both scenarios in both peak periods as compared to the reference case

- There is very little difference in the number of trips completed for all three scenarios. However, the WG +HGV scenario results in slightly more trips completed than the WG scenario in both peak periods
- During the AM peak period, the WG+HGV scenario results in no change in the number of junctions experiencing a moderate increase in queue length as compared to the WG scenario
- During the PM peak period, the WG+HGV scenario results in one additional junction with an expected moderate increase in queue length as compared to the WG scenario
- There are minimal differences for all network analysis measures between the WG and WG+HGV scenarios.

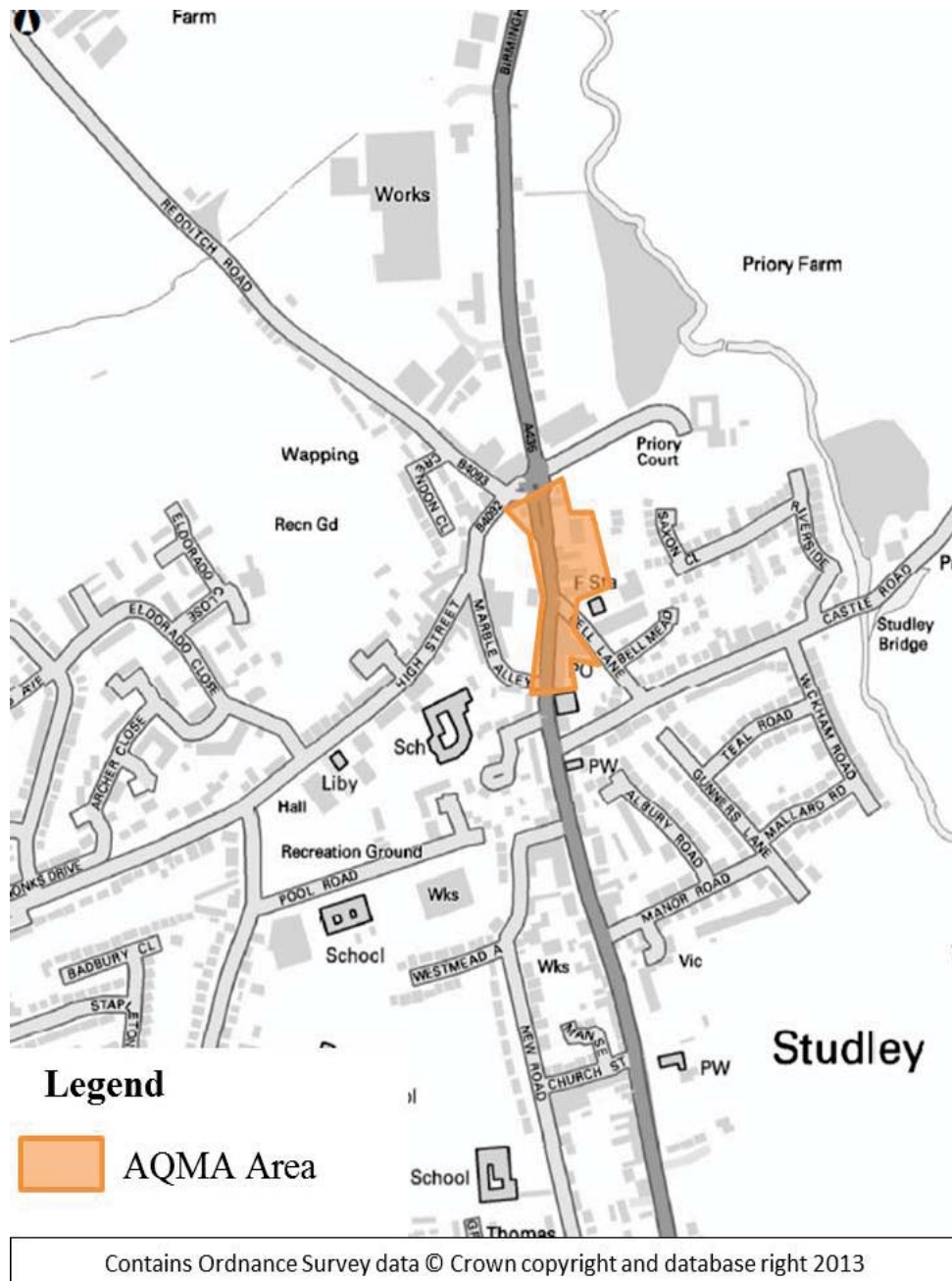
4 AQMA Analysis

4.1 Overview

In addition to the completion of the standard impact analysis, analysis has been undertaken to begin to inform the potential impacts that each option exerts on the AQMA area within Studley.

The area covered by the AQMA is indicated within the following Figure:

Figure 6 : Studley AQMA Area



4.2 Results Analysis

Analysis of the impact on the AQMA, of the various options has focussed initially on the changes in flows and speeds between scenarios and specifically within the AM (08:00 to 09:00) and PM (17:00 to 18:00) peak hours.

Analysis of the differences in the flows and speeds within the area, across the scenarios, has been presented within the tables:

Table 8: 2028 AQMA Flows (Vehicles) Studley 2028 Scenarios, AM Peak hour

	2028 Ref	2028 WG	2028 WG + HGV
NB	800	858	857
SB	772	727	732
Two Way	1,573	1,585	1,589

Table 9: 2028 AQMA Speeds (mph) Studley 2028 Scenarios, AM Peak hour

	2028 Ref	2028 WG	2028 WG + HGV
NB	5.2	5.6	5.7
SB	16.5	18.1	17.1
Two Way	10.7	11.3	10.9

Table 10 :2028 AQMA Flows (Vehicles) Studley 2028 Scenarios, PM Peak hour

	2028 Ref	2028 WG	2028 WG + HGV
NB	777	740	755
SB	798	813	819
Two Way	1,575	1,553	1,574

Table 11 : 2028 AQMA Speeds (mph) Studley 2028 Scenarios, PM Peak hour

	2028 Ref	2028 WG	2028 WG + HGV
NB	5.1	4.7	4.9
SB	16.9	17.4	16.9
Two Way	11.1	11.3	11.1

Analysis of the results presented within the previous Tables demonstrates no substantial difference in the traffic levels or associated speeds between the areas.

It is interesting to note, however, that within the AM there is a reduction in SB traffic levels within the 2028 Winyates Green/Gorcott Hill and HGV scenarios, when compared to the Reference Case whilst within the PM there is a reduction in NB traffic levels across the same scenarios. This could indicate that vehicles are choosing to reassign away from this area in response to increases in queuing levels that have been observed to occur as a result of the assignment of additional demand associated with the proposed developments.

4.3 Summary

Whilst further detailed analysis is required to understand more fully the effects on the AQMA that occur as a result of the assignment of demands associated with the various developments, this initial analysis appears to indicate that none of the options that have been tested result in a significant impact on flows and speeds within the AQMA area.

4.4 Detailed Air Quality Analysis

The following section of this note presents the Air Quality Outputs in the AQMA area only that have been extracted and processed through the PARAMICS Analysis of Instantaneous Road Emissions (AIRE) add on.

AIRE is an ancillary program specifically designed to process the outputs from traffic microsimulation models and calculate vehicle emissions. AIRE incorporates over 3,000 Instantaneous Emissions Modelling (IEM) tables which are used to estimate tailpipe emissions from individual simulated road vehicles. The IEM tables were derived from PHEM (Passenger car and Heavy Duty Emissions Model), which was developed by the Technical University of Graz. PHEM is a vehicle dynamics model with engine maps, enabling emissions to be output for various engine speeds and engine loads.

AIRE produces estimates of the oxides of nitrogen, particulate matter and total carbon that result from the combustion of fuel throughout each simulated vehicle's journey. The estimates are produced on a simulated time step by time step basis, so the detail and quality of the resulting output emissions estimates are directly related to the adopted simulation's fidelity and robustness.

The estimates produced by AIRE are for tailpipe emissions and do not include the impact of dispersion within the atmosphere, ambient factors, such as weather and temperature, or the local built environment.

4.5 Nitrogen

Analysis of the nitrogen (g) pollutants forecast within the Reference Case, WG and WG + HGV scenarios has been presented for the 2025 AM and PM periods within Figure 7 on the following page. Limitations within AIRE prevent analysis beyond the year 2025.

Analysis of Figure 7 reveals that during the both peak periods the HGV scenario results in the greatest amount of nitrogen pollutants being produced, followed by the Winyates Green/Gorcott Hill scenario. Pollutant levels are lowest within the Reference case scenario.

4.6 Particulate Matter

Analysis of the Particulate Matter (g) pollutants forecast within the Reference Case, Roundabout Proposal and Signal Proposal scenarios has been presented for the 2025 AM and PM periods within Figure 8 on the following page.

Figure 8 indicates the particulate matter is expected to increase in the AM peak period for the Winyates Green/Gorcott Hill and HGV scenarios. During the PM peak period, there is slightly less particulate matter expected for the HGV scenario than the Winyates Green/Gorcott Hill scenario.

Figure 7 : 2025 Nitrogen (g)

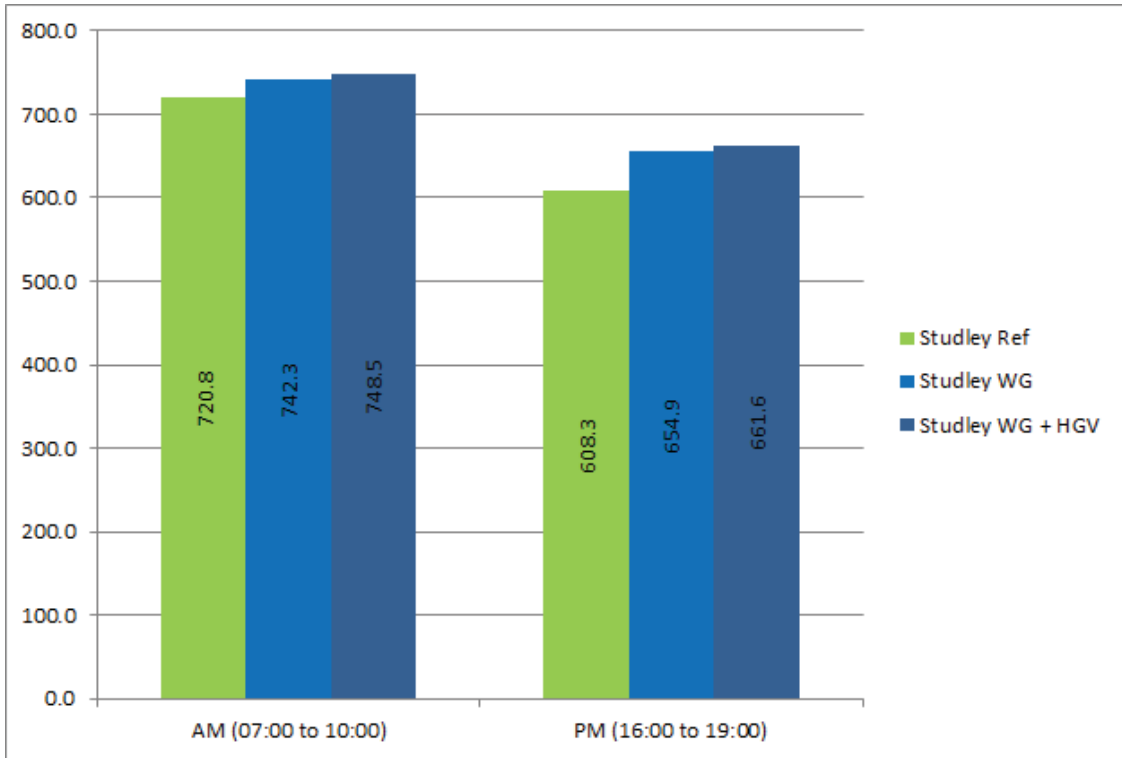
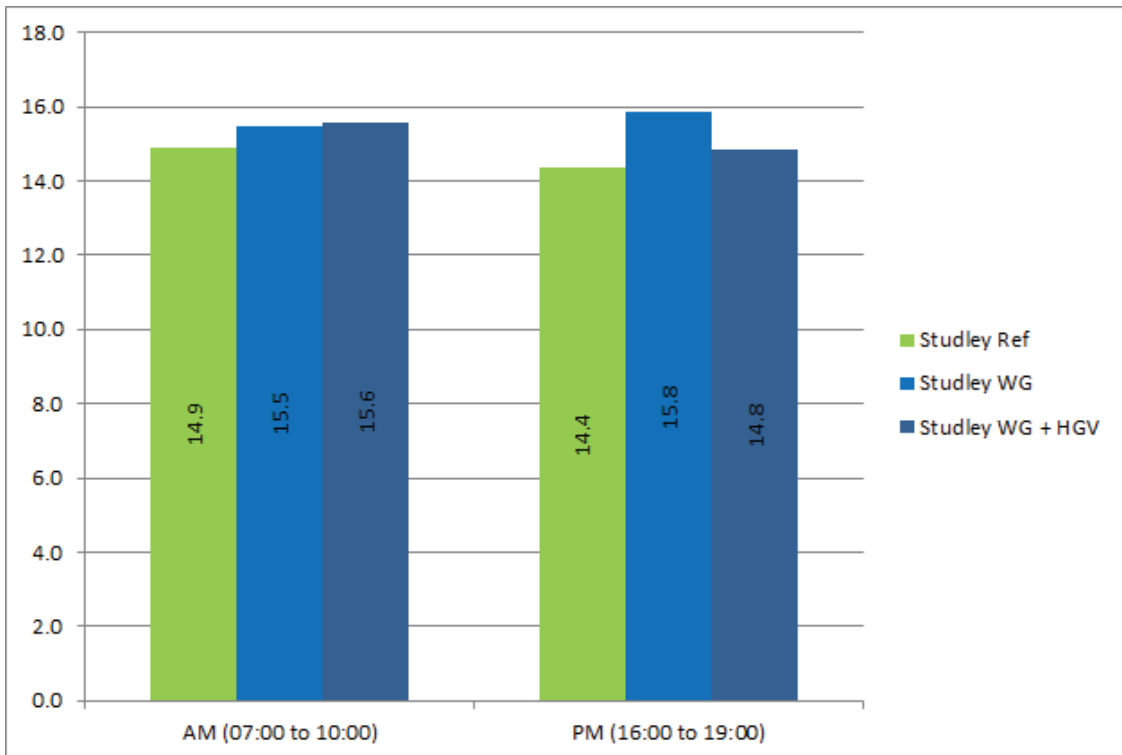


Figure 8: 2025 Particulate Matter (g)



4.7 Carbon

Analysis of the Carbon (g) pollutants forecast within the Reference Case, Roundabout Proposal and Signal Proposal scenarios has been presented for the 2025 AM and PM periods within the following Figure 9:

Figure 9: 2025 Carbon (g)

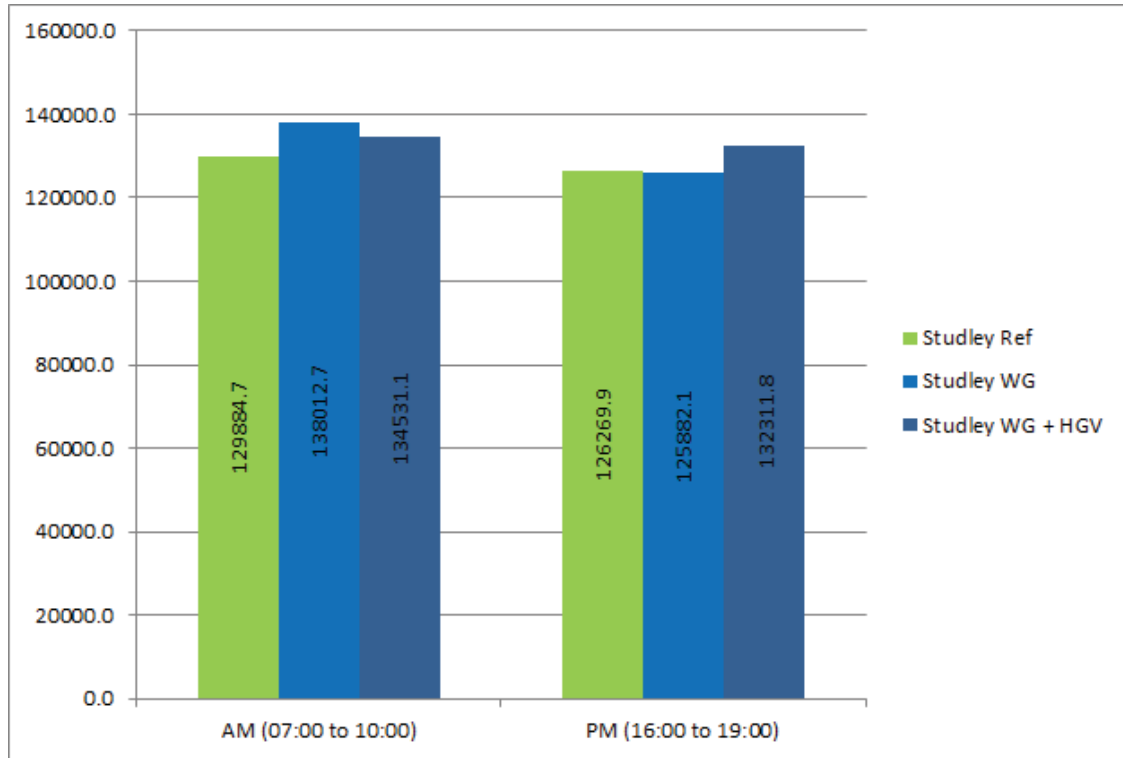


Figure 9 indicates that both the Winyates Green/Gorcott Hill and HGV scenarios result in an increase of Carbon pollutants when compared against the Reference Case during the AM peak period. During the PM peak period the carbon pollutants are expected to very slightly decrease for the Winyates Green/Gorcott Hill scenario but increase for the HGV scenario.

5 Summary & Conclusions

5.1 Summary

Warwickshire County Council (WCC) and Stratford on Avon District Council (SDC) commissioned Arup to investigate the potential effects of reallocating approximately 28 hectares of land at Winyates Green Triangle and Gorcott Hill. This Report builds upon the results of the *Stratford-on-Avon Strategic Transport Assessment Phase 2: Studley Scenario Analysis (July 2013)* Report. More specifically, the objectives of this study were to understand the implications of the allocation of the land at Winyates Green/Gorcott Hill employment site when HGV movements are also included and to assess in detail, the likely impact on the AQMA within Studley, of the assignment of additional vehicular demands as a result of the allocated site.

In order to investigate the effect of this development, HGV trip generation rates were first provided by TRICS 2013 (a) and these new trips were distributed across the network based on a proxy distribution derived from the of Icknield Street Drive/ Washford Drive junction. Overall the new development is expected to result in 26 and 7 new trips during the AM and PM peak periods respectively.

5.2 Conclusions

Overall the additional HGV trips on the network have little impact on the network wide statistics. Average vehicle journey time, speed and the number of completed trips on the network remain relatively consistent. When considering either the Winyates Green/Gorcott Hill or HGV scenario in comparison to the reference scenario the results indicate:

- Average journey time increases by approximately 20% in the AM and PM peak periods
- Average vehicle speeds decrease by approximately 20% in the AM and PM peak periods
- When considering the impact on the AQMA in most cases the inclusion of the development results in a slight worsening of conditions within the AQMA.
- It is reasonable to conclude that the addition of the HGV trips does not materially alter the impact that is predicted to occur as a result of the development inclusion.

It is therefore considered reasonable to conclude that the allocation of this site is likely to lead to a worsening of conditions across the network. Consideration should be given as to whether the delivery of mitigation measures at the area's most likely to be affected by the allocation of this development would reduce the overall impact that has been identified.

Whilst the impacts within the AQMA are less significant there are still impacts observable within the AQMA that are likely to occur as a result of the additional demands that have been assigned to the network due to the allocation of development at Winyates Green and Gorcott Hill. Further investigation of these impacts is recommended to ascertain whether there are potential solutions that can be delivered to mitigate these impacts.

Appendix A

Studley Queue Length Analysis Plots

A1 Contents

MQ001 – 2028 Land at Winyates Green/Gorcott Hill AM Period

MQ002 – 2028 Land at Winyates Green/Gorcott Hill PM Period

MQ003 – 2028 STA Scenario 03 HGV AM Period

MQ004 – 2028 STA Scenario 03 HGV PM Period



Legend

- less than -5 vehicles
- between + 5 and +25
- between +25 and +50
- greater than +50

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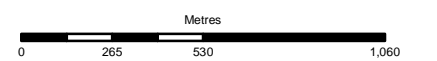
P1	12-06-13	MG	JE	JE
Issue	Date	By	Chkd	Appd

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Job Title
SDC Strategic Transport Assessment



**2028 Land at Winyates Green/Gorcott Hill
AM Period 0700-1000
Average Maximum Queue**

Scale at A3

N.T.S.

Job No 211439-19	Drawing Status Information
Drawing No MQ 001	Issue P1



Legend

- less than -5 vehicles
- between + 5 and +25
- between +25 and +50
- greater than +50

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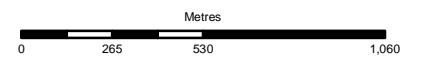
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Job Title
SDC Strategic Transport Assessment



**2028 Land at Winyates Green/Gorcott Hill
PM Period 1600-1900
Average Maximum Queue**

Scale at A3

N.T.S.

Job No
211439-19

Drawing Status
Information

Drawing No
MQ 002

Issue
P1



Legend

- less than -5 vehicles
- between +5 and +25
- between +25 and +50
- greater than +50

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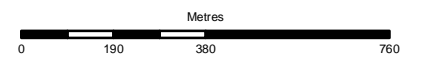
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Client
Warwickshire County Council

Job Title
Studley



**2028 STA Scenario 03 HGV
AM Period 0700-1000
Average Maximum Queue**

Scale at A3		N.T.S.	
Job No 211439-19	Drawing Status Information		
Drawing No MQ 003			Issue P1



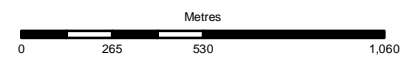
- Legend**
- less than -5 vehicles
 - between + 5 and +25
 - between +25 and +50
 - greater than +50

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P1	21-10-13	ZW	JE	JE
Issue	Date	By	Chkd	Appd

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**2028 STA Scenario 03 HGV
 PM Period 1600-1900
 Average Maximum Queue**

Scale at A3

N.T.S.

Job No 211439-19	Drawing Status Information
Drawing No MQ 004	Issue P1