

Transport Research Laboratory



**Effectiveness of Speed Indicator Devices
on reducing vehicle speeds in London –
Technical appendices**

by LK Walter and J Knowles

Introduction

Contained in this report are the technical appendices for TRL report PPR314: Effectiveness of Speed Indicator Devices on reducing vehicle speeds in London. Numbered sections within this report refer to sections within the main report.

Appendix A DfT SID position

To: Road Safety Officers - Government Offices

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Speed Indicator Devices

1. We have received a number of enquiries regarding the use of Speed Check and Speed Indicator Devices (SIDS). Primarily there seems to be some concern as to whether they constitute a road sign and therefore whether they require special authorisation.
2. I thought it would be useful to clarify the Department's position on the use of these devices.
3. DfT view these devices as no more than an informatory device and not as any form of roadside signage. They do not tell the driver any more than is already displayed on a speedometer.
4. In addition we understand these devices, in all their guises, are moved regularly. The 'Smiley' face SIDS particularly are only in any one location for a matter of hours. Authorisation would therefore be somewhat difficult.
5. The Department understands these devices are already being used widely and whilst we consider their value to be limited (they do not tell the driver what they are doing wrong) we understand local authorities are claiming some success.
6. As such, providing local authorities do not fix any form of speed limit or road traffic sign to these devices, nor do they use them for any kind of enforcement the Department does not consider that any special authorisation is needed (type approval issues are not a matter for this Department).
7. I would be grateful if you could cascade this information to all local authorities as you see relevant.
8. Thanks.

Caroline Britt
Road Safety Division

DfT SID Position.doc

Appendix B Locations and layout maps

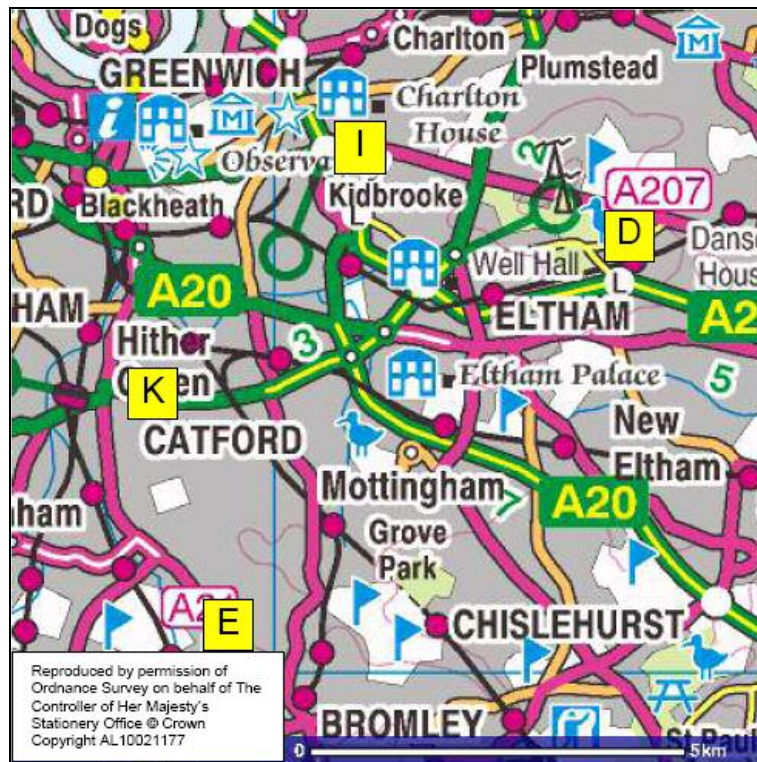


Figure B. 1: SID study sites: Bromley, Bexley, Lewisham

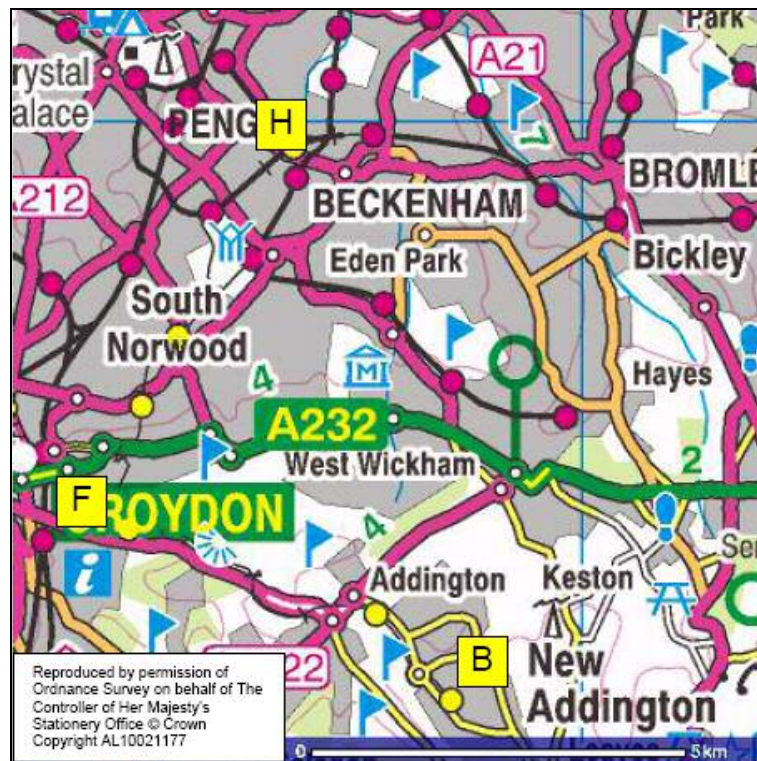


Figure B. 2: SID study sites: Croydon and Beckenham

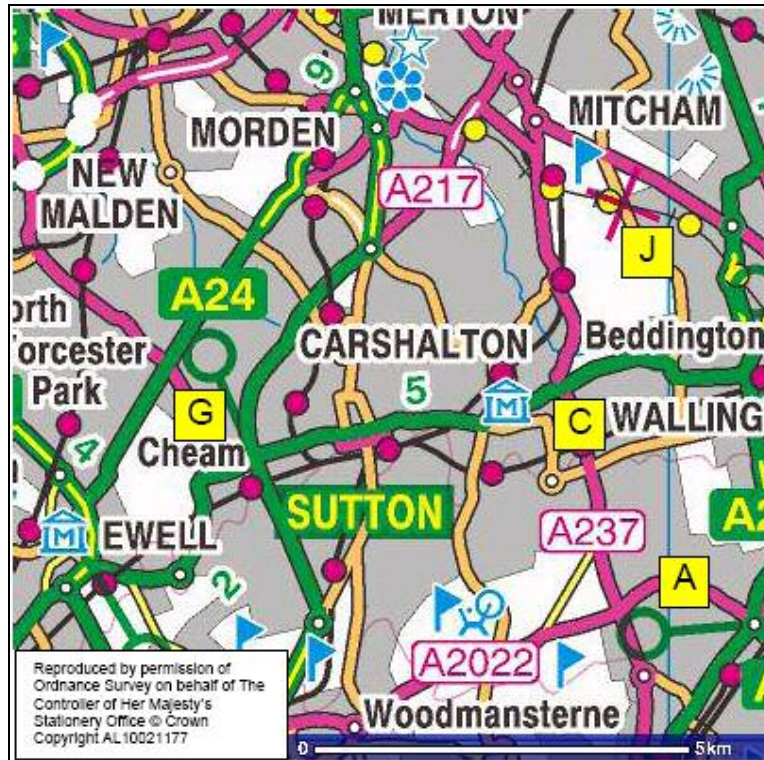


Figure B. 3: SID study sites: Sutton

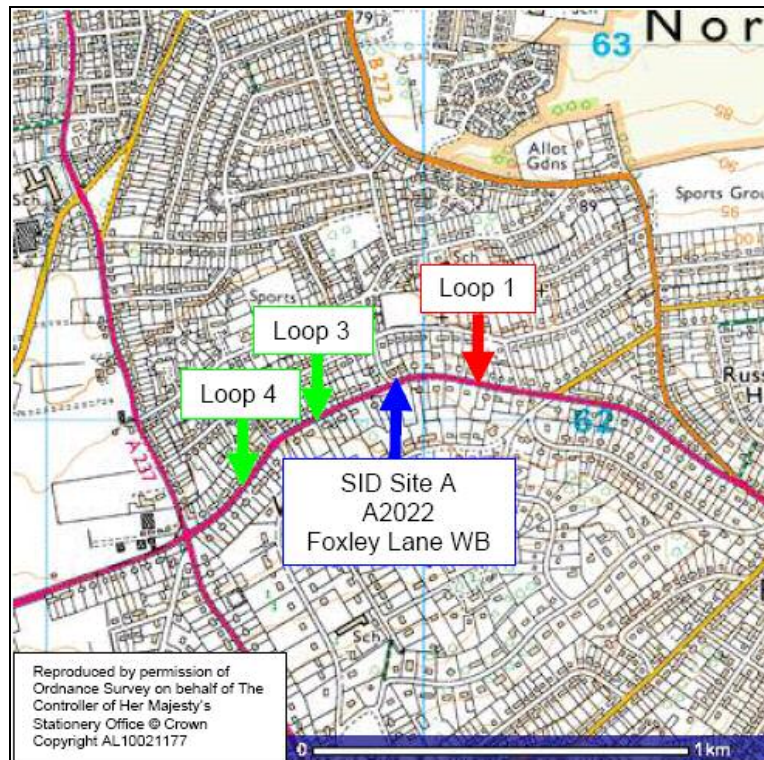


Figure B. 4: Site A location and layout map

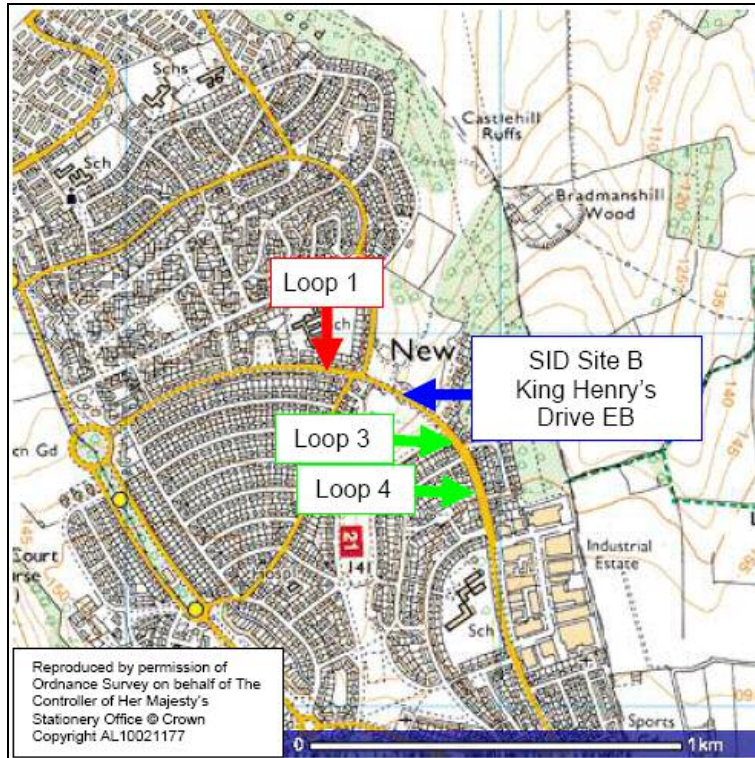


Figure B. 5: Site B location and layout map

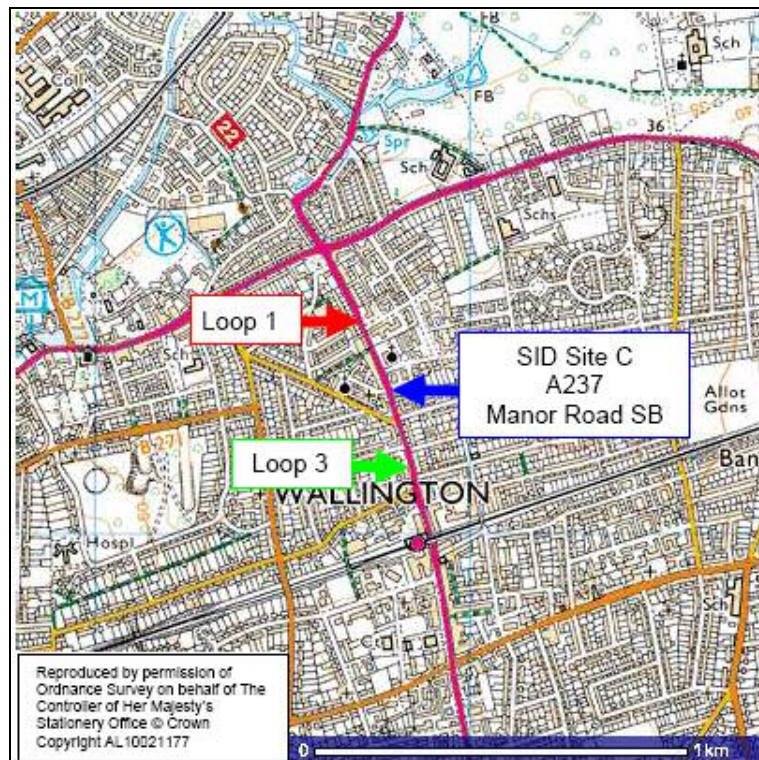


Figure B. 6: Site C location and layout map

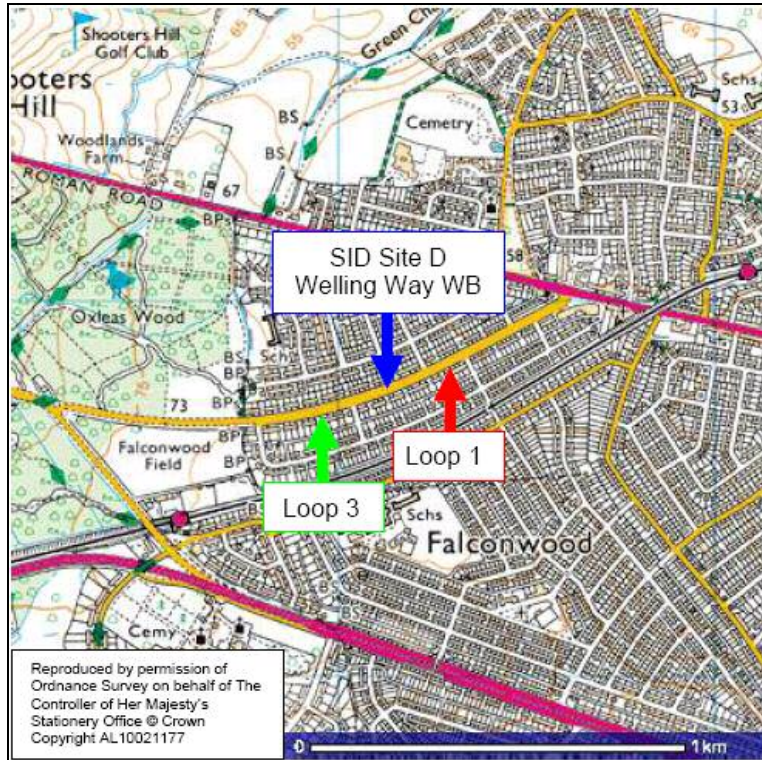


Figure B. 7: Site D location and layout map

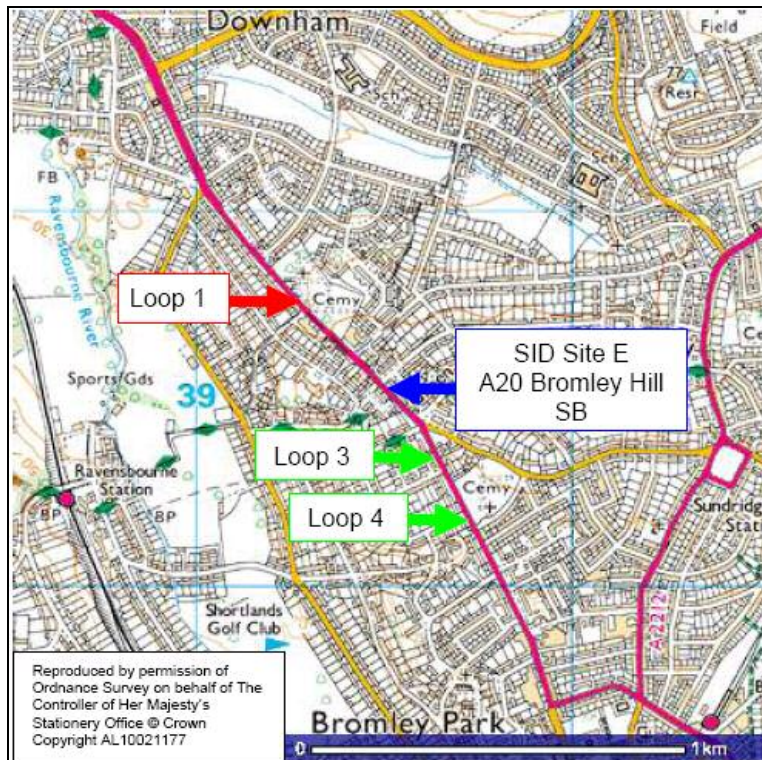


Figure B. 8: Site E location and layout map



Figure B. 9: Site F location and layout map

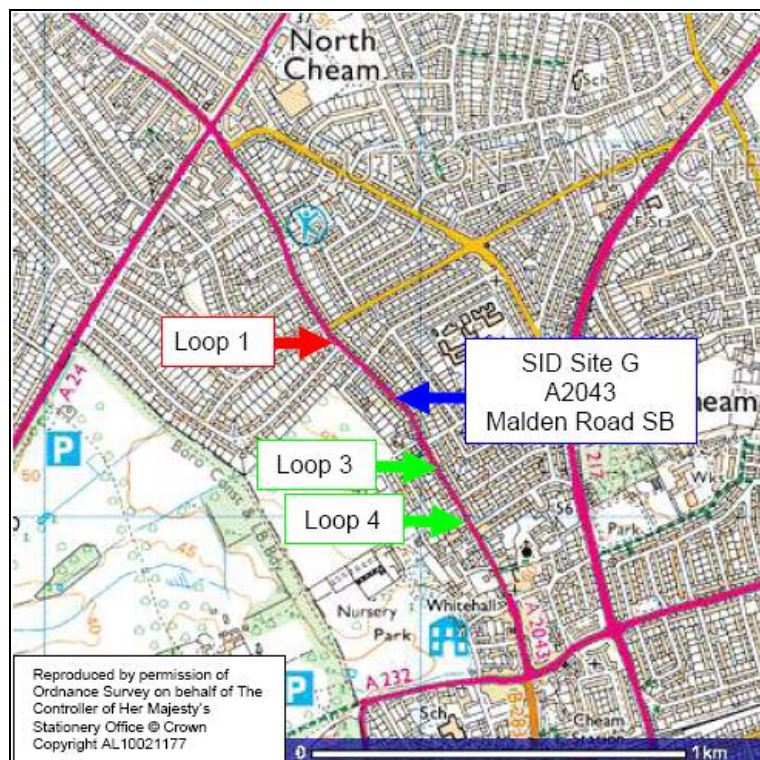


Figure B. 10: Site G location and layout map

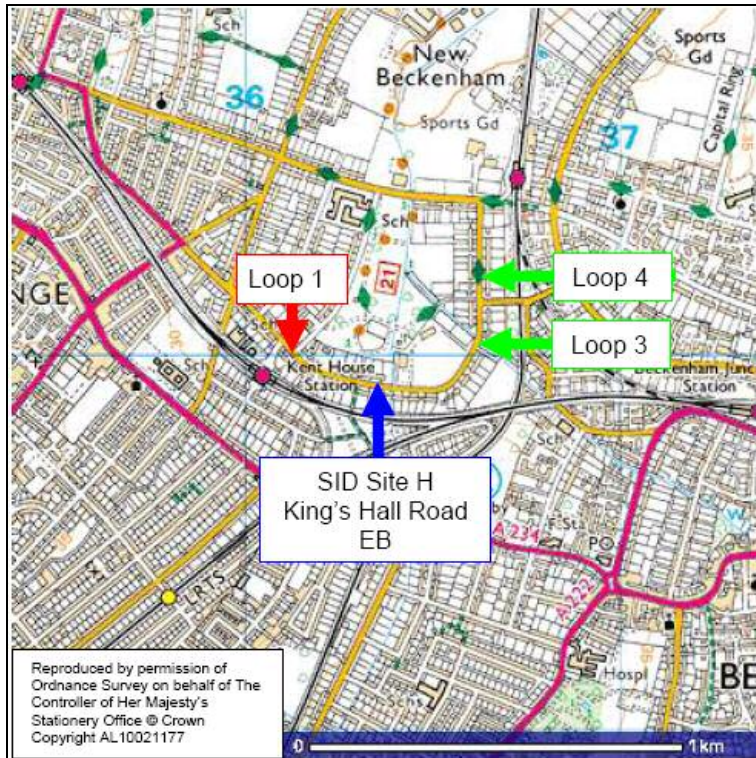


Figure B. 11: Site H location and layout map

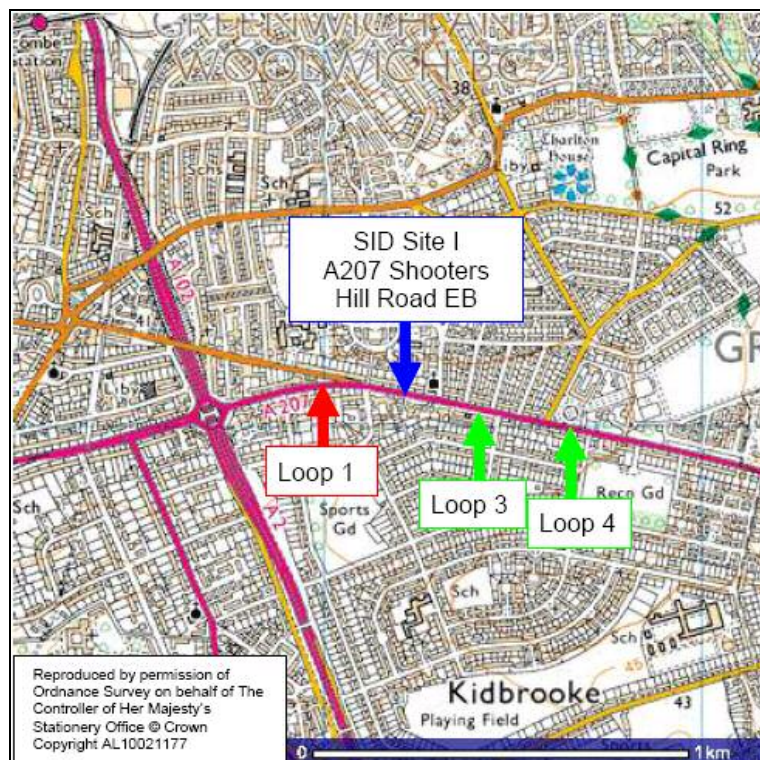


Figure B. 12: Site I location and layout map

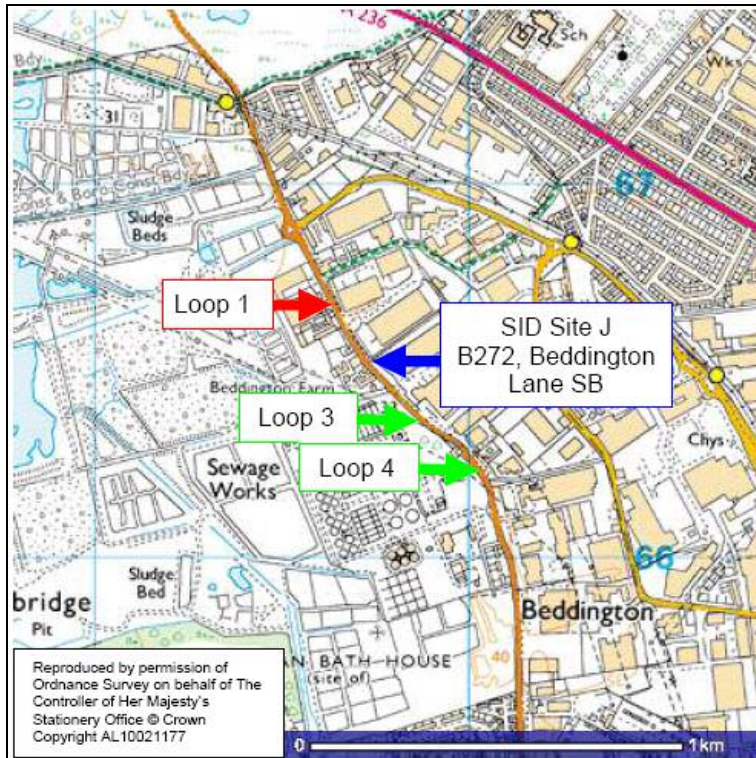


Figure B. 13: Site J location and layout map

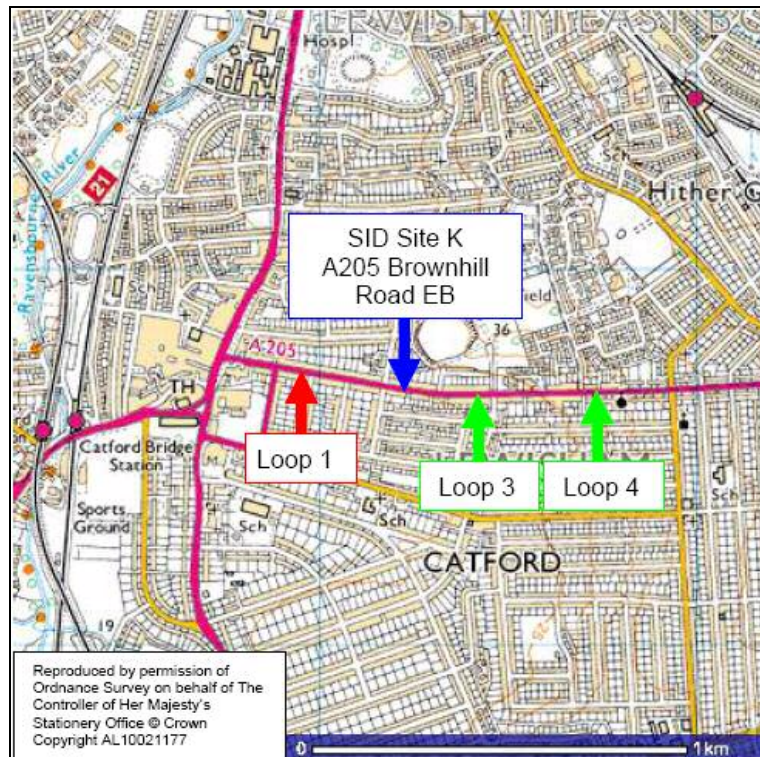


Figure B. 14: Site K location and layout map

Appendix C ATC and SID installation timetable

Table C. 1: Dates of ATC and SID installation and removal

Site	ATCs installed	SID Installed	SID Removed	ATCs removed
A – Foxley Lane (pilot)	16/04/2007	14/05/2007	22/05/2007	11/06/2007
B - King Henry’s Drive	04/06/2007	11/06/2007	02/07/2007	16/07/2007
C - Manor Road	05/06/2007	12/06/2007	03/07/2007	17/07/2007
D - Welling Way	06/06/2007	13/06/2007	04/07/2007	18/07/2007
E - Bromley Hill	04/06/2007	11/06/2007	25/06/2007	09/07/2007
F - Parkhill Road	05/06/2007	12/06/2007	26/06/2007	10/07/2007
G - Malden Road	07/06/2007	14/06/2007	28/06/2007	12/07/2007
H - Kings Hall Road	08/06/2007	15/06/2007	29/06/2007	13/07/2007
I - Shooters Hill Road	06/06/2007	13/06/2007	20/06/2007	04/07/2007
J - Beddington Lane	07/06/2007	14/06/2007	21/06/2007	05/07/2007
K - Brownhill Road	08/06/2007	15/06/2007	22/06/2007	06/07/2007

Appendix D Method for determining free-flowing conditions

D.1 Analysis of speed, flow and headway data

Analysing the effect of SIDs on vehicle speeds should be done under free-flowing conditions. If a driver's speed is going to be influenced by a SID then they must have a choice, i.e. in 'free-flowing conditions'. The study by Poulter and McKenna (2005) excluded vehicles travelling 10mph or less and vehicles travelling less than 5 seconds apart to ensure that the traffic was free-flowing. The study did not include details of how this criterion was derived.

The data collected from the loops comprise of an individual speed and headway record for every vehicle passing over the loop. From these data it is possible to define congested traffic either by traffic flow, mean traffic speed or headway (time between vehicles). This section describes the process used to define free-flowing conditions for this study.

The 'before' period for individual sites were analysed to determine the most appropriate method of defining free-flowing conditions. The results from Sites B and F are presented here for illustration purposes. Figure D. 1 and Figure D .2 present the mean speeds by hour one week before the SID was in operation. In general weekday speeds were considerably lower around 8am and again around 3pm and 6pm. These lower speeds match with expected rush hour times when the roads are generally congested. If a vehicle is travelling in slow moving traffic then the driver is not making a speed choice and therefore their speed cannot be influenced by the SID.

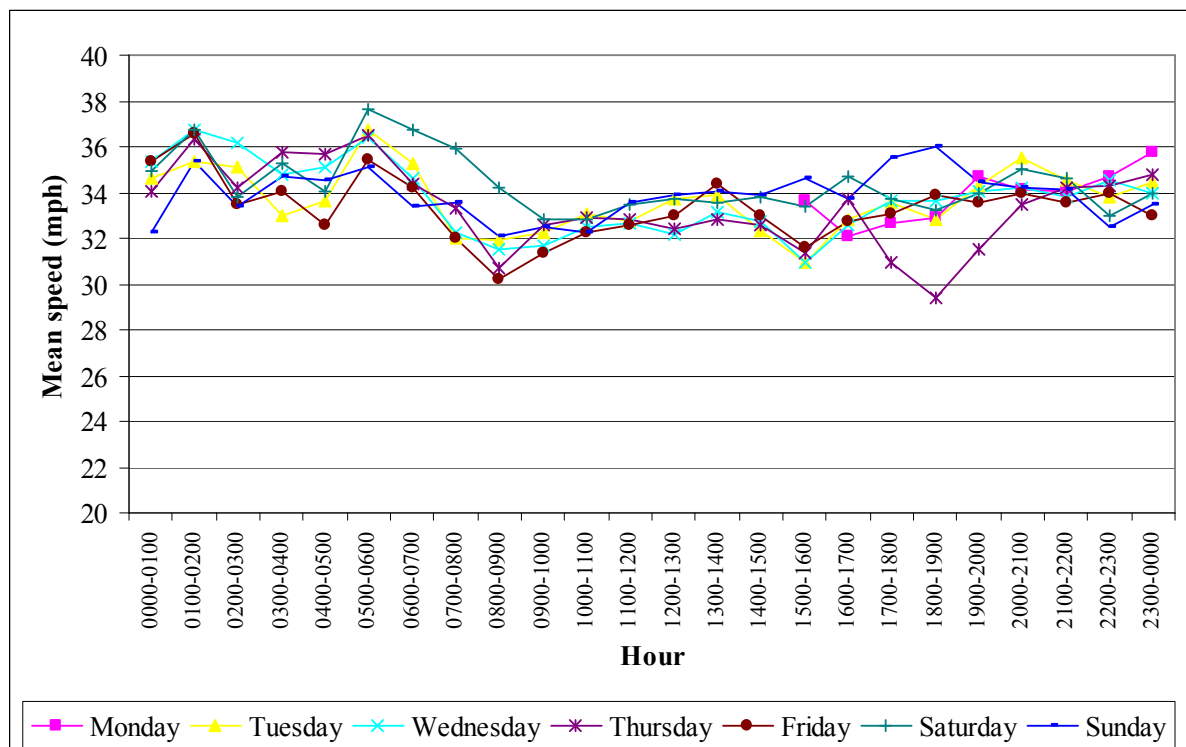


Figure D. 1: Mean speed (mph) by hour one week before the SID was in place (site B)

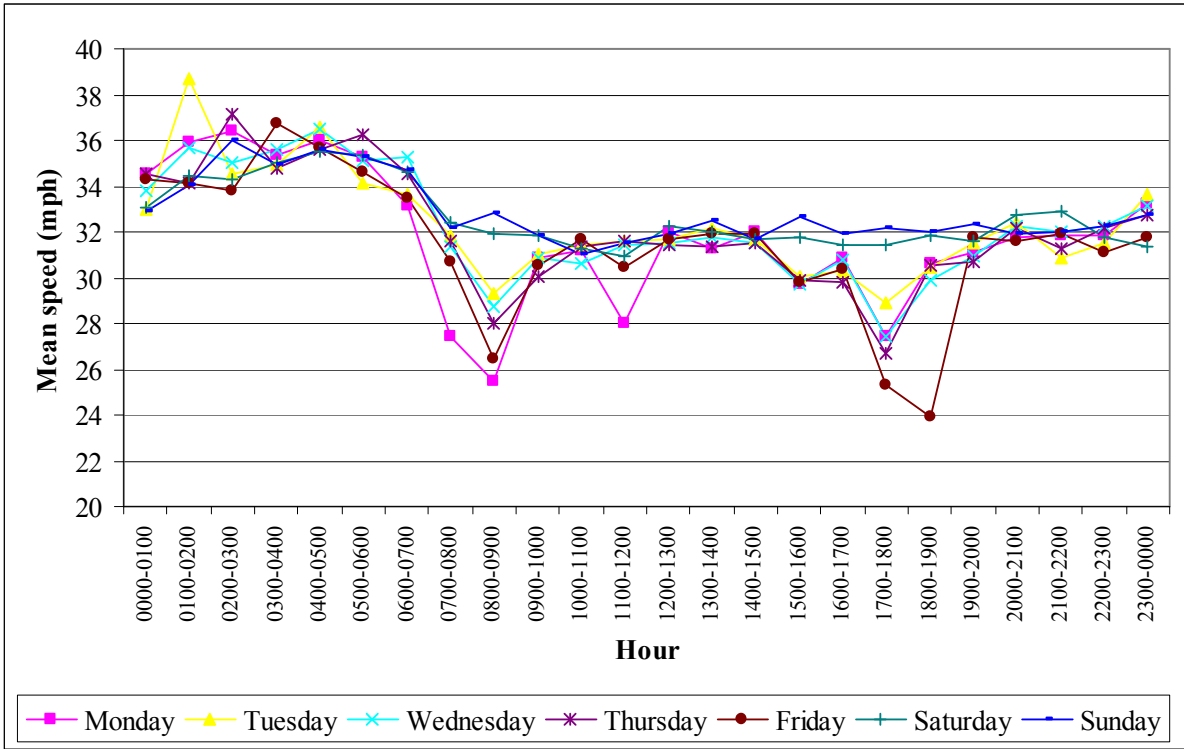


Figure D. 2: Mean speed (mph) by hour one week before the SID was in place (site F)

Figure D. 3 and Figure D. 4 present the speed distribution for sites B and F for the week before the SID was in operation. In Figure D. 4 in particular it is possible to detect more vehicles travelling at lower speeds (i.e. less than 20mph) than would be expected under a normal distribution. Site B has higher frequencies at all speeds between 10-20mph and site F has a longer tail with a small peak around 10mph. This suggests that a congestion cut-off at 20mph might be appropriate.

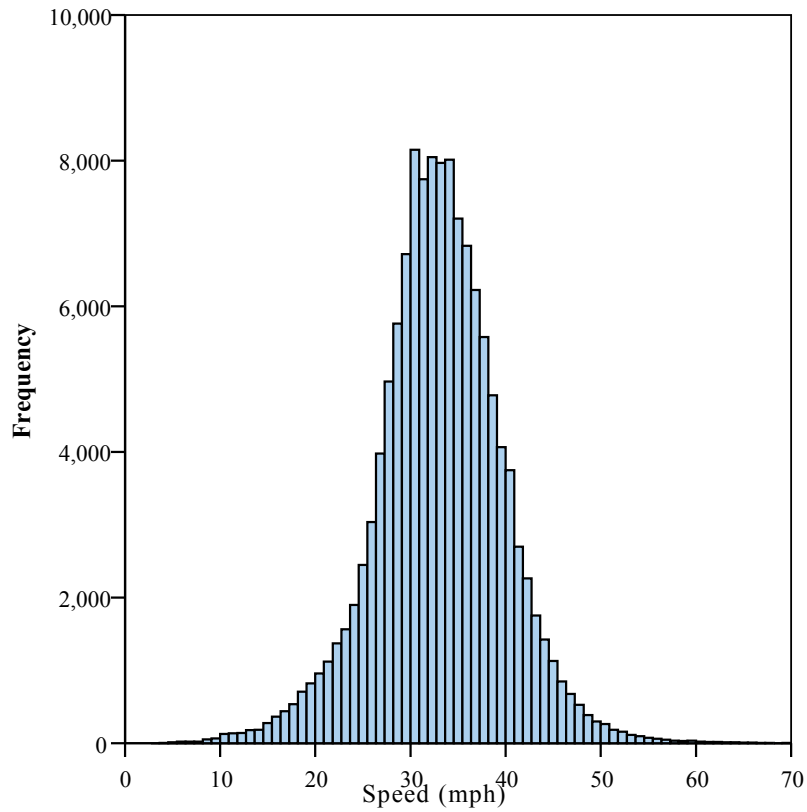


Figure D. 3: Speed distribution (mph) one week before the SID was in place (site B)

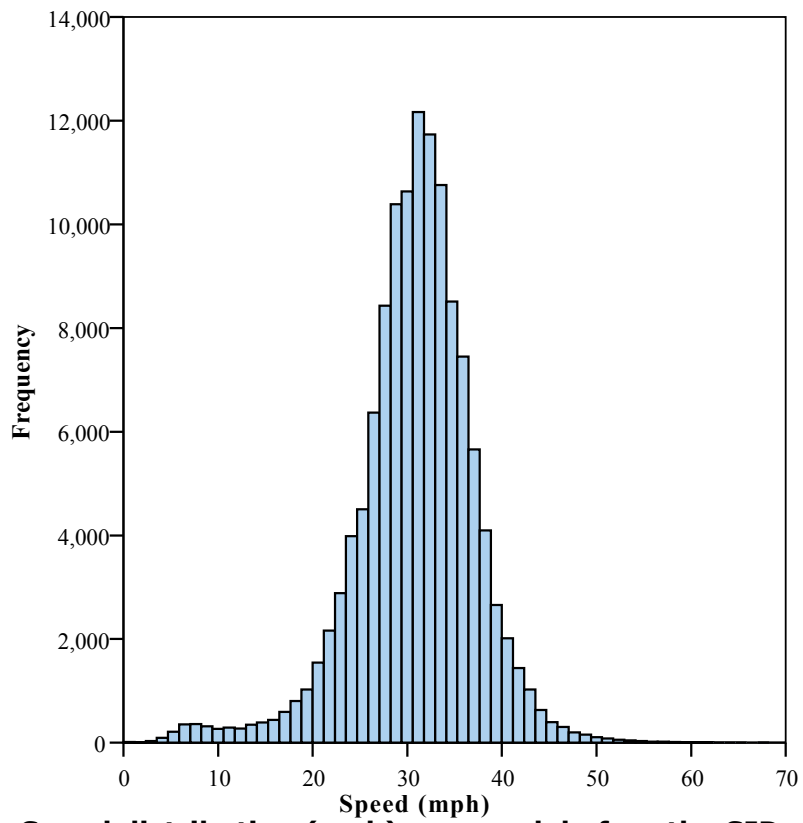


Figure D. 4: Speed distribution (mph) one week before the SID was in place (site F)

Figure D. 5 and Figure D. 6 present the traffic flow by hour for sites B and F one week before the SID was in place. An analysis of the traffic flow show that high flows occur in the weekday mornings peaking between 8-9am and again in the evening peaking around 5pm. Figure D. 7 presents the relationship between flow and speed for site B. The correlation between high flow and slower mean speed is not strong enough to define congestion via flow.

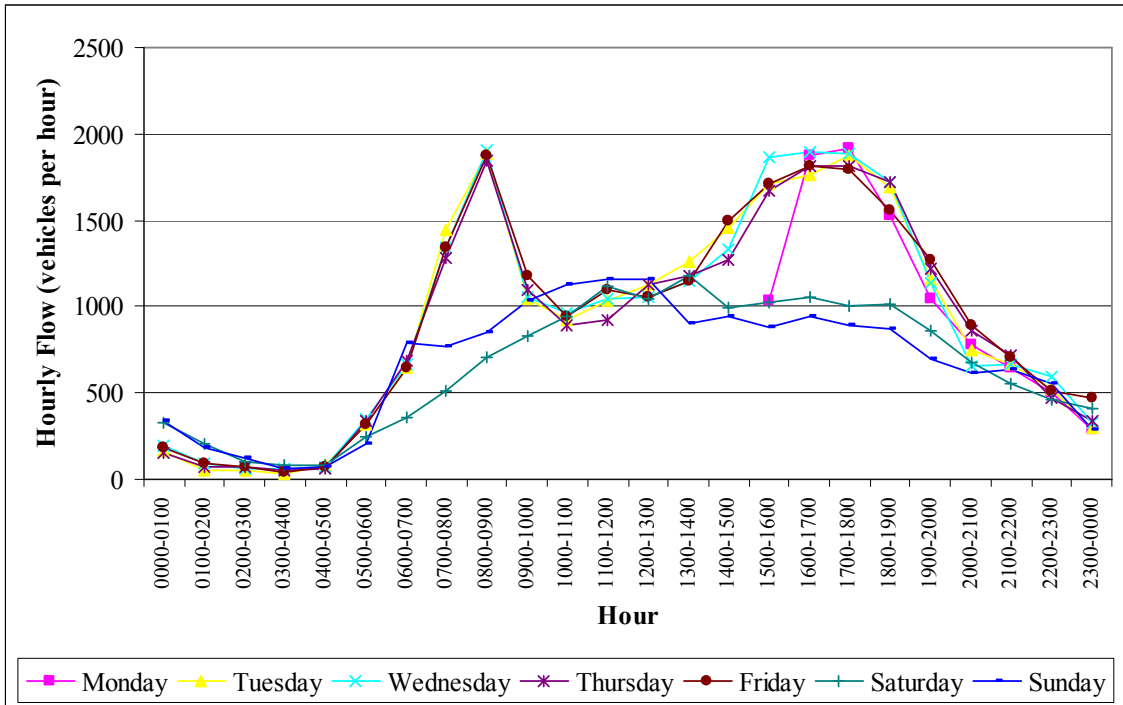


Figure D. 5: Flow by hour one week before the SID was in place (site B)

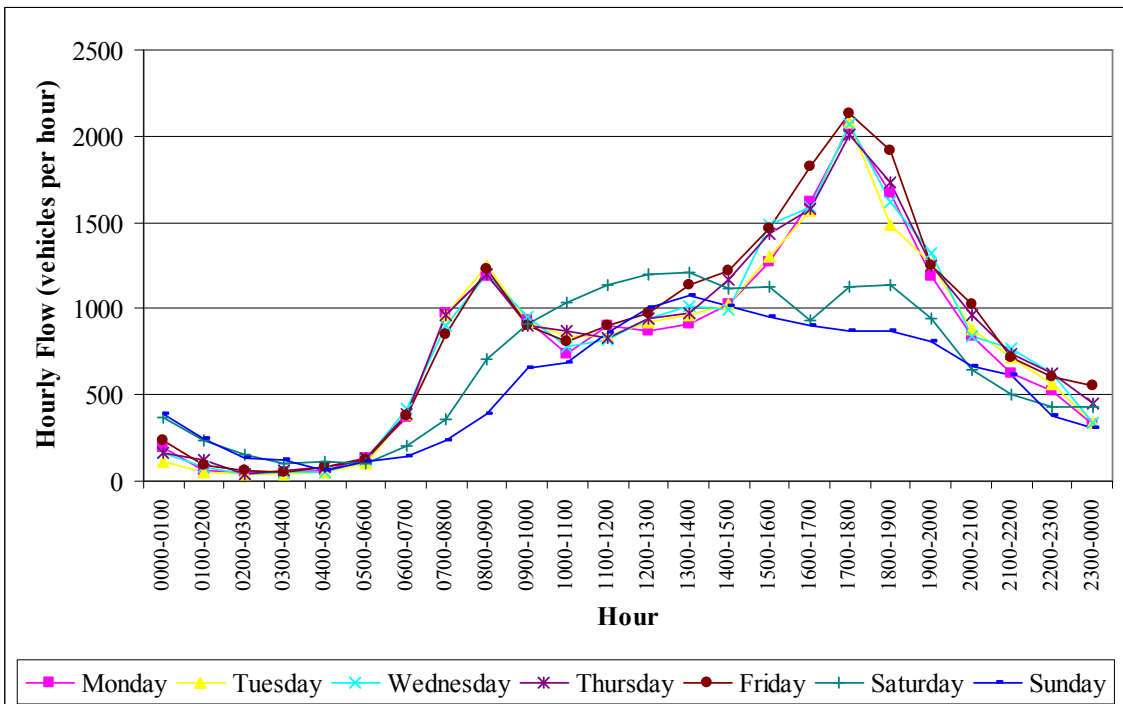


Figure D. 6: Flow by hour one week before the SID was in place (site F)

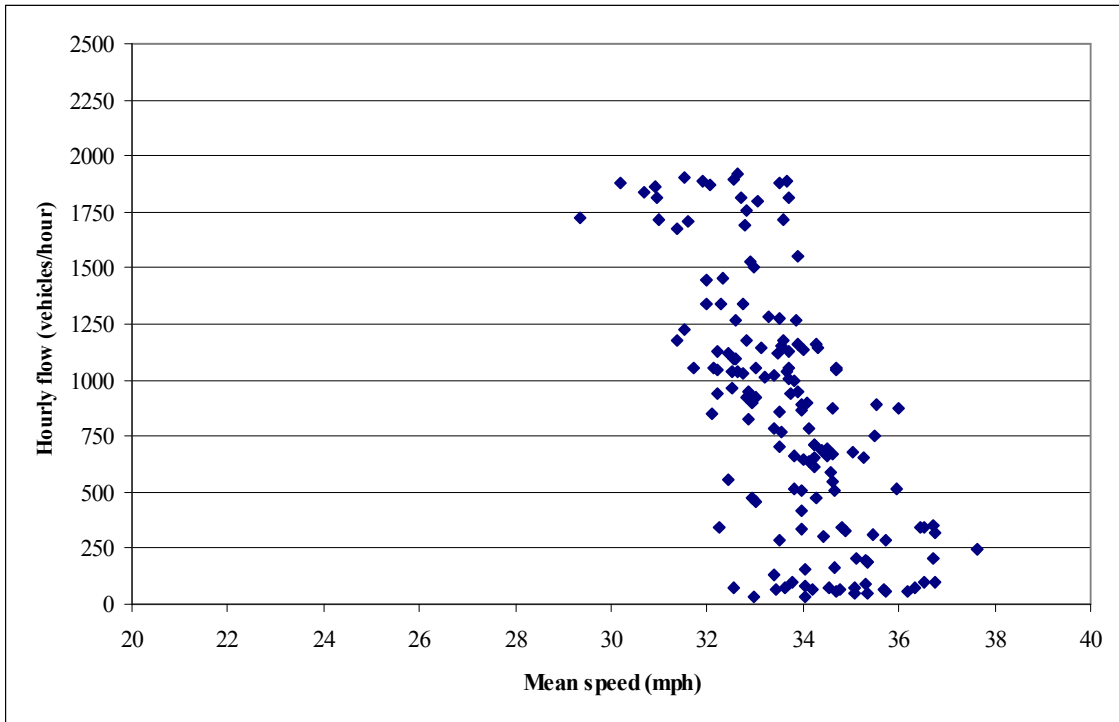


Figure D. 7: Mean speed (mph) and hourly flow one week before the SID was in place (site B)

Finally headway was considered. Figure D. 8 and Figure D. 9 present average headway by hour one week before the SID was in place for sites B and F. There is a clear weekday pattern with lower average headways during the periods of low speeds, i.e. during congested periods.

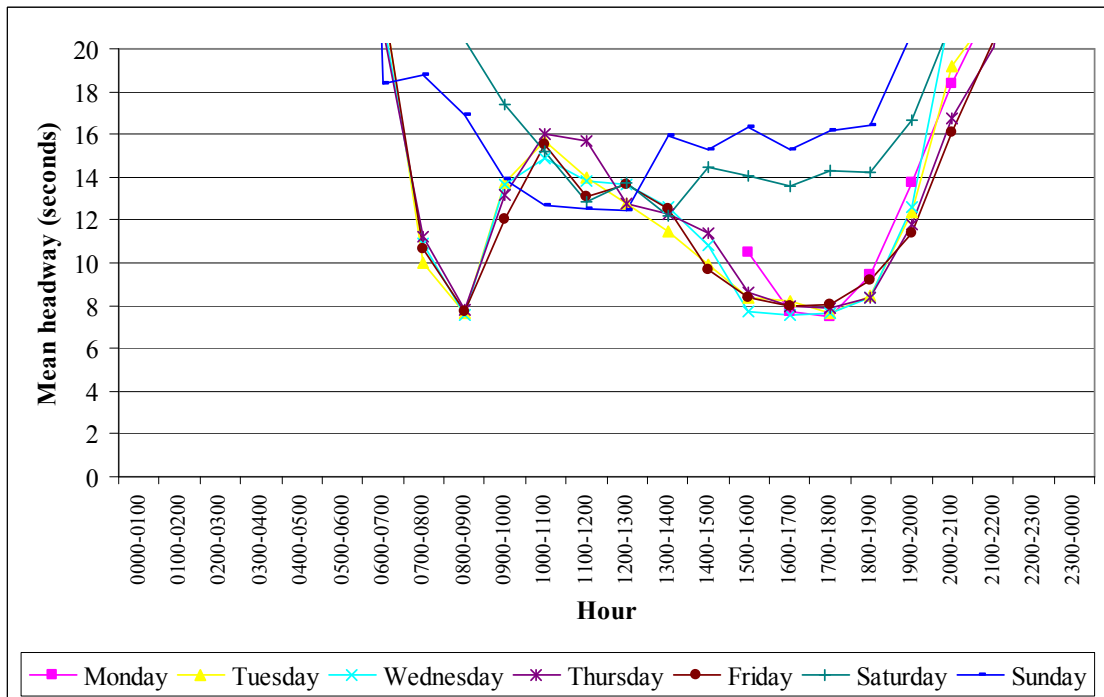


Figure D. 8: Mean headway (seconds) by hour one week before the SID was in place (site B)

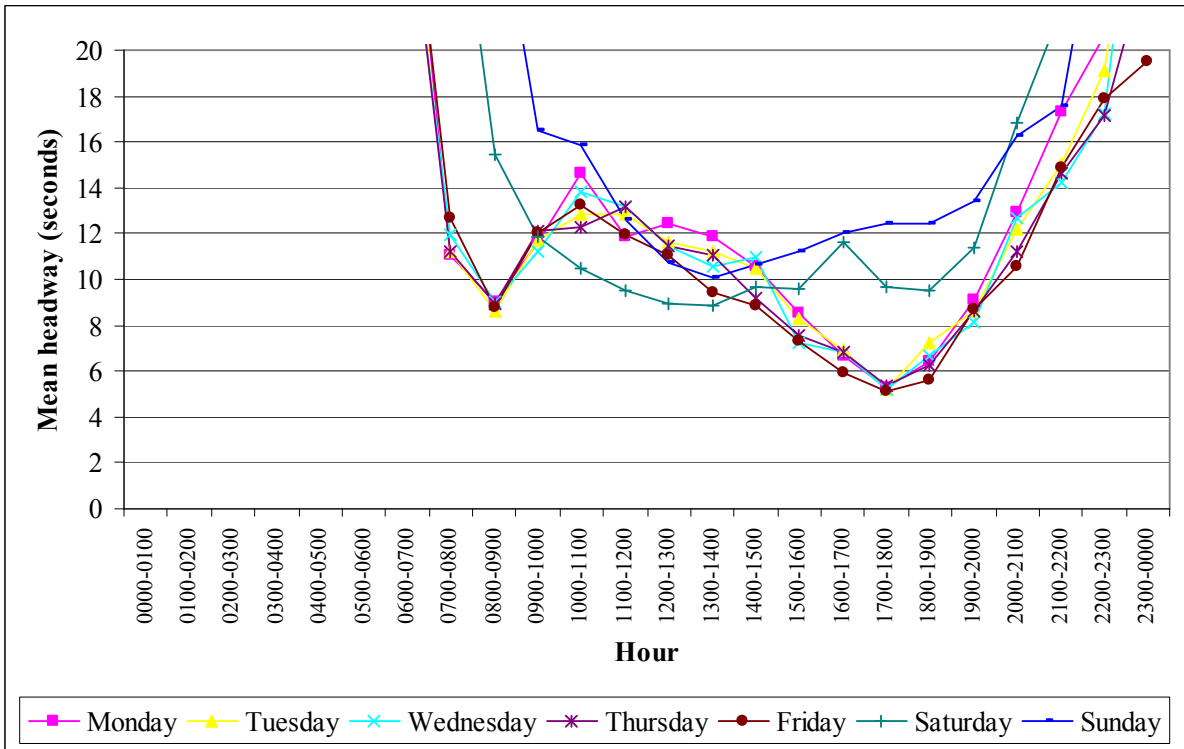


Figure D. 9: Mean headway (seconds) by hour one week before the SID was in place (site F)

The analysis of speed, headway and flow data suggested that congestion should be defined using a definition based on speed maybe with a headway component. The next section discusses how sensitive the results are to different exclusion criteria.

D.2 Sensitivity analysis

A sensitivity analysis was conducted for sites B and F, testing exclusion criteria based on just speed and a combination of speed and headway. Site B results are discussed here, but the conclusions drawn are virtually identical to those drawn from site F. Table D. 1 shows the proportions of data that were excluded for two congestion criteria for site B; firstly excluding all vehicles travelling less than 20mph and secondly including all vehicles travelling less than 20mph and with headway of less than 2 seconds. This excludes vehicles travelling slowly and vehicles travelling very close together. The proportion excluded increases once the additional criterion of greater than 2 second headway is included. This suggests that some vehicles are travelling close together at speeds above 20mph.

Table D. 1: Proportion of data excluded under various congestion criteria (site B)

Period	Exclusion criteria:	
	20mph	20mph & 2 second headway
Before	3.2%	8.1%
During	3.5%	8.2%
After	3.0%	7.9%

Table D. 2 presents the proportions of drivers travelling above the speed limit of 30mph, 36mph (i.e. ACPO guidelines of 10%+3mph above the speed limit) and 45mph (i.e. 15mph above the speed limit) before, during and after the SID was in operation for the two congestion criteria. The same conclusions would be consistently drawn from both criteria. As would be expected the proportions are all slightly higher than if no exclusion criteria had been applied.

Table D. 3 shows the average speed for the 'before', 'during' and 'after' periods for the two exclusion criteria. Both criteria give virtually the same mean speed results. Therefore it was concluded that all vehicles travelling less than 20mph and with a headway of less than 2 seconds would be excluded from the dataset used in the analysis.

Table D. 2: Proportion of drivers exceeding the speed limit under certain congestion criteria (site B)

Percentage at or exceeding:	Period	No exclusion criteria	Exclusion criteria	
			20mph	20mph & 2 second headway
30mph	Before	70.1%	72.5%	72.7%
	During	62.4%	64.6%	64.8%
	After	70.1%	72.2%	72.4%
36mph	Before	31.3%	32.4%	32.9%
	During	22.2%	23.0%	23.5%
	After	30.0%	30.9%	31.3%
45mph	Before	3.5%	3.6%	3.7%
	During	1.9%	2.0%	2.1%
	After	2.8%	2.9%	2.9%

Table D. 3: Mean speed (mph) for various congestion thresholds (site B)

Criteria	Before	During	After
No exclusion	33.1	31.8	33.0
20mph	33.7	32.3	33.5
20mph & 2 second headway	33.7	32.4	33.5

Table D. 4 shows the proportion of data excluded in the analysis for each site for the 'before', 'during' and 'after' periods. The filtering process may affect the results by making the speed reductions slightly conservative. For example because any data <20mph will be excluded, and if whole speed distribution reduces because of the SID then a higher proportion of free-flowing but slow driver data are filtered out.

Table D. 4: Proportion of data excluded due to congestion criteria used to define free-flowing conditions (all sites)

Site	Before	During	After	Total
B - King Henry's Drive	8.1%	8.2%	7.9%	8.1%
C - Manor Road	22.5%	20.2%	20.8%	20.8%
D - Welling Way	4.0%	7.9%	Missing data	4.0%
E - Bromley Hill	13.1%	13.3%	11.9%	13.1%
F - Parkhill Road	5.9%	4.8%	4.3%	5.9%
G - Malden Road	12.6%	14.2%	13.9%	12.6%
H - Kings Hall Road	13.8%	12.7%	12.5%	13.6%
I - Shooters Hill Road	20.5%	21.8%	18.5%	20.5%
J - Beddington Lane	8.3%	8.2%	13.3%	8.3%
K - Brownhill Road	13.2%	14.4%	15.3%	13.2%
All Sites	14.1%	14.3%	14.5%	14.5%

Appendix E Summary data for the individual sites

E.1 Summary data: site B – King Henry’s Drive

The data available for site B are displayed in Table E. 1 which shows that the majority of data is available for all weeks and loops until After2.

Table E. 1: Available speed data in days per week and loop (site B)

Period	Loop1	Loop2	Loop3	Loop4
Before ¹	6.5	6.5	6.5	6.5
During1 ²	6.5	6.5	6.5	6.5
During2	7.0	7.0	7.0	7.0
During3	7.0	7.0	7.0	7.0
After1 ³	6.5	6.5	6.5	6.5
After2	7.0	2.5	3.0	2.0

Mean speeds at all loops at site B are displayed in Table E. 2 and shown in Figure E. 1. This shows a reduction in speed in the ‘during period’ at loop2, however there is some variation in the mean speeds at the other loops which may or may not be effected by the SID. In theory, the vehicle activates the SID between loop1 and loop2 so the SID should not affect a vehicle speed at loop1. However, it is possible that a vehicle will observe another vehicle activating the SID so speeds at loop1 may be affected by the SID. However all analysis assumes that the reduction of speed at loop1 in the ‘during’ period is not due to the SID, and thus estimates of the effect of a SID are likely to be underestimated.

Table E. 2: Mean speed (mph) and standard deviation before, during and after SID operation (site B)

Period	Loop1		Loop2		Loop3		Loop4	
	Mean speed (mph)	SD ⁴	Mean speed (mph)	SD ⁴	Mean speed (mph)	SD ⁴	Mean speed (mph)	SD ⁴
Before	32.3	5.1	35.4	6.0	33.8	6.4	33.0	5.8
During1	32.1	5.1	32.3	5.5	32.2	5.9	32.4	5.5
During 2	31.8	5.0	32.4	5.4	32.9	6.0	32.3	5.4
During3	31.7	5.1	32.3	5.3	33.2	6.1	32.5	5.6
After1	32.3	5.1	34.9	5.6	33.9	6.3	33.0	5.9
After2	32.3	5.1	34.9	5.6	33.9	6.2	33.2	5.8

¹ Day 1 started at 1500hrs when the loops were installed

² Day 8 only includes flows from midday when SID was installed

³ Day 29 is from 12 noon when SID was deactivated

⁴ Standard deviation

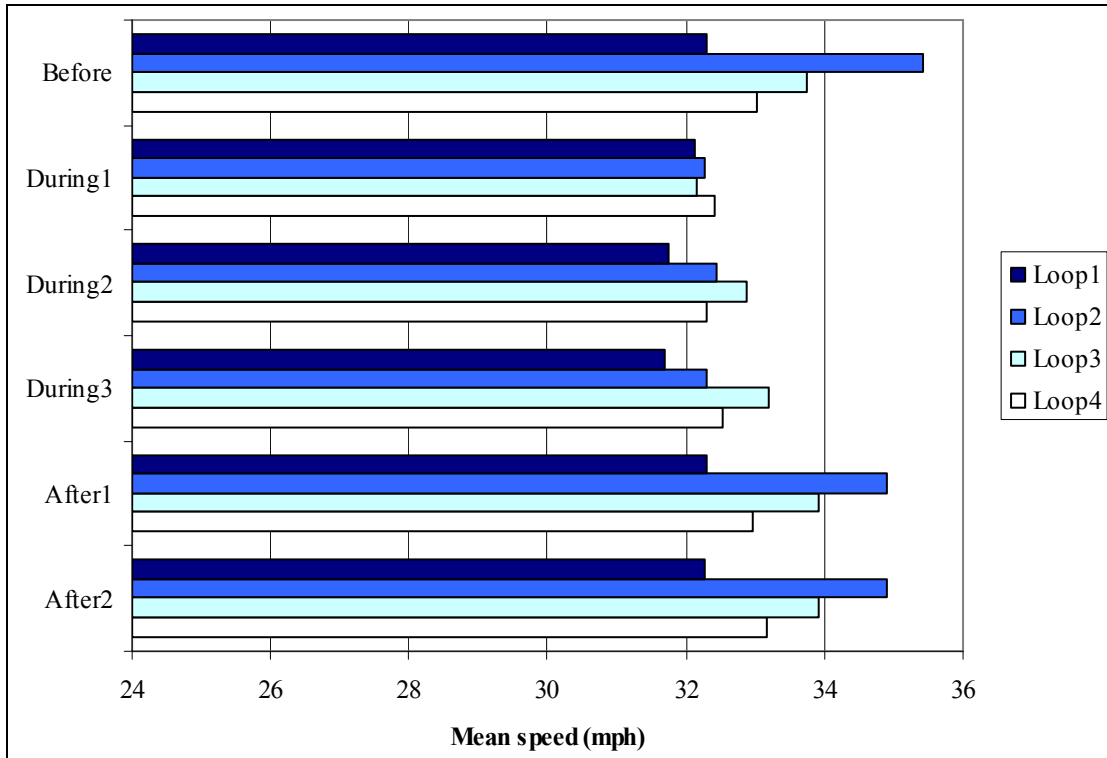


Figure E. 1: Mean speed (mph) by week before, during and after SID operation (site B)

Table E. 3 shows the proportion of vehicles exceeding the speed limit at loop2 before, during and after the installation of the SID; the results are discussed in Section 10.1.

Table E. 3: Proportion of vehicles exceeding speed levels at loop2 by time period (site B)

Period	Proportion at or exceeding		
	30mph	36mph	45mph
Before	80.4%	45.2%	5.9%
During1	61.0%*	23.5%*	2.2%*
During2	62.7%*	24.0%*	2.1%*
During3	61.5%*	22.8%*	2.1%*
After1	79.8%	41.4%*	3.8%*
After2	79.4%	41.8%*	4.1%*

* Indicates the proportion is statistically different from before period (i.e. the probability of no effect is <5%)

Significant differences between proportions are determined using the standard statistical test for comparing two proportions. The test statistic 't' shown in equation (B) (where p = proportion and n = sample size) is compared to the t-statistic to determine significance. For example testing whether there is a significant difference between the proportion of drivers exceeding 36mph before the SID was installed compared to whilst the SID was operational (during1) compares 45.2% with 23.5%:

$$t' = \frac{p_1 - p_2}{\sqrt{\frac{p_1(1-p_1)}{n_1} + \frac{p_2(1-p_2)}{n_2}}} = \frac{0.452 - 0.235}{\sqrt{\frac{0.452(1-0.452)}{30519} + \frac{0.235(1-0.235)}{93968}}} = 68.5 \quad (B)$$

According to the t-distribution, a value of 't' greater than 1.96 represents a statistically significant difference at 95%, that is there is a 5% chance that there is no difference – hence in this example there is a very small probability that these proportions are not different (<0.1%).

Figure E. 2 shows the mean speed at the site of the SID (loop2) by day of study where day 1 was a Monday. Confidence intervals were also calculated however these are too tight due to the large number of vehicles to be seen on the graph. The SID was installed at midday on day 8 and remained in place for three weeks until it was removed at midday on day 29. The graph clearly shows that the mean speeds were significantly reduced during the period the SID was in operation. Mean speeds returned to higher levels as soon as the SID was removed.

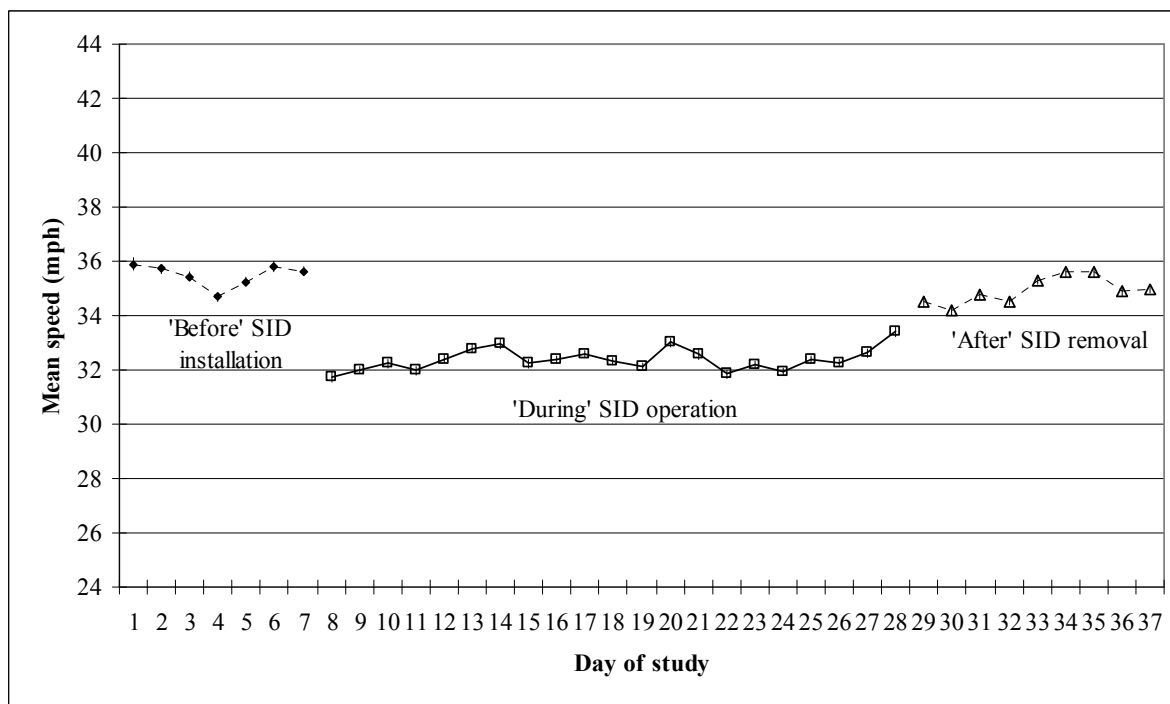


Figure E. 2: Daily mean speed (mph) and 95% confidence interval at loop2, before (days 1-7), during (days 8-28) and after (days 29-37) SID operation (site B)

Figure E. 3 shows the 85th percentile speeds at the SID site by day of study. There is a large drop in percentile speed as soon as the SID is activated but the percentile speed increases gradually towards the end of the SID operational period. When the SID is removed there is a smaller increase in percentile speeds than the mean speeds in Figure E. 2.

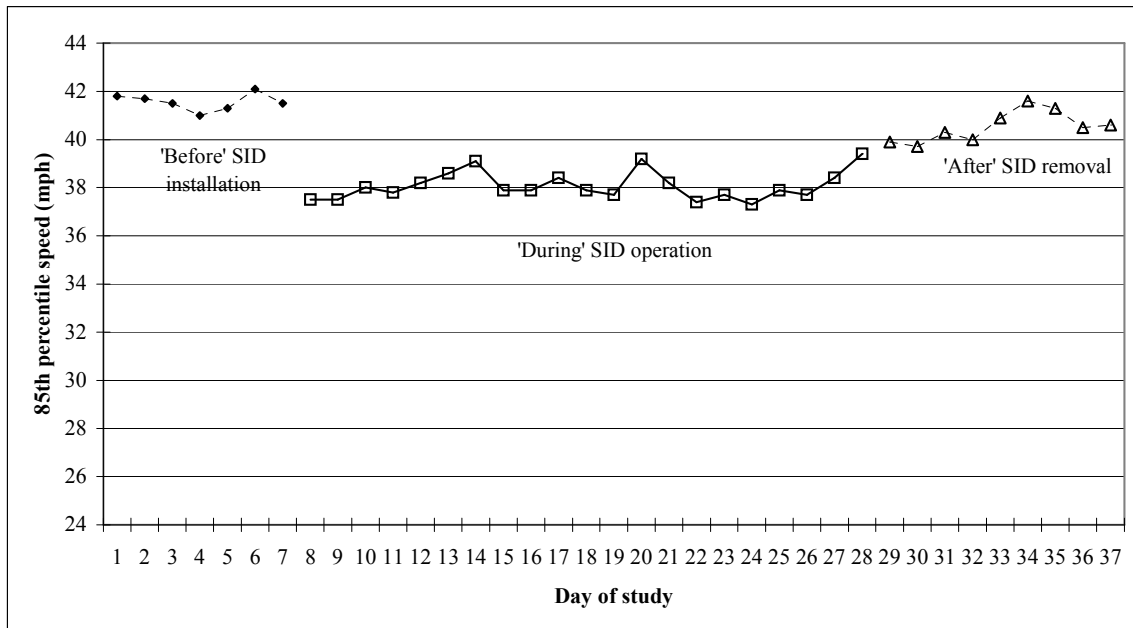


Figure E. 3: Daily 85th percentile speed (mph) at loop2, before (days 1-7), during (days 8-28) and after (days 29-37) SID operation (site B)

E.2 Summary data: site C – Manor Road

The data available for site C are displayed in Table E. 4. The main reason for the missing data is that the SID was installed but not working for 6 days (3 days in during1 and 3 days in during2). In addition loop3 had some periods of not working in the 'during' phase.

Table E. 4: Available speed data in days per week and loop (site C)

Period	Loop1	Loop2	Loop3
Before ⁵	7.0	7.0	7.0
During1 ^{6,7}	3.5	3.0	2.5
During2 ⁷	4.0	4.0	2.0
During3	7.0	7.0	4.5
After1 ⁸	6.5	6.5	6.5
After2	7.0	7.0	7.0

Mean speeds at all loops at site C are displayed in Table E. 5 and shown in Figure E. 4. This shows a reduction in speed in the 'during period' at loop2, very little difference between the time periods for loop1 and a speed reduction in the 'during' period at loop3 (although not as pronounced as loop2).

⁵ Day 1 started at 0000hrs when the loops were installed

⁶ Day 8 only includes flows from midday when SID was installed

⁷ SID did not work for 6 days (3 days in during1, 3 days in during2)

⁸ Day 29 is from 6pm when SID was deactivated

Table E. 5: Mean speed (mph) and standard deviation before, during and after SID operation (site C)⁹

Period	Loop1		Loop2		Loop3	
	Mean speed (mph)	SD ¹⁰	Mean speed (mph)	SD ¹⁰	Mean speed (mph)	SD ¹⁰
Before	30.4	5.1	28.4	5.6	28.1	5.9
During1	30.3	5.0	27.7	5.2	28.1	5.7
During2	30.1	5.0	26.8	4.9	27.3	5.6
During3	30.1	5.0	27.1	5.0	27.8	5.4
After1	30.4	5.1	28.3	5.5	28.1	5.8
After2	30.3	5.1	28.2	5.6	28.0	5.8

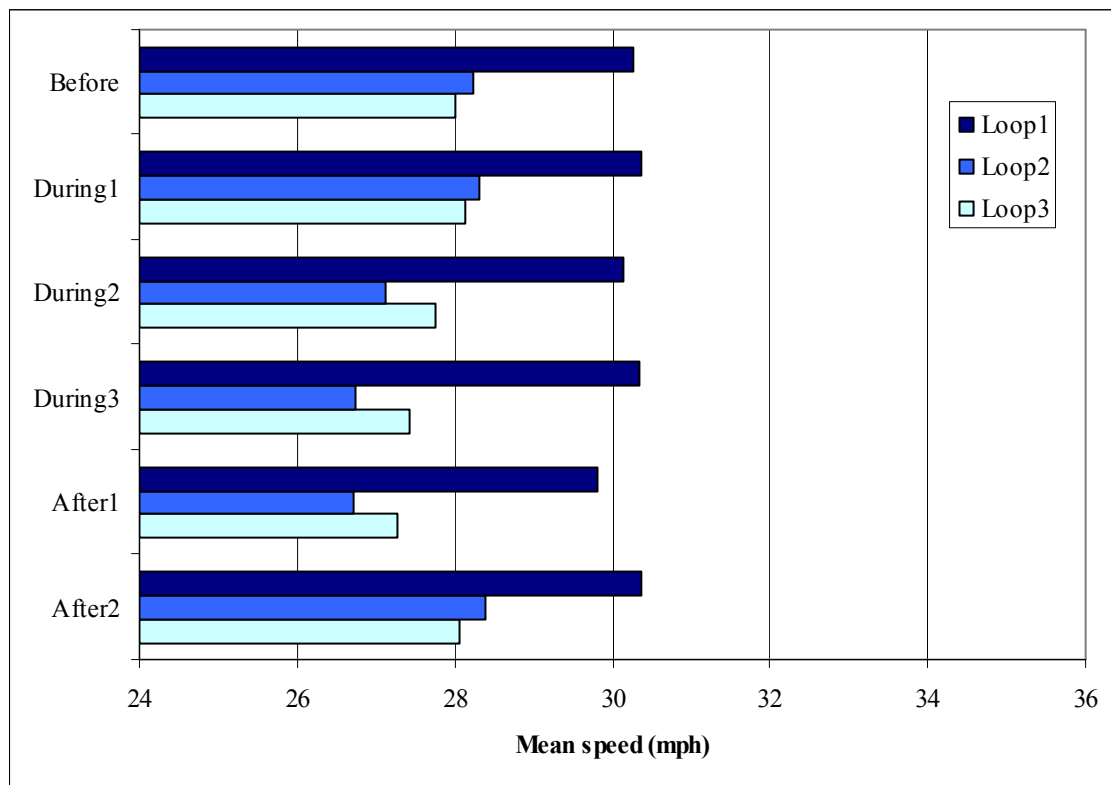


Figure E. 4: Mean speed (mph) by week before, during and after SID operation (site C)

Figure E. 5 shows the mean speed at the site of the SID (loop2) by day of study (day1 = Tuesday). The SID was installed at midday on day 8 and remained in place for three weeks until being removed at 6pm on day 29. The battery failed and the SID did not operate for 6 days during the trial period (day 12 to day 17). The graph clearly shows that the mean speeds were significantly reduced during the period of the SID in operation and that speeds reverted back to 'before' levels as soon as the SID was removed. When the SID was in operation, the large peaks seen at weekends were substantially reduced. This observation was confirmed with an additional ANOVA

⁹ Excluding days when SID was not working

¹⁰ Standard deviation

analysis, which found that the SID had greatest effect at the weekend reducing speeds by 1.9mph compared to 1.0mph for weekdays at this site.

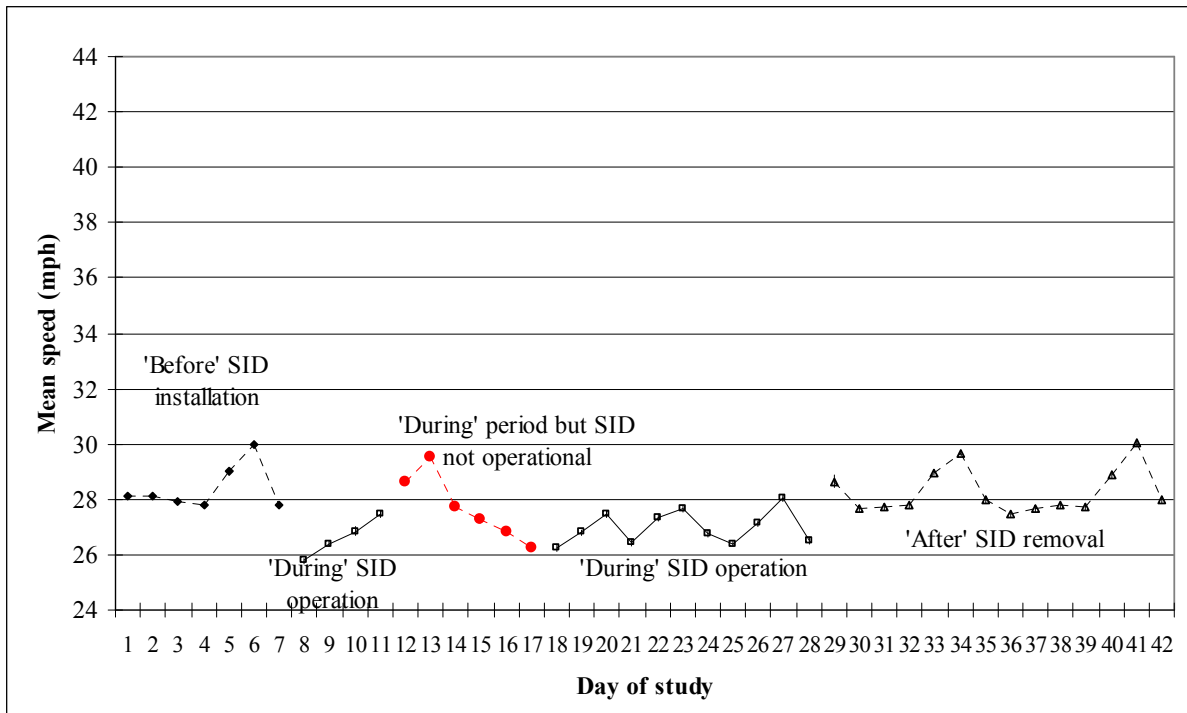


Figure E. 5: Daily mean speed (mph) and confidence interval at loop2, before (days 1-7), during (days 8-28) and after (days 29-42) SID operation (site C)

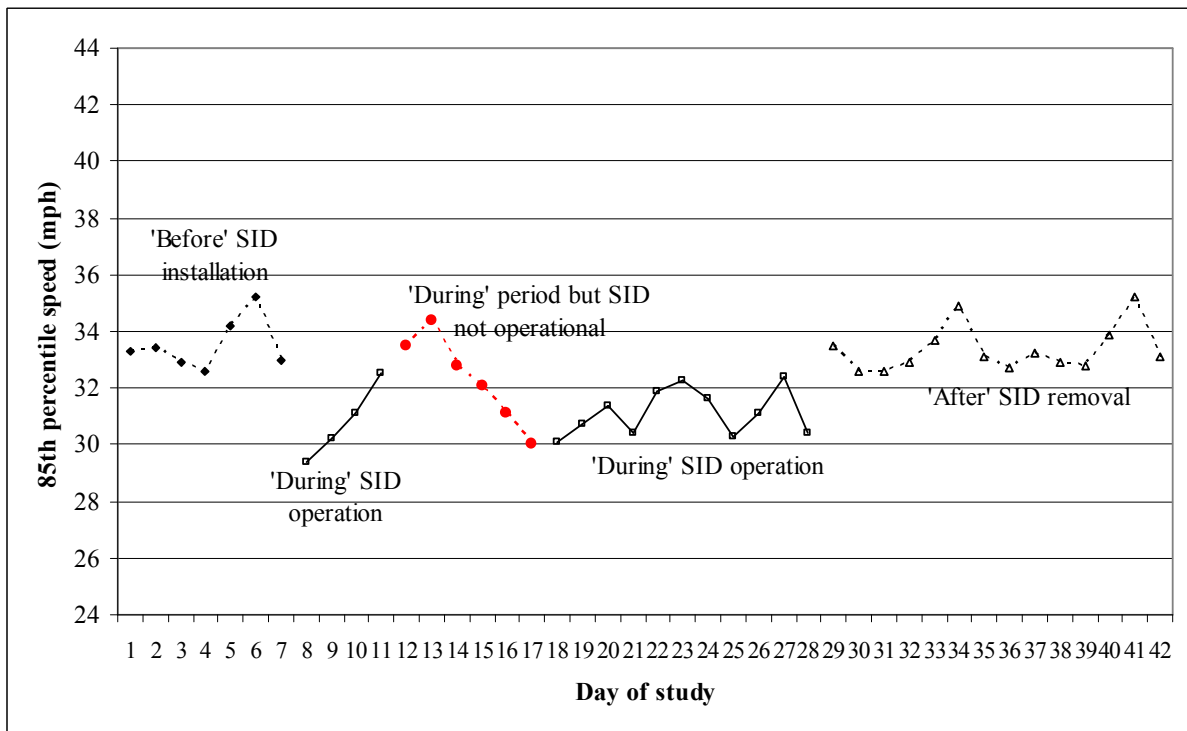


Figure E. 6: Daily 85th percentile speed (mph) at loop2, before (days 1-7), during (days 8-28) and after (days 29-42) SID operation (site C)

Figure E. 6 shows the 85th percentile speeds at the SID site by day of study. There was a large drop in percentile speed as soon as the SID was activated and a return to 'before' levels when the SID was removed.

Table E. 6 shows the proportion of vehicles exceeding the speed limit before, during and after the installation of the SID at loop2. The proportion of vehicles travelling faster than the speed limit was significantly reduced when the SID was in operation at all three speed levels. Once the SID was removed the proportions of speeding vehicles increased, although they were still slightly lower than 'before' the SID was installed (see Section 10.5).

Table E. 6: Proportion of vehicles exceeding speed levels at loop2 by time period (site C)

Period	Proportion at or exceeding:		
	30mph	36mph	45mph
Before	32.3%	9.1%	1.3%
During1	18.7%*	4.5%*	0.7%*
During2	17.6%*	4.8%*	0.7%*
During3	21.0%*	5.7%*	0.9%*
After1	31.6%*	8.5%*	1.2%
After2	31.5%*	8.7%	1.2%

* Indicates the proportion is statistically different from before period (i.e. the probability of no effect is <5%)

E.3 Summary data: site D – Welling Way

The data available for Site D are displayed in Table E. 7. The two reasons for the missing data are firstly that the SID was installed but not working for 4 days (3 days in during1 and 1 day in during2) and secondly the data was unreliable for during3 and the 'after' periods for loops 1 and 3. This meant that site D had to be excluded from the analysis that assessed whether the SID had an effect on speeds after its removal. In addition 'during3' was excluded from the ANOVA analysis in Section 10.2.

Table E. 7: Available speed data in days per week and loop (site D)

Period	Loop1	Loop2	Loop3
Before ¹¹	7.0	7.0	7.0
During1 ^{12,13}	3.5	3.5	3.5
During2 ¹³	6.0	6.0	6.0
During3 ¹⁴	1.0	7.0	0.0
After1 ¹⁴	0.0	5.5	0.0
After2 ¹⁴	0.0	7.0	0.0

¹¹ Day 1 started at 0000hrs when the loops were installed

¹² Day 8 only includes flows from midday when SID was installed

¹³ SID did not work for 4 days (3 days in during1, 1 day in during2)

¹⁴ The data was unreliable for during3 and after periods for loop1 & loop3

Mean speeds at all loops at site D are displayed in Table E. 8 and shown in Figure E. 7. This shows a reduction in speed in the 'during period' at loop2.

Table E. 8: Mean speed (mph) and standard deviation before, during and after SID operation (site D)¹⁵

Period	Loop1		Loop2		Loop3	
	Mean speed (mph)	SD ¹⁶	Mean speed (mph)	SD ¹⁶	Mean speed (mph)	SD ¹⁶
Before	33.9	5.3	34.9	5.2	35.8	5.7
During1 ¹⁵	33.3	5.1	32.8	5.0	34.6	5.3
During2 ¹⁵	33.6	5.2	32.5	5.1	34.7	5.4
During3	Data unreliable		32.4	5.0	Data unreliable	
After1	Data unreliable		34.9	5.2	Data unreliable	
After2	Data unreliable		34.7	5.0	Data unreliable	

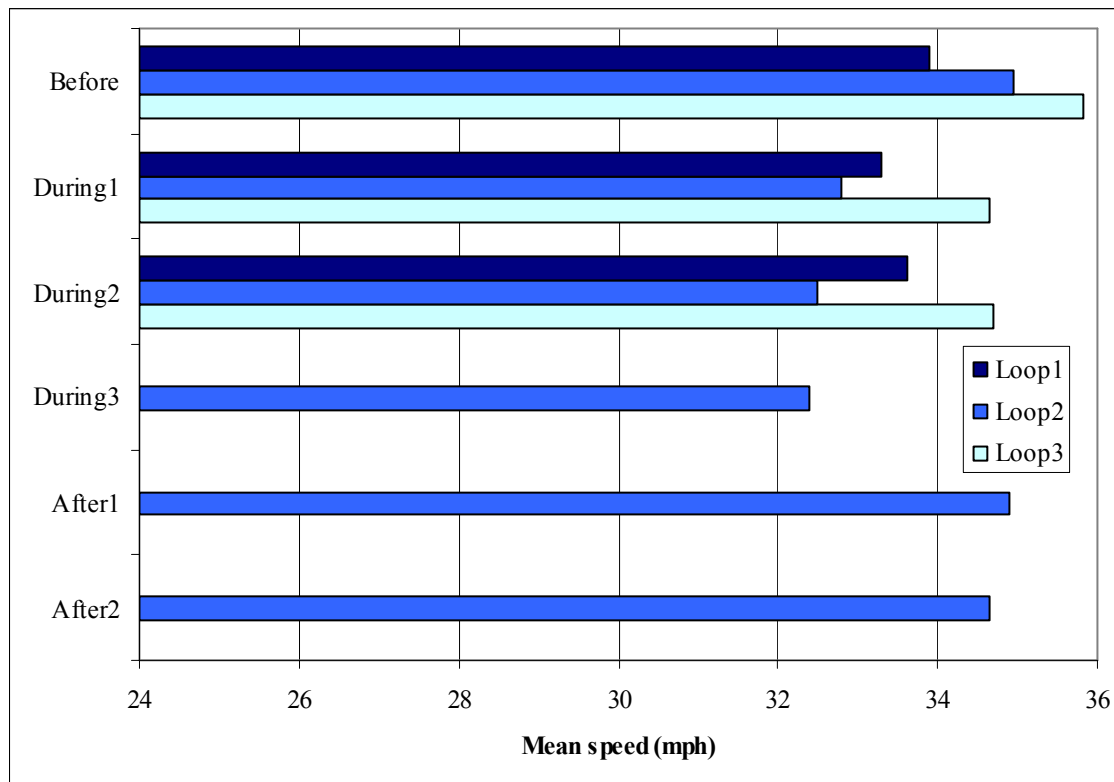


Figure E. 7: Mean speed (mph) by week before, during and after SID operation (site D)

Figure E. 8 shows the mean speed at the site of the SID (loop2) by day of study (day 1 was a Wednesday). The SID was installed at midday on day 8 and remained in place for three weeks until being removed at midday on day 29. The battery failed and the SID did not operate for 4 days during the trial period (day 12 - day 15). The graph clearly shows that the mean speeds were significantly reduced during the period of the SID operation (although day 11 looks unexpectedly high suggesting that the SID battery

¹⁵ Excluding days when SID was not working

¹⁶ Standard deviation

failed earlier than recorded). Speeds returned to 'before' levels as soon as the SID was removed (data was missing for day 29).

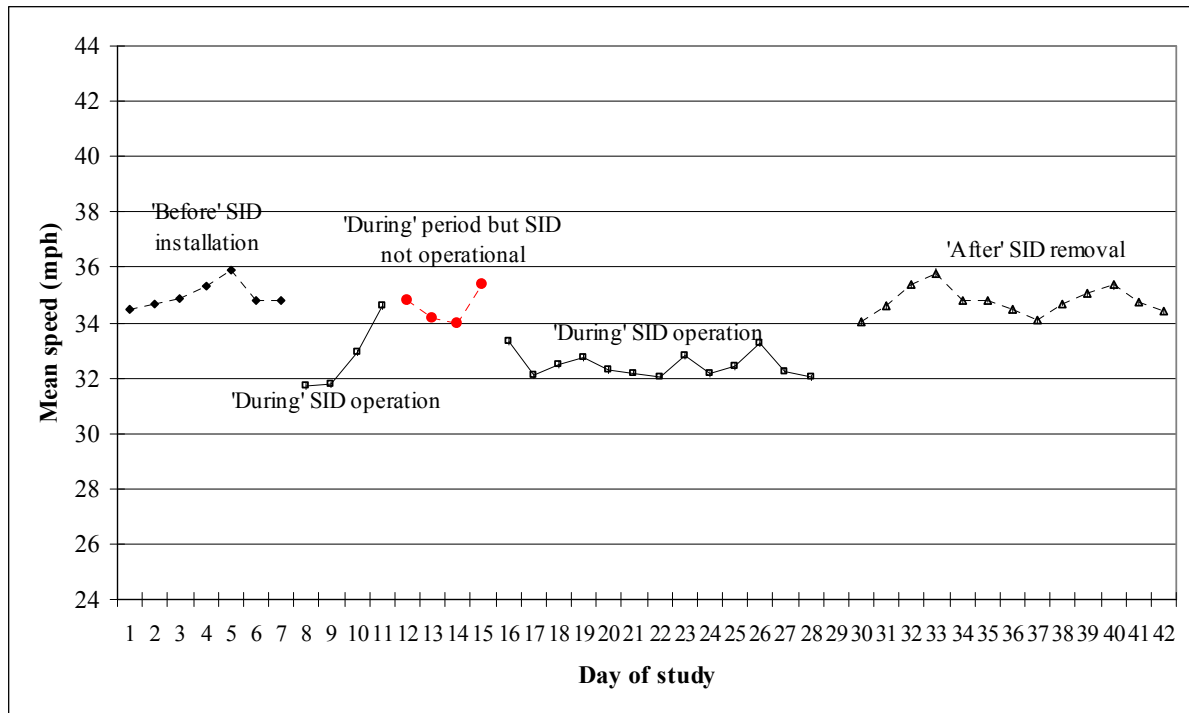


Figure E. 8: Daily mean speed (mph) and confidence interval at loop2, before (days 1-7), during (days 8-28) and after (days 29-42) SID operation (site D)

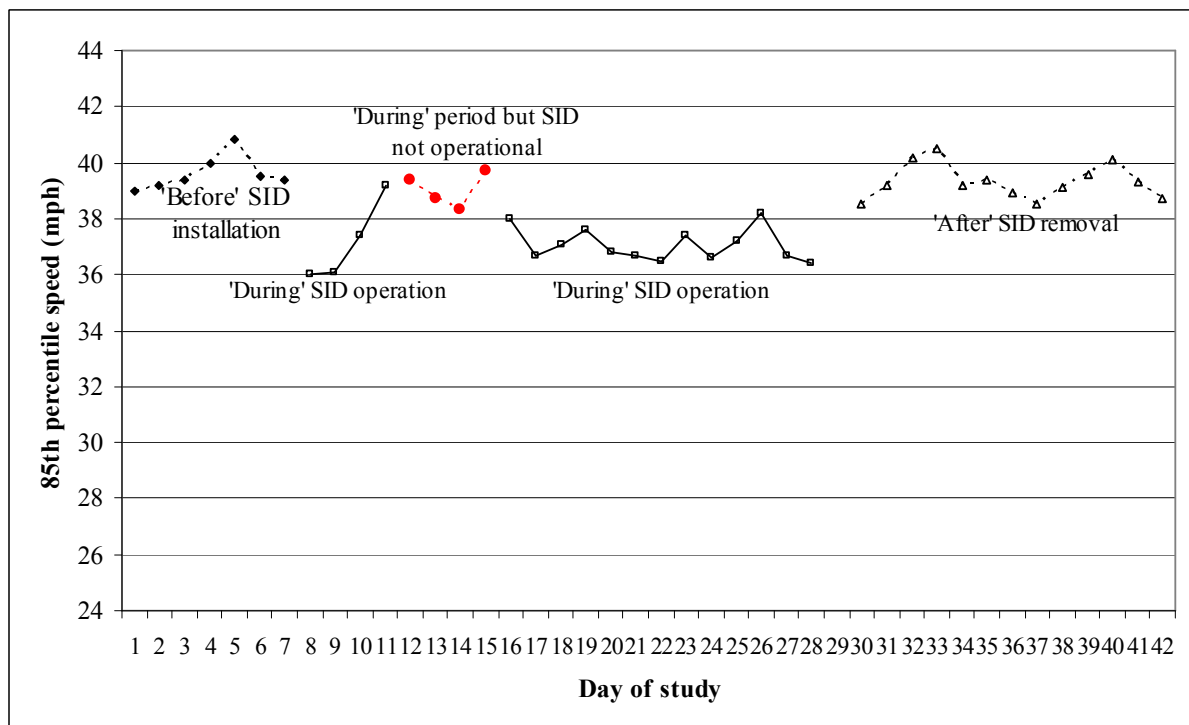


Figure E. 9: Daily 85th percentile speed (mph) at loop2, before (days 1-7), during (days 8-28) and after (days 29-42) SID operation (site D)

Figure E. 10 shows the 85th percentile speeds at the SID site by day of study. The pattern reflects that of Figure E. 8.

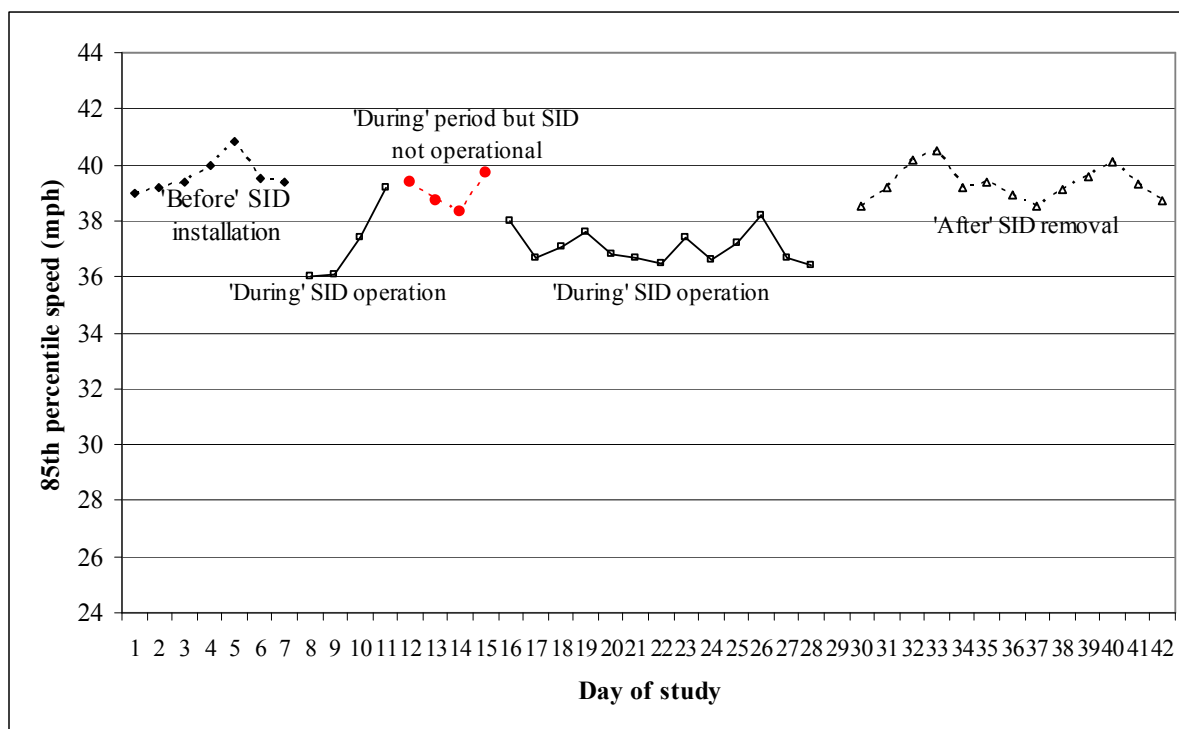


Figure E. 10: Daily 85th percentile speed (mph) at loop2, before (days 1-7), during (days 8-28) and after (days 29-42) SID operation (site D)

Table E. 9 shows the proportion of vehicles exceeding the speed limit before, during and after the SID operation at loop2. The proportion of vehicles travelling faster than the speed limit was significantly reduced when the SID was in operation. Once the SID was removed the proportions of speeding vehicles increased to 'before' levels although proportions travelling faster than 36mph and 45mph were slightly lower than 'before' levels (see Section 10.1).

Table E. 9: Proportion of vehicles exceeding speed levels at loop2 by time period (site D)

Period	Proportion at or exceeding:		
	30mph	36mph	45mph
Before	85.9%	36.5%	3.9%
During1	68.4%*	22.1%*	2.3%*
During2	65.0%*	20.2%*	2.4%*
During3	64.2%*	19.2%*	2.2%*
After1	86.0%	35.6%*	4.0%
After2	85.3%	33.7%*	3.3%*

* Indicates the proportion is statistically different from before period (i.e. the probability of no effect is <5%)

E.4 Summary data: site E – Bromley Hill

The data available for site E are displayed in Table E. 10. The reasons for the missing data were that the SID was installed but not working for 3 days (day 14 to day 16) and loop2 was not working from day 13 until day 17.

Table E. 10: Available speed data in days per week and loop (site E)

Period	Loop1	Loop2	Loop3	Loop4
Before ¹⁷	6.5	6.5	6.5	6.5
During1 ^{18,19}	5.5	4.5 ²⁰	5.5	5.5
During2 ¹⁹	5.0	4.5 ²⁰	5.0	5.0
After1 ²¹	6.5	6.5	6.5	6.5
After2	7.0	7.0	7.0	7.0

Mean speeds at all loops at site E are displayed in Table E. 11 and shown in Figure E.10. This shows a reduction in speed at loop2 and a small reduction at loop3 in the 'during period'. There is virtually no reduction in speed by loop4.

Table E. 11: Mean speed (mph) and standard deviation before, during and after SID operation (site E)²²

Period	Loop1		Loop2		Loop3		Loop4	
	Mean speed (mph)	SD ²³	Mean speed (mph)	SD ²³	Mean speed (mph)	SD ²³	Mean speed (mph)	SD ²³
Before	32.8	5.5	31.7	5.2	31.3	5.0	30.6	5.8
During1	32.5	5.3	29.7	4.8	30.8	4.7	30.0	5.5
During2	32.5	5.4	29.4	4.8	30.9	4.6	30.5	5.6
After1	32.6	5.3	31.5	5.1	31.3	4.8	30.5	5.7
After2	32.6	5.4	31.7	5.1	31.4	4.8	30.6	5.7

¹⁷ Day 1 started at 16hrs when the loops were installed

¹⁸ Day 8 only includes flows from midday when SID was installed

¹⁹ SID did not work for 3 days (1 days in during1, 2 days in during2)

²⁰ Loop2 was not working for day13, 14, 15, 16 and half of day17

²¹ Day 22 is from 12noon when SID was deactivated

²² Excluding days when SID was not working

²³ Standard deviation

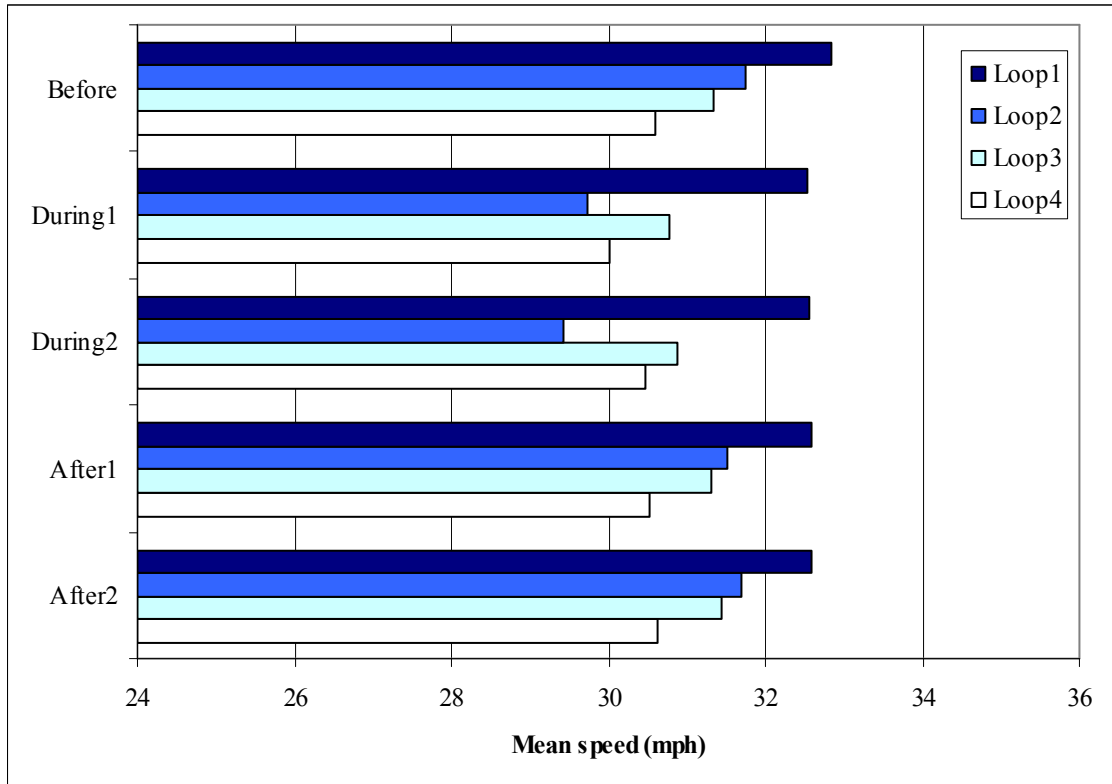


Figure E. 11: Mean speed (mph) by week before, during and after SID operation (site E)

Figure E. 12 shows the mean speed at the site of the SID (loop2) by day of study (day1 was a Monday). The SID was installed at midday on day 8 and remained in place for two weeks until being removed at midday on day 22. The battery failed and the SID did not operate for 3 days during the trial period (day 14 – day 16). Also speed data for day 13 to day 16 are missing as loop2 was not working during this period. The graph clearly shows that the mean speeds were significantly reduced during the period the SID was operational. Mean speeds returned back to 'before' levels as soon as the SID was removed.

Figure E. 12 shows the 85th percentile speeds at the SID site by day of study. The pattern of 85th percentile speeds over the study period reflects that of Figure E. 12.

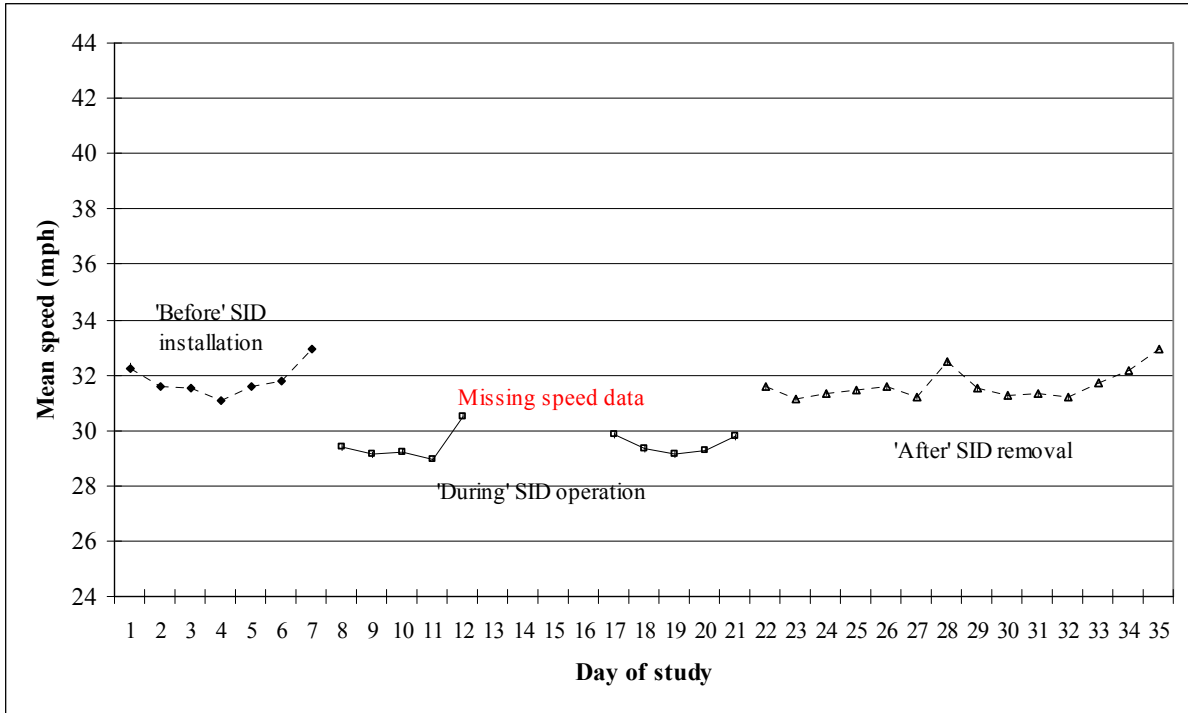


Figure E. 12: Daily mean speed (mph) and confidence interval at loop2, before (days 1-7), during (days 8-21) and after (days 22-35) SID operation (site E)

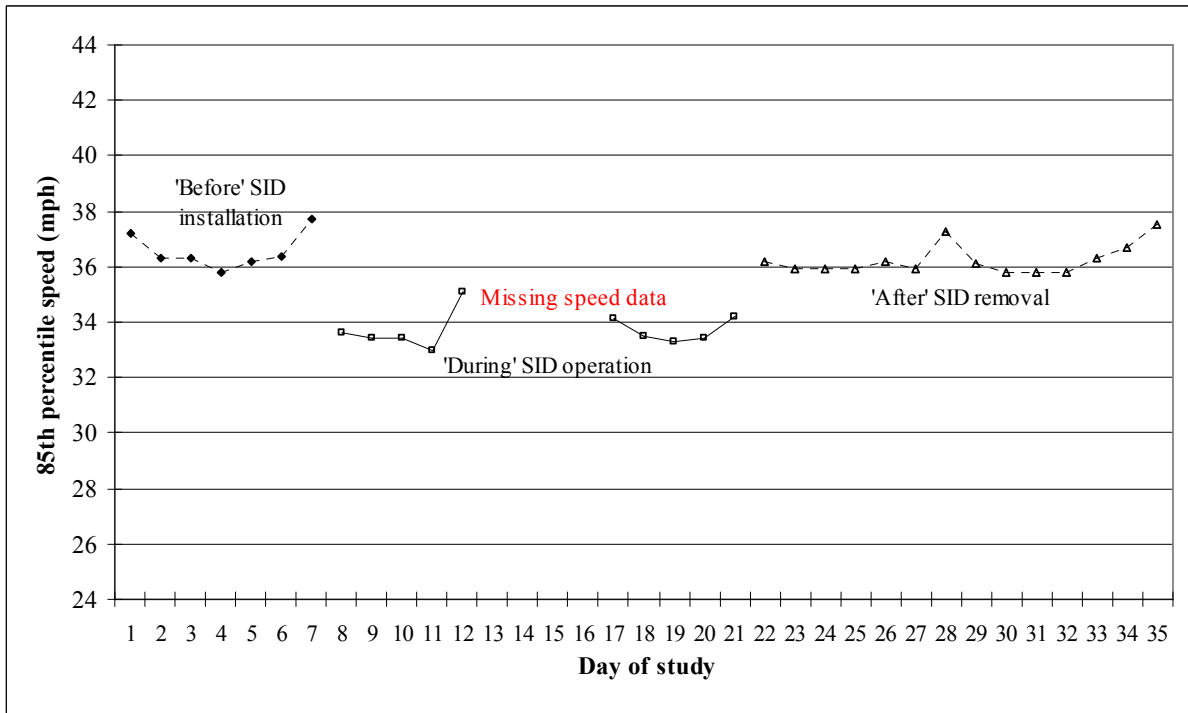


Figure E. 13: Daily 85th percentile speed (mph) at loop2, before (days 1-7), during (days 8-21) and after (days 22-35) SID operation (site E)

Table E. 12 shows the proportion of vehicles exceeding the speed limit before, during and after the operation of the SID at loop2. The proportion of vehicles travelling faster than the speed limit was significantly reduced when the SID was in operation. Once the

SID was removed the proportions of speeding vehicles increased although they were slightly lower than the 'before' period proportions.

Table E. 12: Proportion of vehicles exceeding speed levels at loop2 by time period (site E)

Period	Proportion at or exceeding:		
	30mph	36mph	45mph
Before	63.0%	17.2%	1.7%
During1	38.9%*	8.5%*	1.0%*
During2	38.0%*	8.1%*	1.0%*
After1	61.5%*	16.0%*	1.5%*
After2	63.2%	16.5%*	1.5%*

* Indicates the proportion is statistically different from before period (i.e. the probability of no effect is <5%)

E.5 Summary data: site F – Parkhill Road

The data available for site F are displayed in Table E. 13. The data is almost complete, missing only the half days when the SID was installed and removed.

Mean speeds at all loops at site F are displayed in Table E. 14 and shown in Figure E. 14. This shows a reduction in speed in the 'during period' at loop2 but almost no reduction at loop3.

Table E. 13: Available speed data in days per week and loop (site F)

Period	Loop1	Loop2	Loop3
Before ²⁴	7.0	7.0	7.0
During1 ²⁵	6.5	6.5	6.5
During2	7.0	7.0	7.0
After1 ²⁶	6.5	6.5	6.5
After2	7.0	7.0	7.0

²⁴ Day 1 started at 00hrs when the loops were installed

²⁵ Day 8 only includes flows from midday when SID was installed

²⁶ Day 22 only includes flows from midday when SID was deactivated

Table E. 14: Mean speed (mph) and standard deviation before, during and after SID operation (site F)

Period	Loop1		Loop2		Loop3	
	Mean speed (mph)	SD ²⁷	Mean speed (mph)	SD ²⁷	Mean speed (mph)	SD ²⁷
Before	30.0	4.7	32.3	5.1	32.8	5.2
During1	29.8	4.5	30.0	4.5	32.0	4.8
During2	29.7	4.5	30.1	4.6	32.1	4.9
After1	29.8	4.5	32.0	4.9	32.6	5.0
After2	29.9	4.6	32.2	5.0	32.8	5.1

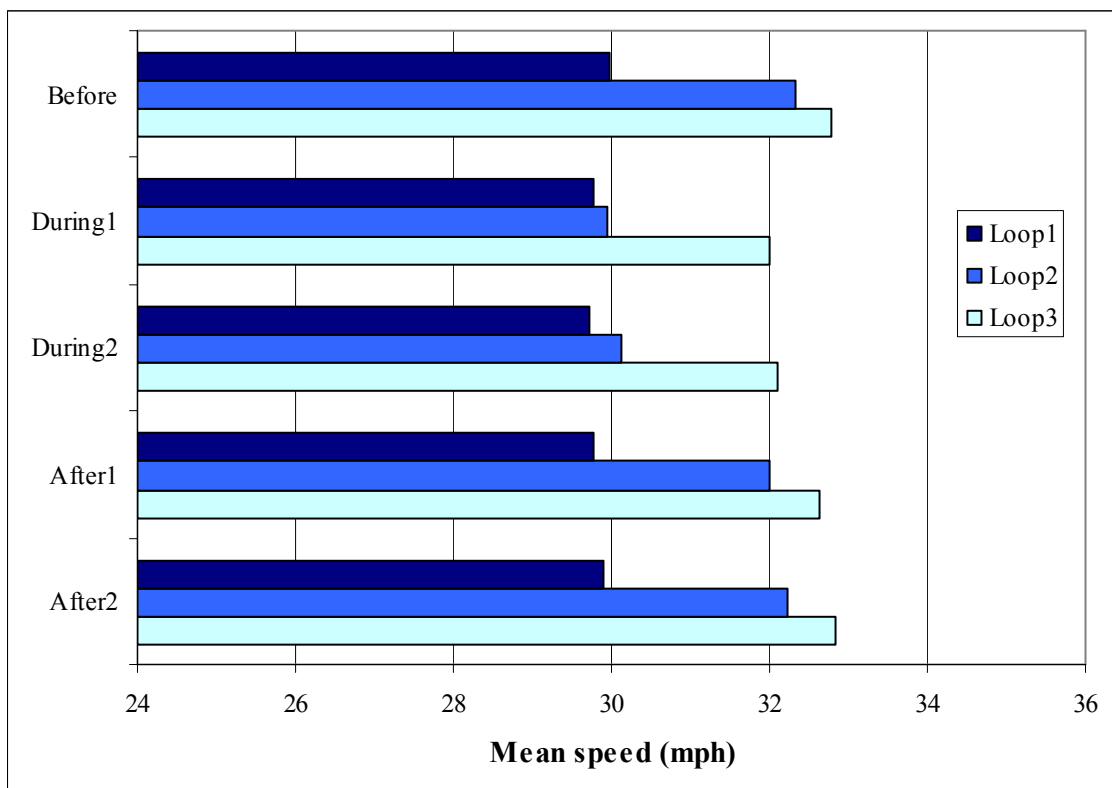


Figure E. 14: Mean speed (mph) by week before, during and after SID operation (site F)

Figure E. 15 shows the mean speed at the site of the SID (loop2) by day of study (day1 was a Tuesday). The SID was installed at midday on day 8 and remained in place for two weeks until being removed at midday on day 22. The graph clearly shows that the mean speeds were significantly reduced whilst the SID was operational. Speeds returned to 'before' levels as soon as the SID was removed. Figure E. 15 shows the 85th percentile speeds at the SID site by day of study. The pattern reflects that of Figure E. 15.

²⁷ Standard deviation

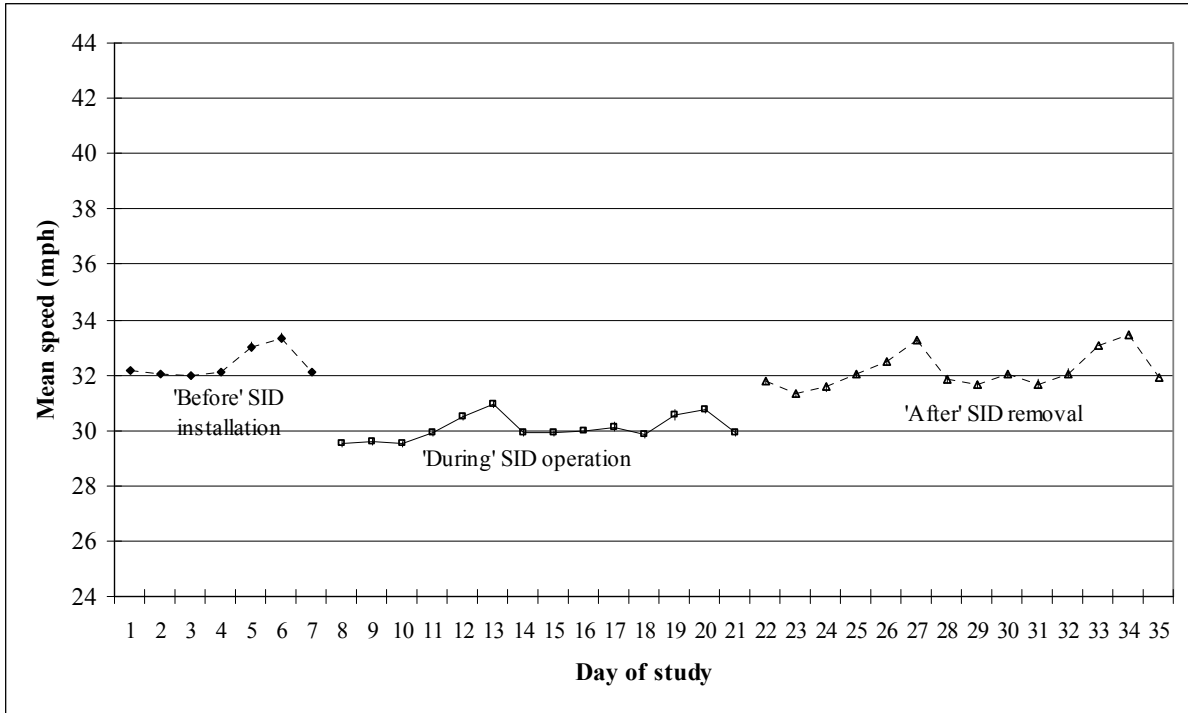


Figure E. 15: Daily mean speed (mph) and confidence interval at loop2, before (days 1-7), during (days 8-21) and after (days 22-35) SID operation (site F)

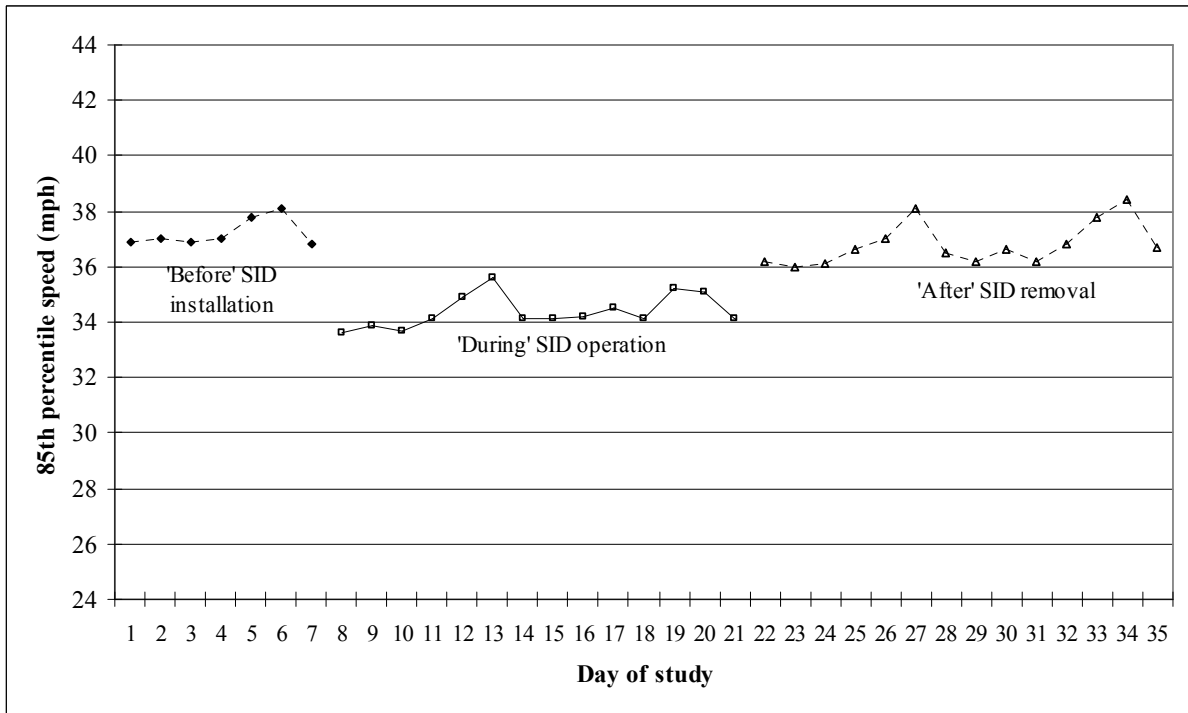


Figure E. 16: Daily 85th percentile speed (mph) at loop2, before (days 1-7), during (days 8-21) and after (days 22-35) SID operation (site F)

Table E. 15 shows the proportion of vehicles exceeding the speed limit before, during and after the operation of the SID at loop2. The proportion of vehicles travelling faster than the speed limit was significantly reduced when the SID was in operation. Once the

SID was removed the proportions of speeding vehicles increased although they were still lower than the 'before' levels.

Table E. 15: Proportion of vehicles exceeding speed levels at loop2 by time period (site F)

Period	Proportion at or exceeding:		
	30mph	36mph	45mph
Before	69.0%	21.3%	1.3%
During1	44.6%*	9.0%*	0.6%*
During2	46.3%*	9.6%*	0.7%*
After1	66.8%*	18.5%*	1.1%
After2	68.1%*	20.2%*	1.3%

* Indicates the proportion is statistically different from before period (i.e. the probability of no effect is <5%)

E.6 Summary data: site G – Malden Road

The data available for site G are displayed in Table E. 16. The data is almost complete, missing the half days when the SID was installed and removed and 1.5 days in the 'after2' period when loop3 stopped working.

Table E. 16: Available speed data in days per week and loop (site G)

Period	Loop1	Loop2	Loop3
Before ²⁸	7.0	7.0	7.0
During1 ²⁹	6.5	6.5	6.5
During2	7.0	7.0	7.0
After1 ³⁰	6.5	6.5	6.5
After2	7.0	7.0	5.5 ³¹

Mean speeds at all loops at site G are displayed in Table E. 17 and shown in Figure E. 17. This shows a small reduction in speed in the 'during period' at loop2 and a small reduction at loop3.

²⁸ Day 1 started at 00hrs as loops installed day before

²⁹ Day 8 only includes flows from 11.39hrs when SID was installed

³⁰ Day 22 only includes flows from 16.20hrs when SID was deactivated

³¹ Tube did not work for 1.5 days

Table E. 17: Mean speed (mph) and standard deviation before, during and after SID operation (site G)

Period	Loop1		Loop2		Loop3	
	Mean speed (mph)	SD ³²	Mean speed (mph)	SD ³²	Mean speed (mph)	SD ³²
Before	28.1	4.7	30.7	4.9	29.2	4.8
During1	28.0	4.7	28.7	4.6	28.7	4.6
During2	28.0	4.7	29.7	4.8	28.8	4.5
After1	28.0	4.6	30.7	4.8	29.2	4.6
After2	28.1	4.7	30.9	4.8	29.0	4.7

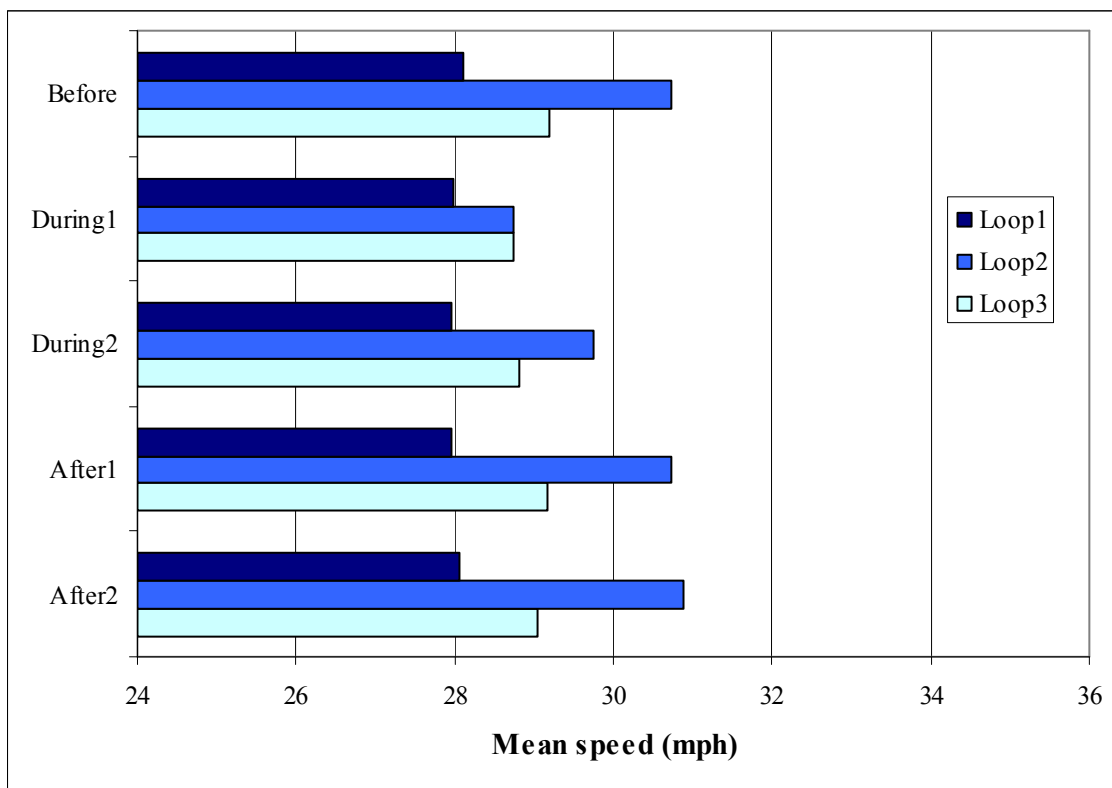


Figure E. 17: Mean speed (mph) by week before, during and after SID operation (site G)

Table E. 18 shows the proportion of vehicles exceeding the speed limit before, during and after the operation of the SID at loop2. The proportion of vehicles travelling faster than the speed limit was significantly reduced when the SID was in operation. Once the SID was removed the proportions of speeding vehicles increased to a slightly higher level than 'before' the SID was installed (although no significant difference was observed for proportions travelling substantially more than the speed limit – 36mph and 45mph).

³² Standard deviation

Table E. 18: Proportion of vehicles exceeding speed levels at loop2 by time period (site G)

Period	Proportion at or exceeding:		
	30mph	36mph	45mph
Before	52.2%	12.1%	1.1%
During1	31.3%*	6.9%*	0.7%*
During2	42.0%*	9.3%*	0.9%*
After1	52.9%*	12.4%	1.0%
After2	54.1%*	12.6%*	1.1%

* Indicates the proportion is statistically different from before period (i.e. the probability of no effect is <5%)

Figure E. 18 shows the mean speed at the site of the SID (loop2) by day of study (day1 was a Thursday). The SID was installed at 11.39am on day 8 and remained in place for two weeks until being removed at 16.20pm on day 22. The graph clearly shows that the mean speeds were significantly reduced when the SID was first in operation gradually rising during the second week of the trial. Speeds returned to 'before' levels as soon as the SID was removed. A separate ANOVA analysis confirms this initial 'novelty' effect with a speed reduction of 1.9mph in the first week and a reduction of 0.8mph in the second week of the trial (Section 10.2). Figure E. 17 shows the 85th percentile speeds at the SID site by day of study. The pattern reflects that of Figure E. 18.

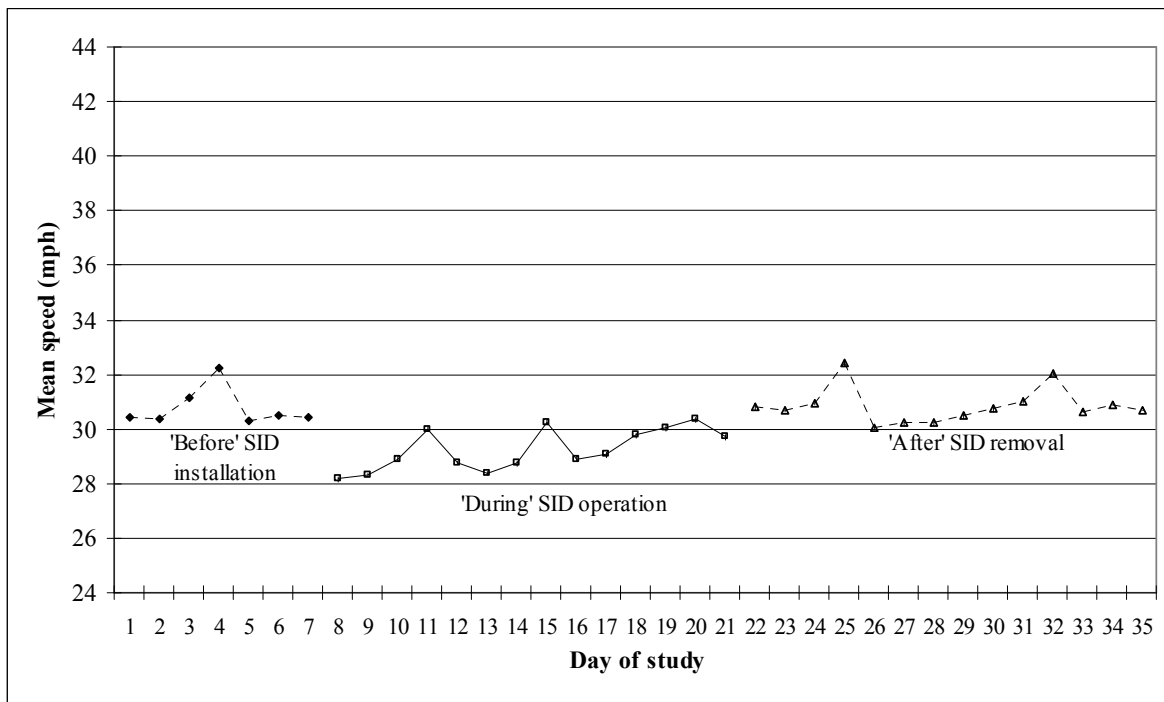


Figure E. 18: Daily mean speed (mph) and confidence interval at loop2, before (days 1-7), during (days 8-21) and after (days 22-35) SID operation (site G)

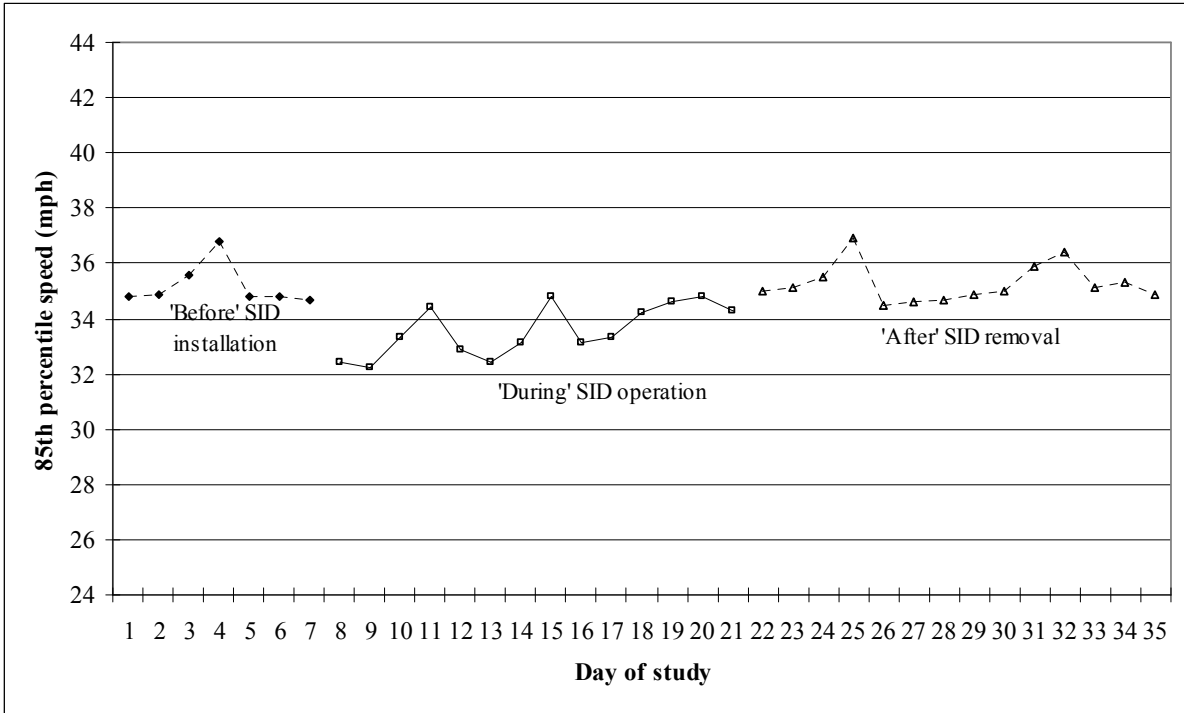


Figure E. 19: Daily 85th percentile speed (mph) at loop2, before (days 1-7), during (days 8-21) and after (days 22-35) SID operation (site G)

E.7 Summary data : site H – Kings Hall Road

The data available for site H are displayed in Table E. 19. The reasons for the missing data were that the SID was installed but not working for 2 days in the during2 period (day 20 and 21).

Mean speeds at all loops at site H are displayed in Table E. 20 and shown in Figure E. 20. This shows very little reduction in speed in the 'during period' at loop2 and no reduction at loop3 and 4.

Table E. 19: Available speed data in days per week and loop (site H)

Period	Loop1	Loop2	Loop3	Loop4
Before ³³	7.0	7.0	7.0	7.0
During1 ³⁴	6.5	6.5	6.5	6.5
During2 ³⁵	5.0	5.0	5.0	5.0
After1 ³⁶	6.5	6.5	6.5	6.5
After2	7.0	7.0	7.0	7.0

³³ Day 1 started at 00hrs as loops installed day before

³⁴ Day 8 only includes flows from 12.30hrs when SID was installed

³⁵ SID did not work for 2 days

³⁶ Day 22 only includes flows from 12.00hrs when SID was deactivated

Table E. 20: Mean speed (mph) and standard deviation before, during and after SID operation (site H)³⁷

Period	Loop1		Loop2		Loop3		Loop4	
	Mean speed (mph)	SD ³⁸	Mean speed (mph)	SD ³⁸	Mean speed (mph)	SD ³⁸	Mean speed (mph)	SD ³⁸
Before	30.4	4.5	33.2	5.5	31.5	3.9	24.8	3.2
During1	30.3	4.5	32.3	5.4	30.9	3.8	24.8	3.1
During2	30.5	4.5	32.8	5.4	31.3	3.9	24.8	3.1
After1	29.9	4.4	33.3	5.6	31.1	3.8	25.0	3.3
After2	30.6	4.5	34.0	5.6	31.9	4.0	25.0	3.3

Figure E. 21 shows the mean speed at the site of the SID (loop2) by day of study (day1 was a Friday). The SID was installed at midday on day 8 and remained in place for two weeks until being removed at midday on day 22. If the first weekend of the SID trial is ignored, the graph clearly shows an initial 'novelty' week where mean speeds were reduced between days 11-17 quickly rising to 'before' levels by the second Monday in the trial (day 18). Figure E. 22 shows the 85th percentile speeds at the SID site by day of study. The pattern reflects that of Figure E. 21.

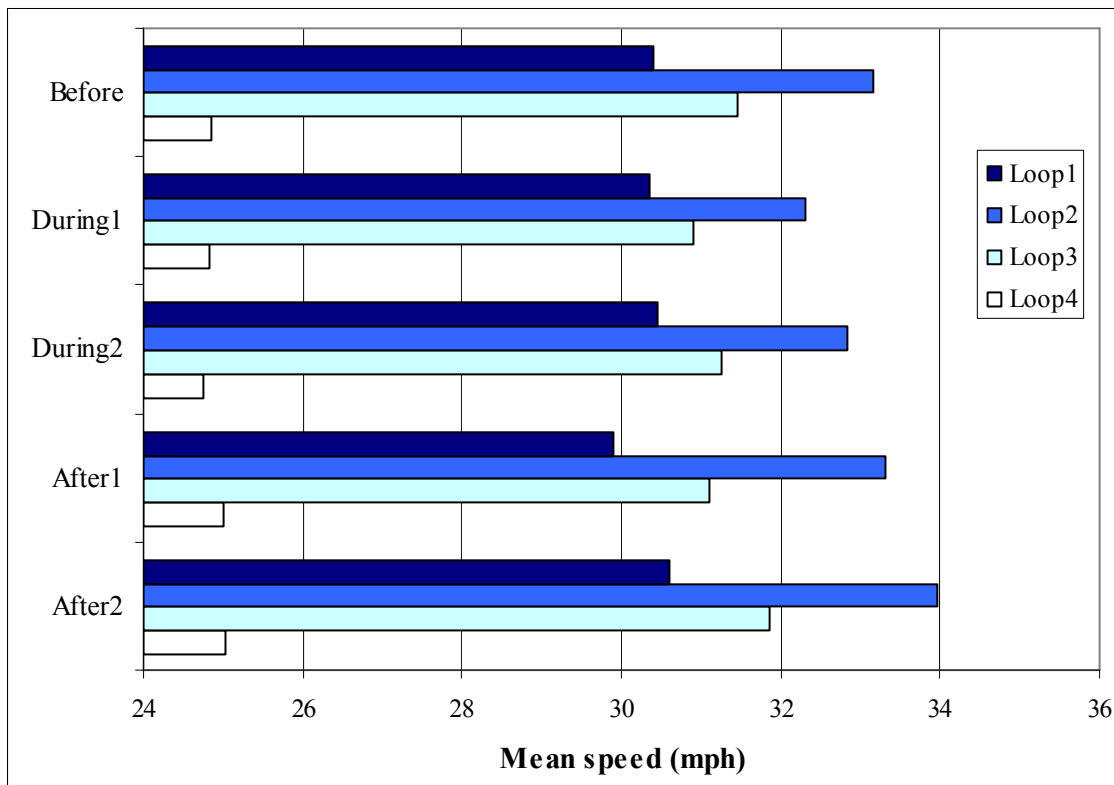


Figure E. 20: Mean speed (mph) by week before, during and after SID operation (site H)

³⁷ Excluding days when the SID was not working

³⁸ Standard deviation

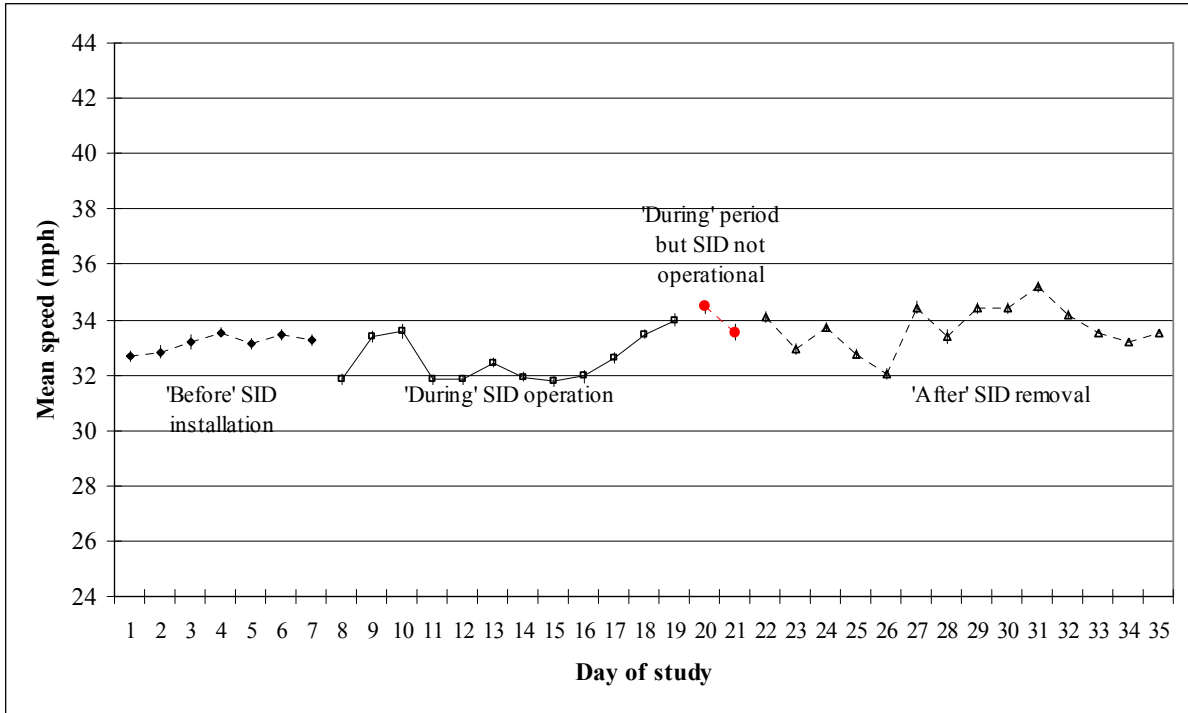


Figure E. 21: Daily mean speed (mph) and confidence interval at loop2, before (days 1-7), during (days 8-21) and after (days 22-35) SID operation (site H)

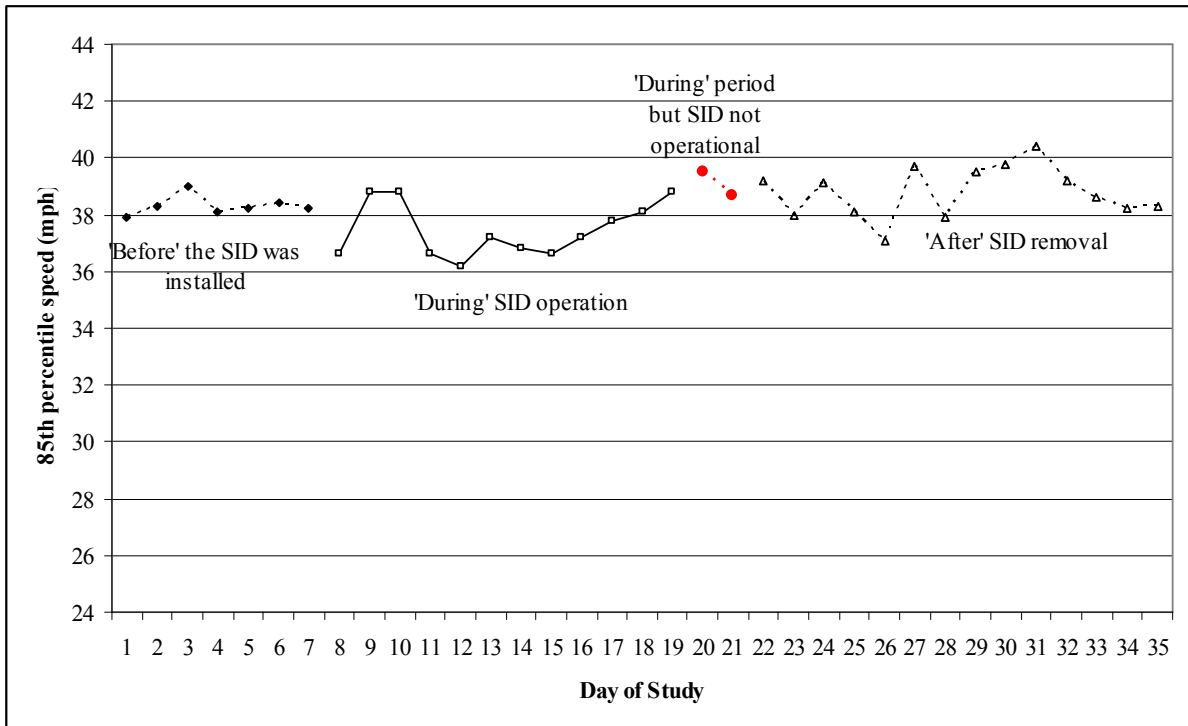


Figure E. 22: Daily 85th percentile speed (mph) at loop2, before (days 1-7), during (days 8-21) and after (days 22-35) SID operation (site H)

Table E. 21 shows the proportion of vehicles exceeding the speed limit before, during and after the operation of the SID at loop2. The proportion of vehicles travelling faster than the speed limit was significantly reduced when the SID was in operation (although

not for those travelling more than 45mph). Once the SID was removed the proportions of speeding vehicles increased to a higher level than 'before' (including for proportions travelling substantially more than the speed limit; i.e. above 36mph and 45mph).

Table E. 21: Proportion of vehicles exceeding speed levels at loop2 by time period (site H)

Period	Proportion at or exceeding:		
	30mph	36mph	45mph
Before	72.1%	26.0%	2.8%
During1	63.7%*	20.1%*	2.5%
During2	68.5%*	23.6%*	2.7%
After1	72.4%	26.9%*	3.1%*
After2	77.3%*	30.9%*	3.8%*

* Indicates the proportion is statistically different from before period (i.e. the probability of no effect is <5%)

E.8 Summary data: site I – Shooters Hill Road

The data available for site I are displayed in Table E. 23. The reason for the missing data was due to problems with loop1. Loop1 did not collect speed data for part of day 6 to day 8, day 10 to day 15 and day 22 and 23. As a result of the missing data, the ANOVA analysis was based on only 1 complete during day (day 9) and so results from this site are not as robust as the other sites.

Table E. 22: Available speed data in days per week and loop (site I)

Period	Loop1 ³⁹	Loop2	Loop3
Before ⁴⁰	5.5	7.0	7.0
During1 ⁴¹	1.5	6.5	6.5
After1 ⁴²	6.5	6.5	6.5
After2 ⁴³	0.0	7.0	7.0

Mean speeds at all loops at site I are displayed in Table E. 23 and shown in Figure E. 23. This shows a small reduction in speed in the 'during period' at loop2 and no reduction at loop3.

³⁹ Loop1 did not work for part day 6-day 8, day 10-day 15, day 22-23

⁴⁰ Day 1 started at 00hrs as loops installed day before

⁴¹ Day 8 only includes flows from 12.40hrs when SID was installed

⁴² Day 15 only includes flows from 12.00hrs when SID was deactivated

⁴³ Data were unreliable at loop1

Table E. 23: Mean speed (mph) and standard deviation before, during and after SID operation (site I)

Period	Loop1		Loop2		Loop3	
	Mean speed (mph)	SD ⁴⁴	Mean speed (mph)	SD ⁴⁴	Mean speed (mph)	SD ⁴⁴
Before	29.4	5.4	28.6	5.1	28.9	6.4
During	29.1	5.3	27.8	4.9	28.5	6.1
After1	29.0	5.1	28.7	5.0	28.9	6.2
After2	Unreliable data		28.8	5.1	29.0	6.4

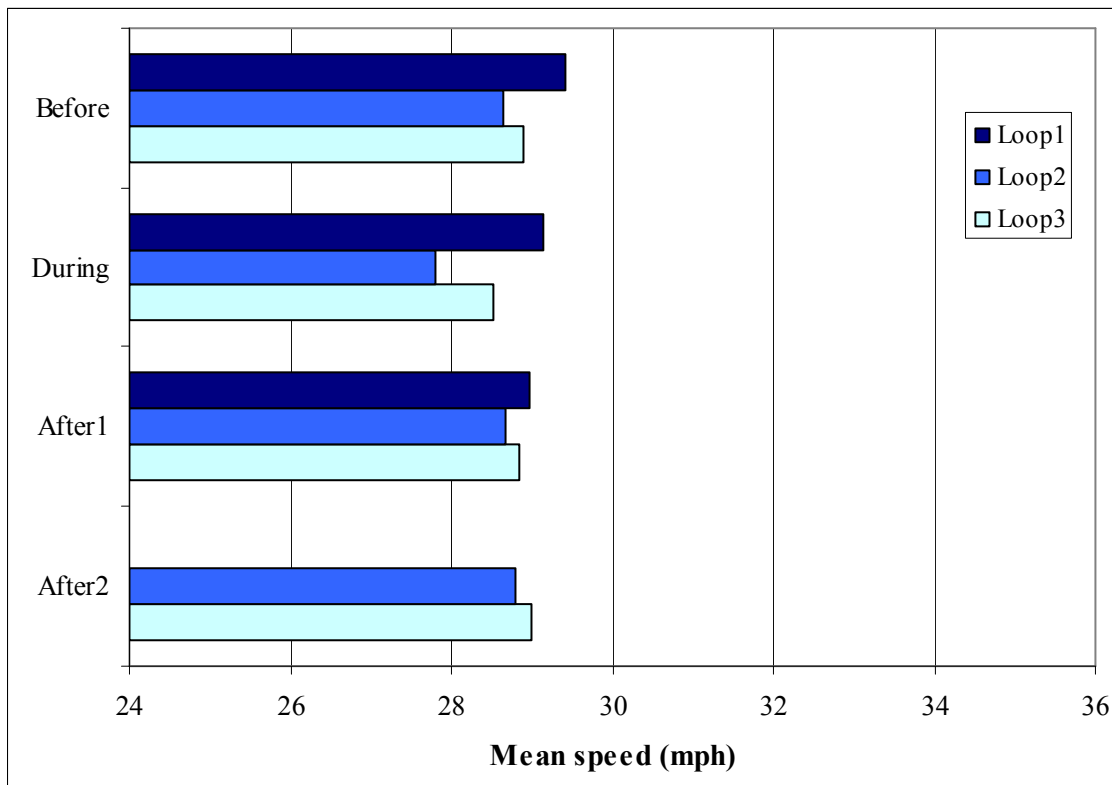


Figure E. 23: Mean speed (mph) by week before, during and after SID operation (site I)

Figure E. 24 shows the mean speed at the site of the SID (loop2) by day of study (day1 was a Wednesday). The SID was installed at 12.40pm on day 8 and remained in place for one week until being removed at midday on day 15. The graph clearly shows an initial 'novelty' period quickly returning to 'before' levels by the end of the trial period. Figure E. 23 shows the 85th percentile speeds at the SID site by day of study.

⁴⁴ Standard deviation

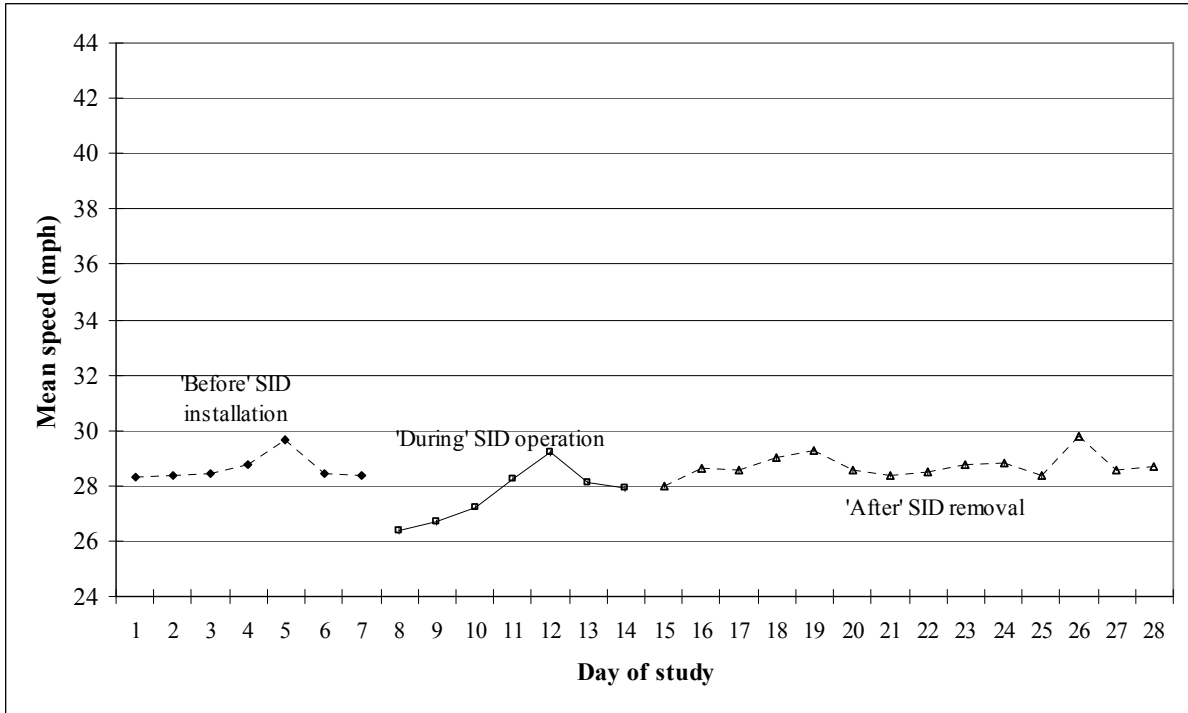


Figure E. 24: Daily mean speed (mph) and confidence interval at loop2, before (days 1-7), during (days 8-14) and after (days 15-28) SID operation (site I)

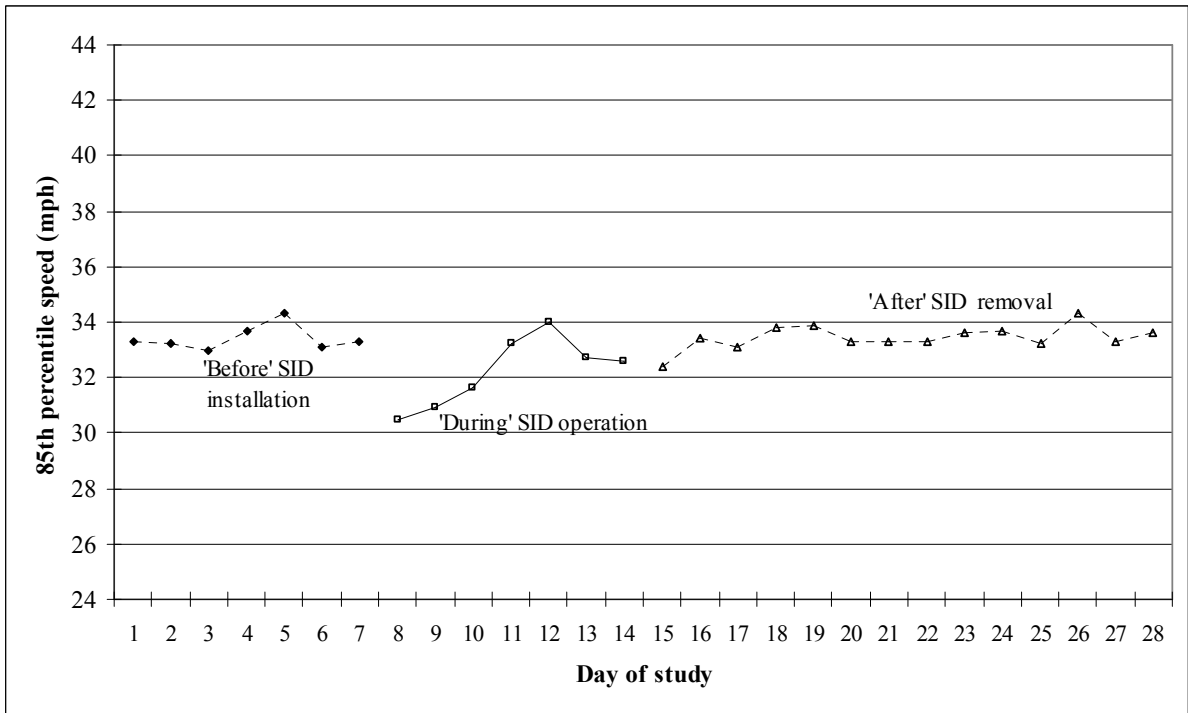


Figure E. 25: Daily 85th percentile speed (mph) at loop2, before (days 1-7), during (days 8-14) and after (days 15-28) SID operation (site I)

Table E. 24 shows the proportion of vehicles exceeding the speed limit before, during and after the operation of the SID at loop2. The proportion of vehicles travelling faster than the speed limit was reduced when the SID was in operation. Once the SID was removed the proportions of speeding vehicles increased to a higher level than 'before'.

Table E. 24: Proportion of vehicles exceeding speed levels at loop2 by time period (site I)

Period	Proportion at or exceeding:		
	30mph	36mph	45mph
Before	33.9%	7.8%	0.8%
During	27.2%*	6.0%*	0.6%*
After1	34.1%	7.7%	0.8%
After2	35.4%*	8.2%*	0.9%

* Indicates the proportion is statistically different from before period (i.e. the probability of no effect is <5%)

E.9 Summary data: site J – Beddington Lane

The data available for site J are displayed in Table E. 25. The reason for the missing data was due to problems with all loops. Loop1 collected data for only 1 complete 'before' day and no 'after' data, loops 2 and 3 both had problems collecting 'after' data. As a result of the missing data, the ANOVA analysis was based on only 1 complete 'before' day and no analysis was done to assess mean speeds after the SID was removed. Thus results from this site are not as robust as the other sites.

Table E. 25: Available speed data in days per week and loop (site J)

Period	Loop1	Loop2	Loop3	Loop4
Before ⁴⁵	1.5	5.5	7.0	7.0
During ⁴⁶	6.0	5.5	6.5	5.5
After1 ⁴⁷	0.0	0.0	0.0	6.5
After2	0.0	0.0	6.0	6.0

Mean speeds at all loops at site J are displayed in Table E. 26 and shown in Figure E. 26. This shows virtually no reduction in speed in the 'during period' at loop2 and no reduction at loop3 and loop4.

Table E. 26: Mean speed (mph) and standard deviation before, during and after SID operation (site J)

Period	Loop1		Loop2		Loop3		Loop4	
	Mean speed (mph)	SD ⁴⁸	Mean speed (mph)	SD ⁴⁸	Mean speed (mph)	SD ⁴⁸	Mean speed (mph)	SD ⁴⁸
Before	32.5	5.4	31.9	5.5	30.6	4.4	31.5	4.8
During	32.8	5.7	31.3	5.6	30.3	4.3	31.2	4.8
After	Insufficient data to calculate							

⁴⁵ Day 1 started at 00hrs as loops installed day before

⁴⁶ Day 8 only includes flows from 11.40hrs when SID was installed

⁴⁷ Day 15 only includes flows from 12.00hrs when SID was deactivated

⁴⁸ Standard deviation

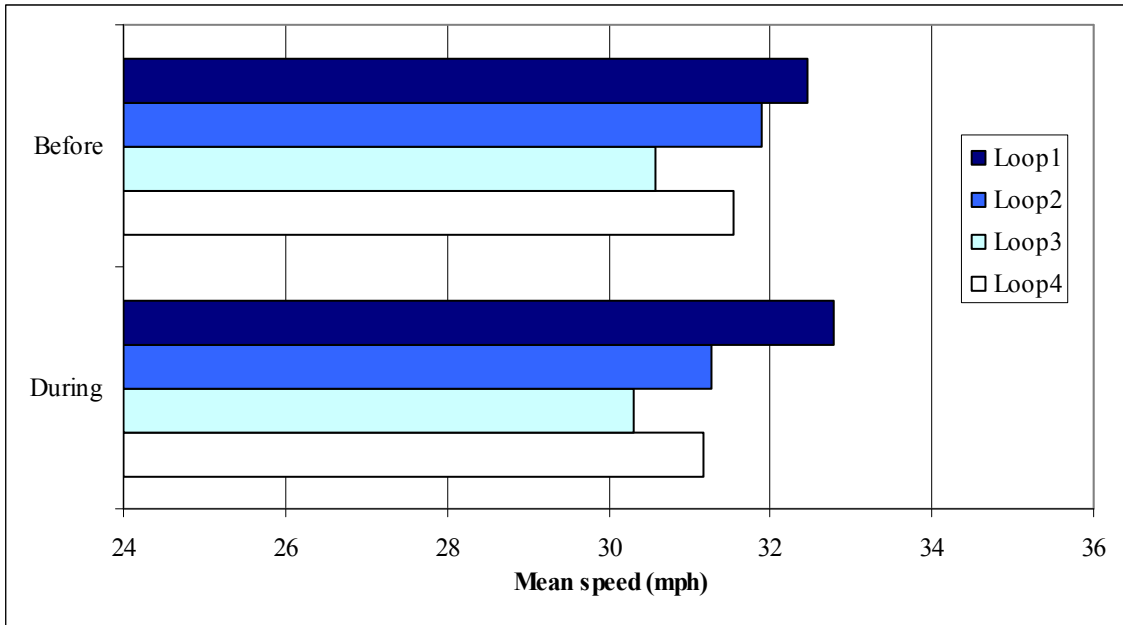


Figure E. 26: Mean speed (mph) by week before, during and after SID operation (site J)

Figure E. 26 shows the mean speed at the site of the SID (loop2) by day of study (day1 was a Thursday). The SID was installed at 11.40am on day 8 and remained in place for one week until being removed at midday on day 15. Loop2 stopped working for days 6 – 7. The graph shows that the SID had only a small effect on mean speeds. Figure E. 26 shows the 85th percentile speeds at the SID site by day of study.

Table E. 27 shows the proportion of vehicles exceeding the speed limit before and during the operation of the SID at loop2. The proportion of vehicles travelling faster than the speed limit was reduced when the SID was in operation.

Table E. 27: Proportion of vehicles exceeding speed levels at loop2 by time period (site J)

Period	Proportion at or exceeding:		
	30mph	36mph	45mph
Before	63.2%	19.5%	2.1%
During	55.8%*	17.2%*	1.9%
After	Missing data		

* Indicates the proportion is statistically different from before period (i.e. the probability of no effect is <5%)

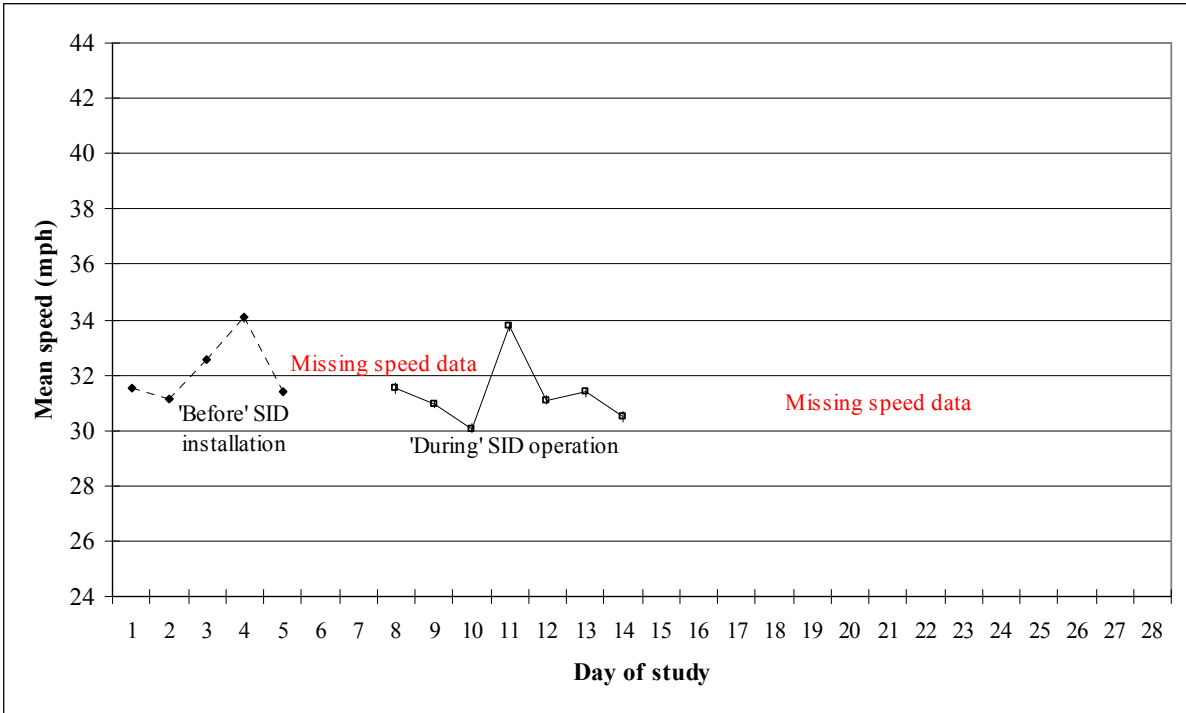


Figure E. 27: Daily mean speed (mph) and confidence interval at loop2, before (days 1-7), during (days 8-14) and after (days 15-28) SID operation (site J)

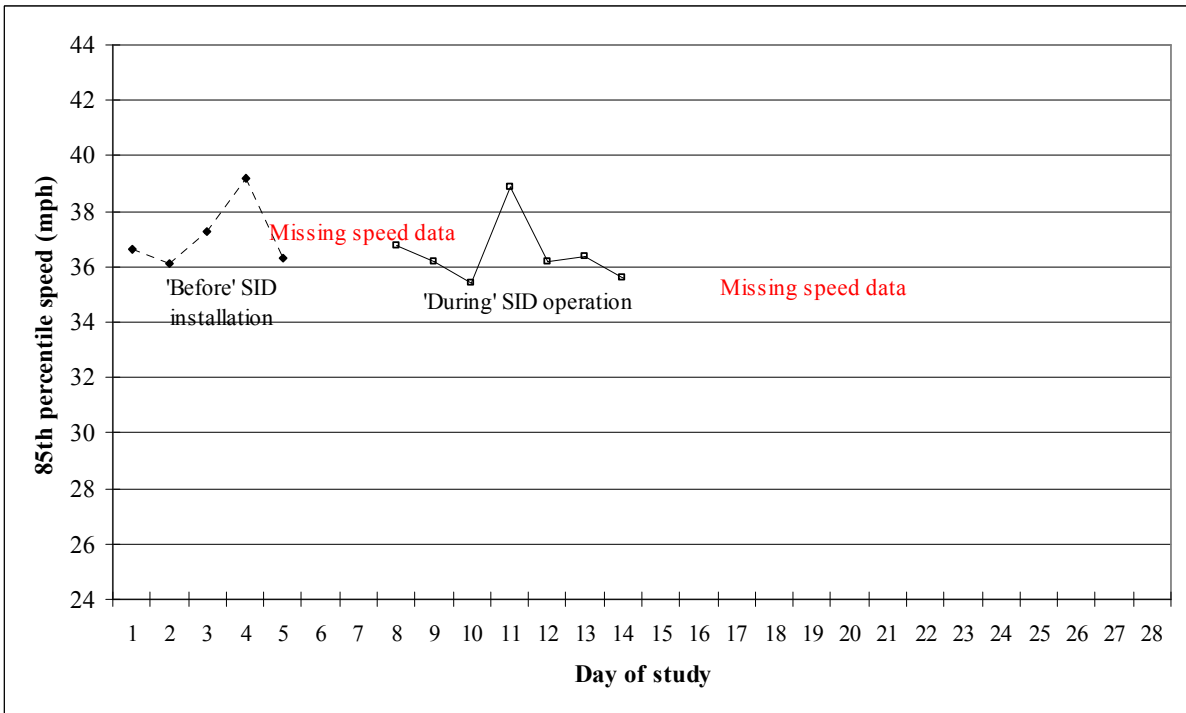


Figure E. 28: Daily 85th percentile speed (mph) at loop2, before (days 1-7), during (days 8-14) and after (days 15-28) SID operation (site J)

E.10 Summary data: site K – Brownhill Road

The data available for Site K are displayed in Table E. 28. Loop1 did not work properly until day 14 and so there was no 'before' and only 1 day of 'during' data. Loop4 also had periods of non-working. This missing data seriously limited the amount of analysis that could be done for this site.

Table E. 28: Available speed data in days per week and loop (site K)

Period	Loop1	Loop2	Loop3	Loop4
Before ⁴⁹	0.0	5.0	7.0	5.5
During1 ⁵⁰	1.0	6.5	6.5	5.5
After1 ⁵¹	6.5	6.5	6.5	1.0
After2	7.0	7.0	7.0	4.5

Mean speeds at all loops at site K are displayed in Table E. 29 and shown in Figure E. 29. This shows virtually no reduction in speed in the 'during period' at loop2 and loop3 and no reduction at loop4.

Table E. 29: Mean speed (mph) and standard deviation before, during and after SID operation (site K)

Period	Loop1		Loop2		Loop3		Loop4	
	Mean speed (mph)	SD ⁵²	Mean speed (mph)	SD ⁵²	Mean speed (mph)	SD ⁵²	Mean speed (mph)	SD ⁵²
Before	Insufficient data		30.4	5.9	31.0	5.7	30.4	5.3
During	Insufficient data		30.5	6.1	30.6	5.4	30.5	5.4
After1	29.3	5.3	30.5	6.1	30.6	5.4	30.6	5.4
After2	29.7	5.5	30.7	6.1	30.6	5.4	30.6	5.5

Figure E. 28 shows the mean speed at the site of the SID (loop2) by day of study (day1 was a Friday). The SID was installed at 11.40am on day 8 and remained in place for one week until being removed at midday on day 15. Loop2 stopped working for days 4-6. The graph shows that the SID had no noticeable effect on the speed data. Figure E. 31 shows the 85th percentile speeds at the SID site by day of study.

⁴⁹ Day 1 started at 00hrs as loops installed day before

⁵⁰ Day 8 only includes flows from 11.40hrs when SID was installed

⁵¹ Day 15 only includes flows from 12.00hrs when SID was deactivated

⁵² Standard deviation

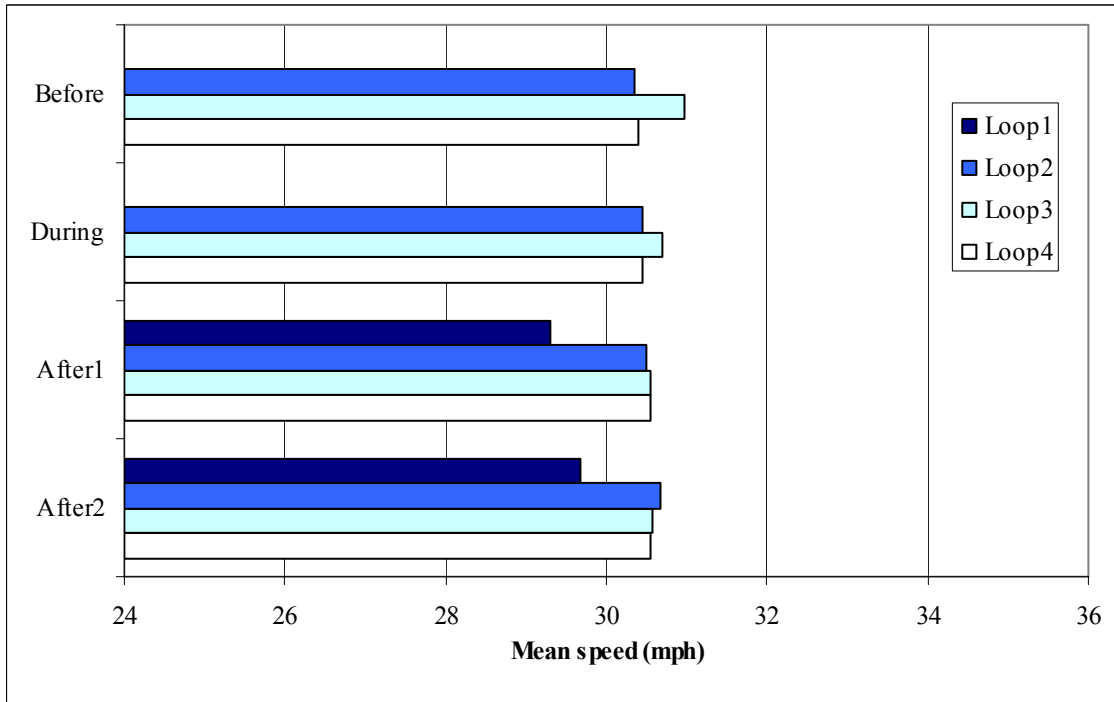


Figure E. 29: Mean speed (mph) by week before, during and after SID operation (site K)

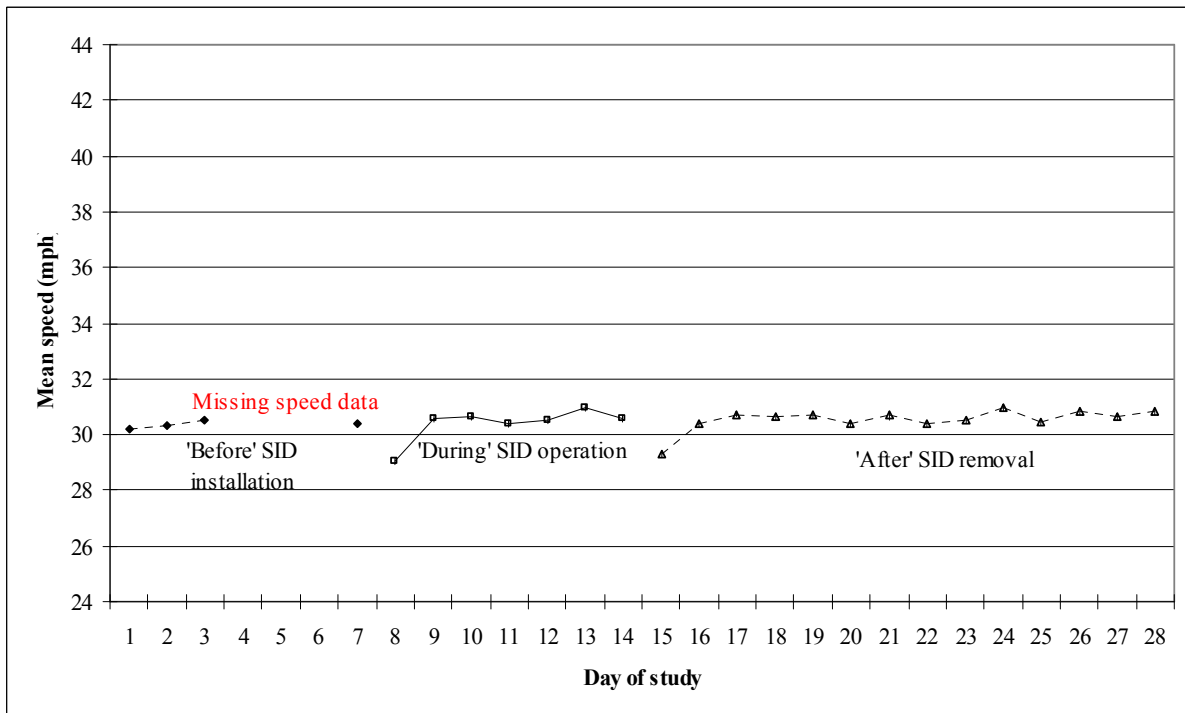


Figure E. 30: Daily mean speed (mph) and confidence interval at loop2, before (days 1-7), during (days 8-14) and after (days 15-28) SID operation (site K)

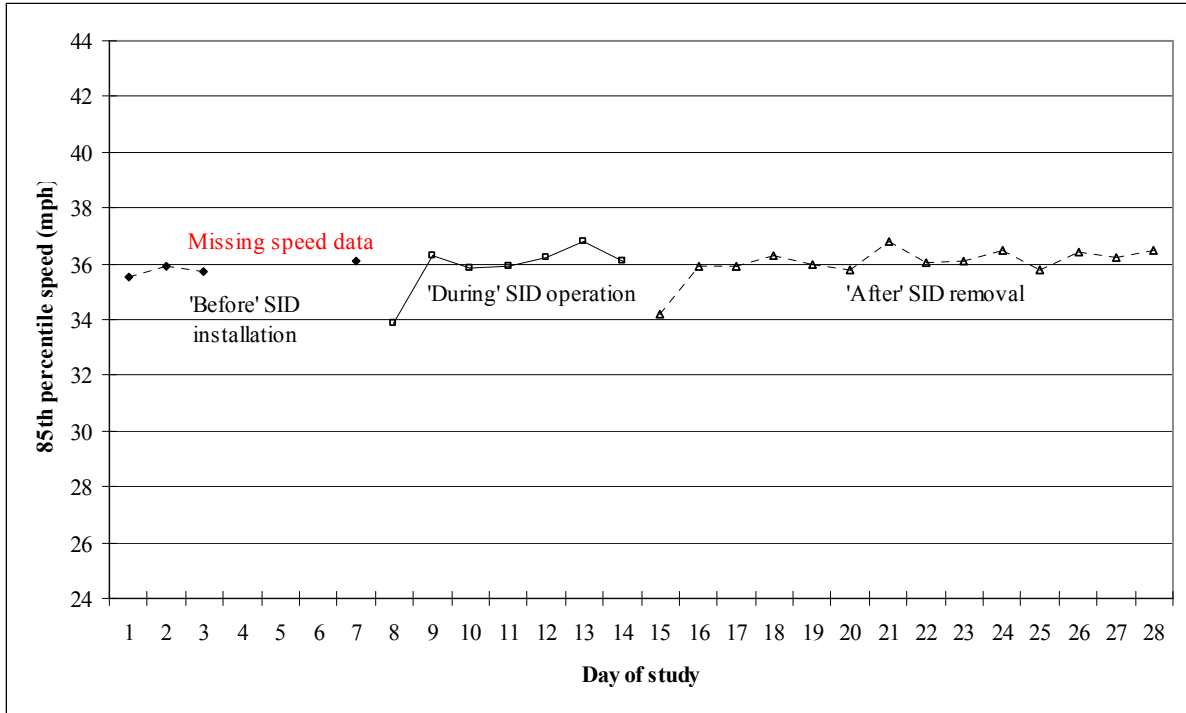


Figure E. 31: 85th percentile speed (mph) at loop2, before (days 1-7), during (days 8-14) and after (days 15-28) SID operation (site K)

Table E. 30 shows the proportion of vehicles exceeding the speed limit before, during and after the operation of the SID at loop2. The proportion of vehicles travelling faster than the speed limit slightly increased when the SID was in operation, increasing still further once the SID was removed.

Table E. 30: Proportion of vehicles exceeding speed levels at loop2 by time period (site K)

Period	Proportion at or exceeding		
	30mph	36mph	45mph
Before	47.7%	14.5%	2.2%
During	48.8%*	15.0%*	2.4%*
After1	49.0%*	14.9%	2.4%*
After2	50.1%*	15.9%*	2.5%*

* Indicates the proportion is statistically different from before period (i.e. the probability of no effect is <5%)

Appendix F Detailed ANOVA analysis

Section 10 reports the results from an analysis using ANOVA models. An analysis of variance, or ANOVA, is a statistical technique used to test whether two or more means for different groups are equal across different explanatory variables. The analysis used one-way fixed effect ANOVA models which assume the data come from normal populations and may therefore differ only in their means. Contrasts were used which are essentially planned comparisons defined before the tests were carried out. This appendix sets out the details of the ANOVA analysis used to answer Q1 for site B. It also details the comparison groups and contrasts set up to answer the other research questions.

F.1 ANOVA analysis – a worked example

The first research question - Q₁ Do SIDs have an effect on vehicle speeds in free-flowing conditions? - was answered by testing the difference between mean speeds in the 'before' period with the 'during' period at the SID site (loop2) taking into account the difference between the 'before' and 'during' period at loop1 (200m before the SID site). That is testing whether the contrast effect defined below is significantly different from zero:

$$\text{Effect} = (\text{mean speed}_{\text{during}}(\text{loop2}) - \text{mean speed}_{\text{before}}(\text{loop2})) \\ - (\text{mean speed}_{\text{during}}(\text{loop1}) - \text{mean speed}_{\text{before}}(\text{loop1}))$$

The first step was to set up the comparison groups as follows:

- Group 1 = vehicle speed measured at loop1 'before' the SID was operational;
- Group 2 = vehicle speed measured at loop1 'during' the time the SID was operational;
- Group 3 = vehicle speed measured at loop2 'before' the SID was operational;
- Group 4 = vehicle speed measured at loop2 'during' the time the SID was operational;

The contrast of interest in this case was used to compare the mean difference of group 4 – group 3 with the mean difference of group 2 – group 1 which required weights of 1 -1 -1 1. Using the means shown in Table F. 1 gives the effect as (32.47 – 35.44) – (32.19 – 32.60) = -2.97 + 0.40 = -2.56mph. The ANOVA analysis with contrasts tests whether this difference is significantly different from zero.

Table F. 1 Summary statistics for each group

Group	Number of vehicles	Mean speed (mph)	Standard deviation
1	24,378	32.6	5.1
2	74,903	32.2	5.1
3	30,519	35.4	6.1
4	93,968	32.5	5.5

Table F. 2 details the ANOVA output from SPSS. The first table, the ANOVA summary table, is divided into 'Between group' effects and 'Within group' effects. The between groups sum of squares and the mean square (=sum of square/degrees of freedom) represent the experimental effect and the within group mean square represents the unsystematic variation in the data due to natural differences in vehicle speeds. The F-ratio (84053.44/29.62 = 2837.7) is clearly significant (p<0.01) i.e. the SID had a significant effect on mean speeds. However, from this table we do not know whether

the effect was an increase or decrease in speed or the size of the effect. Table F. 3 shows the contrast that was set up i.e. (group 4 – group 3) – (group 2 – group 1) and Table F. 4 gives the results from this contrast. Table F. 4 shows that the effect of the SID for site B was a mean speed reduction of -2.57mph with a standard error calculated by the equation below. This effect was clearly significantly different from zero as shown by the t-test.

$$\text{Std Error} = \sqrt{MSE \sum_i \frac{1}{n_i}} = \sqrt{29.6 \times \left(\frac{1}{24378} + \frac{1}{74903} + \frac{1}{30519} + \frac{1}{93968} \right)} = 0.054$$

Table F. 2 ANOVA analysis Q₁ (site B)

ANOVA	Sum of Squares	Degrees of freedom	Mean Square	F	Significance
Between Groups	252,160	3	84,053.4	2,837.7	<0.01
Within Groups	6,627,822	223,764	29.6		
Total	6,879,982	223,767			

Table F. 3: Contrast definition in ANOVA analysis Q₁ (site B)

Contrast	Group			
	1	2	3	4
1	1	-1	-1	1

Table F. 4: Contrast results in ANOVA analysis Q₁ (site B)

Contrast test	Value of contrast (a)	Std Error (b)	't' (a/b)	Degrees of freedom	Significance
1	-2.57	0.05	-47.7	223,764	<0.01

Similar ANOVA analyses were run for the other sites answering the research questions, the results of which are presented in Section 10. Section F.2 gives details of the data groups that were compared and the contrasts used in the analysis.

F.2 Comparison groups and contrasts used in Section 10

F.2.1 Q₁: Do SIDs have an effect on vehicle speeds in free flowing conditions?

Group 1 = vehicle speed measured at loop1 'before' the SID was operational;

Group 2 = vehicle speed measured at loop1 'during' the time the SID was operational;

Group 3 = vehicle speed measured at loop2 'before' the SID was operational;

Group 4 = vehicle speed measured at loop2 'during' the time the SID was operational.

The contrast of interest was:

Table F. 5: Contrast definition in ANOVA analysis Q₁

Contrast	Group			
	1	2	3	4
(group 4 – group 3) – (group 2 – group 1)	1	-1	-1	1

F.2.2 Q₂: How long does the effect last: 1, 2 or 3 weeks?

Group 1 = vehicle speed measured at loop1 'before' the SID was operational;

Group 2 = vehicle speed measured at loop1 'during' week1 when the SID was operational;

Group 3 = vehicle speed measured at loop1 'during' week2 when the SID was operational;

Group 4 = vehicle speed measured at loop1 'during' week3 when the SID was operational;

Group 5 = vehicle speed measured at loop2 'before' the SID was operational;

Group 6 = vehicle speed measured at loop2 'during' week1 when the SID was operational;

Group 7 = vehicle speed measured at loop2 'during' week2 when the SID was operational;

Group 8 = vehicle speed measured at loop2 'during' week3 when the SID was operational.

The contrasts of interest were:

Table F. 6: Contrast definitions in ANOVA analysis Q₂

Contrast	Group							
	1	2	3	4	5	6	7	8
(group 6 – group 5) – (group 2 – group 1)	1	-1	0	0	-1	1	0	0
(group 7 – group 5) – (group 3 – group 1)	1	0	-1	0	-1	0	1	0
(group 8 – group 5) – (group 4 – group 1)	1	0	0	-1	-1	0	0	1

F.2.3 Q₃: Is the SID effective when in place but not in operation?

Group 1 = vehicle speed measured at loop1 'before' the SID was operational;

Group 2 = vehicle speed measured at loop1 'during' but the SID was NOT operational;

Group 3 = vehicle speed measured at loop2 'before' the SID was operational;

Group 4 = vehicle speed measured at loop2 'during' but the SID was NOT operational.

The contrast of interest was:

Table F. 7: Contrast definition in ANOVA analysis Q₃

Contrast	Group			
	1	2	3	4
(group 4 – group 3) – (group 2 – group 1)	1	-1	-1	1

F.2.4 Q₄: How far beyond the SID does the speed reduction last?

- Group 1 = vehicle speed measured at loop1 'before' the SID was operational;
- Group 2 = vehicle speed measured at loop1 'during' the time the SID was operational;
- Group 3 = vehicle speed measured at loop3 'before' the SID was operational;
- Group 4 = vehicle speed measured at loop3 'during' the time the SID was operational;
- Group 5 = vehicle speed measured at loop4 'before' the SID was operational;
- Group 6 = vehicle speed measured at loop4 'during' the time the SID was operational.

The contrasts of interest were:

Table F. 8: Contrast definitions in ANOVA analysis Q₄

Contrast	Group					
	1	2	3	4	5	6
(group 4 – group 3) – (group 2 – group 1)	1	-1	-1	1	0	0
(group 6 – group 5) – (group 2 – group 1)	1	-1	0	0	-1	1

F.2.5 Q₅: Does the effect continue after the SID is removed, and for how long?

- Group 1 = vehicle speed measured at loop1 'before' the SID was operational;
- Group 2 = vehicle speed measured at loop1 one week 'after' the SID was removed;
- Group 3 = vehicle speed measured at loop1 two weeks 'after' the SID was removed;
- Group 4 = vehicle speed measured at loop2 'before' the SID was operational;
- Group 5 = vehicle speed measured at loop2 one week 'after' the SID was removed;
- Group 6 = vehicle speed measured at loop2 two weeks 'after' the SID was removed.

The contrasts of interest were:

Table F. 9: Contrast definition in ANOVA analysis Q₅

Contrast	Group					
	1	2	3	4	5	6
(group 5 – group 4) – (group 2 – group 1)	1	-1	0	-1	1	0
(group 6 – group 4) – (group 3 – group 1)	1	0	-1	-1	0	1

F.2.6 Multivariate analysis

See Section F.2.1 for contrasts for Q₆ and Q₇.