The Road Safety Trust: Light Touch Infrastructure

Technical Report

15 June 2022

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Safety is a significant issue on UK roads, particularly for children travelling to school. In 2015, 40% of road traffic incidents involving injury to children occurred in the morning or evening of a school day (Department for Transport, 2016). Traditional road safety interventions can be expensive and limit opportunities for community-led design. This report investigates the impact of light touch infrastructure on road safety, focussing on thermoplastic road art outside of a school in Exeter. The light touch measures at this school include a thermoplastic dragon-shaped art piece installed on the road, and several planters added on the street.

The aim of this project is to understand whether light touch infrastructure can provide a solution to perceived and actual road safety issues on streets.

Methodology

The road outside the school in Exeter was monitored at baseline (2018) and post-intervention (2021) to observe changes in traffic behaviours produced by light touch interventions on the roads outside the school. This study is innovative in its monitoring of a comprehensive range of traffic behaviours to understand the road safety impact of light touch infrastructure. In order to assess vehicle speed and volume Automatic Traffic Counts (ATCs) were used. To look at pedestrian-vehicle interactions, pedestrian crossing behaviour and dangerous or anti-social parking, video monitoring was carried out. Finally, to gauge feelings of safety when crossing the road and opinions on community empowerment, perception surveys were used.

Findings

The literature review conducted in 2018 demonstrated that the theoretical basis for light touch road safety measures is strong, but the empirical evidence is currently limited. Evidence has shown that despite the lower cost and less substantive nature of these measures, they can improve road safety, with strong reductions in vehicle speed observed in some sites.

Previous research has focussed predominantly on traffic speed and volume measurement, with a paucity of more holistic approaches, which this study aims to address.

The site saw an improvement in vehicle behaviour and road safety post-intervention.

The changes observed in Exeter were:

- **Decrease** in traffic volume on weekdays from **3,366 to 2,642 vehicles**
- The decrease in traffic volume led to **no change** in the proportion of vehicles speeding **(34.6%** to **33.95%)**
- **Increase** in vehicle yielding rate from **46 yields out of 794** yielding situations to **48 out of 420**, reducing the dominance of cars on the road

No change in average vehicle speed was observed at weekends, and a marginal increase of 0.3mph on weekdays, likely due to the road layout at the site, which encouraged the road to be used as a thoroughfare. Consequently, the traffic calming measures are likely to have less impact.

Alongside the mostly positive findings regarding objective measures of traffic behaviour outside of the school, 82% of survey respondents supported installing light touch infrastructure.

Conclusions

The evidence presented suggests that light touch measures have a mostly positive impact on road safety, providing support for the benefits of these measures. The measures have also had a strong impact on the attractiveness of the area and feelings of empowerment among stakeholders, as well as decreasing vehicle speeding. Further research should continue to use Sustrans' multiple methodologies approach to capture these mixed impacts and understand whether the findings are generalisable to other areas. Data collection could be further improved by monitoring more streets in the surrounding area and using control schools to compare to. Light touch infrastructure provides a useful, inexpensive option to add to a local authority's toolbox that allows the local community and parents to get involved with designing measures to improve road safety and a sense of community cohesion.

1. Introduction

The objective of this project is to evaluate the impact of light touch traffic calming measures on road safety outside schools.

1.1 Background

Road safety continues to be a serious issue in the UK, particularly on the walk to school. Between 2006-2011 over 85,000 injuries were sustained by children on roads within a 500-metre radius of schools (AXA, 2013) and in 2015 over 1,283 children on foot were killed or seriously injured on UK roads. 40% of these incidents were in the morning or evening of a school day (Department for Transport, 2016). Speed and volume of traffic represent a substantial risk for children travelling to school.

When parents perceive the journey to school to be unsafe, they are unlikely to encourage their children to walk or cycle to school, reducing opportunities for children to live active and healthy lifestyles. These decisions can also magnify perceptions of road risk, because they may lead to higher numbers of children being driven to school, which increases the numbers of cars on the road and therefore, the road safety risk.

Approaches to improving road safety around schools have traditionally focused on hard, physical infrastructure changes, such as raised crossings. Yet, softer measures are significantly less expensive and offer greater opportunities for schools, parents, and local communities to engage in developing solutions to local road safety issues. Light touch or psychological traffic calming measures differ from physical measures in that they persuade drivers to slow down, rather than forcing them to. Light touch traffic calming is a broad approach that can include painting artwork on the roadway, planting trees and installing planters at the side of road, placing bollards and street furniture along footways to discourage parking and visually narrowing the roadway using coloured road surfacing.

Findings suggest drivers are likely to travel slower and more cautiously when faced with an unfamiliar road environment. However, little empirical evidence currently exists of the impacts of light touch interventions. One of the few examples is Grosvenor Road in Bristol, where 4% more vehicles were observed to be travelling under the speed limit after the addition of a spray painted lizard design intervention on the road in 2016 (Sustrans, 2018a).

Despite not forcing drivers to slow down, light touch measures are still expected to reduce dangerous behaviours through the risk compensation and cognitive load theories, which both suggest drivers will reduce speed when faced with an unpredictable or unusual road layout.

This research was funded by The Road Safety Trust (RST) to provide evidence of the impacts of light touch road safety measures on road safety outside schools. The Road Safety Trust is an independent, grant-giving organisation which supports innovative road safety research and practical interventions to make UK roads safer for all users, by reducing injuries and deaths.

This research will measure the following road safety characteristics:

- **Traffic volume**: the quantity of vehicles travelling across the study area, in both directions, during specified time periods, which increase the potential for collisions.
- **Traffic safety**:
  - Dangerous or anti-social parking: cars parked on yellow lines, keep clear zones or the pavement, which makes it more difficult for vehicles to see pedestrians.
  - Excess vehicle speed: vehicles travelling above the road's legal speed limit, which increases the risk of collisions.
  - Unsafe user interactions: where motor vehicles do not slow down or stop to allow pedestrians to cross, even at formal crossings, making crossing the road more dangerous.
- **Perceived safety**: how safe parents and other stakeholders believe the road to be. Results of this often differ to the objective measures outlined above.

1.2 Research aims and methodology

The research aims to answer the question:

Do light touch traffic calming measures have an impact on dangerous road behaviours outside schools?

For the purpose of the research we will define 'dangerous road behaviours' as speeding; illegal or dangerous parking; conflict between road users; and a high volume of traffic at school pick up and drop off times.

Light touch traffic calming measures can encompass a variety of forms including street art, trees and planters, bollards, non-standard crossings and carriageway narrowing features.

The project ran from January 2018 to May 2021. The initial pre-intervention monitoring occurred in Spring 2018 and post intervention monitoring occurred three years later in Spring 2021.

The key aims of the project are to:

- Measure the impact of light touch traffic calming measures on dangerous driving behaviours, including speeding, illegal or dangerous parking and conflict between road users.
- Provide a robust evidence base for the use of light touch traffic calming interventions to address common road safety problems.
- Provide a toolkit of affordable and accessible proven measures that schools can implement.
- Make it easier for schools to implement light touch traffic calming measures like colour, art and street furniture to change the highway environment and improve road safety.

This report summarises the evidence captured from St Michael's CE Primary School in Exeter to research the impact of light touch traffic calming measures on road safety as delivered at this school site.

1.2.1 Methodology

The research took place over three years, with interventions, monitoring and evaluation delivered by Sustrans, using automatic traffic counts, video analysis and perception surveys between 2018 and 2021. A second site in Southampton was included in the project (see Appendix A), but the introduction of a School Street[1] at the site in between follow-up and baseline data collection made it difficult to isolate the effects of the light touch traffic calming measures from the effects of the School Street. A comparison of the Southampton and Exeter findings becomes problematic as Exeter featured light touch traffic calming measures only, with no School Street. Consequently, the results of the research in Southampton have been included in Appendix A of this report, as a case study of the effects of combined light touch traffic calming and a School Street measures on road safety as observed through the project.

[1] School Streets aim to ease the road safety, congestion and air quality concerns that many schools experience during drop-off and pick-up times, by facilitating temporary traffic restrictions on the road outside the school gates.

1.3 Structure of the report

This report is split into six sections. Section two provides a literature review of the existing evidence and theory surrounding light touch traffic interventions. Section three describes the methodology for this project. Section four provides the results by behaviour according to the following monitoring tools:

- Traffic Speed and Volume (TSV) from Automated Traffic Counts
- Pedestrian and vehicle behaviours using video analysis
- Safety perceptions using a community survey

Section five analyses these results and places them within the wider context of road safety at schools, and section six considers the lessons learnt from the study and the implications for future research and practical delivery of light touch measures, before section seven concludes with the key findings and implications of the project.

2. Literature Review

A literature review of the existing evidence surrounding light touch road safety measures was conducted in 2018 (see Appendix B for the full literature review). This outlined the two key theories behind the impact of light touch intervention measures:

- **Risk compensation theory**: This theory refers to the tendency of people to adjust their behaviour to perceived levels of risk, behaving more cautiously the greater the level of risk they perceive (Adams, 1995). Light touch measures, may heighten perception of risk by motorists, causing them to slow down and drive more carefully.
- **Cognitive load theory**: Cognitive load is the amount of mental effort that is required to complete a task. Increasing the complexity of a driving task will increase the cognitive load on the driver, necessitating more mental effort. Elliott *et al.* (2003) suggested that in more complex driving environments drivers will naturally compensate for the increased mental load by driving at lower speeds, producing a traffic calming effect.

Street art and coloured surfacing in the form of designs and murals painted in the roadway have been used as a method of psychological traffic calming. The theory behind this approach is that designs and murals can be used to highlight particular road features where drivers need to take extra care. They can also be used to visually narrow the roadway (Kennedy *et al.*, 2005). Yet, despite substantial evidence for the theoretical value of light touch road safety measures, there remains limited empirical evidence of their benefits.

Much of the available evidence in practice is from projects run by Sustrans. For example, in response to concerns regarding traffic behaviour and speeds on Grosvenor Road, Bristol, a design in the shape of a lizard was drawn using spray paint on Grosvenor Road, in 2016. The design process involved children from nearby Cabot Primary School. The design was installed permanently using thermoplastics after the trial demonstrated a 4% reduction in the number of vehicles travelling over the speed limit on weekdays.

Experimental evidence has also been used to suggest the benefits of light touch interventions. Kennedy *et al.* (2005) conducted a driving simulator study into the effect of light touch traffic calming measures on driver behaviour in different models of urban and rural environments. They tested the effectiveness of areas of coloured road surfacing on driver behaviour and found that on its own, coloured surfacing, however elaborate did little to slow vehicle speeds. However, the study did find that when combined with other measures, such as a gateway effect that simulated the transition from a rural road to a built-up area coloured surfacing reduced driving speeds by up to 3mph.

Elliot *et al.* (2003) suggested that this is because combinations of measures will increase their alerting effect on motorists and make it more likely that different psychological effects will be induced. This is supported by evidence from Sinclair town in Kirkcaldy, Scotland. Speed and volume monitoring demonstrated a 5% increase in the proportion of vehicles travelling below the 20mph speed limit after a range of interventions had been introduced, and a 38% reduction in peak-time traffic volume.

However, this objective monitoring aligned poorly with perception data, where residents were unconvinced that road safety had improved. This suggests that there is a disparity between how people perceive road safety outside the primary school in Sinclair town and the actual traffic conditions. This may be due to the small and unrepresentative sample of households in the survey or several cases of negative press surrounding the safety implications of the road markings outside of the primary school.

This literature review also highlighted the dominance of vehicle speed as a measure of road safety. In three of the Sustrans case studies vehicle speed was the only monitoring tool used to assess safety, and in Kennedy *et al*.'s (2005) driving simulator study vehicle speed was also used as the primary measure of road safety. Vehicle speed is not the only measure of road safety though, with factors such as the interaction between road users and dangerous or anti-social parking also affecting levels of safety. The prevalence of vehicle speed in the evidence base highlights a further knowledge gap that the research carried out in this study can fill.

Overall, evidence has shown that despite the lower cost and less substantive nature of these measures, they can improve road safety, with strong reductions in vehicle speed observed in some sites. Whilst light touch measures on their own have a limited effect on road safety, when they are combined with other traffic calming approaches they can positively affect both actual and perceived levels of road safety.

3. Methodology

To assess the impact of light touch measures a longitudinal study was conducted at St Michael's CE Primary School in Exeter at two monitoring points: pre-intervention in spring 2018 and post-intervention in spring 2021. Exact dates of the data capture are shown in Table 1.

Table 1: Dates of pre- and post- intervention monitoring methods

	Pre intervention (2018)	Post intervention (2021)
Traffic Speed and Volume (TSV)	20th – 26th May	10th – 16th May
Video monitoring	23rd – 26th May	12th – 15th May
Perception survey	November	May

3.1 School sites

School participants were identified through the local authority based on their willingness to participate in the programme and where the local authority felt there was a desire for changing the street layout or tackling road safety issues. This led to two locations being selected, but due to the School Street in Southampton material related to this site is not included in the main body of the report and has instead been placed in Appendix A.

Table 2: Schools initially selected to participate in the study.

Location	Participating schools
Exeter	St. Michael's Church of England Primary Academy
Southampton	Valentine Primary School

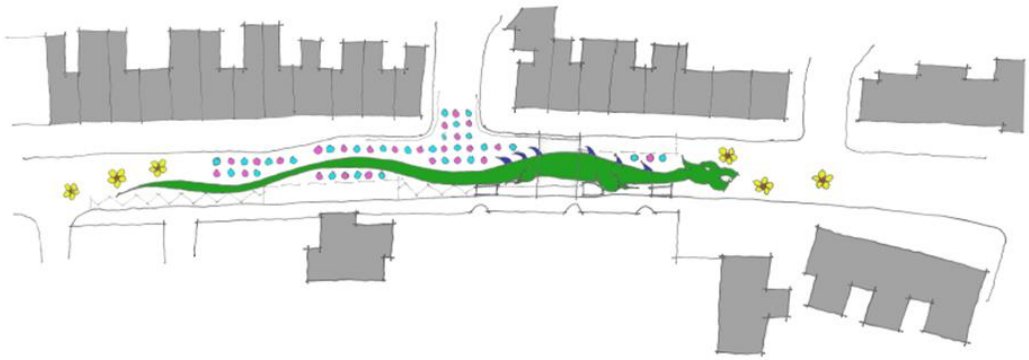
At each site, pneumatic tubes were temporarily installed to monitor traffic speed and volume (TSV), video cameras were attached nearby to record crossing and driving behaviours, and safety perception surveys were carried out with local stakeholders (Table 3).

Table 3: Data collection methods used before and after implementation of light touch road safety measures.

Data collection method	Safety characteristics assessed
Automatic traffic counts (ATCs)	Vehicle speed Traffic volume
Video monitoring	Pedestrian-vehicle interactions Pedestrian crossing behaviour Illegal or unsafe parking
Perception surveys	Feelings of safety crossing the road Opportunity for community empowerment

St. Michael's C of E Academy school is located in the Heavitree area of Exeter. Monitoring focused on South Lawn Terrace, the main road outside the school, where a thermoplastic dragon-shaped art piece was installed on the road (Figure 1), and planters added on the street. Practical design options were limited at this site, due to the presence of a bus lane. The road has a speed limit of 20mph and is used as a connector road by vehicles not stopping on the road. The 20mph speed limit on South Lawn Terrace, combined with the fact that it is used as a thoroughfare by many vehicles may limit what can realistically be expected in terms of reduced speed on the street as a result of the light touch measures.

Figure 1: Proposed design of thermoplastic art added to South Lawn Terrace outside St. Michael's school in Exeter.



3.2 Data collection

3.2.1 Traffic Speed and Volume (TSV)

A pneumatic tube device was installed to record vehicle speeds over one week, to evaluate traffic speed and volume throughout the day and compare to post-intervention. The devices were installed on South Lawn Terrace the main road outside St. Michael's C of E Academy school. This data was collected to demonstrate both whether the quantity of vehicles changed and whether dangerous behaviours, such as speeding, reduced.

3.2.2 Video monitoring

Video cameras were mounted in view of South Lawn Terrace for a four-day period (Wednesday to Saturday). These days were selected to ensure a mix of weekday and weekend days, with Sunday excluded due to anticipated lower volumes of traffic. The recorded footage was analysed during the time periods shown in Table 4, which were chosen from the TSV data to represent both off-peak and peak times. Three sections were defined within the footage gathered from South Lawn Terrace, and the section within which each behaviour occurred was recorded, to demonstrate the specific locations on the street where behaviours were occurring.

Table 4: Times of video monitoring used

	AM off-peak	PM peak
Pre	1100-1200	1500-1600
Post	1100-1200	1500-1600

One peak and one off-peak hour per day were chosen for analysis to provide a sample of usage on the street. The size of the sample was constrained by the scope of the project and the available resource to carry out the video analysis. The video cameras used at baseline were pre-set to capture a range of possible peak and off-peak hours. The video cameras were pre-set as they had a limited battery life. The possible off-peak hours were 1000-1200 and the possible peak hours were 1500-1700. These ranges were based on observed peak and off-peak hours in previous Sustrans projects where TSV data was collected. From these ranges, the off-peak hour of 1100-1200 and peak hour of 1500-1600 were chosen based on a review of the traffic speed and volume data. The hours analysed at post-intervention were selected based on the hours analysed at pre-intervention. Future studies need not be affected by the same constraints, therefore further research could look at a larger sample of time in the data collection and compare morning/afternoon peaks.

The selected video footage was analysed for:

- **Pedestrian crossing movements**: the location where pedestrians cross the road, measured from the point at which pedestrians leave the pavement.
- **Vehicle yielding behaviour**: whether vehicles slow down or stop to let pedestrians standing at the side of the road to cross over.
- **Presence of a lollipop person**: whether a lollipop person was observed during the analysed time periods.
- **Dangerous or anti-social parking**: parking on double yellow or keep clear lines either side of South Lawn Terrace was defined as illegal.

Vehicle yielding behaviour and whether a lollipop person was present at the yield or non-yield event can be used to assess driver awareness of pedestrians and measure the level of cooperation within a road environment, whilst where pedestrians choose to cross the road indicates pedestrian perceptions of the safety of the road and dangerous or anti-social parking can create a road safety issue through reduced visibility.

3.2.3 Perception survey

To understand how users and local residents' views on safety on the road changed, a perception survey was carried out before and after the intervention. The surveys were distributed online, with a link shared to Sustrans' local delivery officers responsible for working with the participating schools. They then passed this on to key contacts to distribute further.

The pre-intervention survey received 34 responses, and the post-intervention survey received 136, with both containing a mix of parents, school staff and local residents.

3.2.4 Issues around data collection

3.2.4.1 Methodological issues

Issues with the installation and batteries of the video cameras used for the baseline recordings meant that only four days of video footage was captured (Wednesday-Saturday). This has implications for the representativeness of the data as it means that unlike the TSV analysis, a full 7 days of data is not available.

The sample size was smaller than anticipated due to the data from Southampton not being used in the main study, and there were differences in the video monitoring methodology before and after the interventions, specifically the sections the road was split into, and the methods used for defining yielding situations.

3.2.4.2 Uncontrolled factors

There were also several uncontrolled factors, including the presence of a lollipop person at different time periods at pre and not at all at post. Furthermore, the effects of COVID-19 restrictions on traffic levels needs to be taken into account when considering the results of this study.

In March 2020, in response to the COVID-19 pandemic the UK government announced a nationwide stay at home order, banning all non-essential travel and closing schools and businesses. By May 2021 when post monitoring commenced although COVID-19 restrictions had eased considerably and schools had reopened, people were still advised to minimise travel as much as possible and to work from home if they could. Changes in working and commuting patterns and the increase in home-working may have provided parents with more time to walk or cycle with their children and removed the time constraints that made travelling by car necessary. Consequently, traffic volumes had still not returned to pre-pandemic levels, making a direct comparison of pre and post traffic data challenging and making it difficult to isolate the effects of the light-touch traffic infrastructure on traffic levels and perceptions of safety.

These issues weaken the conclusions that can be drawn from the data and limit the extent to which the findings can be generalised to other sites.

4. Evidence

This section will present the evidence relating to traffic speed and volume, road user interactions, issues concerning the safety of pedestrian crossing and perceptions of safety. It demonstrates the impact of light touch interventions by comparing baseline and follow-up data for each aspect. In doing so, the evidence will be used to answer the research question:

Do light touch traffic calming measures have an impact on dangerous road behaviours outside schools?

Table 5: Key changes in vehicle behaviour and safety perceptions, for pre- compared to post-intervention.

		Baseline	Follow-up
Traffic Speed and Volume (TSV)			
Average traffic speed	Weekdays	18 mph	18.3 mph
	Weekend days	19 mph	19 mph
Speeding (vehicles travelling over 20 mph)		35% (7286 vehicles)	34% (5670 vehicles)
Traffic Volume	Weekdays	16,829 vehicles	13,210 vehicles
	Weekend days	4,234 vehicles	3,490 vehicles
Video monitoring			
Pedestrians crossing in section two (designated crossing area)	Peak	94% (684 pedestrians)	68% (541 pedestrians)
	Off-peak	56% (35 pedestrians)	34% (32 pedestrians)
Vehicle yielding rate		6% (46 vehicles)	11% (48 vehicles)
Illegal parking		4 vehicles	25 vehicles
Perceptions survey			
Feel somewhat or very safe crossing the road		53% (18 responses)	45% (61 responses)
The street is at least a little safer		N/A	28% (38 responses)
The street is at least a little more child friendly		N/A	68% (91 responses)
The street is at least a little nicer place to be		N/A	69% (92 responses)

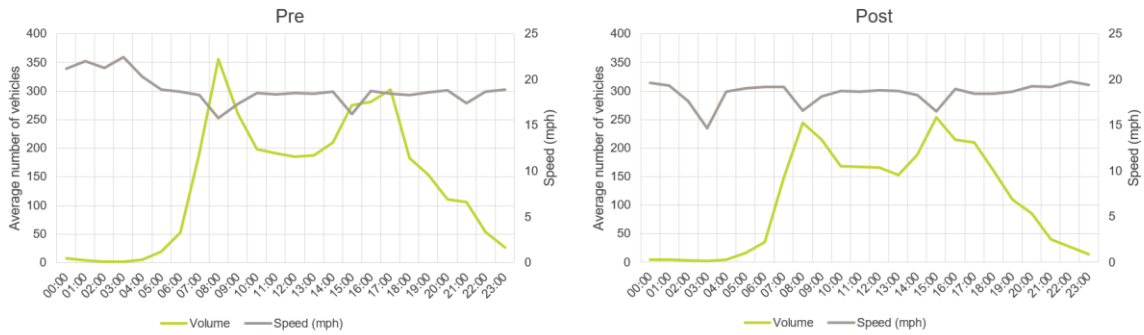
4.1 Traffic speed and volume (TSV)

High speeds and volumes of traffic outside schools can make it more difficult for children to cross the road and deter parents from letting their children walk or cycle to school. This in turn further increases the volume of traffic as a higher proportion of parents resort to driving their child to school.

At higher speeds drivers have less time to react to pedestrians in the road, making collisions more likely to occur. Higher volumes also reduce opportunities to cross the road, forcing pedestrians to make riskier crossing movements.

The initial TSV monitoring conducted in May 2018 identified higher traffic volumes on weekdays, with 3,366 vehicles travelling in either direction on an average weekday, compared to 2,117 at the weekend. In the May 2021 follow up, a 22% decrease was observed on weekdays (2,642 vehicles per day), and 18% at the weekend (1,745 vehicles per day). This substantial decrease occurred predominantly during peak hours on weekdays, whereas at the weekend most of the reduction was in the evening hours. This decrease in vehicle volume must be viewed in the context of the COVID-19 pandemic though and the COVID-restrictions that are likely to have contributed to the reduction in vehicle volume from pre to post.

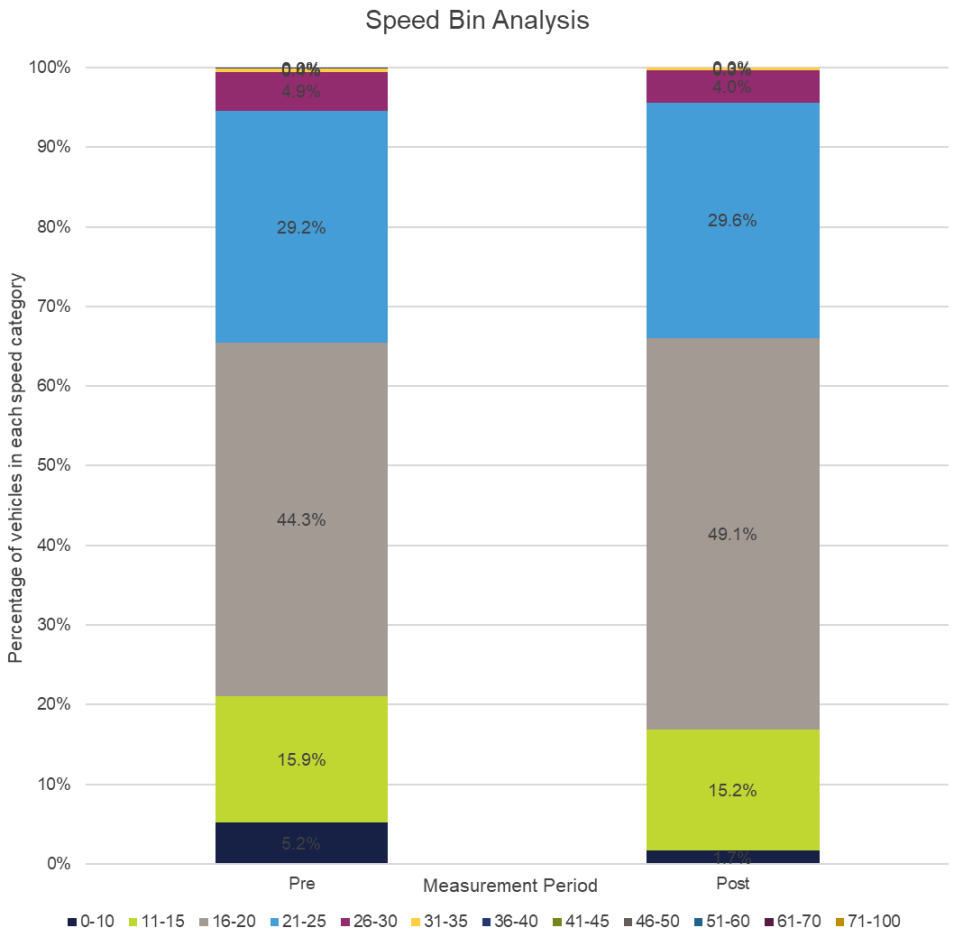
Figure 2: Hourly traffic counts in Exeter during pre- (left) and post-intervention (right).



In terms of speed, there was very little change in average speeds at the Exeter site. The average speed at the weekend stayed the same at 19mph, whilst on weekdays the average speed increased marginally from 18mph to 18.3mph. However, a 0.6% decrease in speeding was observed (vehicles travelling above 20mph), although speeding was still notable, with 34% of vehicles observed in 2021 travelling over the speed limit of 20mph (Figure 3).

This decrease in traffic volume would make the road safer for children to travel actively to school, and easier for them to cross South Lawn Terrace outside St. Michael's school. However, the post-construction levels of speeding remain a safety concern.

Figure 3: Bar chart showing the proportion of vehicles observed travelling within each speed category in Exeter, pre- and post-intervention.



4.2 Pedestrian crossing behaviour

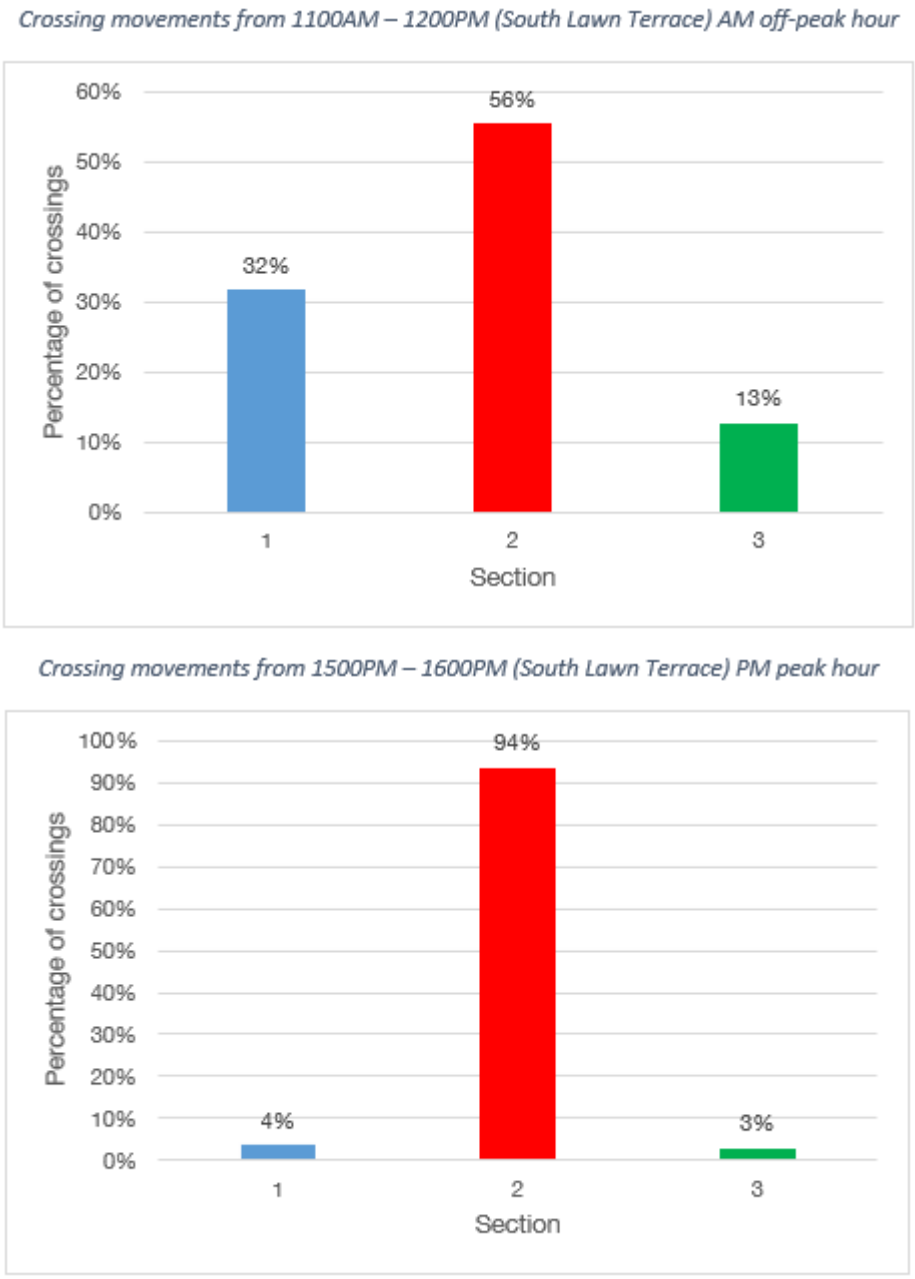
For video monitoring purposes South Lawn Terrace in Exeter was divided into three sections. Section two contained a raised, formal crossing and a lollipop person was present in this section for most of the peak times at pre-intervention but not at post-intervention (Figure 4).

Figure 4: Screenshot of video footage captured from the camera on South Lawn Terrace in Exeter at pre-intervention.

At baseline, pedestrian crossing behaviour at peak times was very concentrated in the section including the raised crossing area (section two). At baseline, 94% (684 out of 731) of pedestrians crossed here, compared to 56% (35 out of 63) pedestrians crossing here in the off-peak hours (Figure 5). This may be due to the presence of a lollipop person in the section containing the crossing during peak hour. The presence of this lollipop person may have encouraged pedestrians to cross at the raised crossing.

After the light touch measures were installed, 96% (848) of all pedestrians crossing the road were observed on weekdays, and the majority of pedestrians were observed in the first half of the peak hour. The number of pedestrians crossing at the raised crossing dropped to 68% (541 out of 791) pedestrians during peak hours, and just 34% (32 out of 95) pedestrians during off-peak hours.

Figure 5: Distribution of crossing behaviour between section in Exeter at off-peak (top) and peak times (bottom) at pre-intervention.



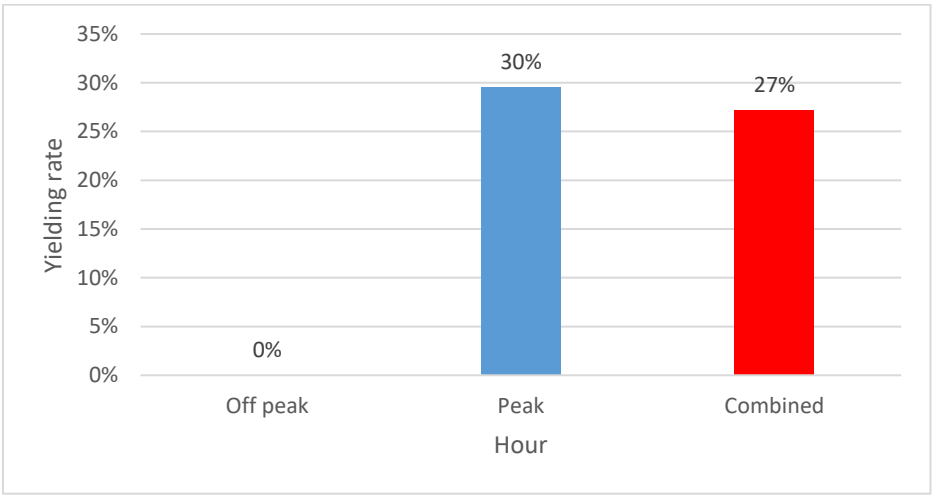
4.3 Vehicle-pedestrian interactions

Vehicle-pedestrian interactions can be used as an indicator of vehicular traffic's awareness of pedestrians and the dominance of motor vehicles on the road. When a pedestrian tries to cross the road, if a car slows down or stops for them this is counted as a 'vehicle yield'.

Vehicle yielding makes it easier and safer for pedestrians to cross the road and should always occur when a lollipop person is present as they have a legal right to stop traffic. High rates of vehicle yielding indicate a cooperative road environment.

Before any light touch measures were installed outside St. Michael's school rates of a vehicle yielding to a pedestrian were very low, at 6% (out of 794 instances where a pedestrian crossing movement occurred). The yielding rate also varied throughout the day. In section two, where the majority of vehicle-pedestrian interactions occurred, the yield rate from vehicle-pedestrian interactions was 30% during peak hour (15:00-16:00) and 0% during the off-peak hour (10:00-11:00) (Figure 6). Both these rates are low, suggesting an uncooperative environment and a safety concern, as vehicles are not deferring to pedestrians trying to cross.

Figure 6. Percentage of vehicle-pedestrian interactions that resulted in a vehicle yielding to a pedestrian in section two outside St. Michael's school in Exeter, during baseline monitoring in 2018, at off-peak and peak hours.



Of particular concern was the low yield rate even in the presence of the lollipop person. 73% of vehicle yields occurred when the lollipop person was there. This amounted to a 40% yielding rate in the presence of the lollipop person, despite their legal authority to stop traffic. This suggests a serious road safety problem, with limited opportunities for pedestrians to cross the road safely despite the presence of a lollipop person.

Spatial variations were observed in yielding behaviour. During the off-peak hour, 76% of yielding events occurred in section two, which contained the formal, raised crossing, with only 12% of yields occurring in sections one and three. This pattern intensified during the peak hours, where 99% of yielding events occurred in section two It is possible that this effect was

related to the volume of crossing movements occurring in this section, which made vehicle interactions more likely.

During the follow up monitoring in May 2021, there were fewer crossing movements observed. A total of 420 crossing movements were observed during the follow-up monitoring period. The total yielding rate increased to 11% after the light touch measures were installed, an increase of 5% compared to before installation.

4.4 Parking behaviour

Dangerous or anti-social parking presents a road safety issue because it reduces visibility of the road, particularly at key locations, which can make it harder for drivers to see pedestrians trying to cross, and harder for pedestrians to see vehicles in the road, increasing the likelihood of collisions. In locations where dangerous or anti-social parking is high, road safety issues increase. This parking can be either directly related to the school, for example parents temporarily parking illegally next to the school to drop off children, or residents on the road parking illegally to be near their home, usually for longer periods. This variation in source of the problem highlights the importance of engaging the local community in road safety issues.

During the baseline monitoring four instances of dangerous or anti-social parking were observed outside St Michael's school in Exeter, all of which were in section one. Three of these situations occurred at the weekend, and the one car that parked unsafely on the Friday of monitoring only stayed for one minute. Generally, this evidence suggests that dangerous or anti-social parking was not a significant issue for children's safety walking to school at this site.

In the follow-up monitoring, there was an increase in dangerous or anti-social parking observed from the baseline of four to a total of 25 occurrences of unsafely parked vehicles. There was greater variation in the locations of unsafely parked vehicles, although none parked in the section containing the raised crossing area. Therefore, the light touch interventions have not shown any benefit to preventing dangerous or anti-social parking at the Exeter site.

4.5 Perceptions of safety

Perceptions of safety are important as there is often a disparity between objective measures of road safety and subjective perceptions of parents and staff (see Appendix B). Even if a road is deemed safe through empirical research, if parents do not perceive it to be safe, they will not allow their children to walk to school, reducing opportunities for active travel. This can also contribute to issues with traffic volume if a higher proportion of parents drive their children to school.

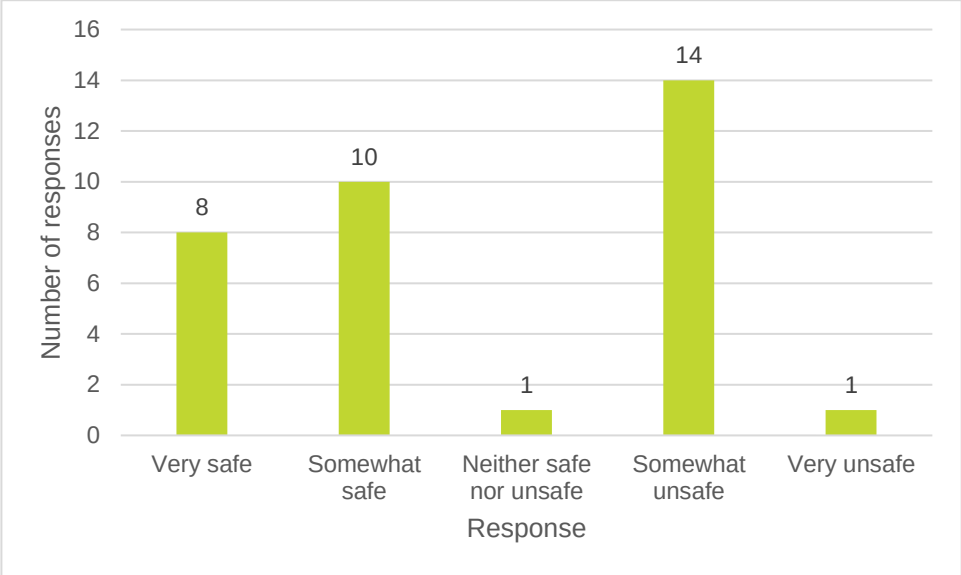
Table 6: Safety perceptions of survey respondents, before (2018) and after (2021) the light touch interventions.

St. Michael's School, Exeter					
	Very safe	**Somewhat safe**	**Neither safe nor unsafe**	**Somewhat unsafe**	**Very unsafe**
Pre (34 responses)	2**4% (**8 responses)	29% (10 responses)	3% (1 response)	41% (14 responses)	3% (1 response)
Post (136 responses)	10% (13 responses)	35% (48 responses)	14% (19 responses)	33% (45 responses)	8% (11 responses)

4.5.1 Exeter

The baseline perceptions survey in Exeter identified that 52% (18 out of 34 respondents) felt somewhat or very safe using the street outside St Michael's school before the light touch measures were installed (Figure 7). There was support for the measures, with 82% (28 respondents) saying it would make the street a lot nicer place to be and a lot more child friendly. There was also support for the potential impact of the light touch intervention on safety, with just under half of respondents (16 out of 34) respondents saying it would make the street a lot and a little safer, respectively.

Figure 7: Feelings of safety crossing South Lawn Terrace in Exeter pre-intervention



In the follow up survey, 45% (61 out of 136 respondents) reported feeling somewhat or very safe using the street (Figure 8). Whilst this is a decrease compared to baseline, this was mostly attributable to parents' perceptions, which stayed very similar in both surveys. Among other respondents, feelings of safety increase; with 60% (six out of ten) residents and 73% (eight out of 11) staff saying they felt somewhat or very safe after the light touch measures were introduced. Just over two-thirds of respondents (92 out of 136) felt the thermoplastic art made the street at least a little nicer place to be and more child friendly (91 out of 136 respondents) (Figure 9) but 56% of respondents (74 out of 136) didn't perceive the intervention to make the street safer.

Figure 8: Feelings of safety crossing South Lawn Terrace in Exeter post-intervention

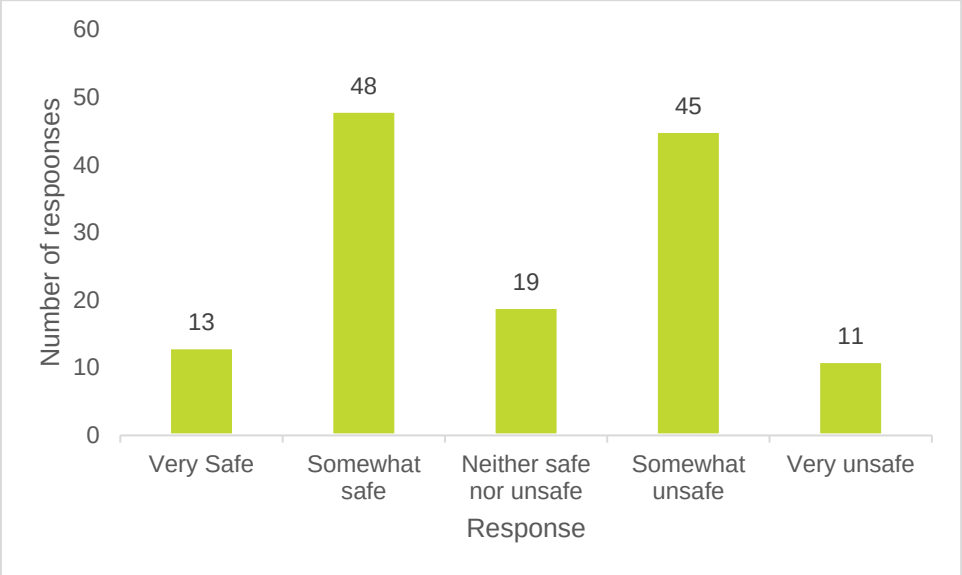
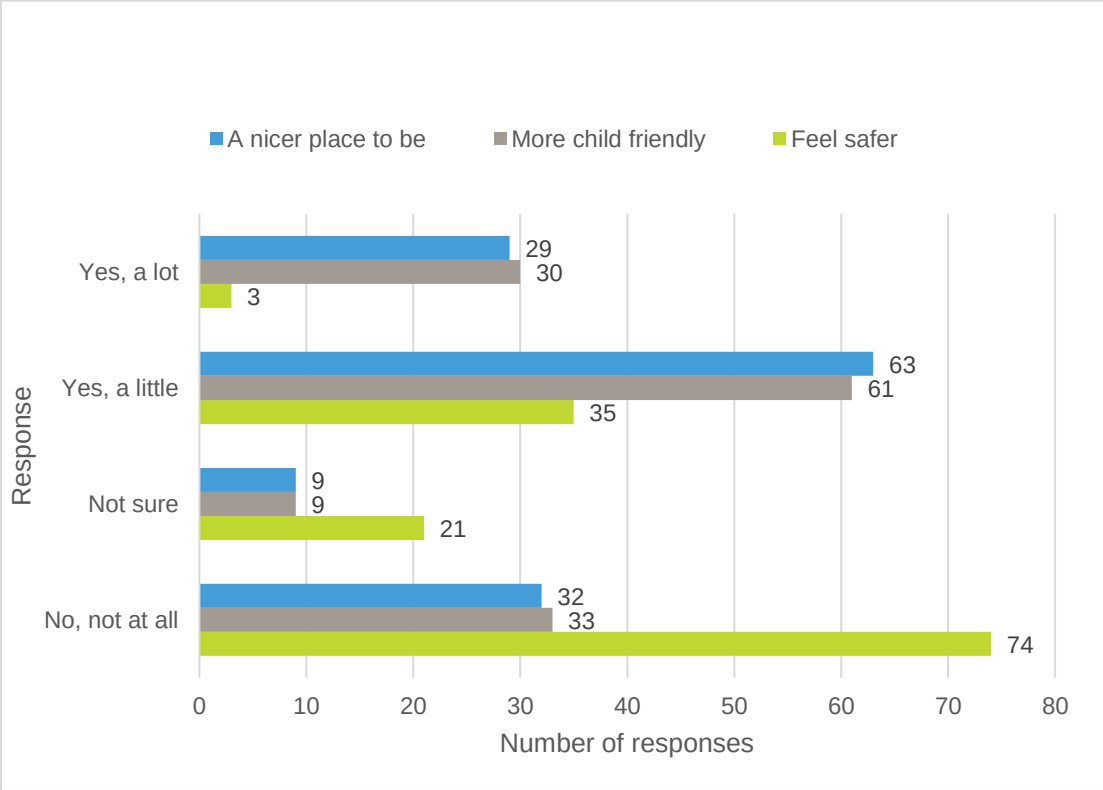


Figure 9: Perceived impact of the light touch measure in Exeter, post-intervention.



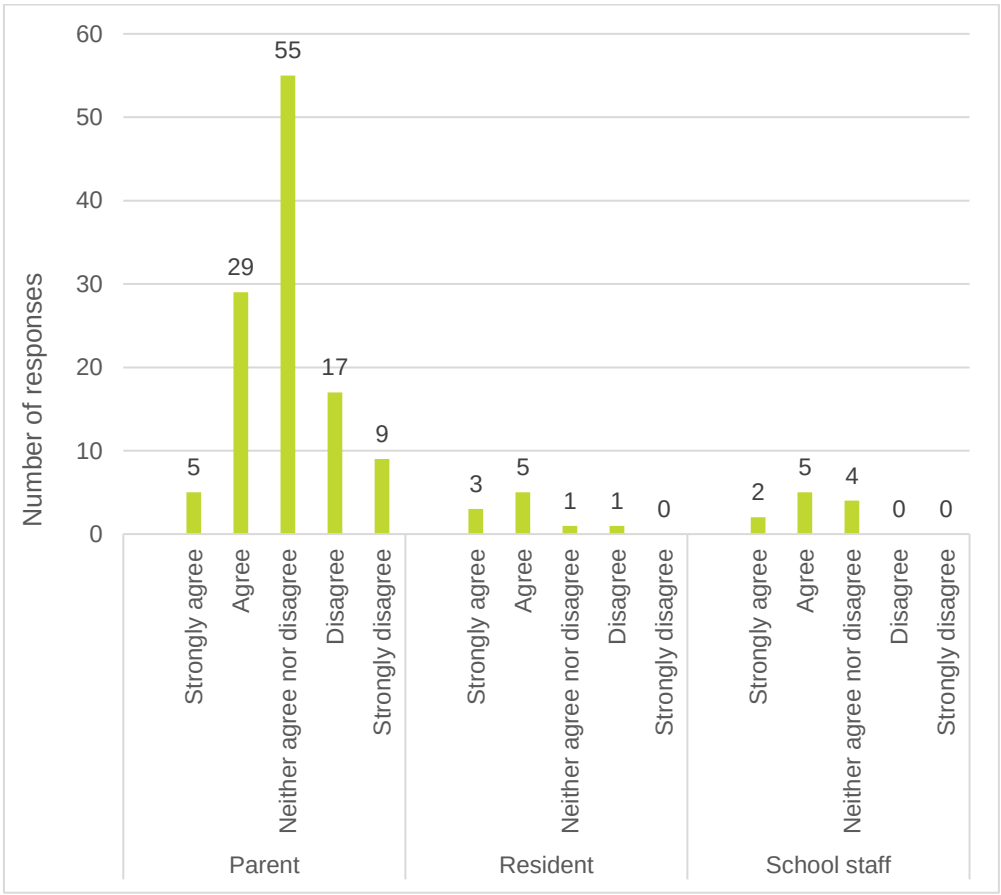
Before any light touch interventions were installed, open comments indicated that poor visibility and traffic speed were key road safety issues. In the follow up, open comments were

predominantly negative, with 31% (24 out of 78 respondents) saying they would prefer a lollipop person and 27% (21 out of 78 respondents) feeling that the measure was inadequate at reducing traffic speeds. This suggests there is strong community support for increased efforts to improve road safety.

The survey suggested that the measure had produced very little change in active travel, with six out of 136 respondents saying that the thermoplastic art was responsible for an increase in the amount that their children walk, cycle or scoot to school.

The results were more positive in terms of empowering the community. At baseline, 94% (32 out of 34 respondents) felt the project would allow them to contribute, and 32 agreed that events like this were a good opportunity to meet parents or neighbours to discuss issues. During the follow up period, 34% (49 out of 136 respondents) were encouraged to have a say about changes to the street, although 27 responded that they did not feel encouraged. Lots of parents neither agreed nor disagreed at 48% (55 out of 115), whereas most residents (eight out of ten) and staff (seven out of 11) agreed that they were encouraged to have a say (Figure 10). This suggests that the project was more effective at empowering residents and school staff than parents. This could make future interventions more successful, as stakeholders feel they can actively contribute to plans and are empowered to help make changes to improve the environment.

Figure 10: Agreement that the project had encouraged respondents to have a say about changes to the street outside the school at post-intervention, split into parents, residents and school staff.



In summary, parents of school pupils agreed, both before and after intervention, that the light touch measures had improved the street as a place to be, but the perceived benefits were less strong for active travel and safety. Residents and school staff also showed support for the measures, although the sample size of these groups was much smaller than the sample of parents.

5. Discussion

The evidence captured during this project has shown that light touch infrastructure has had some positive impact on road safety at the Exeter site. Substantial decreases in traffic volume of 21% were seen, but a considerable uncontrolled for variable in this statistic is the impact of COVID-19 restrictions on vehicle numbers. The decreases in traffic volume did not result in an increase of the proportion of speeding vehicles, avoiding a potential negative outcome of decreasing the number of vehicles in an area. The Transport Technology Forum (TTF) estimated that in the week commencing 10th May 2021 (when post-intervention monitoring was completed), national average traffic levels remained 4% below baseline levels from previous years (TTF, 2021). Furthermore, the DfT (2021) estimated that road traffic levels in the week commencing 10th May were on average 6% lower than the first week in February 2020, before the pandemic struck. Research evidence (e.g. Hine, 1996) indicates that the reduced traffic levels between the implementation of the intervention and follow up perception survey may influenced respondents' perception of safety.

Despite the reduction in vehicle speeding, speeding remains a significant issue at this site, which may be due to the road's layout, with many vehicles travelling along the length of the road without stopping. The 5% improvement in vehicle yielding is significant, although lower than the 22% increase seen in Derby (Sustrans, 2015c), but this may be due to differing methodologies for calculating yielding rate. Though it should be noted that the 5% increase in yielding was achieved despite the lollipop person that was there at pre not being present at post-intervention. The removal of the lollipop person at post-intervention is likely to have had some impact on crossing behaviour and pedestrian-vehicle interactions, making a before-after comparison more problematic. However, it is likely that the increase in yielding rate would have been greater if the lollipop person had also been present at follow-up monitoring. Changes in safety perceptions were mixed, with high agreement that the thermoplastic art had improved the street at least a little, but feelings of safety among parents in particular had not increased.

The evidence demonstrates that both sites had some impact on road safety and traffic behaviour, and contributed to place-making, improving feelings about the street where the interventions were added.

This was the first study to utilise a wide range of methods to evaluate the impact of light touch interventions on road safety. In particular, the use of video analysis provided more comprehensive coverage of changes in behaviour as a result of light touch interventions. This report demonstrates the significance of this, as changes were seen between different behaviours, so not all the improvements would have been captured in a study using more a more limited range of methodologies.

Alongside the mostly positive findings regarding objective measures of traffic behaviour, there was strong support from survey respondents for the place-making and attractiveness benefits of the interventions, as well as parents feeling empowered to participate in road safety interventions, supporting the approach adopted by Sustrans. The study provides initial evidence for the positive impact generated by light touch interventions. Light touch measures are cheaper and less disruptive than other interventions, so should be employed further, both for their positive benefits and to increase understanding of the specific type and magnitude of benefits they produce, and how generalisable they are to other sites. This study investigated light touch interventions at schools, but this method may also have applications in other road safety areas.

6.Learning

The following section documents lessons learned and recommendations for future research or practical delivery of light touch infrastructure gleaned through the delivery of this project. Section 6.1 focusses on lessons learned from the research and data collection, while section 6.2 shares learning around the practical delivery of light touch infrastructure.

6.1 Research and data collection

Some limitations in the study exist; the research study size was smaller than anticipated due to the impact of the School Street at Southampton causing difficulties drawing clear conclusions about the impact of the light touch infrastructure. There were also challenges from inconsistent survey sample sizes in the before and after intervention data collection periods across all sites. Additionally, several uncontrolled factors, including the presence of a lollipop person at different time periods at pre and not at all at post and other interventions occurring simultaneously has an impact on the strength of the evidence. These may make the results difficult to generalise, but overall the findings still suggest some road safety benefit from the light touch infrastructure has been observed.

Regarding the School Street in Southampton, though the installation of such measures was outside of Sustrans control, measures could have been put in to mitigate the effects of the Street.

One such measure is the use of a ‘control school’ which is monitored in the same way and during the same time periods, but which did not have any road safety measures implemented during the period of the study. A control school that featured a School Street but no other road safety measures could have been used to isolate the effects of the School Street from the light touch traffic calming measures.

Future researchers should be aware that the street landscape is constantly changing and there is an increased demand for measures like School Street to increase walking and cycling and improve air quality. Good lines of communication with local authorities and schools should be established to understand potential changes that might affect findings.

It is also unclear what the impacts of the light touch measures were on vehicle behaviour and road safety in the area surrounding the school, as the monitoring focussed on the road where the thermoplastic art was installed. Monitoring a wider area of the road network around the schools could provide a more comprehensive picture of the impact of these light touch measures.

Unfortunately, the study was reduced to one site at Exeter only due to the School Street. In order to mitigate the risks around this it would have been sensible to have started with a longer list of potential schools for inclusion in the study and to have explored how contingency and longer study time-frames might allow a school to be replaced if needed in future.

Another uncontrollable factor that affected the study was the COVID-19 pandemic. The pandemic hit in the middle of the project and impacted on the timings of the installation of design measures. As discussed, this will have impacted traffic volume but may have also affected traffic behaviour more widely, including modal choice. No monitoring tools were used to measure potential modal shift amongst the school population, therefore any changes in travel behaviour caused by the pandemic would not have been understood necessarily by our data.

Road layout of schools likely means the traffic we observed in the follow-up period could have been affected by COVID-19.

Control sites for measuring background traffic flow and volume could help to mitigate some of the potential impact of COVID-19.

The presence of a lollipop person at both schools at baseline but not at all at follow-up is likely to have affected crossing behaviour. In future at the outset of a study, researchers could check that schools plan to continue either having or not having a lollipop person. A control school with no lollipop might have helped to isolate the effects of the lollipop person and isolate its effects on crossing behaviour.

As discussed in Section 3.2.4 there were methodological issues with the study that affected data collection. There was an issue surrounding the installation and batteries of the video cameras used for the baseline recordings which meant that only four days of video footage was captured. This lesson was learnt from and a specific video service provider was used at follow-up to avoid more issues. It is strongly recommended that future studies use external video service providers rather than in-house technology to collect video footage.

Another methodological issue surrounded the survey samples. At the Exeter site there was a large disparity in the size of the baseline and follow-up survey samples and at the Southampton site both the baseline and follow-up samples were small. The variance and size of the survey samples limited the strength of the conclusions that can be drawn from the perception data. The perception surveys were distributed online via local leads. In future, to try and increase the response rate attempts could be made to expand the sample using incentives, incorporating the survey within community engagement and trying other data collection methods (e.g., postal surveys around the community). The surveys were also focussed on the school community rather than taking a wider look at the effects of the interventions on local residents or the business community.

The sample of video footage collected at each school was constrained by the scope of the project and the available budget and resource. It would also have been valuable to capture the morning peak to see if this differed from the afternoon peak. Further research should look at a larger sample of time in the data collection and compare morning/afternoon peaks.

6.2 Practical delivery of light touch infrastructure

As part of this project, a toolkit to support the practical design and delivery of light touch infrastructure to be carried out by community groups and practitioners has been developed. The toolkit is publically available on the Sustrans website and summarises best practice and outlines some of the common practical challenges for street design projects of this type.

Key lessons learned or recommendations for future projects include having a clear scope and focus before initiating any project development. This will maximise the impact of any community engagement (with schools and parents) in the early stages of a project, through to developing concept designs. A clear scope and focus are helped by capturing baseline data, understanding existing road safety issues at the project site.

Community engagement is crucial to build strong support for the schemes. This is best done by identifying the relevant audience and local stakeholder groups to engage, co-developing solutions (not imposing any designs) and building consensus throughout the engagement process. A coherent community behind any light touch street design project brings benefits to practitioners/delivery authorities by ensuring the schemes meet local needs and are appropriate to the local contexts and generate buy-in that helps the implementation phase to run smoothly.

Challenges in delivering light touch measures vary according to delivery context and local authority. It can be challenging to maintain a level of control or oversight depending on how many actors are involved in the delivery process. Common challenges are that the highways environment belongs to the relevant local authority (rather than any school, community or practitioner organisation necessarily) and is subject to a high level of regulation. Making changes within the highway environment works best when they are incorporated within existing local authority mechanisms that don't always support external delivery partners to implement this type of street design. Depending on the level of experience with this type of project, there may also be a level of caution to be overcome as light touch infrastructure schemes are innovative and non-standard in terms of highway design. This presents an additional challenge as local authority departments may struggle with resourcing and capacity, in particular to support such non-conventional or non-standard schemes that may be more time-consuming to deliver. This presents challenges in taking designs from the engagement and concept stage, through to implementation and delivery.

7. Conclusion

This study investigated the impact of light touch interventions on road safety at a school in Exeter. Following baseline monitoring of traffic behaviour and safety perceptions, thermoplastic art was installed on the road outside the school and post-intervention monitoring was conducted three years later. Road safety was measured based on traffic speed and volume, vehicle-pedestrian interactions and dangerous or anti-social parking.

Overall, the results demonstrate that light touch interventions did have a considerable impact on certain road safety characteristics. Traffic volume showed the strongest decrease of the behaviours measured, but it is unlikely that this is completely due to the light touch interventions, as other factors, such as the COVID-19 pandemic likely affected traffic volumes. Decreases in traffic volume did not lead to an increased proportion of speeding vehicles The yielding rate also doubled from pre- to post-intervention.

Parent perception of the attractiveness of the street increased as well, but were accompanied by a mixed response towards perceptions of safety.

This evidence suggests that future research should continue to measure a wide range of behaviours to comprehensively assess the changes to traffic behaviour. Expanded spatial data collection, by including nearby roads or control schools could further improve understanding of the impact of these light touch measures on vehicle behaviour and road safety.

8. Appendix A – Southampton

Valentine Primary School in Valentine Avenue Southampton participated in this research project and baseline and follow-up data was collected from the site. The results of the Southampton research are not included in the main body of this report and instead as a case study in this Appendix. This is because the introduction of a School Street in Southampton between baseline and follow-up data collection made it difficult to isolate the effects of the light touch traffic calming measures on road safety and makes a comparison with the Exeter site problematic.

8.1 Methodology

To assess the impact of light touch measures in combination with a School Street a longitudinal study was conducted at a school in Southampton at two monitoring points, pre-construction in spring 2018 and post construction in spring 2021. The methodology followed the same process as the Exeter site, outlined in section three of this report, with the following exceptions.

8.1.1 Monitoring dates and timings

Table 7: Dates of pre- and post- intervention monitoring methods

	Pre intervention (2018)	Post intervention (2021)
Traffic Speed and Volume (TSV)	16th – 22nd April	10th – 16th May
Video monitoring	18th – 21st April	12th – 15th May
Perception survey	May	May

Video footage was gathered at the following times at the Southampton site:

Table 8: Times of video monitoring used

	AM off-peak	PM peak
Pre	1000-1100	1500-1600
Post	1000-1100	1530-1630*

* The time period 1530-1630 was used in Southampton at post to avoid a clash with the School Street which was operating from 1430-1530.

8.1.2 Site Background

In Southampton, Valentine Primary school participated. The school is found in the east of the city and faces onto Valentine Avenue, opposite the junction with Elgar Road. Valentine Avenue, which has a speed limit of 30mph, is located in a quiet, residential area and consequently is less frequently used as a thoroughfare than South Lawn Terrace in Exeter.

A colourful thermoplastic crossing was installed at the junction of Elgar Road and Sullivan Road as part of the project. During the period of the study other road safety aspects were also installed at the school, including pencil bollards, benches, a paper clip-shaped bike stand and an interactive trumpet noise stand (Figure 11). A School Street programme was introduced from the 29th of March 2021 onwards, meaning that during the follow-up monitoring the road was closed to road traffic between 8:15-9:15AM and 2:30-3:30PM.

Figure 11: Thermoplastic art added to Valentine Avenue outside Valentine School in Southampton.

8.1.3 Video Monitoring

Pedestrian crossing movements, vehicle yielding behaviour and the presence of a lollipop person was analysed at Southampton using the same methodology used at the Exeter site, however in Southampton dangerous or anti-social parking was defined as parking on double yellow lines, keep clear lines, or on the pavement either side of Valentine Avenue and Elgar Road.

8.1.4 Perception Survey

In Southampton, the pre-intervention survey obtained 39 responses, whereas the follow up received 19 responses, which were all from parents.

8.1.5 Issues around data collection

The main methodological issue which affected the Southampton study was the School Street. Unfortunately, the authors of this study were not made aware of the closure until after it had been implemented and as such the School Street was in operation during the planned

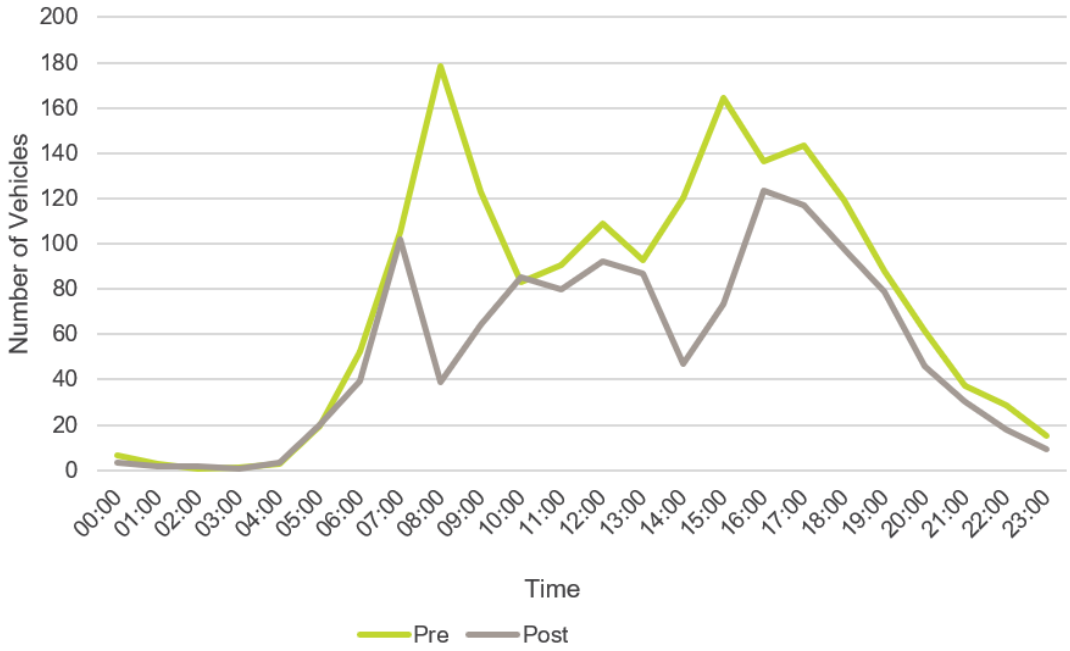
follow-up monitoring. Though the timings of the video analysis were altered to avoid a direct clash, the School Street is likely to have had a significant effect on overall levels of traffic volume at post and may have also affected vehicle speeds and perceptions of safety. Though the School Street affected the study and meant that the original research question could not be answered using the Southampton findings, the School Street does provide a useful opportunity to examine the effects of combined measures on road safety so is included as a case study in the appendix of this report.

8.2 Evidence

8.2.1 Traffic Speed and Volume (TSV)

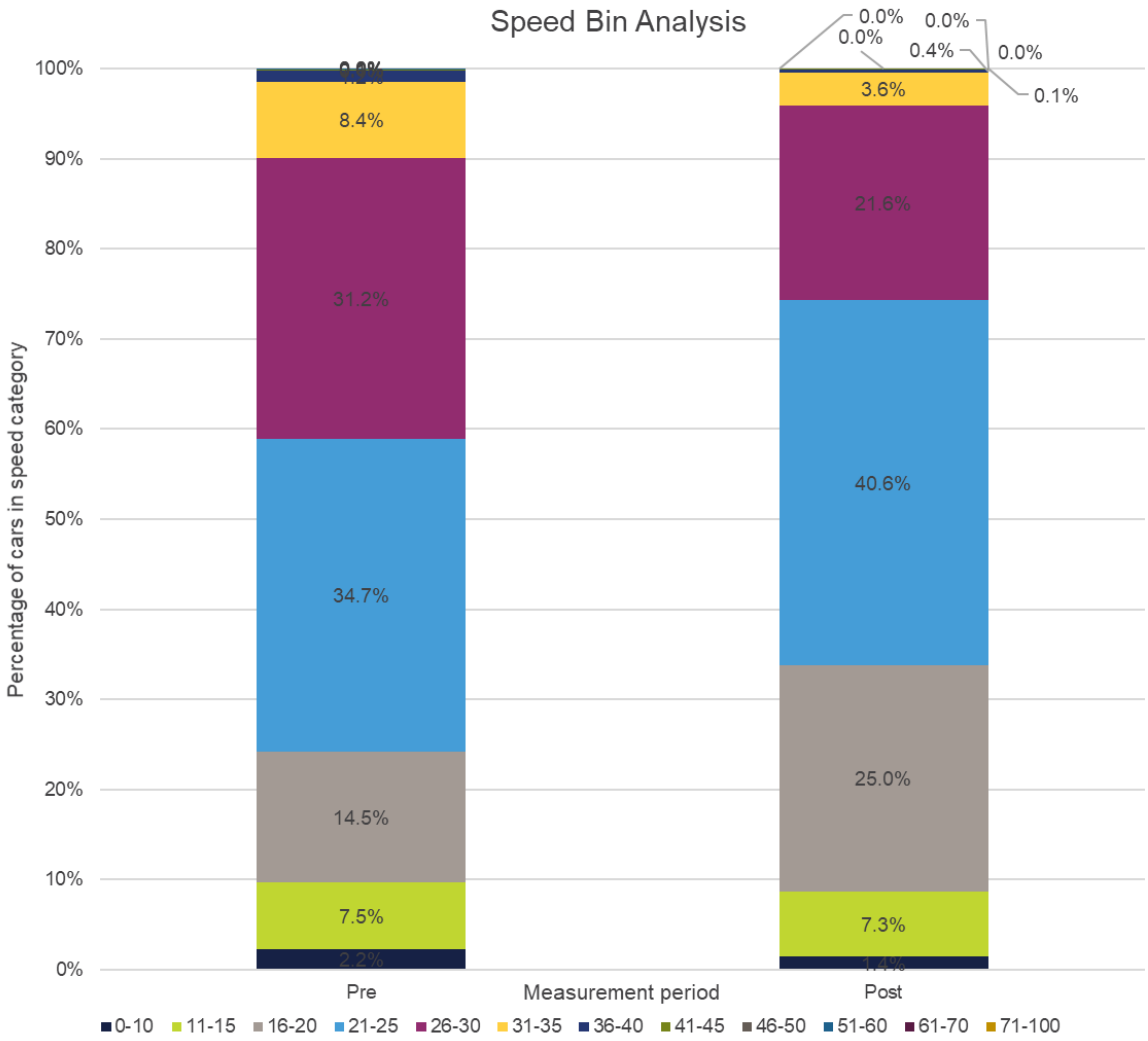
At baseline, an average of 1,782 vehicles per day on weekdays and 1,303 at weekends were recorded at Southampton. At follow-up, the average number of vehicles per day reduced by 29% on weekdays (1,258), and 18% at the weekend (1,064). The decrease was largest on Monday, Tuesday, and Fridays, which in 2018 were the busiest days.

Figure 12: Number of vehicles counted per hour in Southampton, pre- and post-intervention.



There was a substantial decrease in average speed at the Southampton site, particularly at the weekend. In May 2018, the average speed of vehicles passing the site at the weekend was 25.4mph, but in May 2021 this had reduced to 22.7mph (11% decrease). There was also a smaller decrease in average speed on weekdays, from 22.7mph to 21.5mph (5% decrease). This clear decrease in average speeds was accompanied by a 5.8% decrease in the number of vehicles which were travelling over the speed limit of 30mph, from 9.9% to 4.1% (Figure 13).

Figure 13: Bar chart showing the proportion of vehicles observed travelling within each speed category in Southampton, pre- and post-intervention.



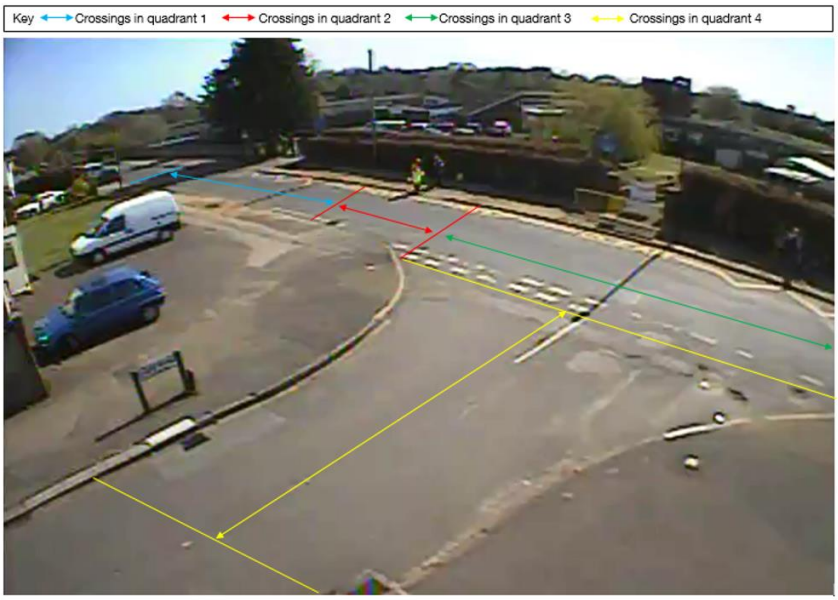
It is important to note, that due to the range of interventions introduced at Valentine School, these observed decreases may not be completely due to the light touch infrastructure. For example, the majority of the decrease in traffic volume was observed between 7:00-9:00AM and 14:00-16:00PM, but this is likely to be linked to the School Street initiative. The combination of the School Street closure and the effects of the COVID-19 pandemic are likely to have had a substantial effect on traffic volumes at post-intervention in Southampton.

This substantial reduction in traffic volume, average speed and speeding suggests that the road outside Valentine School has become much safer for pedestrians to use, encouraging active travel behaviour for the school commute through increased road safety.

8.2.2 Pedestrian crossing behaviour

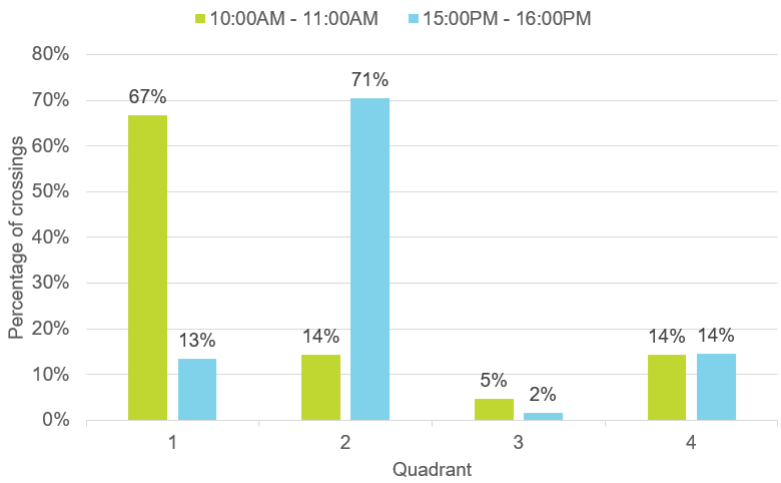
In Southampton, the site was divided into four sections: three on Valentine Avenue, and one on Elgar Road. Section two contained a suggested crossing point with dropped kerbs, and for most of the pre-intervention peak hours a lollipop person was present in this section (Figure 14).

Figure 14: Screenshot of video footage captured from the camera on Elgar Road in Southampton at pre-intervention.



The pre-intervention monitoring showed that the number of crossings was much higher during peak hours, when 1,225 pedestrian crossings occurred, compared to 42 in off peak hours. This is a difference of 1,183 pedestrian crossings. Pedestrian crossing movements during peak times occurred predominantly in section two which contained dropped kerbs, with 71% of crossings happening here during peak hours (Figure 15).

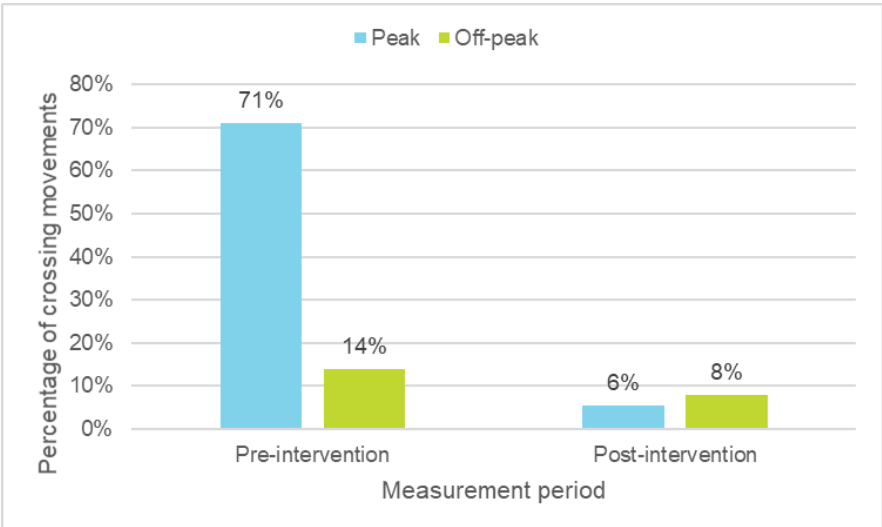
Figure 15: Distribution of vehicle and pedestrian Interactions during off-peak (10:00AM – 11:00AM) and peak (15:00PM – 16:00PM) hours in Southampton at pre-intervention.



After the light touch measures were installed, the proportion of crossings occurring during peak hour decreased, with 70% occurring in peak hour, compared to 97% pre-intervention. This may partly be due to the altered timings of the monitoring, which was necessary because of the introduction of a School Street at Valentine Primary.

Furthermore, at post-intervention only 7% of crossings occurred in section two, suggesting a more even distribution of crossing movements and a safer, more accessible road. This decrease in the proportion of crossing movements occurring in section two was greater during the peak hour but occurred during both the peak and off-peak hours (Figure 16).

Figure 16: Percentage of crossing movements occurring in section two (containing the formal crossing) at pre- and post-intervention during peak and off peak hours (peak hour pre-intervention: 15:00-16:00, post intervention: 15:30-16:30).

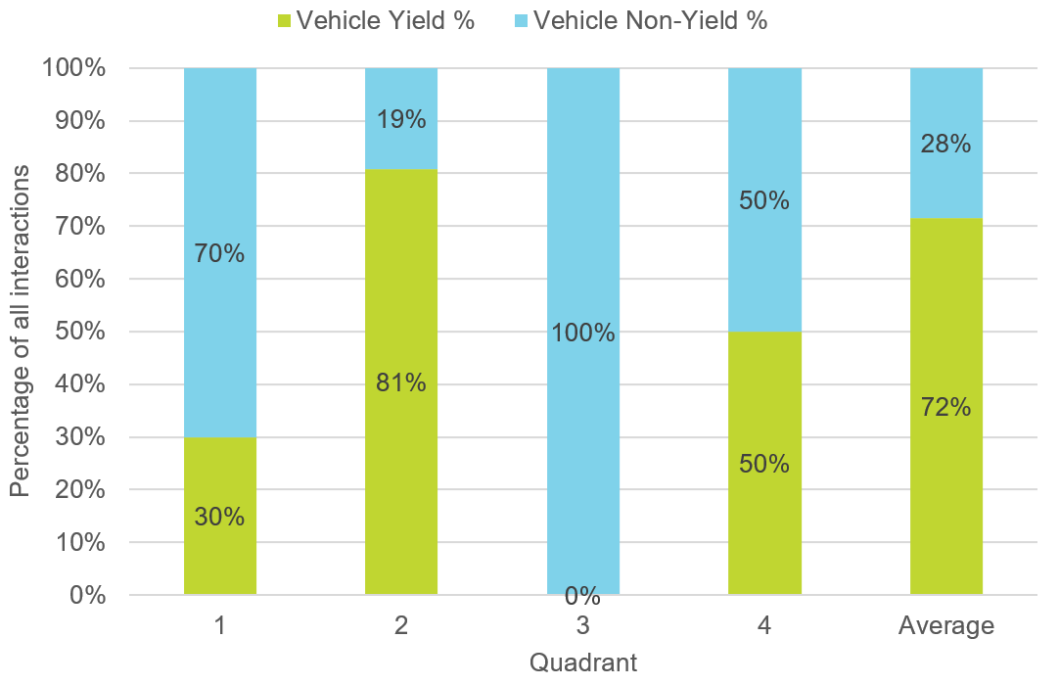


8.2.3 Vehicle Pedestrian Interactions

In Southampton at pre-intervention there were very few vehicle and pedestrian interactions during the off-peak hours. All of the off-peak interactions occurred in section one, and no vehicles gave way to pedestrians during this time. During the peak hours the yielding rate was much higher: out of 116 pedestrian-vehicle interactions, 72% resulted in a vehicle yield.

During the peak hours, 77% of the 116 interactions occurred in section two, which had the highest yield rate (81%). This may be due to the presence of the lollipop person, encouraging vehicles to give way to pedestrians.

Figure 17. Distribution of yielding and non-yielding interactions in Southampton at peak hour at pre-intervention.



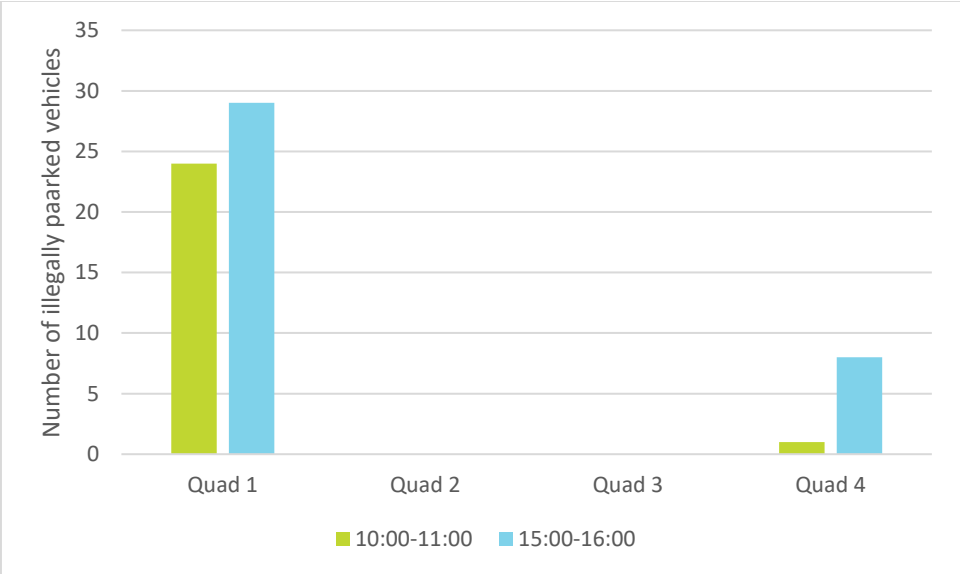
The yielding rate and number of interactions were lower in sections where the lollipop person was not present. In sections one (10 interactions) and three (one interaction) the yield rate was 30% and 0% respectively (Figure 17). Section four had a slightly higher yielding rate of 50% (of 16 interactions), as compared to section one which may be because traffic had to give way at the junction, so the slower speeds could have contributed to the higher yield rate in this section.

During baseline monitoring, there were 83 vehicle yields recorded out of 266 crossing movements observed, giving a yield rate of 31%. In the follow-up monitoring, there were fewer crossing movements observed, with 128 crossings in total, but the number of these movements that resulted in a vehicle yield was just seven, giving an overall yield rate of 5%, lower than pre-intervention. As fewer cars were observed it is possible that there were fewer interactions, and consequently fewer yields. However, in the follow-up monitoring vehicle-pedestrian interactions which did not result in a vehicle yield were not recorded. This creates an uncertainty over the number of interactions that occurred, and consequently the number of opportunities for vehicle yielding. Overall, these results indicate that in terms of vehicle yielding in Southampton, there has not been an improvement due to the light touch, or other measures introduced.

8.2.4 Parking behaviour

Outside Valentine school in Southampton, 62 unsafely parked vehicles were observed before light touch measures were installed, 60% of which were seen during peak time. Most dangerous or anti-social parking occurred in section one, where 96% (24 out of 25) unsafely parked vehicles were seen during off-peak hours, and 79% (29 out of 37) during peak hours (Figure 18). No dangerous or anti-social parking was seen in section two, which contained the lollipop person and formal crossing, or section three which focused on the road junction.

Figure 18: Distribution of unsafely parked vehicles pre-intervention in Southampton at peak and off-peak hours.



There was significant variation in the length of time vehicles were parked for. For vehicles that left within the observation time, the length of time parked varied from 1 minute 40 seconds to 30 minutes. Off-peak a pattern emerged of vehicles parking illegally in section one while the driver ran into the school, then came back quickly and drove off, but during peak hours vehicles tended to be parked for longer and were generally waiting to pick up children.

There is some uncertainty in the observations as only 21% of vehicles left within the monitoring time, all other vehicles were assumed to be there all day. Vehicles in this scenario were probably owned by residents rather than parents or staff, highlighting the importance of engaging the community on road safety issues, particularly around parking but the issue is unlikely to be solved through engagement alone. Addressing the observed anti-social or dangerous parking could be supported by implementing deterrents, such as raised verges or planters or bollards on pavement. If dangerous or anti-social parking is a significant issue around a school, it may be necessary to go beyond light touch measures and consider

introducing parking restrictions (e.g. zig zag lines), School Streets and enforcement (through video or manual means).

The follow up monitoring saw a 79% decrease in dangerously parked vehicles, with only 13 instances of dangerous or anti-social parking observed. The temporal distribution remained similar but shifted so that most dangerous or anti-social parking occurred during off peak times (54%), rather than peak (46%). All dangerous or anti-social parking was on the eastbound side of the road. 46% of vehicles stayed for 15 minutes or less, with only one vehicle staying for the entire two-hour monitoring period that day. Of the five vehicles that stayed an hour or more, three were LGVs, suggesting that long-stay dangerous or anti-social parking was not directly related to residents during the follow up period.

Overall, a decrease in dangerous or anti-social parking was observed in Southampton, including changes to the characteristics of dangerous or anti-social parking instances. Fewer unsafely parked cars will improve road visibility, making it safer for children to cross.

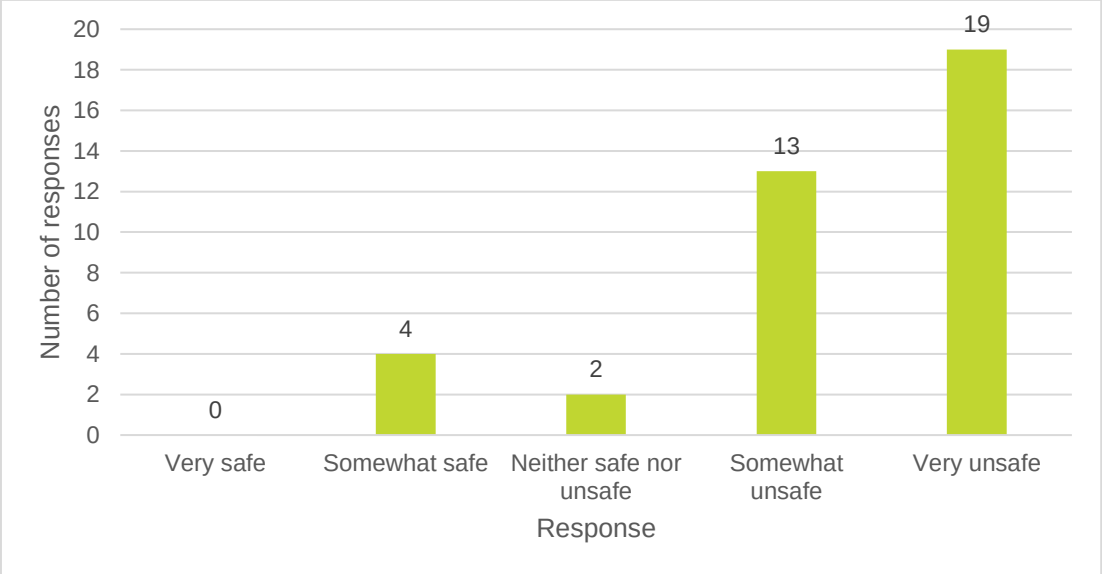
8.2.5 Perceptions of safety

Table 9. Safety perceptions of survey respondents, before (2018) and after (2021) the light touch interventions.

Valentine Primary School, Southampton					
	Very safe	**Somewhat safe**	**Neither safe nor unsafe**	**Somewhat unsafe**	**Very unsafe**
Pre (38 responses)	0% (0 respondents)	11% (4 respondents)	5% (2 respondents)	34% (13 respondents)	50% (19 respondents)
Post (19 responses)	53% (10 respondents)	37% (7 respondents)	0% (0 respondents)	2% (2 respondents)	0% (0 respondents)

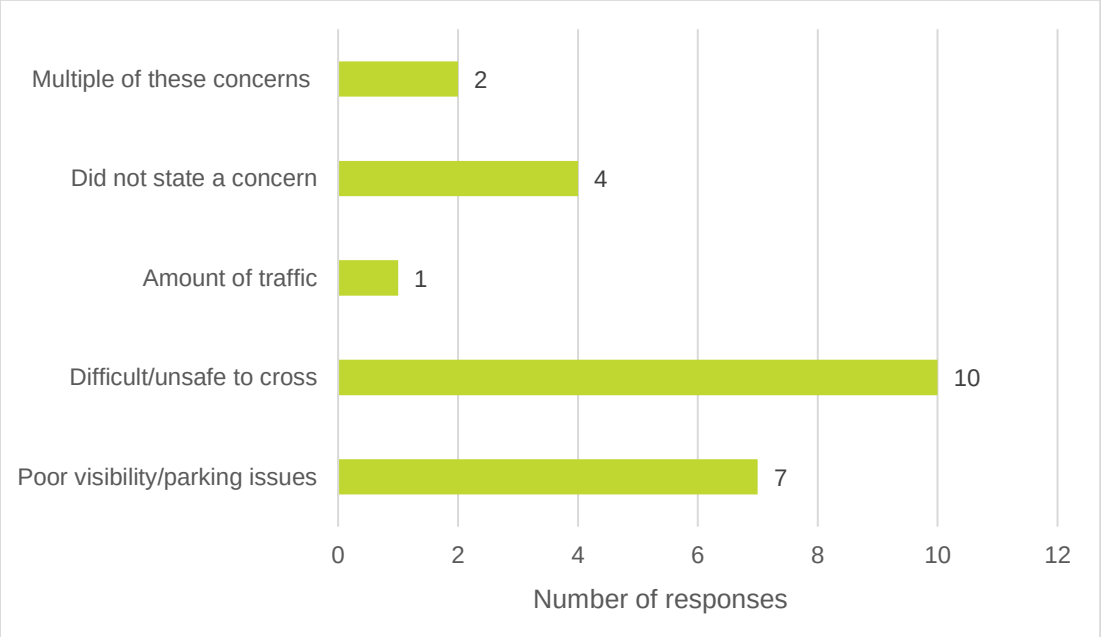
The baseline survey in Southampton demonstrated strong safety concerns, with 84% (32 out of 38) of respondents feeling somewhat or very unsafe when crossing the road outside Valentine school (Figure 19). No respondents felt very safe. There was strong support for the measures, with 32 respondents saying it would make the street a lot nicer place to be and more child friendly. Respondents also viewed the potential safety benefits of the intervention more positively, with 71% (27 out of 38) of respondents expecting the measure to make the street a lot safer.

Figure 19: Feelings of safety using the street outside Valentine School in Southampton, pre-intervention.



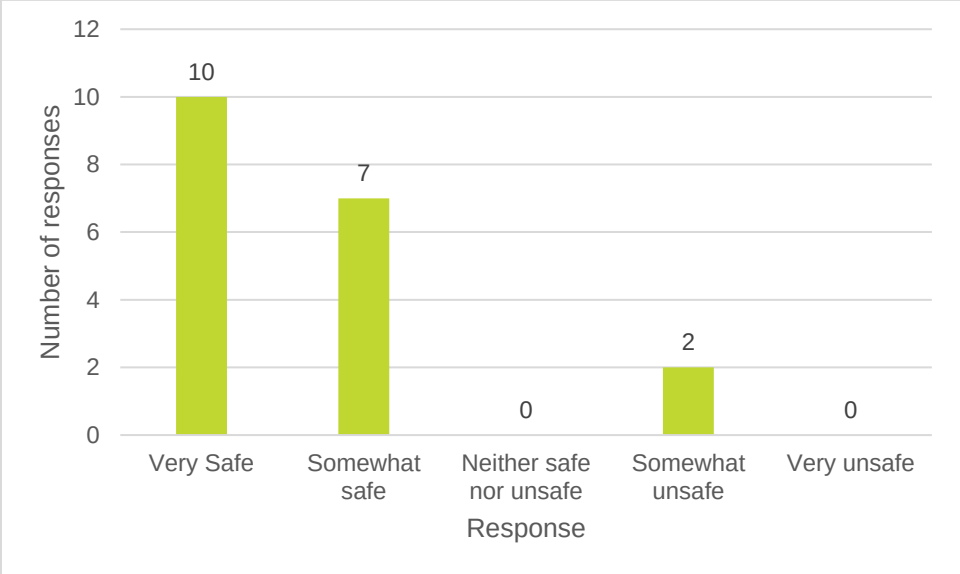
Initially, the open comments suggested that the top concern about the road was that it was difficult or unsafe to cross in 42% (10 out of 24) of comments, followed by poor visibility (7 comments). The amount of traffic was less of a concern at this site, and only mentioned in one comment (Figure 20).

Figure 20: Number of open comments mentioning each road safety issue pre-intervention in Southampton.



After the intervention, feelings of safety had increased significantly, with 89% (17 out of 19 respondents) of respondents feeling somewhat or very safe crossing the road, and over half of these feeling very safe. The proportion of respondents feeling unsafe decreased to 10.5% of respondents (two out of 19 respondents), and none felt very unsafe. This demonstrates a substantial increase in the proportion of respondents considering the street safe (Figure 21), although this may be influenced by the other measures introduced during the same period. As discussed earlier, the combination of the School Street and the COVID-19 pandemic are likely to have contributed towards the substantial reduction in vehicle volumes in Southampton and these reductions may have had a positive effect on perceptions of safety. Research evidence supports this link, Hine (1996) found that pedestrians who used routes with high traffic volumes reported that they did not feel safe crossing the road at informal crossing points, with the high vehicle flows forcing them to use formal crossing points. Research evidence also suggests that the introduction of School Streets on their own can have a positive effect on perceptions of safety. A study of 17 School Streets across the UK by Sustrans (2019) found that 90% of local residents and parents or careers of school children either strongly agreed or agreed that the road felt safer after the closure.

Figure 21: Feelings of safety using the street outside Valentine School in Southampton, post-intervention.



After the light touch measures were installed, 68% (13 of out 19 respondents) of respondents felt the thermoplastic art made the street at least a little nicer place to be and 14 said the street was at least a little more child friendly. 89% (17 out of 19 respondents) agreed that the thermoplastic art made the street at least a little safer. No one said that the thermoplastic art had not changed these characteristics at all.

In terms of empowerment, at baseline 84% (32 out of 38 respondents) said the project will allow them to contribute, and 94% (34 out of 36 respondents) said events like this were a good opportunity to meet parents and neighbours and discuss issues, only two people said no. This topic was not asked again at follow up.

As the Southampton site had multiple measures implemented between 2018 and 2021, survey respondents were asked which measure they felt had had the biggest impact on road safety. 63% (12 out of 19 respondents) said the School Street and two said the light touch thermoplastic art. Whilst not as strong as the response for the School Street, this demonstrates that the light touch intervention has had a noticeable impact on perceptions of safety.

8.3 Discussion

Southampton saw no improvement in vehicle yielding, but there was a substantial decrease in average speed, particularly at the weekend. Decreases in the number of speeding vehicles

and in dangerous or anti-social parking were also observed at the site. Changes in yielding were difficult to compare due to different methodologies in the pre- and post-intervention monitoring, which may explain the lack of change in this behaviour. Southampton's significant decrease in traffic volume may also be partially explained by other road safety measures put in place in this area, including the School Street.

Unlike most pre-existing evidence summarised in the literature review, Southampton saw a substantial improvement in perceived safety, particularly the percentage of people feeling safe, where 84% (32 out of 38 respondents) felt unsafe crossing the road pre-intervention, compared to 11% (2 out of 19 respondents) post-intervention and there was high agreement that the art makes the road safer. However, these changes in perceptions cannot be directly attributed to the thermoplastic art light touch intervention. As discussed earlier, research from Sustrans (2019) showed that School Streets can have a positive effect on perceptions of road safety and the closure in Southampton is likely to have affected the findings of this study.

Overall, the changes in perceptions and traffic speed were greater in Southampton than Exeter, which may be due to the light touch intervention happening in combination with other measures such as the School Street. This is supported by the evidence in the literature review which suggests that combined measures can generate more substantial improvements (Elliot et al., 2003; Kennedy et al., 2005).

8.4 Conclusion

In conclusion, the findings of this case study indicate that a combination of measures i.e., light touch traffic calming and a School Street can positively affect road safety, with substantial decreases in vehicle speed and increases in perceptions of safety observed at the site.

Despite these findings there remain gaps in the understanding of the relationship between multiple interventions implemented simultaneously. This has been suggested by existing literature to increase the road safety benefits, but it is hard to identify how different measures interact, and the multiple measures implemented in Southampton made the specific benefit of the light touch measures as compared to the School Street difficult to discern.

Future research into combined measures should look to use control sites to help isolate the effects of each individual measure.

9. Appendix B – Literature Review

9.1 Introduction

Traffic calming measures are designed to reduce both the number and severity of accidents that occur in urban areas, by reducing the traffic flow through the streets, as well as the speed of the vehicles (Gonzalo-Orden *et al*., 2016). Traditionally, traffic calming approaches have focused on physical measures, defined as those that deflect vehicles vertically, for example speed bumps or horizontally, for example chicanes (Figure 22) as they drive along the road.

Figure 2: Example of physical measures

Light touch or psychological traffic calming measures differ from physical measures in that they compel drivers to slow down, rather than forcing them to. Light touch traffic calming is a broad approach that can include painting artwork on the roadway (Figure 23), planting trees and installing planters at the side of road, placing bollards and street furniture along footways to discourage parking and visually narrowing the roadway using coloured road surfacing.

Figure 3: Example of street artwork

This literature review focuses on the issue of road safety outside of schools. Research compiled by AXA (2013) indicated that in 37% of local school areas at least one child sustained a road injury each year from 2006 to 2011. Furthermore, in this period there were over 85,000 injuries sustained by children on roads within a 500-metre radius of schools. In 2015, 1,283 children on foot were killed or seriously injured on UK roads, and 40% of these incidents were in the morning or evening of a school day (Department for Transport, 2016).

This evidence highlights the risk posed to schoolchildren travelling to and from school. This risk is heightened by the relationship between speed and road safety. Research by Wann *et al*. (2011) suggested that primary-age schoolchildren cannot accurately judge the speed of vehicles travelling above 25mph due to underdeveloped perceptual abilities. The danger this poses to schoolchildren is exacerbated by the direct relationship between speed and accident severity, with higher vehicle speeds resulting in higher accident risks and higher risks of fatality and injury. This literature review examines the effectiveness of light touch measures as a method of reducing vehicle speeds that has been used to improve road safety outside of schools.

Light touch measures can improve road safety by increasing driver's perceptions of risk, thereby encouraging more cautious and safer driving behaviour. By creating non-standard road environments, light touch measures can also increase the cognitive load on drivers, necessitating more mental effort and encouraging lower driving speeds. Light touch measures can also introduce a place-making function within the street and contribute towards people-prioritised areas, with improved use of public space. The presence of people in a public spaces can act as a 'mental speed bump', encouraging drivers to slow down and drive more carefully (Engwicht, 2005).

The purpose of this literature review is to:

- Identify what evidence currently exists around light touch measures and road safety and how The Road Safety Trust project may be filling a research gap or adding value
- Evidence the effectiveness of light touch traffic calming measures in order to justify the measures that are being implemented in The Road Safety Trust
- Synthesise key evidence from other case studies or literature

The literature review begins with a discussion of the theories that have been used to explain the mechanisms that underpin light touch traffic calming measures. It goes on to document the light touch measures that are commonly used in the UK, alongside evidence assessing their effect on dangerous road behaviours. In the discussion section the effectiveness of light touch measures is summarised and the gaps that exist in the knowledge base and their implications for The Road Safety Trust are considered. The review finishes with a conclusion of the implications of this review for research into light touch measures.

9.2 Theory of light touch measures

As discussed, light touch traffic calming measures compel drivers to slow down rather than forcing them to, and as such their effectiveness rests on their ability to influence the psychology of drivers. Several psychological theories have been developed that may explain the effect of light touch measures. The first of these theories is the ***risk compensation theory***. The theory of risk compensation refers to the tendency of people to adjust their behaviour to perceived levels of risk, behaving more cautiously the greater the level of risk they perceive (Adams, 1995). Light touch measures, for example the 3D zebra crossing displayed in Figure 24 may alarm motorists, heightening their perception of risk. This can cause them to slow down and drive more carefully.

Figure 4: 3D zebra crossing installed on a street in Iceland

The second psychological theory that has been used to explain the effect of light touch measures on driver behaviour is the ***cognitive load theory***. Cognitive load is the amount of mental effort that is required to complete a task. Increasing the complexity of a driving task will increase the cognitive load on the driver, necessitating more mental effort. Elliott *et al.* (2003) suggested that in more complex driving environments drivers will naturally compensate for the increased mental load by driving at lower speeds, producing a traffic calming effect. Light touch measures such as street furniture and greenery at the side of the road and road narrowing designs can increase the complexity of the road environment and the cognitive load on drivers.

As well as stimulating drivers and increasing perception of risk, light touch measures can also positively affect the ambience of street environments. By creating more attractive streets with trees and planters, street furniture and artwork, light touch measures can improve the public realm, increasing pedestrian usage and encouraging people to spend time in a public space rather than pass through it. This approach is commonly referred to as place-making and it comprises a diverse range of interventions that are used in the regeneration of places. In recent years papers such as *Manual for Streets* (Department for Transport, 2007) have stressed the importance of balancing the movement and place functions of streets, arguing that streets should no longer be designed based on the assumption that the place function is of secondary importance to the movement function. Neither function should be considered independently of the other, even in streets carrying heavy volumes of traffic, such as high streets. Using light-touch measures to create people-prioritised streets, putting the needs of people over motorised traffic, can clearly signal that a place is a people and community space and that drivers should adjust their behaviour accordingly. In establishing lower levels of vehicle dominance, people-prioritised streets can reduce levels of dangerous interactions between road users and encourage drivers to behave courteously towards non-motorised users.

Light touch traffic calming measures can encompass a variety of forms including street art, trees and planters, bollards, non-standard crossings and carriageway narrowing features. The follow sections of this review document a range of light touch measures that are commonly used in the UK and consider their strengths and weaknesses by reviewing a number of case studies. This will allow the knowledge gaps on light touch measures to be identified and the implications of this for future research to be revealed.

Sustrans have been directly involved in the delivery of light traffic calming measures through a programme of community-led design projects for over 10 years. Many of these projects have evaluated the effectiveness of light touch measures on road safety issues. The Sustrans case studies outlined in these sections reflect the findings of these evaluations and their implications for research into light touch measures.

9.3 Street art and coloured road surfacing

Street art and coloured surfacing in the form of designs and murals painted in the roadway have been used as a method of psychological traffic calming. The theory behind this approach is that designs and murals can be used to highlight particular road features where drivers need to take extra care. They can also be used to visually narrow the roadway (Kennedy *et al.*, 2005). Two case studies are presented below that have examined the effectiveness of designs and murals on road safety issues surrounding traffic speed and pedestrian crossing accessibility and vehicle yielding.

9.3.1 Grosvenor Road, Bristol

As part of the Sustrans Imagine St. Pauls project, a design in the shape of a lizard was drawn using spray paint on Grosvenor Road, Bristol in 2016 (Figure 25). The design was created during a street trial and traffic speed volume counts were used to measure the impact of this temporary measure.

Figure 5: Lizard street art design in Grosvenor Road

9.3.1.1 Intervention

The street art was introduced in response to concerns regarding traffic behaviour and speeds on Grosvenor Road that were raised during door knocking, drop-in street events and a round of leafleting. The design process involved children from nearby Cabot Primary School. The children were tasked with designing solutions to road safety on Grosvenor Road, and with the help from a local artist came up with the lizard design for the roadway.

9.3.1.2 Results

In order to measure the impact of the street art on driving behaviour, Sustrans (2018a.) measured vehicle speed prior to and during the trial.

The results of the analysis indicated that the introduction of the lizard design during the trial had a positive effect on driver behaviour in Grosvenor Road. Vehicle speed measured on three days before and during the intervention demonstrated that there had been a positive shift in the distribution of traffic speeds:

- On a Monday during the intervention 59% of all traffic was recorded at travelling below the 20mph speed limit, compared to 55% on a Monday before the intervention.
- Over a weekend during the intervention 61% of all traffic was recorded as travelling below the 20mph speed limit, compared to 55% over a weekend before the intervention.

The analysis of traffic speeds on Grosvenor Road suggests that the introduction of the lizard created uncertainty and intrigue amongst drivers and had an impact on traffic. After the lizard was trialled on Grosvenor Road the design was installed permanently using thermoplastics. Following the permanent installation the Head Teacher at Cabot Primary School commented

that “The children noticed how the colourful design is helping drivers slow down in this busy area as well as making it look more attractive.”

9.4 Normanton, Derby

As part of the Sustrans Health Calm project in Normanton, Derby, a tiger was painted on a busy junction in response to road safety concerns regarding crossing accessibility for pedestrians and low rates of vehicle yielding (Figure 26).

Figure 6: Normanton Tiger

9.4.1 Intervention

The tiger design was developed through a series of workshops with local children and the community. The installation was designed to have a psychological traffic calming effect, changing drivers’ expectations and encouraging them to take more notice of the surroundings and be more aware of pedestrian movements.

9.4.2 Results

In order to monitor the effectiveness of the design at improving pedestrian crossing accessibility and reducing vehicle dominance, Sustrans (2015c.) recorded the number of vehicles that yielded to pedestrians standing at the side of the roadway before and after the

installation. The results of this observation indicated that there had been a 22% increase in the number of vehicles yielding to pedestrians after the tiger was painted on the street.

This suggests that the street art improved road safety, reducing the dominance of motor vehicles and improving pedestrian crossing accessibility.

9.4.3 Implications of the findings

The research carried out by Sustrans (2015c.; 2018a.) has indicated that the introduction of street artwork can have a positive effect on dangerous road behaviour, reducing vehicle speed and encouraging greater rates of vehicle yielding.

In order to assess whether these findings are supported by other studies of coloured road surfacing and street art, a wider review of existing evidence was conducted. Kennedy *et al.* (2005) conducted a driving simulator study into the effect of light touch traffic calming measures on driver behaviour in different models of urban and rural environments. They tested the effectiveness of areas of coloured road surfacing on driver behaviour and found that on its own coloured surfacing, however elaborate did little to slow vehicle speeds. However, the study did find that when combined with other measures, such as a gateway effect that simulated the transition from a rural road to a built up area coloured surfacing reduced driving speeds by up to 3mph. This finding suggests that certain light touch measures such as coloured surfacing may be more effective when combined with other traffic calming measures. This supports the findings of Elliott *et al.* (2003) who concluded that combinations of traffic calming measures tend to be more effective than individual measures. Elliott *et al.* (2003) suggested that this is because combinations of measures will increase their alerting effect on motorists and make it more likely that different psychological effects will be induced.

The limitations of standalone psychological traffic calming measures was also highlighted by research carried out by Goldenbeld *et al*. (2017), which examined the effectiveness of illustrated road signs featuring drawings of children's fictional characters on vehicle speed in the Netherlands. The study measured vehicle speed on roads with and without illustrated signs and found that average speeds reduced by around 1km/h in the week after the signs were introduced, but returned to pre-intervention levels in the following weeks. This suggests that such signs can contribute to small short-term reductions in vehicle speed, but after an initial 'awareness' effect the behavioural effects quickly disappear.

This suggests that the street artwork introduced in Bristol and Derby may have had a greater effect on road safety than was observed if it was combined with other traffic calming measures. In the next section of the review, case studies of schemes that featured coloured road surfacing alongside other traffic calming measures are discussed and the implications of this for road safety considered.

9.5 Schemes featuring a combination of traffic calming measures

9.5.1 Sinclairtown

Sinclairtown was a Sustrans delivered school-focused project that aimed to improve pupil safety outside of Sinclairtown Primary School in Kirkcaldy, Scotland. The designs for the project were developed with the school and community over three planning sessions and an on-street event and focused on concerns that were raised during the engagement regarding chaotic levels of traffic at the start and end of the school day, with illegal vehicle parking on the pavements, verges and keep clear markings.

9.5.2 Intervention

The objective of the project was to create a more informal street environment outside of the school, with less rules and lower vehicle speeds. As part of this, motifs were drawn on a wall outside of the school and a raised platform was constructed on a junction (Figure 27), to make it easier for pupils and parents with prams to cross and to encourage vehicles to slow down. The road outside of the school, Roomlin Gardens was also painted with geometric patterns to create levels of uncertainty amongst drivers and slow them down (Figure 28). The issue of illegal vehicle parking was flagged in the public consultations and the design discouraged parking on the pavements and verges by installing low bollards.

Figure 7: Raised junction outside of school

Figure 8: Geometric patterns on Roomlin Gardens

9.5.3 Results

Sustrans (2014) carried out household surveys before and after the project to examine perceptions of safety. Automatic traffic monitoring was carried out for a seven day period before and after the installation to examine the effect of the measures on road safety (i.e. speed) and levels of vehicle dominance. The findings of the household survey were limited by the low sample size, with only 24 pre-surveys and 22 post-surveys carried out, and only four household responding to both pre- and post-surveys. This meant that a robust analysis could not be carried out on attitudes towards the scheme.

Whilst the results of the household surveys should be treated with caution, they indicate that the measures did not have a positive effect on perceptions of road safety:

- After the development, 14% of respondents either agreed or strongly agreed that the amount of traffic had been reduced at drop-off and pick-up times, and only 9% agreed or strongly agreed that the speed of traffic had been reduced.

These safety concerns were not supported by the analysis of traffic speed and volume however, which showed that the proportion of all vehicles travelling below 20mph increased by five percentage points. Furthermore, there was a 38% reduction in peak-time traffic volume after the measures were introduced.

This suggests that there is a disparity between how people perceive road safety outside the primary school in Sinclairtown and the actual traffic conditions. This may be due to the small and unrepresentative sample of households in the survey. There were also several cases of negative press surrounding the safety implications of the road markings outside of the

primary school, and these may have contributed towards the negative perceptions of road safety and may have discouraged households from taking part in the survey.

The household surveys also revealed that perceptions of vehicle parking were generally negative, with just 10% of respondents agreeing or strongly agreeing that parking by non-residents had been reduced, and 24% agreeing or strongly agreeing that untidy parking has been reduced. The geometric pattern introduced in Roomlin Gardens was designed to create uncertainty and intrigue in motorists outside of Sinclairtown Primary School and in combination with the raised platform and motifs drawn on the walls, encourage cautious behaviour and reduce vehicle speeds. The findings of the TSV analysis suggest the combination of measures has been effective, with 5% less vehicles travelling at speeds at 20mph or above on Roomlin Gardens after the patterns were created compared to before they were created. These findings were not echoed by the findings of the household survey however, indicating that there may be a disparity between perceived and actual levels of safety.

9.6 Pathhead

One of the three ‘Make your move Kirkcaldy’ projects delivered by Sustrans, Pathhead involved changes to the layout of five streets in Kirkcaldy to encourage lower vehicle speeds and improve pedestrian accessibility.

A key objective of this project was to make it easier to cross busy roads, an issue that was raised in the community led design process, which involved ten development sessions, five of which were with pupils from Pathhead Primary School. Several crossing points were identified as feeling unsafe due to large crossing distances, high vehicle speeds or parked cars.

9.6.1 Intervention

In order to address these issues, the radii of junctions on seven roads around Pathhead Primary School was tightened to reduce crossing distances. Three controlled crossings were also created in areas where pupils had suggested that there were a lack of crossing facilities, and Kilgour Avenue outside of the primary school which had been used as a rat-run for school traffic was narrowed, with ‘builds out’ to reduce vehicle speeds and improve visibility for children between parked cars. Lighter touch traffic calming measures were also introduced in Kilgour Avenue in the form of informal crossing points that were marked out using a distinctive dot pattern to alert drivers to places where people crossed (Figure 29).

Figure 9: Informal crossing point on Kilgour Avenue

9.6.2 Results

In order to monitor the interventions Sustrans (2015a.) conducted household surveys before and after the interventions to assess residents' perceptions of safety. A total of 59 households replied to the baseline survey and 105 to the follow-up survey. Vehicle speed and volume data were also collected at seven sites around Pathhead primary school in order to assess the effectiveness of the combination of traffic calming measures on road safety. The results of this analysis were as follows:

- Despite widespread concern regarding traffic issues at school drop-off and pick-up in the baseline survey, only 19% of respondents agreed or strongly agreed that these traffic issues had been resolved after the interventions.
- These findings were not supported by the speed measurements outside of the primary school however, which indicated that the road narrowing and creation of geometric patterns on Kilmour Avenue had positively affected road safety, with the proportion of vehicles travelling at speeds of 20mph or below on Kilgour Avenue increasing from 84% before the changes to 95% after.
- Average vehicle speeds at drop-off and pick-up times on Kilgour Avenue also decreased from 13.8mph before the changes to 12.2mph after.

As in Sinclairtown, the findings from Pathhead suggest that the introduction of light touch traffic calming measures alongside more traditional traffic calming measures involving physical measures improved actual levels of road safety, with observed reductions in vehicle

speed. However, this improvement was not mirrored by improvements in perceptions of road safety outside the school.

9.7 DIY Streets Porters Lodge

DIY Streets Porters Lodge was a community led street design process delivered by Sustrans in Barking and Dagenham, London that aimed to create public spaces that are safe and attractive to play and socialise in and to travel through.

9.7.1 Intervention

As part of the project, a street outside of a local primary school was redesigned to make active travel easier and safer for pupils travelling to school.

The designs for Cannington Road incorporated a combination of light touch traffic calming measures, with children's footprints painted onto the roadway and globe bollards designed by pupils, installed to help reduce parking congestion and provide safer crossing points (Figure 30).

Figure 10: Traffic calming measures in Cannington Road

9.7.2 Results

In order to monitor the effect of the traffic calming measures in Cannington Road Sustrans (2015b.) carried out automatic traffic speed and volume monitoring for seven days before and after the interventions.

The traffic speed volume results showed that the number of cars exceeding the 20mph speed limit on Cannington Road decreased from 25% of the total flow before the interventions, to 20% of the total flow after the interventions. Furthermore, the number of vehicles travelling between 10 and 15mph increased from 25% before the interventions, to 32% after.

These results suggest that that the introduction of a combination of light touch traffic calming measures in Cannington Road improved road safety outside of Roding Primary School, with reductions in vehicle speed along the road.

Pupils from the school were interviewed by the Barking and Dagenham Post in order to examine whether they felt safer crossing the road after the interventions (Barking and Dagenham Post, 2015). The evidence, whilst anecdotal suggests that the measures have had a positive effect on perceptions of safety. One pupil commented that:

"The bollards have made it easier to cross and walk to school."

Alison Camp, Every Child Matters coordinator at the school, added:

"***The pupils have been really involved in everything, from coming up with the original ideas to designing the bollards. It's much safer for them now, encouraging more kids to cycle to school."***

9.8 Marks Gate

Marks Gate was a Sustrans delivered community-led street design, behavioural change and infrastructure project that aimed to reduce car dominance in the London borough of Barking and Dagenham. The project began in 2015 and was completed in 2017.

Marks Gate residents and local stakeholders were involved from the outset of the project, with 400 people attending on-street pop-up events and co-design sessions to redesign their neighbourhood.

An important issue that emerged from engagement with parents and pupils at the local school was congestion outside the school gates at the beginning and end of the day. The pavements outside the school were narrow and guard rails restricted pedestrian movement, meaning that school children were often forced to walk on a muddy verge to pass each other, creating a dangerous environment. Traffic counts revealed that Rose Lane high street was used as a 'rat run', with 77% of vehicles travelling over the speed limit of 20mph. Furthermore, parked cars along the high street forced people to cross between them. These road safety issues manifested themselves as eight collisions in the three years preceding the start of the project, six of which involved children under 13. Community co-design sessions revealed that residents were concerned about the level of traffic on Rose Lane, and felt the environment was unattractive, unappealing and dangerous.

9.8.1 Intervention

In order to address these concerns a range of traffic calming features were introduced. Waiting areas for parents were created outside of the local schools and the pavements were widened and resurfaced to improve access (Figure 31). The road layouts were also altered to address concerns regarding traffic speed and road safety. The radii of the main junction to the neighbourhood was tightened and a mini-roundabout was reshaped to reduce the speeds of vehicles entering Rose Lane. Trees were also planted to create gateway features at the entrances to Rose Lane and green the high street, and place-making features including a way-finding boat were introduced to create a more people-prioritised environment (Figure 32).

Figure 11: Improved crossing points and resurfaced pavements

Figure 12: Way-finding boat

9.8.2 Results

Sustrans (2017) assessed the effect of the interventions on attitudes and behaviour through surveys, focus groups and a traffic speed volume analysis.

Survey findings indicated that the combination of traffic calming and place-making features had a positive effect on road safety:

- 74% of surveyed residents said that there had been positive changes in road safety due to the project.
- There were still concerns about vehicle speed after the project, with 59% of respondents stating that traffic speed was an issue, but this represented a decrease of 15 percentage points compared to the baseline survey.

The generally positive survey findings regarding road safety were supported by the traffic speed volume analysis:

- There was a 30% reduction in the number of vehicles exceeding the 20mph speed limit at the entrance to Rose Lane.
- Furthermore, there was a 15% reduction in average vehicle speeds in Rose Lane, indicating that the road changes have deterred drivers from using Rose Lane as a ‘rat run’.

9.9 Implications of the findings

Research evidence e.g. Kennedy *et al.* (2005); Elliott *et al.* (2003) indicated that combinations of traffic calming measures are more effective at reducing dangerous road behaviours that individual measures. In order to assess the credibility of this finding, several Sustrans street design projects that implemented a range of traffic calming measures were reviewed. All four of the schemes reported improvements in actual levels of road safety, with reductions in the number of vehicles travelling above the 20mph speed limit ranging from 5% of the total flow in Sinclairtown and DIY Streets Porters Lodge, to 30% of the total flow in Marks Gate.

These reductions in vehicle speed were not consistently associated with improvements in perceptions of road safety however, with both Pathhead and Sinclairtown reporting low levels of perceived safety following the interventions. This was not supported by the other schemes, with anecdotal evidence from DIY Streets Porters Lodge suggesting improvements in perceptions of road safety, and survey evidence from Marks Gate indicating that residents felt the scheme had a positive effect on road safety. Comparing the range of traffic calming measures implemented in Marks Gate with those in Sinclairtown and Pathhead, Marks Gate featured a more holistic approach, with place-making features such as mosaics and trees installed alongside more traditional physical traffic calming measures. The success of the Marks Gate scheme suggests that these place-making features can improve the public realm and create people-prioritised streets that send drivers the signal that the space is for people, not motor vehicles. In order to further examine this, the next section of the review considers evidence on the effect of place-making features on levels of road safety.

9.10 Place-making features

Place-making is defined as ‘both a philosophy (way of thinking) and an approach (way of working) that brings together multi-facetted interventions to the regeneration of a place as a means of improving its economic, social, environmental, and cultural well-being. Community engagement lies at the heart of good place-making: place-making should be done with people and partners rather than to people and partners’ (Sustrans, 2018b.).

Place-making features can take on a variety of forms including planting, seating, street art and sculptures and improved lighting.

Some studies have linked the presence of trees along the side of the road to increases in cognitive load and reductions in vehicle speeds. Slangen (1983) suggested that speed reductions of 12-14% can be achieved by lining roads with trees. Trees may also reduce forward visibility, creating uncertainty about the presence of potential objects ahead. Mok *et*

al. (2006) compared accident rates on urban arterial roads in Texas before and after planting trees. They found a 46% decrease in accident rates across the sites after landscape improvements incorporating tree planting had been introduced. Slangen (1983) and Mok *et al.*'s (2006) studies were both conducted outside the UK; Slangen's study was carried out in the Netherlands and Mok *et al.*'s study was conducted in the US. In order to assess whether the findings are relevant to the UK, a street design case study from Bristol is reviewed below:

9.10.1 Embleton Road SuDS

The Embleton Road SuDs project was a Sustrans delivered community led street design project in Bristol that worked with residents and pupils at Little Mead Primary Academy to help make Embleton Road greener, calm traffic and improve drainage in the street using Sustainable Drainage Systems (SuDS).

9.10.1.1 Intervention

A key theme that emerged from engagement with residents of Embleton Road and pupils at Little Mead Primary Academy was the need to calm traffic outside Little Mead Primary Academy and help to encourage people to drive responsibly and courteously along the road. Traffic data collected from Embleton Road indicated that around half of vehicles exceeded the 20mph speed limit before the interventions, creating a road safety issue. The project adopted an innovative approach to addressing this issue, with rain gardens, rolls of turf planted with flowers installed at the side of the roadway (Figure 33).

The rain gardens were designed to collect large quantities of surface water, providing an effective sustainable drainage solution to reduce future flood risk. They were also designed to create a more attractive street environment and help to calm traffic along Embleton Road. As well the physical traffic calming element of the build-outs, the rain gardens were intended to catch drivers' attention and induce a psychological traffic calming effect.

Figure 13: Rain Garden in Embleton Road

In addition to the rain gardens, artwork in the form of thermoplastic designs laid on the road were installed along Embleton Road to help raise awareness of the proximity of the school to the road, and to encourage drivers to slow down and drive more carefully (Figure 34).

Figure 14: Thermoplastic artwork in Embleton Road

9.10.1.2 Results

In order to examine the effectiveness of the rain gardens and thermoplastic artwork Sustrans (2016) collected traffic speed data before and after their implementation. There was a small reduction in average vehicle speeds of 0.8mph following the implementation of the rain gardens, however the number of cars exceeding the 20mph speed limit decreased from 61% of the total flow before the rain gardens were introduced, to 51% after. Additionally, this figure decreased by a further 4% after the thermoplastic artwork was installed on the roadway.

The results of the analysis suggest that the introduction of areas of greenery in a roadway outside a primary school in Southmead, Bristol had a positive effect on road safety, with a reduction in the number of vehicles travelling above the speed limit. Furthermore, when the rain gardens were combined with other traffic calming measures in the form of thermoplastic artwork the traffic calming effect was greater, with an additional 4% reduction in vehicles travelling above the speed limit. These findings indicate that the rain gardens had a successful psychological traffic calming effect, supporting the findings of Slangen (1983) and Mok *et al.* (2006). The findings also suggest that combinations of measures are more effective than individual ones, adding further support to the findings of Kennedy *et al.* (2005) and Elliott *et al.* (2003).

9.11 Discussion

The primary objective of this literature review was to identify what evidence currently exists around light touch measures and road safety, and consider the implications of this for The Road Safety Trust project. The review of studies external to Sustrans indicated that there is paucity of evidence on the effect of light touch measures on road safety. The knowledge base is dominated by one study by Kennedy *et al.* (2005) which used a driving simulator to model the effect of various light touch measures on road safety. This has positive implications for The Road Safety Trust as it highlights a knowledge gap that can be addressed by the research carried out in this project.

The second objective of the literature review was to examine the effectiveness of light touch measures. In light of the gap in external literature, a range of Sustrans case studies that implemented light touch measures were reviewed. These case studies featured a range of light touch measures, from coloured road markings, bollards and place-making features such as trees and artwork. Several of the case studies featured single light touch measures which allowed the effectiveness of individual measures to be objectively assessed, and several case studies featured a combination of measures, making it more difficult to analyse the value of individual measures.

The Grosvenor Road and Normanton projects installed coloured road markings as individual traffic calming measures and both schemes reported improvements in road safety following the intervention, with reported reductions in vehicle speed in Grosvenor Road and an increase in vehicle yielding in Normanton.

In order to further the understanding of the influence of combinations of traffic calming measures on road safety several Sustrans case studies were reviewed. The findings from this review indicated that in order to positively affect levels of actual and perceived safety it is necessary to implement a wide range of measures, with light-touch, physical and place-making traffic calming approaches. This supports the findings of Kennedy *et al*. (2005) and Elliot *et al*. (2003) and strongly suggests that The Road Safety Trust projects should feature a range of light-touch measures, including both physical and psychological.

As discussed in section one, there is a focus on school safety in the evidence presented in this review, with four out of the seven Sustrans case studies featuring traffic calming measures installed on roads outside of schools. The findings of these case studies indicate that light touch measures can positively affect the pressing issue of road safety outside of schools, with reported reductions in vehicle speed in three of the schemes.

This literature review has also highlighted the dominance of vehicle speed as a measure of road safety. In three of the Sustrans case studies vehicle speed was the only monitoring tool used to assess safety, and in Kennedy *et al*.'s (2005) driving simulator study vehicle speed was also used as the primary measure of road safety. The association between speed and safety is well established, with studies such as Várhelyi et al. (2003) suggesting that for every 1km/h reduction in average vehicle speed on a road there is a 3% drop in the number of casualties. Vehicle speed is not the only measure of road safety though, with factors such as the interaction between road users and dangerous or anti-social parking also affecting levels of safety. The prevalence of vehicle speed in the evidence base highlights a further knowledge gap that the research carried out by The Road Safety Trust can fill.

9.12 Conclusion of literature review

Evidence has shown that despite the lower cost and less substantive nature of these measures, they can improve road safety, with strong reductions in vehicle speed observed in some sites.

This literature review also suggests that whilst light touch measures on their own have a limited effect on road safety, when they are combined with other traffic calming approaches they can positively affect both actual and perceived levels of road safety.

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