Quantitative Evaluation of the 20mph trial in the Scottish Borders

Final Report

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Executive Summary

Introduction

- Since October 2020, the Scottish Borders Council (SBC) has been leading the roll out of an experimental trial of 20mph speed limits in a number of villages and towns. This intervention can be considered as a first-of-its-kind in Scotland, as it was carried out on a large scale in predominantly rural areas. This trial was funded by the "Spaces for People" Programme of the Scottish Government in response to the pandemic. The programme is managed by Sustrans.
- The 20mph speed limits were introduced in over 97 settlements of Scottish Borders in the period between October and December 2020.
- The Transport Research Institute of the Edinburgh Napier University was commissioned to evaluate the impact of the 20mph trial as well as other safety interventions (that were implemented at separate stages after the onset of the 20mph trial) on vehicle speeds.

Aim and purpose

- The main purpose of the 20mph intervention, funded as it was through a Spaces for People programme to provide more encouragement for active travel especially in rural areas, by ensuring that the environment is convenient and safe for people to walk, cycle and wheel for their daily journeys.
- The overarching aim of this project is to evaluate the impact of the 20mph trial on various dimensions of motor vehicle speeds across the settlements of Scottish Borders where the intervention took place.

Data, Methods and Analysis

- An almost exclusively quantitative analysis approach was adopted in this evaluation study. Specifically, a "before-after" analysis of vehicle speeds was conducted considering the introduction of the 20mph speed limit as the threshold defining the "before" and "after" periods.

The quantitative data was drawn from traffic surveys that were carried out at various stages of the trial, pre- and post-intervention.

- The metrics used for the evaluation include the mean speed, 85th percentile of speed, standard deviation of speed, and various speeding indicators (such as proportions of vehicles exceeding the posted speed limit and other speeding thresholds).
- Data from four survey waves were processed and statistically analysed; Survey 1 was carried out before the trial, whereas Survey 2, 3, and 4 were conducted at different stages after the trial, as follows:
    - **Before"** survey (conducted in August– September 2020)
    - **"After I"** survey (conducted in November – December 2020 and early 2021)
    - "**After II**" survey (conducted in April – May 2021)
    - "**After III**" survey (conducted in June 2021)
- Traffic surveys were conducted by the technology company Tracsis. Apart from speed data, the surveys provided traffic-related information, such as traffic volume counts, and traffic composition per vehicle type. For the vast majority of the survey sites, data was collected 24 hours per day throughout a 7-day period.
- To identify the impact of the 20mph trial on vehicle speeds, descriptive statistics were calculated for various before-after comparisons taking also into account various temporal (e.g., day of the week) and settlements' (e.g., type of area, school presence) characteristics. Further statistical testing and modeling was also conducted to identify patterns that could not be unveiled through the descriptive analysis.

Summary of Findings

- Following the introduction of the 20mph trial, speed reductions were observed for the vast majority of the locations. The mean speed was found to reduce by 3.1 mph (approx.) on average a few weeks after the introduction of the speed limit.
- Similar decrease was also observed for the 85th percentile speed being equal to 3.2 mph (approx.) a few weeks after the introduction of the 20mph speed limit.

- The standard deviation of mean and 85th percentile speeds was also found to reduce after the onset of the 20mph trial suggesting more homogeneous speed patterns across the settlements after the intervention.
- In a period 7 to 8 months after the trial, the reductions in mean and 85th percentile speed were found to be largely maintained. In fact, at this period, the mean speed was lower by 2.7 mph (approx.) compared to the mean speed before the intervention. The 85th percentile speed was found to reduce by 2.6 mph (approx.) compared to its counterpart before the intervention.
- The largest speed reductions were observed in sites with high-speed patterns before the intervention, and especially in sites with mean speeds greater than 25mph before.
- Significant speed reductions were also observed in locations with a school in their vicinity (within a range of 300 metres). While, before the 20mph trial, the majority of these locations had mean speeds greater than 25 mph, most of these have mean speeds lower than 25 mph, at a shorter or longer term after the intervention.
- Speed reductions were noted for weekdays and weekends after the 20mph intervention. However, slightly larger decreases were observed in weekdays.
- The statistical analysis revealed that the observed differences in speed metrics after the 20mph trial were statistically significant for the vast majority of settlements.
- The Vehicle Activated Signs (VAS) displaying the vehicle speeds, which were placed after the installation of the 20mph speed limit signs, were found to be associated with further, slight reductions of mean and 85th percentile speeds, on the top of the reductions observed after the introduction of the new speed limit. We did not identify adequate evidence suggesting further traffic calming from other safety interventions, such as buffer zones and speed limit repeater signs.
- Traffic volumes fluctuations were observed across the period of the 20mph trial, potentially due to varying impact of COVID-19 travel restrictions that were in place over time. The statistical analysis revealed that the impact of traffic fluctuations on vehicle speeds is statistically observable, but minimal.

Policy Implications and Future Work

- The increased application of 20mph speed limits is likely to help with the ambitions of the national Road Safety Framework to reduce casualties, as it has been long established that reduction of average speeds in rural roads is associated with reduction in collisions.
- The findings of this study help to fill an evidence gap regarding the effectiveness of 20mph speed limits in rural settlements.
- The 20mph speed limits have also the potential to reduce the demand for unsustainable travel, and thus help achieving the Scottish Government's commitment to reduce car kilometres by 20% by 2030.
- The lessons learned from the 20mph trial in Scottish Borders provide encouragement to the current plans for considering 20mph as the default in built-up areas.
- Future work can include further data collection, which will enable a long-term evaluation of the 20mph trial and associated traffic calming measures. Further research should also focus on identifying any changes in travel behaviour over time, especially with regard to potential shifts away from the car, and in favour of active travel modes (e.g., walking and cycling). This should include qualitative research on attitudes and reported behaviours.
- Future evaluation endeavours can also focus on the analysis of the frequency and injury severitiy of road collisions that occurred after the introduction of the 20mph speed limit. However, the identification of a potential impact of the 20mph speed limit on road collisions and the comparison with the pre-intervention state requires a long-term evaluation.

Contents

1 Introduction

1.1 Background

Since October 2020, the Scottish Borders Council (SBC) has been leading the roll out of an experimental trial of 20mph speed limits in over 97 settlements. Due to the spatial distribution of this traffic calming intervention predominantly across rural areas, this scheme can be considered as a first-of-its-kind in Scotland. This trial was funded by the Spaces for People Programme of the Transport Scotland/Scottish Government (managed by Sustrans Scotland), which aimed to support pilot trials and traffic interventions intending to promote safer mobility and active travel, as part of the recovery from the COVID-19 pandemic and its impact on mobility. Apart from the 20mph scheme, the new trial also included additional road safety interventions, such as the installation of speed limit repeater signs, Vehicle Activated Signs (VAS), buffer zones, and others, which are expected to foster traffic calming synergies in combination with the 20mph trial. The Edinburgh Napier University Transport Research Institute was commissioned to evaluate the impact of the 20mph scheme on vehicle speeds in various urban and rural settlements under the jurisdiction of the Scottish Borders Council.

The role of speed in traffic safety

Vehicle speed have been long acknowledged as one of the most influential factors in road safety. In fact, high speeds have been linked not only with higher frequencies of road collisions, but also with more severe injury outcomes. Prior studies across years have established a consistent connection between higher speeds and greater probabilities for severe collisions, which may result in Killed or Seriously Injured (KSI) casualties (Quddus, 2013; Sarkar et al., 2018; Fountas et al., 2020; 2021). There is substantive evidence over the years that excessive speed patterns can lead to major safety issues, hence appropriate countermeasures need to be implemented in order to effectively address speeding behaviour and its significant burden on traffic safety and public health. In this context, the implementation of lower speed limits is a widely employed policy action aiming to curb the high levels of collision occurrence and injury-severity, in the UK and overseas.

1.2 Previous evidence on 20mph schemes and their implementation

The history of 20mph limits in the UK is dated to early 90s, when in December 1990, the Department of Transport released guidelines for the implementation of 20mph speed limits.

According to these guidelines, the local authorities were mandated to seek approval by way of consent from the Secretary of State before the scheme could be implemented (RoSPA, 2017). The first was in Tinsley, Sheffield and in north Norwich.

Interest in 'signing only' 20mph speed limits in the UK commenced around 2000. Scotland was in the vanguard in the UK. One reason for this interest is the ability to address a far larger area through speed limits only than through traffic calmed zones. This makes limits rather than traffic-calmed zones a considerable attraction for highway authorities with limited budgets. In 2001, a trial in Scotland of 20mph speed limits at 78 sites found reductions in speed and casualties, with killed and serious declining from 20% of the total to 14%. The Consultant's report concluded that such limits offer a low cost option for promoting road safety (Burns et al., 2001). Overall, results from an attitudinal survey demonstrated strong local support for the schemes and almost three quarters of respondents considered that the experiment had been either 'very' or 'partly' successful.

Internationally, Sweden has been a leading country globally on speed management as a result of its commitment, in its Parliament in 1996, to Vision Zero. This was, and remains, to commit to achieving zero road traffic fatalities and serious injuries. Speed limits have been set according to the amount of biomechanical energy humans can tolerate without sustaining permanent injury (sometimes referred to as Vision Zero speed limits). These speed limits are 30 km/hr (~20 mph) in areas where pedestrians may be struck by motor vehicles (Elvik, 2012). A key aspect of Vision Zero is reducing speed limits and speeds driven. As a result, Swedish municipalities have been able to decide to implement 30 km/h themselves since 1998. This has considerably accelerated the implementation. 2000-3000 km of 30 km/hr speed limits are currently in function (Sweden Trendsetter for 30km/h, undated). Stockholm was one of the first cities in Europe to introduce the 30 km/hr limit across a large area of the city.

In England, the Department for Transport has been more favourable to the use of 20mph speed limits since the results of the scheme across Portsmouth, which they stated was 'a highly successful city-wide trial' (Department for Transport, 2009). It was also noted by the Department for Transport that 'they [local authorities] can introduce them at a lower cost and with less inconvenience to local residents'. The boldest position in the UK has been taken in Wales with the First Minister announcing in May 2019 that the default speed limit where it is currently 30mph

will be changed to 20mph. A Welsh Task Force report (Welsh Government, 2020) has since set out an ambition for a national default 20mph speed limit in 2023 with exceptions for existing 30mph where the movement function dominates and there is little if any place function such as pedestrian activity e.g. an industrial estate.

In Scotland, the Good Practice Guide for the purpose of setting 20mph speed restrictions was published by the Scottish Government in 2015 and revised in 2016. The purpose of the guide was to give insight as well as the available options to the local council authorities on the implementation of 20mph speed across Scotland as to an element of consistency. Notable among the considerations and options were the introduction of the 20mph scheme near schools, in residential areas, and other areas with a strong presence of pedestrians and cyclists within the rural areas, towns and cities.

Recently, in the city of Edinburgh, the implementation of (almost) city-wide 20mph speed limits, which covered sixty-six streets that were previously 30mph streets, was studied (Nightingale and Jepson, 2019). Based on the evaluation, the 20mph streets recorded a statistically significant decrease in average vehicle speeds. A conclusion was that in the post-implementation period, a reduction in the number of drivers travelling above 20mph, as measured by the number of drivers exceeding 24mph and 30mph (Nightingale and Jepson, 2019) was identified, and that this was evidence of the effectiveness of the 20mph speed limit intervention in the city of Edinburgh. The final paper from this study concluded by reporting that "Importantly it has shown that 20mph speed limits can lead to reductions in speed, collisions and casualties, and are therefore an effective public health intervention" (Milton et al., 2021).

1.3 Area of Interest: Scottish Borders' Settlements

The 20mph speed limit scheme was implemented in 97 settlements in the area of Scottish Borders, which all previously had a 30mph speed limit. More information about the spatial distribution of the settlements can be found in the interactive online map, which was developed by the Scottish Borders Council in collaboration with the technology company Tracsis. The full list of towns and villages where the 20 mph trial has been implemented is available here. These settlements are located across five local areas: Tweeddale, Cheviot, Teviot & Liddesdale, Eildon and Berwickshire. Figure 1 shows the map of the overall area in Scottish Borders where the trial took place.

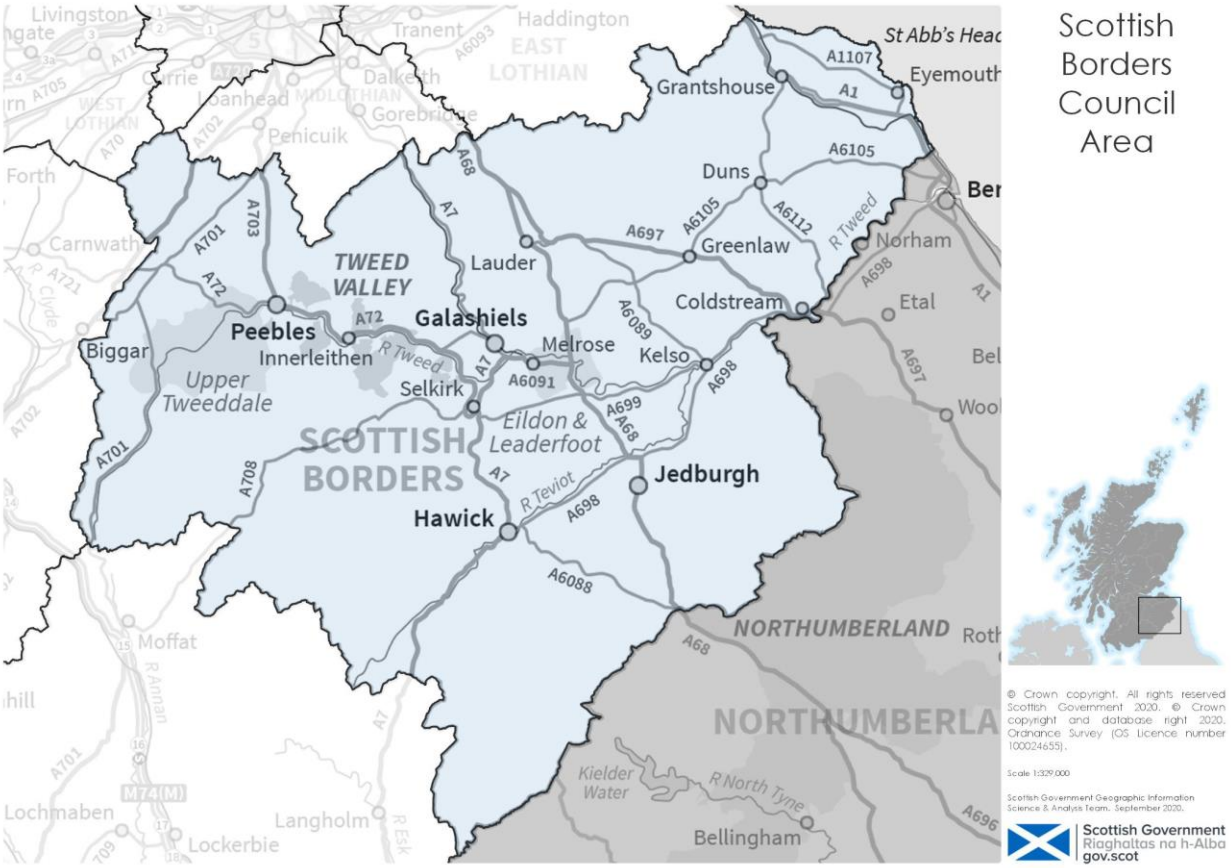


Figure 1-1: Map of the Scottish Borders area (Source: Scottish Government)

1.4 Timeline of the 20mph trial

The timeline of the 20mph trial in the area of Scottish Borders is summarised below:

- *August 2020*: The Scottish Borders Council took the decision to go ahead with the 20mph trial
- *August – September 2020*: Traffic and speed data were collected from most of the sites included in the 20mph trial just before the implementation of the scheme (i.e., the installation of the 20mph signage)
- *October – December 2020*: The 20mph trial has been fully implemented across all sites (the 20mph signage has been fully installed)

- *November 2020 – January 2021*: Traffic and speed data were collected from the sites a few weeks (4 or 5 weeks for most of the cases) after the implementation of the 20mph speed limit
- *March – July 2021*: Installation of other road safety interventions and traffic calming measures, such as speed limit repeater signs, Vehicle Activated Signs (VAS) and buffer zones.
- *April – May 2021*: Traffic and speed data were collected from a selected set of sites a few months (5 to 6 months in most of the cases) after the implementation of the 20mph speed limit.
- *June 2021*: Traffic and speed data were collected from most of the sites several months (7 to 8 months in most of the cases) after the implementation of the 20mph speed limit.

2 Aim, Purpose, and Research Questions

2.1 Aim

The overarching aim of this project is to evaluate the impact of the 20mph trial on vehicle speeds across the various settlements of Scottish Borders where the intervention took place.

The following set of objectives are set out to achieve the overall aim:

- Examine various aspects of vehicle speeds (individual & aggregate) before and after the introduction of the 20mph speed limit in all the selected sites.
- Determine whether there are statistically significant differences in vehicle speeds before and after the introduction of the 20mph speed limit in all the selected sites.
- Determine how other traffic, road, contextual, and settlement characteristics are associated with differences in vehicle speeds before and after the introduction of the 20mph speed limit.

2.2 Purpose

The main purpose of the 20mph trial is to enhance safe and sustainable mobility, especially in rural areas, and promote active travel by ensuring that the environment is convenient and safe for people to walk, cycle and wheel for their daily journeys. The purpose of this evaluation study is to conduct a quantitative analysis of motor vehicle speeds in order to identify and evaluate how the 20mph scheme has affected speed behaviour in the Scottish Borders area and to understand which factors are influential in reducing vehicle speeds after the implementation of the trial.

2.3 Research Questions

In this context, the specific evaluation study aims at examining the following research questions:

- How did key speed metrics change after the introduction of the 20mph speed limit across the selected sites of the Scottish Borders Council area?
- Were there any differences in speed change patterns immediately after as well as several months after the introduction of the 20mph speed limit?

- Were there any differences in speed change patterns between settlements with different characteristics before and after the introduction of the 20mph speed limit?
- Which was the impact of other safety interventions (e.g., repeater signs, electronic signs, etc.) on vehicle speeds after the introduction of the 20mph speed limit?

3 Methods

A quantitative analysis approach was adopted in this evaluation study to identify the impact of the 20mph trial on various dimensions of vehicle speeds. Specifically, a "before-after" analysis of vehicle speeds was conducted considering the introduction of the 20mph speed limit as the threshold defining the "before" and "after" comparative states. The quantitative data is drawn from traffic surveys that were carried out at various stages of the trial, pre- and post-intervention.

3.1 Overview of data

3.1.1 Data sources

Traffic surveys were carried out by Tracsis, a technology company specialised in traffic and data services, which was appointed by the Scottish Borders Council to collect traffic and speed data at locations across the Scottish Borders in different stages of the 20mph trial. For this study, four survey waves have been processed and analysed corresponding to distinct phases of the trial, as follows:

- **Survey 1:** conducted a few weeks before the introduction of the 20mph speed limit (in late August and September 2020) reflecting the pre-intervention state of vehicle speeds. This survey will be also referred to as "*before*" survey in the analysis and results.
- **Survey 2:** conducted a few weeks (4 or 5 weeks for most of the sites) after the introduction of the 20mph speed limit. For the majority of sites, the Survey 2 data was collected between November and December 2020, whereas only for a very limited number of sites, the traffic data was collected in January-February 2021. The Survey 2 data is intended to capture the post-intervention state of vehicle speeds in a short period after the beginning of the trial. This survey will be also referred to as "*After I*" survey in the analysis and results.
- **Survey 3:** conducted several months (5 to 6 months for most of the sites) after the introduction of the 20mph speed limit. For almost all sites, the Survey 3 data was collected between April and May 2021, thus capturing the post-intervention state of vehicle speeds in a relatively longer period after the introduction of the 20mph speed limit. Survey 3 data was also used a baseline to examine the impact of traffic calming interventions (e.g., electronic signs, buffer zones), which were implemented in the period between Survey 3

and Survey 4. This survey will be also referred to as “After II” survey in the analysis and results.

- **Survey 4:** conducted several months (7 to 8 months for most of the sites) after the introduction of the 20mph speed limit. For all sites included in the Survey 4, data was collected in June 2021, thus capturing the post-intervention state of vehicle speeds in a relatively longer period after the introduction of the 20mph speed limit (later than the period where Survey 3 data was collected). Survey 4 data was also used as post-intervention information when examining the impact of traffic calming interventions (e.g., electronic signs, buffer zones) that were installed after Survey 3, but before Survey 4. This survey will be also referred to as “*After III*” survey in the analysis and results.

In Survey 1 & 2, traffic and speed data were collected for almost all sites where the 20mph trial took place. For Survey 3, data is available only for a subset of sites among those included in Survey 1 & 2. Survey 4 contains information for the vast majority of sites included in Survey 1 & 2.

3.1.2 Speed and traffic volume data

During the traffic surveys, speed and traffic data were collected through Automatic Traffic Counters (ATC). Figure 3-1 shows the ATC positioned at site 106, at an unnamed road in Traquair. Specifically, at the period of data collection, the ATC equipment was temporarily installed at the location of the data collection, primarily consisting of pneumatic tubes attached on the pavement surface running the entire width of the road as well as a recording device being attached on a roadside fixed object (e.g., an electricity or a lighting pole). For illustration purposes, the following photo in Figure 3-1 shows a particular site (Unnamed road, Traquair) in the Scottish Borders with the ATC equipment installed during the data collection process, as provided by the TRACSIS. ATCs provide information about the instantaneous speeds of the vehicles passing through the specific site. Apart from speed data, ATCs also provide various traffic-related information, such as traffic volume counts, traffic composition (e.g., volume counts per vehicle classification) and so on. For the vast majority of sites, ATC data were collected 24 hours per day throughout a 7-day period. In line with current practice on the use of traffic surveys for evaluation of vehicle speeds, the ATC provide average speed values per various temporal resolutions, such as day of the week, time of the day or traffic entities, such as vehicle type.

Apart from average speeds, individual vehicle speed observations were also available for most of the sites in Survey 1 & 2. The analysis of individual observations can show the variations of speeds before and after the introduction of the trial at a more detailed and disaggregate level, hence paving the way for a more thorough descriptive and statistical investigation. However, given the dimensionality of the individual speed data for a considerable number of locations, the processing, alignment, and integration of the individual speed data was a computationally cumbersome process. The individual speed data were provided from TRACSIS as an SQL database, which contained approximately 2.5 million observations corresponding to individual vehicle speeds for 98 sites in Survey 1 & 2. For these records, information was also available about the site, date, and time at which the specific individual speed was recorded. Due to the significant amount of information that had to be handled, for which conventional database management tools may have quite limited capabilities, a big data analysis was carried out using appropriate data analytics to process such a highly disparate and extensive dataset. Specifically, the Python and MySQL programming languages were leveraged to integrate all the data in a unified database, process the data, and carry out suitable statistical analyses.

In this study, we explore both the individual vehicle speed observations as well as aggregate metrics of speed distributions across all sites with available data. Specifically, the individual vehicle speed observations were used to conduct statistical tests between Survey 1 and Survey 2 as well as for the descriptive analysis. The average speed data was used for the descriptive analysis, the overall statistical tests across all survey waves, and the regression analysis that was conducted to quantify the impact of the 20mph intervention and other controlling factors on vehicle speeds.

Figure 3-1: Automated Traffic Counter positioned at site 106 in Traquair (Source: Tracsis)

3.1.3 Speed metrics

For the quantitative analysis, various speed metrics have been drawn from the traffic surveys and thoroughly examined, following the standard practice and previous research for analysis of speed data (Corkle et al., 2001; Sarwar et al., 2017; Vaitkus et al., 2017):

(i) **Mean speed**

This is a standard metric used for the monitoring of vehicle speeds before and after any intervention. Mean speeds were calculated, as the average of the instantaneous vehicle speeds that were measured at a specific point (where the ATC was installed) throughout a specific temporal entity, such as week, day, specific time of the day and so on. Comparison of mean speeds has been predominantly employed as a measure for the evaluation of 20mph schemes in the UK and abroad (RoSPA, 2017; Bornioli et al., 2018).

(ii) **85th percentile speed**

This is defined as the speed at or below which the 85 percent of vehicles travel considering that the speed is not affected by adverse traffic or weather conditions. This value serves as an indication of the speed that the majority of drivers consider as reasonable for the specific road environment. The 85th percentile speed has been also extensively used a representative metric of the speed distribution for the evaluation of 20 mph schemes (Maher, 2018).

(iii) **Standard deviation of speed**

The standard deviation constitutes a measure of the variability of the speed data indicating how the individual vehicle speeds deviate from the mean speed. Higher values of standard deviations indicate higher spread of the individual values around the mean speed, thus implying more heterogeneity in speed patterns. Lower values of standard deviation signify lower spread of speeds around the mean, hence, a more consistent speed behavior.

(iv) **Percentage of vehicles exceeding the posted speed limit**

This metric shows the percentage of vehicles that employ speeds greater than the speed limit; these vehicles are typically considered as speeding vehicles (i.e., travelling at speeds greater than the posted speed limit – see also Pantangi et al., 2019; Pantangi et al., 2020). The percentage of vehicles exceeding the speed limit can provide insights into the level of drivers' compliance with the 20mph speed limit.

(iv) **Percentage of vehicles exceeding the Association of Chief Police Officers (ACPO) speed threshold**

The ACPO speed threshold is set as 1.1*speed limit + 2mph; for roads with 20mph speed limit, this speed threshold is equal to 24 mph. This speed threshold has been considered for speed enforcement purposes by the police. It can give useful insights into the extent of speeding behaviours observed after the introduction of the 20mph speed limit.

(v) **Percentage of vehicles exceeding the Department for Transport (DfT) speed threshold**

This speed threshold is set as speed limit + 15 mph; for the case of the 20mph speed limit, the DfT threshold is equal to 35mph. This constitutes a key statistic used by the DfT in official reports to

show the level of severe speed limit violations, i.e., the proportion of vehicles traveling with speeds over 15 mph above the posted speed limit.

3.2 Quantitative data analysis

For a robust evaluation of the effectiveness and impact of the 20mph trial on vehicle speeds, we conducted both descriptive and statistical analyses of the available speed data. The descriptive analysis provides a thorough overview of the data through descriptive statistics, such as percentages, frequencies, mean values, percentiles, standard deviations, minimum/maximum values and thorough comparisons across survey waves and cross-tabulations. For the descriptive analysis, we used the SPSS statistical package.

The statistical analysis mainly encompasses inferential statistics, which allowed to identify whether differences in speed metrics before and after the implementation of the 20mph scheme for various sites are statistically significant. In this context, two types of statistical tests were conducted:

- Parametric tests: Student's t-test
- Non-Parametric tests: Wilcoxon signed-rank test

In line with research and practice in the evaluation of speed data (Corkle et al., 2001; Sarwar et al., 2017), t-tests can yield whether the difference in the means of two compared data sets is statistically significant or not. For the sub-groups of speed data on which t-tests were performed, the t-test statistics and p-values are reported. If the p-value is lower than a critical value, which depends on the level of confidence considered for the comparison, then the difference in the means between the compared sub-groups is statistically significant at the specified level of confidence. In the tests conducted for this study, a minimum 90% level of confidence has been considered; the critical p-value for this level is 0.10. If the p-value of a test is lower than 0.10, which means there is sufficient statistical evidence that the mean values of the two datasets are different for 90% of cases. However, in most of statistical testing cases, the 95% level of confidence has been employed as a benchmark for comparison.

The Wilcoxon signed-rank test is a non-parametric test that can show whether the differences in the distribution of sites per speed range across various distinct survey waves are statistically

significant or not. As with the t-tests, the p-values can be again used to assess statistical significance at a particular level of confidence. To carry out all the statistical tests, we used the SPSS statistical package.

To comprehensively identify the impact of the 20mph intervention across all survey waves, while controlling, at the same time, for the impact of other exogenous factors (e.g., traffic volumes, COVID-19 restrictions), we also carried out a regression analysis. For the latter, the mean speed of each site across all survey waves served as the dependent variable. For the regression analysis, we used the Ordinary Least Squares approach (Washington et al., 2020), and the model was developed using the NLOGIT 6 software.

4 Results

This section of the report presents the results and findings of the evaluation of the 20mph trial in selected sites in the Scottish Borders Council's (SBC) area. The section analyses the traffic speed and volume data collected before (Survey 1) and after (Survey 2, Survey 3, and Survey 4) the implementation of the 20mph speed limit. The results are presented according to the three key layers of the quantitative analysis discussed in the Methods section, which include the descriptive, parametric and non-parametric inferential statistics, and regression analysis. Based on the results of the three-fold analysis, we make relevant inferences, which are discussed in this section.

4.1 Descriptive analysis of vehicle speeds before and after the 20mph intervention

For the sets of speed surveys conducted, the distributions of sites per range of mean and 85th percentile speeds are analysed. Specifically, in line with previous research and practice for speed surveys, sites are classified in groups (they will be referred to as "bands") based on the range of mean or 85th percentile speed they are associated with. In this context, subsequent speed ranges are defined for each band starting from zero to 20 mph, and considering a separate range per each 5-mph increment afterwards. Hence, the frequency of sites associated with each speed range was calculated by using different speed metrics as criteria for classification, i.e., the mean and 85th percentile speed. Such a configuration of speed data can provide a more comprehensive overview of the distribution of sites across different levels of the examined speed metrics.

4.1.1 Distribution of sites per speed range

Data for one hundred and seventeen (117) sites and one hundred and fifteen (115) sites are available for Survey 1 and Survey 2, respectively. Across Survey 1, Survey 2 and Survey 3, data are commonly available for fifty-five (55) sites. Across Survey 1, Survey 2 and Survey 4, data are commonly available for 109 sites. It should be noted that all these sites had 30mph speed limits before the introduction of the 20mph scheme. Hence, the comparison of speed values for these sites intends to measure the impact of a speed limit change from 30 mph to 20 mph on vehicle speeds.

Figures 4-1 (a) and (b) show the distribution of sites per range of **mean speed** across the first two surveys (Survey 1 - "before", and Survey 2 -"after I") and three surveys (Survey 1 – "before", Survey 2 – "after I", and Survey 3 – "after II"), respectively. Note that all distributions have been

derived from sites with commonly available data across the examined survey waves (e.g., the distribution shown in Figure 4-1 (b) is based on sites with available speed data across all survey waves, hence a direct comparison can be made).

As can be seen in Figures 4-1, the distribution in Survey 1 (in yellow colour) is skewed towards the left leaving the majority of the sites on the right side of the graph, which reflects higher speed ranges. In fact, before the introduction of the 20mph speed limit, the majority of sites (59.2%) has a mean speed greater than 25 mph, with most of them being associated with the band >25-30 mph. A few weeks after the introduction of the 20mph scheme (i.e, Survey 2), the shape of the distribution of sites across speed bands (in green colour) changes drastically, with almost 83% of sites having a mean speed below 25 mph. Specifically, the percentage of sites in the range >20-25 mph increases by 37% in the "after I" survey compared to the "before" survey, whereas at the same time, the percentage of sites in the range >25-30 mph decreases by 30% approximately. Notably, there are no sites with mean speed greater than 30mph in the "after I" survey, as compared to 12.2% of sites before the introduction of the 20mph speed limit.

Focusing on the comparison of sites across the three survey waves in Figure 4-1(b), the distribution of sites in Survey 3 (in purple colour) exhibits a similar pattern with the Survey 2, as it has characteristics of a right-skewed distribution, with most of the sites (67.3%) belonging to lower ranges of mean speed (less or equal than 25 mph). Compared to Survey 1, Survey 3 sees a reduction in the frequency of sites in the lowest speed range (less or equal than 20 mph), an increase of sites in the speed ranges >20-25 mph and >25-30 mph, and decrease in the number of sites for the band with mean speeds greater than 30mph. In Survey 3, the distribution of sites is quite similar (with some minor differences) to Survey 2, especially for the speed bands that are higher than 20 mph, thus showing that the post-intervention speed patterns are overall similar "after I" and "after II" (i.e., a few weeks and a few months after the introduction of the 20mph speed limit). However, some differences in specific speed ranges are further elaborated in the next sections of the descriptive analysis.

Figures 4-2 (a) shows the distribution of sites per **mean speed** band in Survey 1, 2 and 4, while the Figure 4-2 (b) provides the distribution of sites per **mean speed** band across all survey waves. Comparing Surveys 1,2 and 4, it appears that the "after III" speed distribution is quite similar to the "after I" distribution. In other words, the proportion of sites in the >30-35 mph band is almost

zero, whereas more than 75% of sites have mean speeds lower than 25 mph. The distribution in Survey 4 provides evidence that decreases in mean speeds observed “after I” seem to be largely maintained almost 8 months after the introduction of the 20mph speed limit. Focusing on the 55 sites with speed data commonly available across all survey waves, their mean speed distributions are graphically provides in Figure 4-2 (b). This comprehensive comparison suggests that the speed distributions “after II” and “after III” follow quite similar trends.

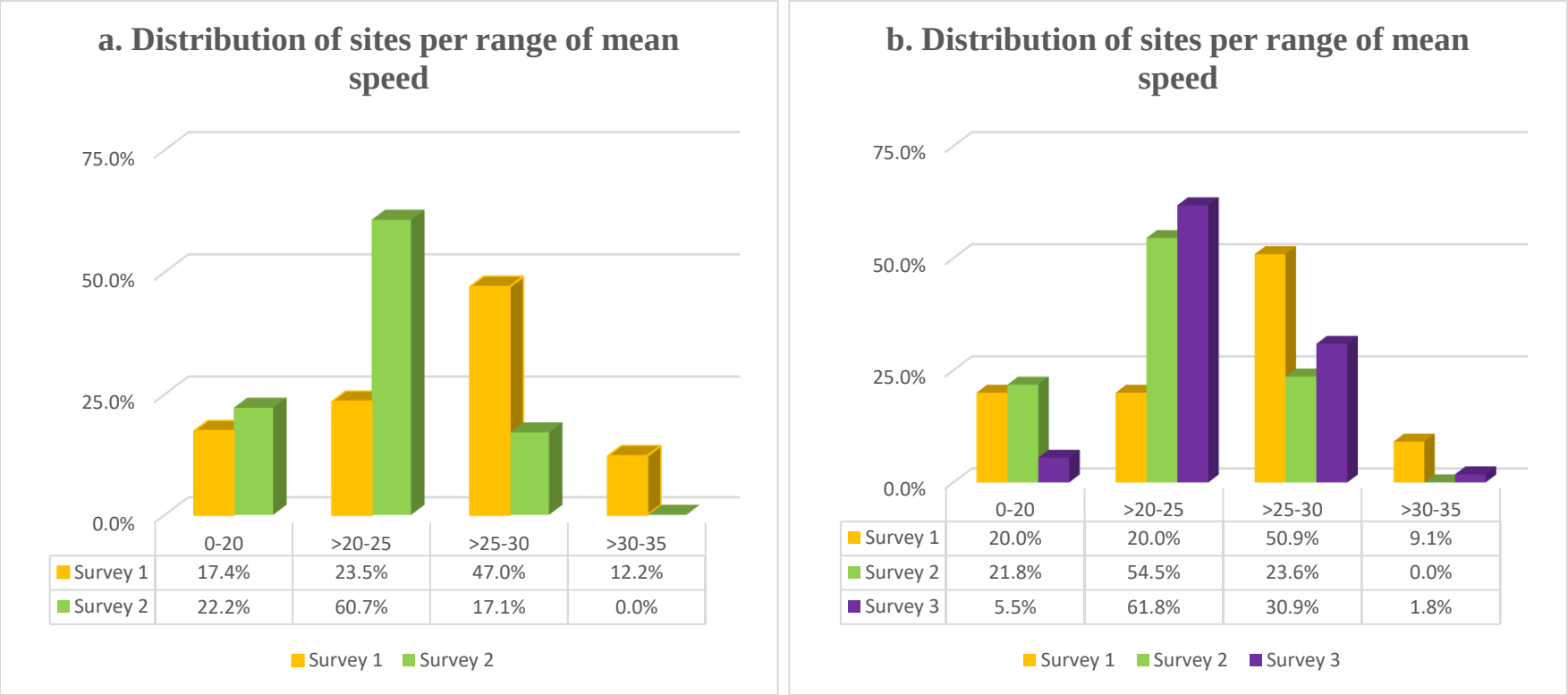
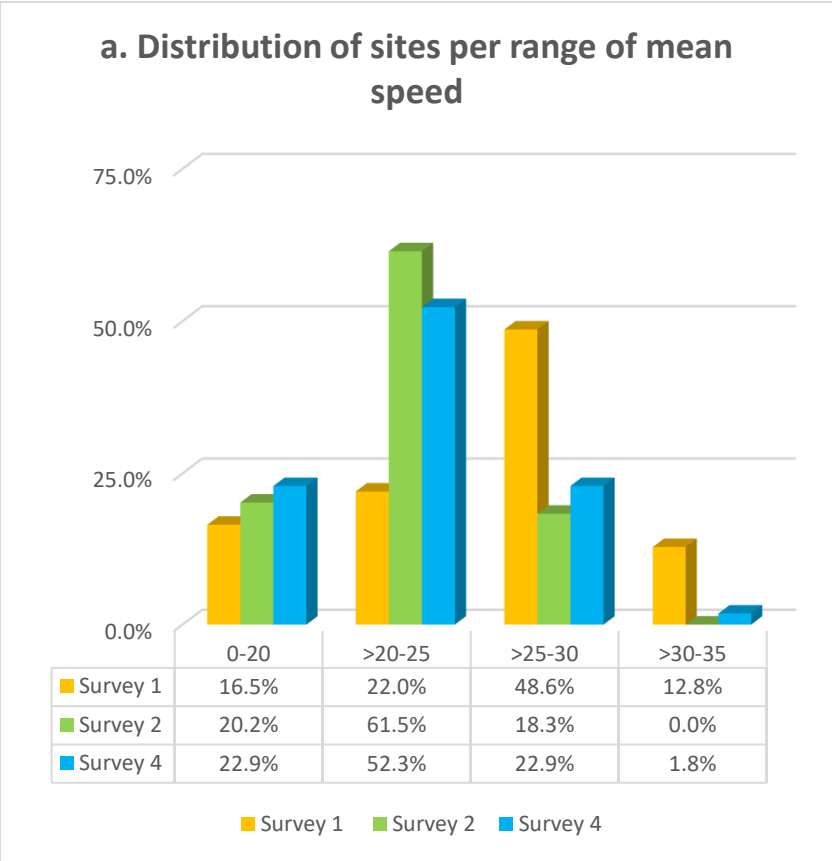


Figure 4-1 : Distribution of sites per range of mean speed for Survey 1 *vs* Survey 2 and Survey 1 *vs* Survey 2 *vs* Survey 3



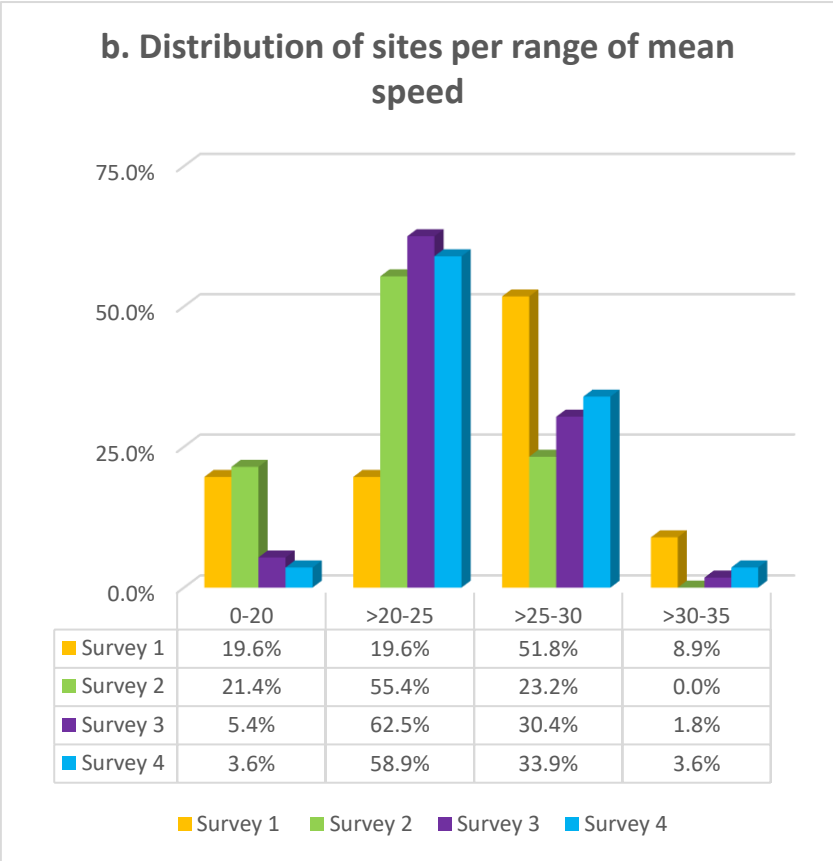


Figure 4-2: Distribution of sites per range of mean speed for Survey 1 *vs* Survey 2 *vs* Survey 4 and Survey 1 *vs* Survey 2 *vs* Survey 3 *vs* Survey 4

4.1.2 Cross-tabulation of sites per speed range "before" & "after"

The distribution of sites per **mean speed** range has shown significant differences in proportions per speed range before and after the introduction of the 20mph speed limit. However, it cannot unveil the extent of relative shifts of sites across the speed ranges; in other words, whether and how many sites remained at the same speed band or moved to a higher or lower speed band. For this reason, cross-tabulations (also known as cross-tab or contingency table) of the number of sites per speed range (or speed "band") before and after the intervention have been also carried out. Table 4-1 shows the cross tabulation results for Survey 1 ("before") and Survey 2 ("after I").

Table 4-1: Cross tabulation of sites per speed band for Survey 1 ("before") and Survey 2 ("after I")

Number of sites per speed "band" (mph)		Survey 2 ("after I")			Total
		0-20	>20-25	>25-30	
Survey 1 ("before")	0-20	19	1	0	20
	>20-25	6	20	0	26
	>25-30	0	45	10	55
	>30-35	0	4	10	14
Total		25	70	20	115

No change in speed "band"
Increase by one speed "band"
Decrease by one speed "band"
Decrease by two speed "bands"

The results in Table 4-1 indicate that out of the 20 sites that belong in the 0-20 mph speed band in Survey 1, 19 sites remained in the same speed band in Survey 2. Similarly, it is shown that out of the 26 sites that belong in the >20-25 mph speed band in Survey 1, 20 sites are found to remain at the same band in Survey 2, while the rest 6 sites have seen reductions in their mean speeds, which led to their classification in the lowest band (0-20 mph).

Furthermore, out of the 55 sites that belong to the >25-30 mph band in Survey 1, only 10 sites remained at the same band in Survey 2, while the remaining 45 sites moved to a lower band (20-25 mph). In addition, 14 sites had mean speeds in the range of >30-35 mph before the 20mph, but after the introduction of the new speed limit, none of these remained at the same range. In fact, 10 sites (71% approx.) moved to the immediately lower band (25-30 mph), whereas four sites have

seen major speed reductions leading them to two speed bands below (20-25 mph). Overall, no site was found to have mean speed in the range >30-35 mph in Survey 2 ("after I").

Cross tabulations were also carried out among Survey 1 ("before"), Survey 2 ("after I") and Survey 3 ("after II") for the 55 sites with available data across all survey waves.[1] These were done in the following order: Survey 1 ("before") versus Survey 2 ("after I"), Survey 1 ("before") versus Survey 3 ("after II"), and Survey 2 ("after I") versus Survey 3 ("after II"). Table 4-2 shows the results of the cross-tabulation analysis between Survey 1 & 2.

Table 4-2: Cross tabulation of sites per speed band for Survey 1 ("before") and Survey 2 ("after I")

Number of sites per speed "band" (mph)		Survey 2 ("after I")			Total
		0-20	>20-25	>25-30	
Survey 1 ("before")	0-20	1	0	0	1
	>20-25	1	7	0	8
	>25-30	0	29	5	34
	>30-35	0	3	9	12
Total		2	39	14	55

No change in speed "band" | Increase by one speed "band"

Decrease by one speed "band" | Decrease by two speed "bands"

Table 4-2 indicates that the only site with mean speed in the 0-20 mph band in Survey 1 remained at the same, low speed band in Survey 2. This site is located at Loan, Hawick in the Teviot & Liddesdale local area. A primary school and a park are present close to the site of the data collection.

Also, Table 4-2 indicates that out of the 8 sites that belong in the >20-25 mph speed band in Survey 1, 7 sites do not yield major speed differences, thus remaining at the same band in Survey 2 ("after I"), while 1 of them exhibits lower speed patterns, hence being moved to the lowest speed band (0-20 mph). Out of the 34 sites with mean speeds in the >25-30 mph band in Survey 1, 5 sites remain at the same band, while 29 sites (i.e., more than 85%) are classified at the immediately

[1] It should be noted that Table 4-1 presents the results of the cross-tabulation analysis for 115 sites, for which data are commonly available in Survey 1 & 2.

lower band (>20-25 mph), due to reductions in their mean speeds. Finally, all the sites that were classified in the highest speed (>30-35 mph) band in Survey 1 exhibit speed reductions, since all of them are associated with a lower speed band (>25-30 mph) in Survey 2. Overall, the findings drawn from Table 4-2 are consistent with those exported from Table 4-1.

Reporting on the cross-tabulation of Survey 1 ("before") and Survey 3 ("after II"), the results from the Table 4-3 indicate that the only one site that is in the 0-20 mph speed band in Survey 1 remains at the same band in Survey 2. Out of the eight sites with mean speed between 20 and 25 mph in Survey 1, 6 sites remain at the same band, whereas two are associated with lower speed ranges in Survey 3. Focusing on sites with higher mean speeds before the introduction of the 20mph limit, speed reductions are much more evident. For example, approximately 82% of sites with mean speeds in the range >25-30 mph in Survey 1 are associated with lower speed ranges (>20-25 mph) in Survey 3. Speed reductions are even stronger for the sites belonging in the speed band >30-35 mph "before", as all of them are associated with lower speed bands in Survey 3. Overall, the specific cross-tabulation results imply that sites with higher speeds (>25 mph) "before" are all associated with consistent speed decreases "after II", i.e., 5 to 6 months after the beginning of the trial. Speed differences are milder for sites with low speed patterns "before" (<25 mph), but again the trend suggests either stability or reduction in terms of mean speeds over time.

Table 4-3: Cross tabulation of sites per speed band for Survey 1 ("before") and Survey 3 ("after II")

Number of sites per speed "band" (mph)		Survey 3 ("after II")			Total
		0-20	>20-25	>25-30	
Survey 1 ("before")	0-20	1	0	0	1
	>20-25	2	6	0	8
	>25-30	0	28	6	34
	>30-35	0	1	11	12
Total		3	35	17	55

No change in speed "band"

Decrease by one speed "band"

Decrease by two speed "bands"

Table 4-4 shows the outputs of the cross-tabulation analysis between Survey 2 ("after I") and Survey 3 ("after II"). The results indicate that the two sites that are in the 0-20 mph speed band in Survey 2 remained in the same range of mean speeds in Survey 3. A similar pattern was also observed in the cross-tabulation analysis between Survey 1 and Survey 3. Slightly different patterns are observed for sites belonging in the speed range >20-25 mph between Survey 2 and 3. The majority of sites (33 out of 39) remain at the same band exhibiting similar speed patterns in Survey 3, whereas 5 sites were found to move to the immediately higher speed range (>25–30 mph). There is also one site that moved to the lowest speed range (0-20 mph) in Survey 3, while it was belonging in the >20-25 mph range in Survey 2. For sites belonging in the range >25-30 mph in Survey 2, the results differ mildly, as 2 out of the 14 sites yield speed reductions in Survey 3, whereas the remaining 12 sites remain at the same speed band. Overall, Table 4-4 suggests that the speed reductions gained immediately after the introduction of the new speed limit seem to be reasonably maintained a few months afterwards for the majority of sites, as approximately 86% of the sites in Survey 3 are classified in the same speed bands with Survey 2.

Table 4-4: Cross tabulation of sites per speed band for Survey 2 ("after I") and Survey 3 ("after II")

Number of sites per speed "band" (mph)		Survey 3 ("after II")			Total
		0-20	>20-25	>25-30	
Survey 2 ("after I")	0-20	2	0	0	2
	>20-25	1	33	5	39
	>25-30	0	2	12	14
Total		3	35	17	55

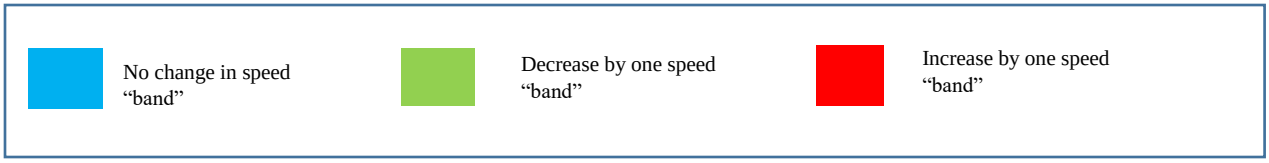
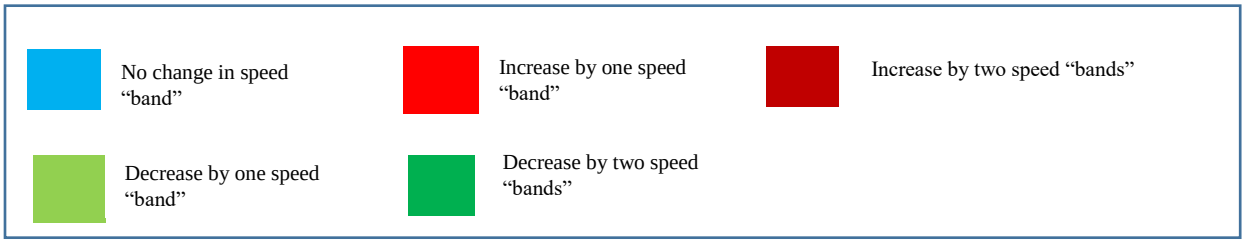


Table 4-5:Cross tabulation of sites per speed band for Survey 1 (“before”) and Survey 4 (“after III”)

Number of sites per speed “band” (mph)		Survey 4 (“after III”)				Total
		0-20	>20-25	>25-30	>30-35	
Survey 1 (“before”)	0-20	18	1	1	0	20
	>20-25	7	17	0	0	24
	>25-30	0	39	13	0	52
	>30-35	0	1	11	1	13
Total		25	58	25	1	109



Focusing on the comparison between Survey 1 (“before”) and Survey 4 (“after III”), the observed patterns, as derived from the Table 4-5, are overall similar to those drawn from the comparison between Survey 1 and Survey 3. In other words, for 58 sites (approximately 53%), shifts to lower speed bands are observed, for 49 sites (approximately 45%), there are no changes in speed band classification, whereas for the remaining 2 sites (approx. 2%) shifts to higher speed bands are observed. The latter two sites appear to have quite low mean speeds “before”, with both of them belonging in the 0-20 mph speed band in Survey 1. It should be also noted that for sites having mean speeds “before” greater than 25 mph, shifts to lower speed bands are more evident “after III”. For example, 39 out of the 52 sites (75%) belonging in the band >25-30 mph “before” and 12 out of 13 sites (92.3%) belonging in the >30-35 mph “before” saw speed reductions in Survey 4 that classified them in lower speed bands. In other words, 7 to 8 months after the onset of the intervention, speed reductions are more evident in sites with higher mean speeds “before”. This pattern is consistent across all survey waves.

Table 4-6: Cross tabulation of sites per speed band for Survey 2 (“after I”) and Survey 4 (“after III”)

Number of sites per speed “band” (mph)		Survey 4 (“after III”)				Total
		0-20	>20-25	>25-30	>30-35	
Survey 2 (“after I”)	0-20	20	4	1	0	25
	>20-25	5	50	10	0	65
	>25-30	0	4	14	1	19
Total		25	58	25	1	109

No change in speed “band”

Increase by one speed “band”

Decrease by one speed “band”

Increase by two speed “bands”

The cross-tabulation analysis of the two post-intervention surveys (Survey 2 & 4) is presented in Table 4-6. As in the “after I”-“after II” cross tabulation, Table 4-6 shows that a slight tendency for higher speed bands, almost 8 months after the introduction of the 20mph speed limit, is only evident for sites with low-speed patterns immediately after the intervention, and particularly for sites with mean speeds in the range 0-20 mph. Specifically, 5 out of the 25 sites are seen to be associated with higher speed bands. This trend is milder for sites belonging in the band >20-25 mph in Survey 2, as approximately 85% of these sites exhibit stability or band reduction in Survey 4. Encouraging findings arise from sites with mean speeds in the >25-30 mph band during Survey 2, as almost all sites are associated with speed band downgrade or stability in Survey 4. Overall, the mean speeds observed immediately after the 20mph trial seem to be largely maintained 7-8 months afterwards (see also section 4.1.3). There are a few instances of speed increases, but these are limited to a small number of sites (less than 15% in total).

4.1.3 Descriptive statistics of key speed metrics

To provide granular insights into the evolution of key speed metrics across various survey waves, the following Tables summarise the descriptive statistics of the mean and 85th percentile speeds for all the sites included in the 20mph trial where speed data were available. Specifically, the Table 4-7 summarises the descriptive statistics of mean speeds for sites where speed data was collected

before and a few weeks after the introduction of the 20mph speed limit. It should be noted that all these sites had 30mph speed limit before. Overall, the average decrease in **mean speed** in Survey 2 compared to Survey 1 is equal to 3.17 mph. Decrease is also observed in the standard deviation of mean speeds and this is equal to 1.55 mph. Lower standard deviations of speeds across different locations, where the 20mph limit has been introduced, overall suggests more homogeneous speed patterns after the onset of the 20mph trial.

Table 4-7: Descriptive statistics of mean speed for Survey 1 ("before") and Survey 2 ("after I")

Mean speed (mph)	N	Minimum	Maximum	Average	Std. Deviation
Survey 1 ("before")	115	14.5	34.8	25.45	4.52
Survey 2 ("after I")	117	14.2	27.6	22.28	2.97

Locations with notably low and high speed patterns, as identified in Survey 1 ("before") and Survey 2 ("after I"), are discussed below.

Locations with the lowest mean speeds in Survey 1

1. Cove: the mean speed "before" was 14.5 mph, and slightly increased at 15.2 mph "after I"
2. Shoestanes Road, Heriot: the mean speed "before" was 15.1 mph and remained approximately at the same level (15.4 mph) "after I"
3. Redpath: the mean speed "before" was 15.2 mph and reduced to 14.8 mph "after I"

Locations with the lowest mean speeds in Survey 2

1. Darnick: Mean speed "after I" equal to 14.2 mph versus 15.6 mph "before"
2. Thirlestane Drive, Lauder: Mean speed "after I" equal to 14.6 mph versus 16.9 mph "before"
3. Redpath: Mean speed "after I" equal to 14.8 mph versus 15.2 mph "before"

Locations with the highest mean speeds in Survey 1

1. Stow Road, Lauder: Mean speed "before" equal to 34.8 mph versus 26.5 mph "after I"
2. Skirling (A72 south): Mean speed "before" equal to 32.7 mph versus 27.5 mph "after I"
3. C78, Smailholm: Mean speed "before" equal to 32.2 mph versus 26.7 mph "after I"

Locations with highest mean speeds in Survey 2

1. West Linton: Mean speed "after I" equal to 27.6 mph versus 30.3 mph "before"

2. Skirling (A72 south): Mean speed "after I" equal to 27.5 mph versus 32.7 mph "before"
3. A701, Broughton: Mean speed "after I" equal to 26.9 mph versus 29.8 mph "before"

Table 4-8 shows the descriptive statistics of 85th percentile speeds for the locations with available speed data in Survey 1 & 2. Similar to the mean speeds, an overall decrease is also observed for the 85th percentile speed after the introduction of the 20mph limit, equal to 3.2 mph approximately. More homogeneous patterns are also observed for the 85th percentile speeds across the various locations "after I", as the standard deviation also reduces by 1.17 mph in Survey 2.

Table 4-8: Descriptive statistics of 85th percentile speed for Survey 1 ("before") and Survey 2 ("after I")

85th percentile speed (mph)	N	Minimum	Maximum	Average	Std. Deviation
Survey 1 ("before")	115	18.1	42.4	30.33	4.82
Survey 2 ("after I")	117	17.3	34.1	27.11	3.65

To provide a more detailed overview of the speed changes due to the 20mph trial, more disaggregate descriptive statistics per group of sites associated with each speed "band" (as previously defined) for various survey waves are provided below.

Survey 1 ("before") *vs* Survey 2 ("after I")

Group 1: Sites with mean speed less than or equal to 20 mph "before"

The descriptive statistics for the mean and 85th percentile speeds of sites with mean speed less than or equal to 20 mph "before" are compared with the corresponding statistics of the same sites in the "after I" state. Table 4-9 and Table 4-10 show the key statistics for mean and 85th percentile speeds, respectively, in Survey 1 ("before") and Survey 2 ("after I").

Table 4-9: "Before-after I" comparison of mean speed for sites with mean speed less than or equal to 20 mph in Survey 1

Mean speed (mph)	N	Minimum	Maximum	Average	Std. Deviation

0-20	Survey 1 ("before")	20	14.5	20.0	18.06	1.67
	Survey 2 ("after I")	20	14.2	20.5	17.41	1.78

From Table 4-9, there is an indication of an average decrease of 0.65 mph in mean speed between Survey 1 and Survey 2. While, a marginal increase of 0.11 mph in standard deviation of the mean speed is also observed, implying that the spread of mean speeds for these 20 sites did not significantly change after the introduction of the 20mph speed limit.

Table 4-10: "Before-after I" comparison of 85th percentile speed for sites with mean speed less than or equal to 20 mph in Survey 1

85th percentile speed (mph)		**N**	**Minimum**	**Maximum**	**Average**	**Std/ Deviation**
0-20	Survey 1 ("before")	20	18.1	26.1	22.22	2.19
	Survey 2 ("after I)	20	17.3	25.3	21.36	2.25

Similarly, Table 4-10 shows that there is an average decrease of 0.86 mph in 85th percentile speeds between Survey 1 ("before") and Survey 2 ("after I"). While there is a very minor increase of 0.06 mph in standard deviation of 85th percentile speeds, which practically suggests no change in the standard deviation of speeds between Survey 1 and 2.

Overall, both Tables 4-9 and 4-10 show that for sites with mean speeds already lower than 20 mph before the 20mph trial, small reductions (less than one mph) in mean and 85th percentile speeds are observed a few weeks after the intervention, whereas no notable differences are identified for the standard deviations of both speed metrics.

Group 2: Sites with mean speed greater than 20 mph "before"

The descriptive statistics for mean and 85th percentile speed of the sites with mean speed greater than 20 mph "before" are compared with the corresponding statistics for the same sites in the "after I" state. Table 4-11 and Table 4-12 show the key statistics for mean and 85th percentile speeds, respectively, for Survey 1 ("before") and Survey 2 ("after I").

Table 4-11: “Before-after I” comparison of mean speed for sites with mean speed greater than 20 mph in Survey 1

Mean speed (mph)		N	Minimum	Maximum	Average	Std. Deviation
>20-25	Survey 1	26	20.6	25.0	22.69	1.28
	Survey 2	26	18.4	24.1	21.19	1.34
>25-30	Survey 1	55	25.2	30.0	27.99	1.41
	Survey 2	55	21.1	26.9	23.75	1.28
>30-35	Survey 1	14	30.1	34.8	31.16	1.31
	Survey 2	14	24.3	27.6	25.76	1.17

From Table 4-11, for the >20-25 mph speed band, there is an indication of a decrease of 1.5 mph (approx.) in mean speed between Survey 1 (“before”) and Survey 2 (“after I”). While the standard deviation exhibits a very minor difference, suggesting that this remains practically the same “after I”.

For the >25-30 mph speed band, the same Table shows that there is a decrease of 4.24 mph in mean speed between Survey 1 (“before”) and Survey 2 (“after I”). While there is also a small decrease of 0.13 mph in standard deviation of the mean speeds for the same speed band.

Similarly, from the Table 4-11, for the >30-35 speed band, there is a decrease of 5.4 mph in mean speed between Survey 1 (“before”) and Survey 2 (“after I”). While there is a small increase of 0.14 mph in standard deviation of the mean speeds for the same speed band.

Overall, speed reductions are identified for all speed ranges a few weeks after the introduction of the 20mph speed limit, with evidently larger reductions being observed for the high-speed bands, i.e., the >25-30 mph and >30-35 mph bands.

Table 4-12: “Before-after I” comparison of 85th percentile speed for sites with mean speed greater than 20 mph in Survey 1.

85th percentile speed (mph)		N	Minimum	Maximum	Average	Std. Deviation
>20-25	Survey 1	26	25.9	30.8	28.10	1.39
	Survey 2	26	22.9	29.0	25.96	1.54
>25-30	Survey 1	55	29.4	36.4	32.75	1.63
	Survey 2	55	24.1	34.1	28.60	2.07
>30-35	Survey 1	14	33.8	42.4	36.54	2.26
	Survey 2	14	29.1	34.1	31.64	1.84

Similarly, for the 85th percentile speed, Table 4-12 shows that for the >20-25 mph speed band, there is an average decrease of 2.14 mph between Survey 1 ("before") and Survey 2 ("after I").

For the >25-30 mph speed band, Table 4-12 shows that there is an average decrease of 4.15 mph in the 85th percentile speeds between Survey 1 ("before") and Survey 2 ("after I"). While there is an increase of 0.44 mph in standard deviation for the same speed band.

Also, from Table 4-12, for the >30-35 mph speed band, there is an average decrease of 4.9 mph in the 85th percentile speed between Survey 1 ("before") and Survey 2 ("after I"). While there is a decrease of 0.42 mph in standard deviation of the 85th percentile speeds across the sites for the same speed band.

Overall, the "before-after I" comparison of mean and 85th percentile speeds shows that larger speed reductions (greater than 4 mph) are observed in sites yielding mean speeds greater than 25 mph before the introduction of the 20mph scheme. Milder reductions are observed for sites with mean speeds in the range of >20-25 mph "before", whereas speed variations for sites with low speeds "before" (lower or equal to 20 mph) are practically marginal.

Survey 1 ("before") vs Survey 2 ("after I") vs Survey 3 ("after II")

Group 1: Sites with mean speed less than or equal to 20 mph "before"

The descriptive statistics of key speed metrics for sites with commonly available data in Survey 1 ("before"), Survey 2 ("after I") and Survey 3 ("after II") are presented in Tables 4-13 to 4-16. The descriptive statistics for the mean and 85th percentile speeds of sites with mean speed less than or equal to 20 mph "before" are compared with the corresponding statistics of the same sites in the "after I" and "after II" states, as shown in Table 4-13 and Table 4-14, respectively.

Table 4-13: "Before-after I-after II" comparison of mean speeds for sites with mean speed less than or equal to 20 mph "before"

Mean speed		N	Minimum	Maximum	Average
0-20	Survey 1 ("before")	1	19.60	19.60	19.60
	Survey 2 ("after II")	1	18.90	18.90	18.90
	Survey 3 ("after II")	1	18.70	18.70	18.70

From Table 4-13, there is a decrease of 0.70 mph in mean speed between Survey 1 and Survey 2 for the only site with available data in that band (among the 55 sites with available data in Survey 1, 2 & 3). However, for the same site, a decrease of 0.90 mph in mean speed is observed between Survey 1 and Survey 3, as the average speed descends from 19.60 mph to 18.70 mph. Interestingly, the specific site is at Loan, Hawick, which is located in the Teviot & Liddersdale local area.

Table 4-14: "Before-after I-after II" comparison of 85th percentile speeds for sites with mean speed less than or equal to 20 mph "before"

85th percentile speed (mph)		**N**	**Minimum**	**Maximum**	**Average**
0-20	Survey 1 ("before")	1	26.10	26.10	26.10
	Survey 2 ("after I)	1	25.30	25.30	25.30
	Survey 3 ("after II)	1	24.70	24.70	24.70

Similarly, focusing on the 85th percentile speed, Table 4-14 shows that there is an average decrease of 0.80 mph between Survey 1 and Survey 2 at the same site. Furthermore, an average decrease of 1.40 mph between Survey 1 and Survey 3 is observed.

Group 2: Sites with mean speed greater than 20 mph "before"

Descriptive statistics of the mean and 85th percentile speeds for sites with mean speed greater than 20 mph "before" are compared with the corresponding statistics of the same sites in the "after I" and "after II" states. Table 4-15 and Table 4-16 show the key statistics for mean and 85th percentile speed, respectively, for Survey 1 ("before"), Survey 2 ("after I") and Survey 3 ("after II").

Table 4-15: “Before-after I-after II” comparison of mean speeds for sites with mean speed greater than 20 mph “before”

Mean speed (mph)		N	Minimum	Maximum	Average	Std. Deviation
>20-25	Survey 1 (“before”)	8	21.40	25.00	23.30	1.150
	Survey 2 (“after I”)	8	19.90	24.10	21.36	1.361
	Survey 3 (“after II”)	8	17.80	25.00	21.68	2.301
>25-30	Survey 1 (“before”)	34	25.20	30.00	27.91	1.466
	Survey 2 (“after I”)	34	21.10	26.90	23.62	1.339
	Survey 3 (“after II”)	34	22.10	27.00	23.91	1.174
>30-35	Survey 1 (“before”)	12	30.10	34.80	31.25	1.391
	Survey 2 (“after I”)	12	24.30	27.60	25.93	1.156
	Survey 3 (“after II”)	12	24.50	27.90	26.14	0.966

Table 4-15 shows a decrease of 1.94 mph in mean speed between Survey 1 and Survey 2 for sites in the speed band >20-25 mph; for the same sites, a decrease of 1.62 mph in mean speeds between Survey 1 and Survey 3 is also observed. Focusing on the standard deviation of speeds, there is an increase of 0.21 mph between Survey 1 and Survey 2, whereas an increase of 1.15 mph is identified between Survey 1 and Survey 3, suggesting more heterogeneous patterns of mean speeds 5 to 6 months after the 20mph speed limit intervention across locations with relatively lower speed patterns.

Focusing on sites related to the speed band >25-30 mph, Table 4-15 shows a decrease of 4.29 mph in mean speed between Survey 1 and Survey 2. A significant decrease of mean speeds equal to 4.00 mph is observed between Survey 1 and Survey 3 for the same locations.

Similarly, sites in the speed band >30-35 mph yield a large decrease of 5.32 mph in mean speed between Survey 1 and Survey 2. Such a speed decrease is maintained in Survey 3, and becomes equal to 5.11 mph when Survey 1 and Survey 3 are compared. The standard deviation differs

between Survey 1 and 2 exhibiting a decrease of 0.24 mph, and an even larger decrease by 0.43 mph in Survey 3 compared to Survey 1, thus implying that drivers' speed patterns become more homogeneous in sites of the specific band a few months after the introduction of the 20mph trial. Interestingly, the standard deviation of mean speeds in Survey 3 for the sites belonging in the band >30-35 mph is among the lowest that have been identified in this report.

Table 4-16: "Before-after I-after II" comparison of 85th percentile speeds for sites with mean speed greater than 20 mph "before"

85th percentile speed		**N**	**Minimum**	**Maximum**	**Average**	**Std. Deviation**
>20-25	Survey 1 ("before")	8	26.60	30.80	28.41	1.332
	Survey 2 ("after I")	8	24.50	28.80	25.94	1.393
	Survey 3 ("after II)	8	23.30	29.60	26.38	2.053
>25-30	Survey 1 ("before")	34	30.00	35.30	32.64	1.518
	Survey 2 ("after I")	34	24.10	34.10	28.36	2.138
	Survey 3 ("after II)	34	25.50	33.10	28.88	1.730
>30-35	Survey 1 ("before")	12	33.80	42.40	36.38	2.388
	Survey 2 ("after I")	12	29.10	34.10	31.77	1.835
	Survey 3 ("after II)	12	29.60	34.70	32.02	1.621

Table 4-16 provides quite similar results with the Table 4-15. Specifically, decreases in the average values of 85th percentile speeds are observed for all speed ranges between Survey 1 and Survey 2. Comparing Survey 2 and Survey 3, a slight increase in the 85th percentile speeds (by 0.44 mph on average) is observed for sites belonging in the speed range >20-25 mph. For all other speed ranges, speed reductions are still identified between Survey 1 and 3, equal to 3.76 mph for the speed range >25-30 mph, and equal to 4.36 mph for the speed range >30-35 mph. With regard to standard deviations of 85th percentile speeds, there is no practical difference observed between Survey 1 and Survey 2 for sites belonging in the speed range >20-25 mph, but an increase of 0.72 observed for the same speed range between Survey 1 and Survey 3. For speed range >25-30 mph, slight increases are observed between Survey 1 and 2 as well as Survey 1 and 3. However, notable

decreases are observed between Survey 1 and 2 as well as Survey 1 and 3 in the highest speed range (>30-35 mph), which is consistent with the trend identified in the descriptive statistics of mean speeds.

Overall, the analysis of disaggregate key statistics for sites with mean speed greater than 20 mph shows that for all speed ranges, the mean and 85th percentile speeds show substantial reductions, not only a few weeks after the introduction of the 20mph speed limit, but also 5 to 6 months later. Such reductions are larger for sites associated with higher speed ranges (>25-30 & >30-35 mph). Both speed metrics exhibit similar patterns in Survey 2 and Survey 3, whereas any observed variations are minimal, suggesting that speed reductions gained a few weeks after the beginning of the trial were also maintained a few months afterwards. Focusing on standard deviations of speeds, there is an increasing trend across survey waves in sites belonging in the speed band >20-25 mph, whereas the trend is clearly declining across all survey waves for sites in the highest speed range (>30-35 mph), implying that speed behaviours become more homogeneous across sites with high speeds "before".

Survey 1 ("before") vs Survey 2 ("after 1I") vs Survey 3 ("after II") vs Survey 4 ("after III")

The following Tables (4-17 to 4-20) provide the overall descriptive statistics for the mean and 85th percentile speeds for sites with available speed data across all survey waves. Particular consideration is given to the comparison of descriptive statistics for Survey 1, 2 & 4 (Table 4-19 and Table 4-20), for which speed data have been collected from the majority of sites. In any case, major differences are not expected between Survey 3 and 4, since these two surveys were carried out closely in time. Changes may be expected in sites where other safety interventions were implemented in the meantime between Survey 3 and Survey 4 (see also the Section 4.4).

Table 4-17: Descriptive statistics of mean speed for Survey 1 ("before"), Survey 2 ("after I"), Survey 3 ("after II") and Survey 4 ("after III")

Mean speed	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	55	19.60	34.80	27.81	2.962
Survey 2	55	18.90	27.60	23.71	1.989
Survey 3	55	17.80	27.90	23.98	2.016
Survey 4	55	18.40	30.20	24.22	2.168

Table 4-18: Descriptive statistics of 85th percentile speed for Survey 1("before"), Survey 2 ("after I"), Survey 3 ("after II") and Survey 4 ("after III")

85th percentile speed	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	55	26.10	42.40	32.72	3.055
Survey 2	55	24.10	34.10	28.69	2.691
Survey 3	55	23.30	34.70	29.12	2.508
Survey 4	55	23.30	35.60	29.28	2.639

Focusing on the 55 sites with speed data available across all survey waves, it is evident that all post-intervention surveys exhibit mean and 85th percentile speed reductions compared to "before" (see Table 4-17 and Table 4-18). Slight increases compared to Survey 2 ("after I") are observed in Survey 3 ("after II") and Survey 4 ("after III"), but these increases are quite small, since they do not exceed 0.5 mph in almost all cases. Overall, the average speed values in Survey 2, Survey 3 and Survey 4 are evidently lower compared to "before", suggesting an average reduction in the range of 3.5-3.6 mph, which remains for both speed metrics even 7 to 8 months after the introduction of the 20mph limit. Between Survey 3 and Survey 4, speed patterns seem to stabilize, with minor differences in speeds being observed between these two survey waves.

Table 4-19: Descriptive statistics of mean speed for Survey 1("before"), Survey 2 ("after I") and Survey 4 ("after III")

Mean speed	N	Minimum	Maximum	Mean	Std. Deviation
Survey 1	109	14.50	34.80	25.33	4.564
Survey 2	109	14.20	27.60	22.22	3.018
Survey 4	109	13.50	30.20	22.64	3.274

Table 4-20: Descriptive statistics of 85th percentile speed for Survey 1 ("before"), Survey 2 ("after I") and Survey 4 ("after III")

85th percentile speed	N	Minimum	Maximum	Mean	Std. Deviation
Survey 1	109	18.10	42.40	30.21	4.896
Survey 2	109	17.30	34.10	27.03	3.753
Survey 4	109	16.20	35.60	27.59	3.932

The comparison of Survey 1, 2 & 4 (Table 4-19 and Table 4-20) sheds more light on the evolution of speed metrics over time, as these waves were carried out in the vast majority of sites with speed

limit change (i.e., at 109 locations). The general finding is that both Survey 2 and Survey 4 show considerable speed reductions, both in terms of mean and 85th percentile speed. Interestingly, the mean and 85th percentile speed values converge to close values "after I" and "after III" revealing speed reductions in the range of 2.7-3.2 mph compared to "before". Standard deviations of mean and 85th percentile speeds in Survey 2 & 4 are lower compared to "before" providing additional evidence on the presence of more homogeneous speed patterns after the introduction of the 20mph speed limit.

Group 1: Sites with mean speed less than or equal to 20 mph "before"

The findings of the "before-after I-after III" comparison are consistent with the findings of the "before-after I-after II" comparison, clearly showing no significant differences in terms of mean and 85th percentile speeds (see also Table 4-21 and Table 4-22) for sites with low mean speeds before the 20mph intervention. In fact, the results show a slight mean speed decrease of 0.65 mph in Survey 2 and an infinitesimal drop of 0.05 mph in Survey 4, with both speed metrics (mean & 85th percentile speed) consistently remaining below the pre-intervention levels in all "after" surveys.

Table 4-21: "Before-after I-after III" comparison of mean speed for sites with mean speed less than or equal to 20 mph "before"

Mean speed (mph)		**N**	**Minimum**	**Maximum**	**Average**	**Std. Deviation**
0-20	Survey 1	20	14.50	20.00	18.06	1.671
	Survey 2	20	14.20	20.50	17.41	1.781
	Survey 4	20	13.50	26.00	18.01	2.835

Table 4-22: "Before-after I-after III" comparison of 85th percentile speed for sites with mean speed less than or equal to 20 mph "before"

85th percentile speed (mph)		**N**	**Minimum**	**Maximum**	**Average**	**Std. Deviation**
0-20	Survey 1	20	18.10	26.10	22.22	2.193
	Survey 2	20	17.30	25.30	21.36	2.252
	Survey 4	20	16.20	33.20	22.13	3.626

Group 2: Sites with mean speed greater than 20 mph "before"

The results of the comparison for sites with mean speeds greater than 20 mph "before" show that the mean and 85th percentile speeds (Table 4-23 and Table 4-24) in "after III" are lower compared to "before", and similar to "after I" values. That trend is evident for sites belonging in all speeds bands. For the >20-25 mph band, the mean and 85th percentile speeds in Survey 4 are close to the Survey 2 levels. Similar trends are observed for the >25-30 mph and >30-35 mph bands, whereas only minor increases are identified in mean speeds of Survey 4, which do not exceed a range of 0.5-0.6 mph. Overall, the outcomes of the "before-after I-after III" comparison corroborate with the findings of the "before-after I-after II" comparison, confirming the trend of observing larger speed decreases in sites with higher mean speeds "before".

Table 4-23: "Before-after I-after III" comparison of mean speed for sites with mean speed greater than 20 mph "before"

Mean speed (mph)	N	Minimum		Maximum	Average	Std. Deviation
>20-25	Survey 1	24	20.60	25.00	22.58	1.266
	Survey 2	24	18.40	24.10	21.01	1.231
	Survey 4	24	18.40	24.00	21.12	1.706
>25-30	Survey 1	52	25.20	30.00	27.94	1.412
	Survey 2	52	21.10	26.90	23.71	1.293
	Survey 4	52	21.60	27.70	24.17	1.486
>30-35	Survey 1	13	30.10	34.80	31.17	1.363
	Survey 2	13	24.30	27.60	25.87	1.131
	Survey 4	13	24.90	30.20	26.45	1.581

Table 4-24: "Before-after I-after III" comparison of 85th percentile speed for sites with mean speed greater than 20 mph "before"

85th percentile speed (mph)	N	Minimum		Maximum	Average	Std. Deviation
>20-25	Survey 1	24	25.9	30.8	27.98	1.38
	Survey 2	24	22.9	28.8	25.78	1.43
	Survey 4	24	23.3	30.0	26.04	1.83
>25-30	Survey 1	52	29.4	36.4	32.74	1.65
	Survey 2	52	24.1	34.1	28.60	2.13
	Survey 4	52	25.9	33.5	29.19	1.96
>30-35	Survey 1	13	33.8	42.4	36.52	2.35
	Survey 2	13	29.1	34.1	31.83	1.77
	Survey 4	13	30.0	35.6	32.47	2.04

Absolute and relative speed changes "before – after I"

The "before-after I" comparison of key descriptive statistics in the previous sub-section explicitly showed that the extent of the speed change after the introduction of the 20mph limit is dependent on the speed patterns "before". To better understand the relative change in mean speeds after the introduction of the 20mph intervention considering the mean speed "before" as a baseline, Figure 4-3 provides a graphical overview of speed changes "before-after I" in absolute and percentage terms. The horizontal axis shows the mean speed "before" for each site, from the lowest to the highest value, whereas the speed reductions "after I" in absolute (mph) and percentage terms (compared to "before" mean speed) are provided on the left and right vertical axis, respectively. A clear pattern can be drawn from the Figure 4-3: the higher is the mean speed "before", the greater is the speed reduction "after I". In particular, the majority of sites with "before" mean speeds lower than 25 mph result in speed reductions up to 10%. Whereas most of the sites with "before" mean speeds greater than 27 mph result in "after I" speed reductions that exceed 10%, and in some cases, such speed reductions are close to 25%, always compared to mean speeds "before".

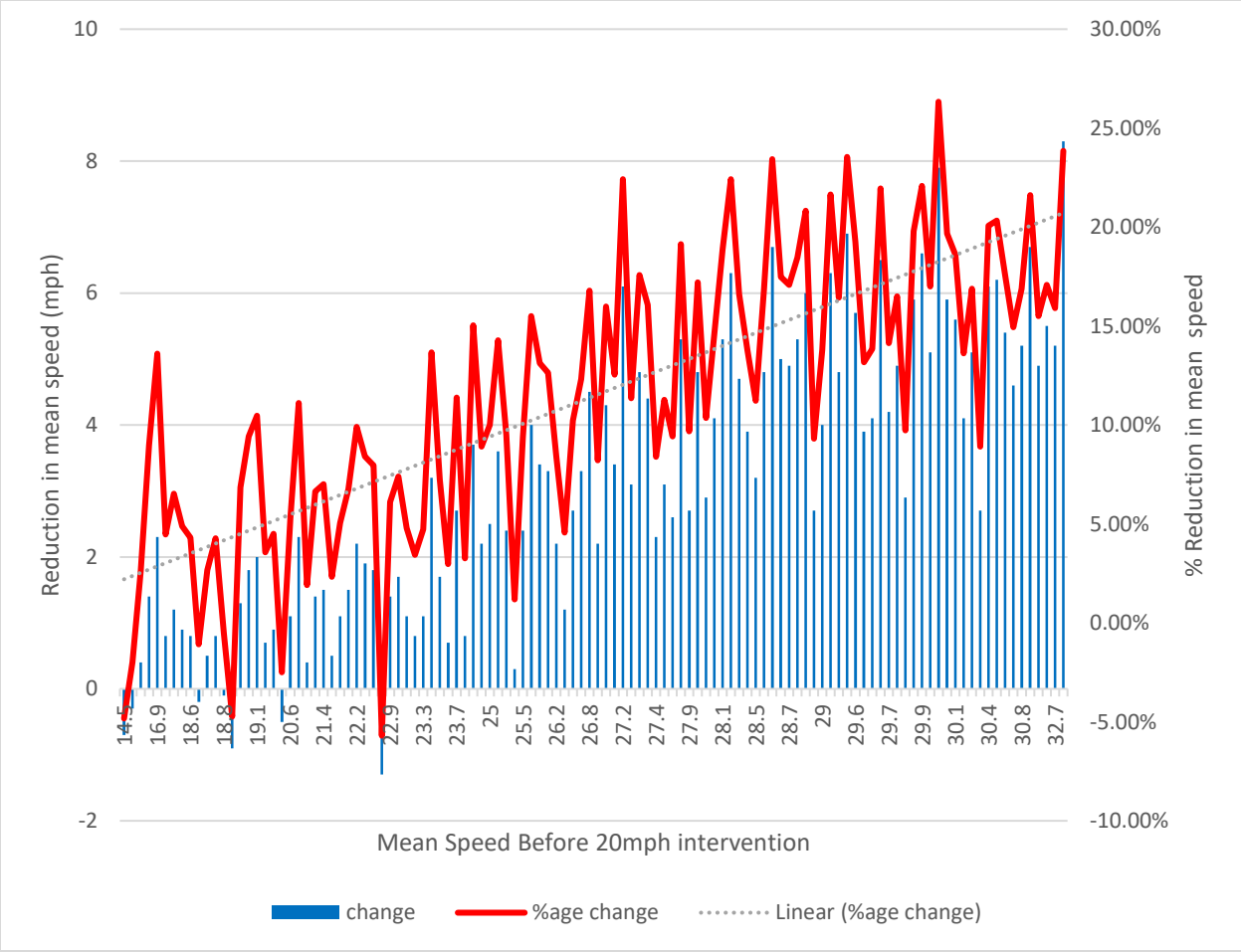


Figure 4-3: Absolute and relative speed changes "after I" compared to mean speed "before"

Table 4-25: Difference in mean speed per speed band

Speed band (mph)	Before	After I	Average difference
0-20	18.06	17.41	-0.66
>20-25	22.69	21.19	-1.50
>25-30	27.99	23.75	-4.25
>30-35	31.15	25.76	-5.40
Total*	25.45	22.28	-3.17

* Note that the values in the last row indicate the total average speed computed across all sites regardless of the speed band where each site belongs.

The pattern observed in Figure 4-3, is also consistent with the key differences in mean speeds calculated per speed band, as discussed in the previous sub-section. These are outlined in the Table 4-25, which summarises the mean speed per band and the associated differences "before" and "after I". It is evident that the speed reductions are minimal for the 0-20 mph band, and become

larger for higher speed ranges, with the most pronounced reductions being evident for the >30-35 mph range.

Absolute and relative speed changes "before – after I – after II"

Figure 4-4 offers a comprehensive, graphical overview of absolute and relative speed changes "before-after I", "before-after II", "after I-after II" for sites with commonly available data across the three survey waves (Survey 1, 2 & 3). The findings can be summarised as follows:

- The "before-after I" comparison shows that speed reductions are observed for almost all sites, with larger reductions being observed in sites with higher mean speeds "before".
- The "before–after II" comparison shows similar patterns with the "before-after I" comparison in terms of observed speed changes. Specifically, for sites with mean speed "before" lower than 25 mph, speed reductions are mostly observed but to a relatively lower extent. For sites with mean speed "before" greater than 25 mph, significant decreases are observed for the vast majority of sites, either in terms of absolute or percentage values.
- The "after I-after II" shows minor fluctuations across almost all sites. For some sites, slight increases are observed (speed increases are denoted by negative values in the vertical axis of the graph), whereas for other sites slight reductions (on the top of those identified in "after I" compared to "before") are evident. However, the overall trend shows that such speed changes are quite small spreading around zero, hence the relative stability of speed values between Survey 2 and Survey 3, which was inferred from the descriptive statistics analysis. Furthermore, as "before" mean speeds increase, the range of such fluctuations becomes smaller and approaches the zero.

The speed change patterns, presented by the "before-after I- after II" comparison, are consistent with the key differences per speed band, which were identified in the descriptive statistics analysis and are also summarised in the Table 4-26.

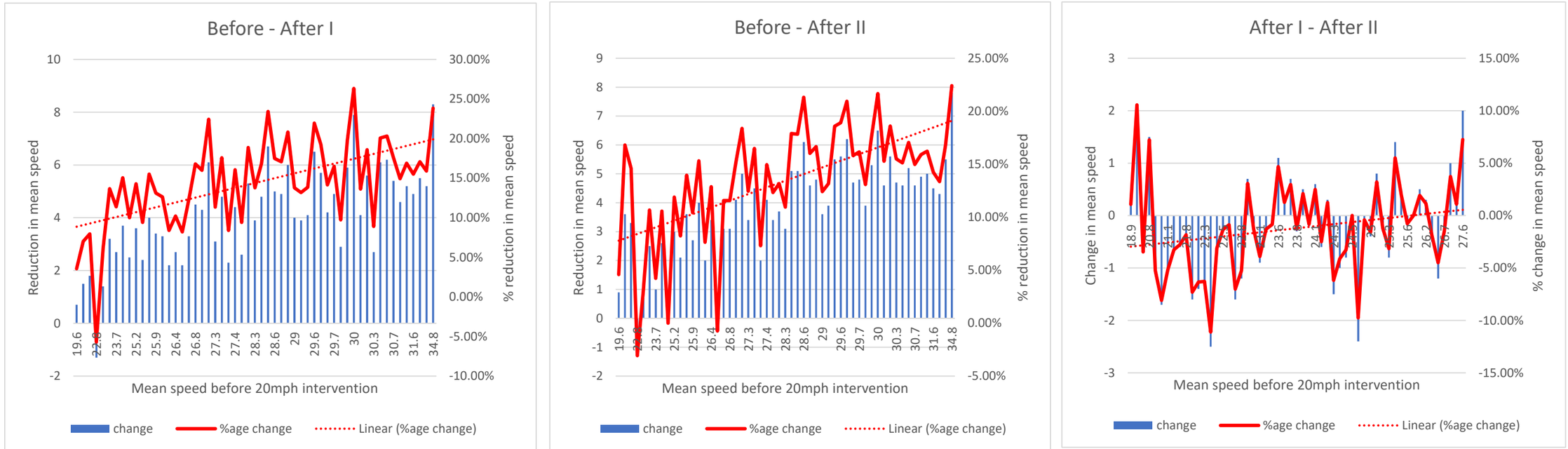


Figure 4-4:Absolute and relative speed changes “after I” compared to mean speed “before”, “after II” compared to mean speed “before”, and “after II” compared to mean speed “after I”

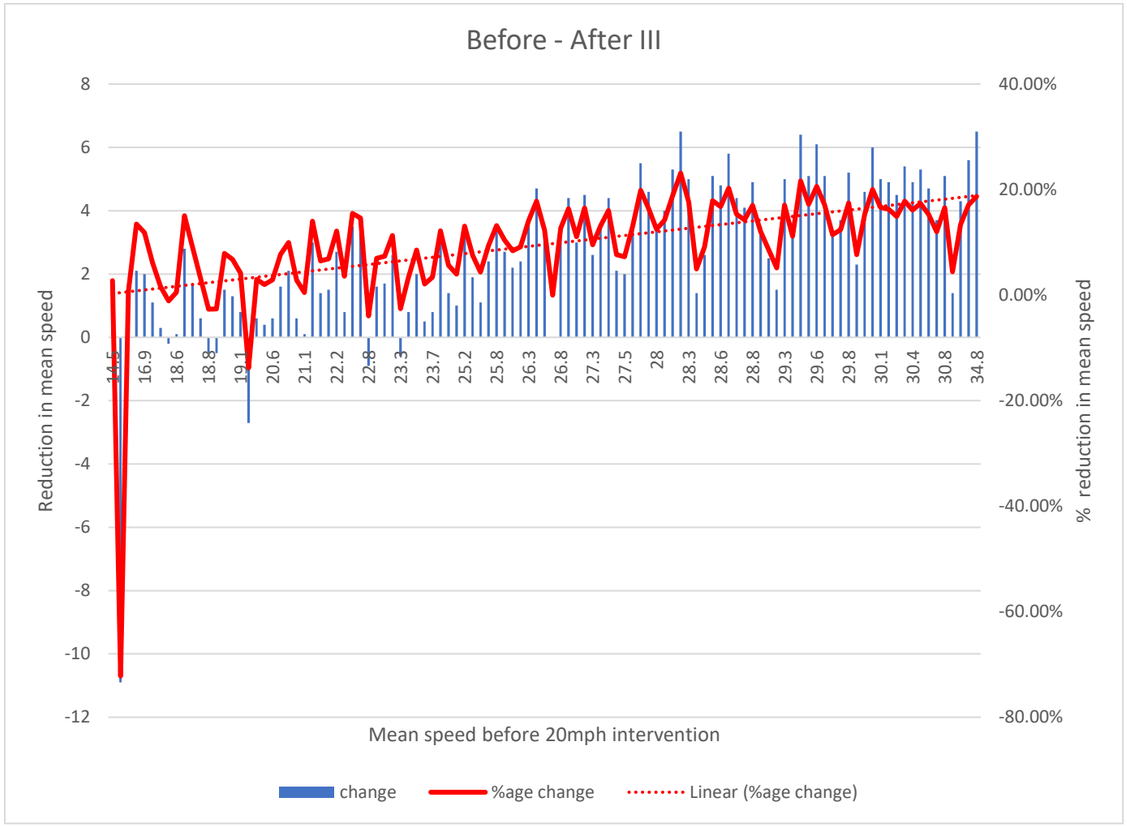
Table 4-26: Difference in mean speed per speed band for “before-after I”, “before-after II”, and “after I-after II”.

Speed range	Survey 1	Survey 2	Average difference
0-20	19.600	18.900	-0.70
>20-25	23.300	21.363	-1.94
>25-30	27.906	23.618	-4.29
>30-35	31.250	25.933	-5.32
Total*	27.815	23.709	-4.11

Speed range	Survey 1	Survey 3	Average difference
0-20	19.600	18.700	-0.90
>20-25	23.300	21.675	-1.63
>25-30	27.906	23.912	-3.99
>30-35	31.250	26.142	-5.11
Total*	27.815	23.978	-3.84

Speed range	Survey 2	Survey 3	Average difference
0-20	18.900	18.700	-0.20
>20-25	21.363	21.675	0.31
>25-30	23.618	23.912	0.29
>30-35	25.933	26.142	0.21
Total*	23.709	23.978	0.27

* Note that the values in the last row indicates the total average speeds computed across all sites regardless of the speed band where each site belongs to.



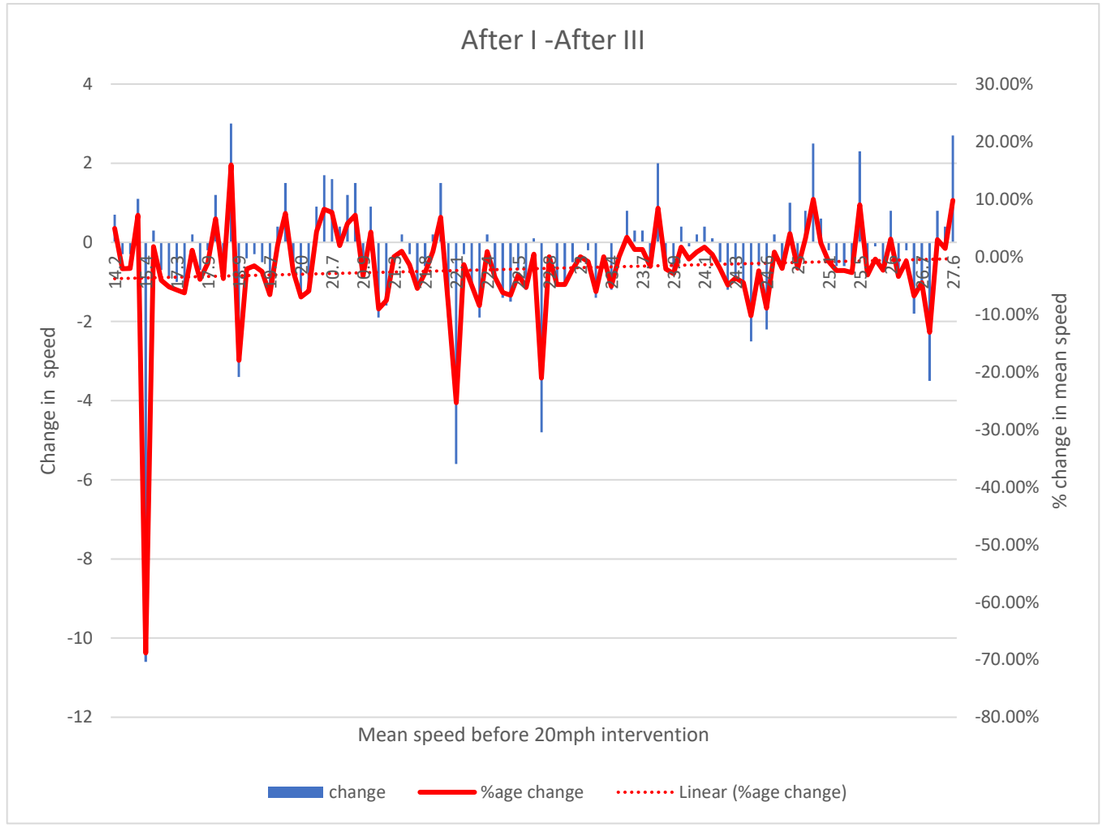


Figure 4-5: Absolute and relative speed changes “after III” compared to mean speed “before” and “after III” compared to mean speed “after I”

Table 4-27: Series of speed difference per band for Survey 1 vs Survey 2 vs Survey 4

Speed range	Survey 1	Survey 4	Average difference
0-20	18.060	18.010	-0.05
>20-25	22.579	21.117	-1.46
>25-30	27.938	24.171	-3.77
>30-35	31.169	26.454	-4.72
Total*	25.331	22.640	-2.69

*Note that the values in the last row indicates the total average speed computed across all sites regardless of the speed band where each site belongs.

Speed range	Survey 2	Survey 4	Average difference
0-20	17.405	18.010	0.60
>20-25	21.013	21.117	0.10
>25-30	23.713	24.171	0.46
>30-35	25.869	26.454	0.58
Total*	22.218	22.640	0.42

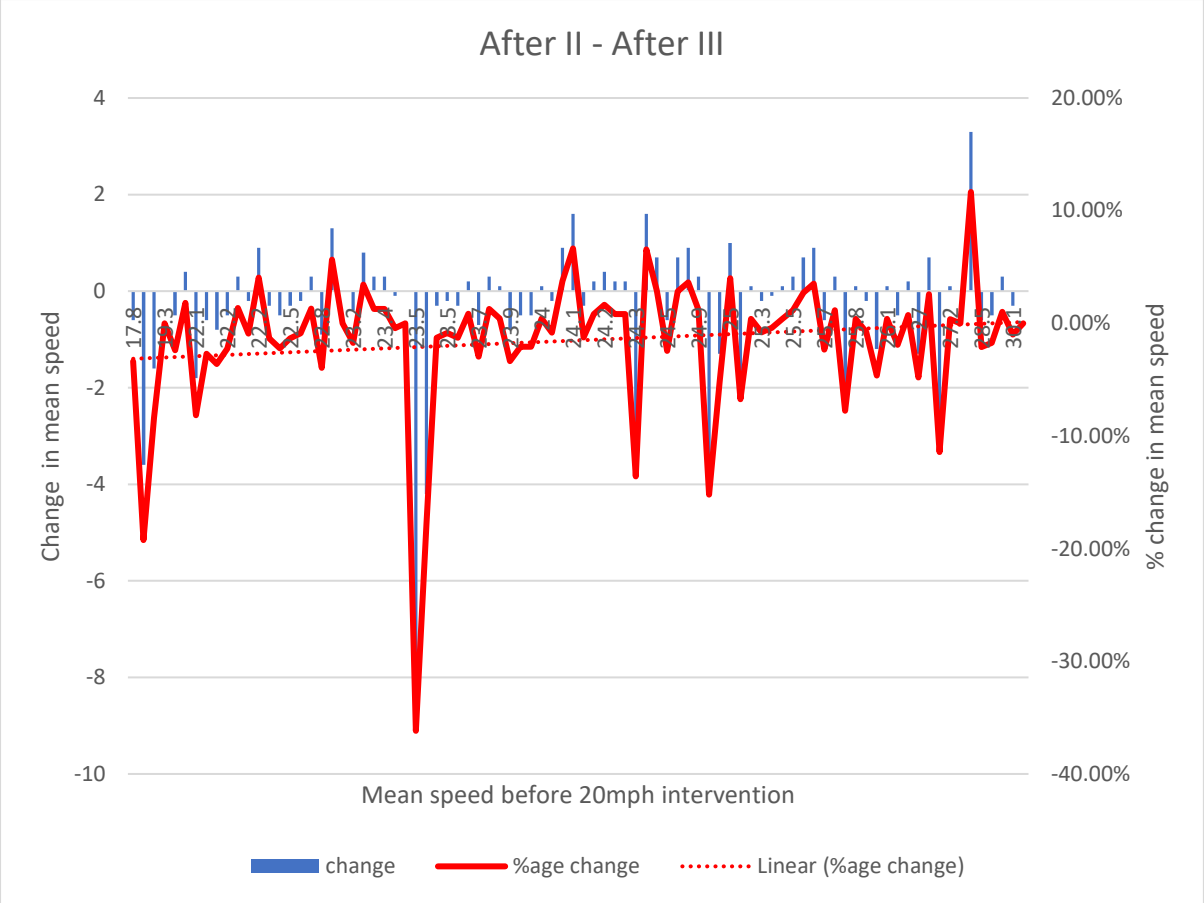


Figure 4-6: Absolute and relative speed changes “after III” compared to mean speed “after II”

Table 4-28: Series of speed difference per band for Survey 1 vs Survey 2 vs Survey 4

Speed range	Survey 3	Survey 4	Average difference
0-20	24.49	25.13	0.64
>20-25	24.47	24.65	0.18
>25-30	24.01	24.21	0.20
>30-35	23.20	23.58	0.38
Total*	24.33	24.67	0.34

*Note that the values in the last row indicate the total average speed computed across all sites regardless of the speed band where each site belongs to.

Figure 4-5 offers a comprehensive, graphical overview of absolute and relative speed changes “before-after III”, and “after I-after III” for sites with available data across Survey 1, 2 & 4. Figure 4-6 provides the same graph but for “after II-after III”. The findings can be outlined as:

- Mean speed reductions are observed in “after III” compared to “before” for almost all sites. As in the “before-after I” and “before-after II” comparisons, reductions are relatively larger at sites having mean speeds “before” greater than 25 mph.

- The “after I-after III” and “after II- after III” comparisons overall show that mean speeds exhibit stable trends after the introduction of the 20mph speed limit, with mild fluctuations being observed. However, such fluctuations (reflecting either increases or decreases of speed) are lower than 1 mph for the majority of sites; for example, the average difference between mean speeds in Survey 3 and Survey 4 is 0.34 mph.

4.1.4 Traffic volumes and distribution by mean speed band

The following pie charts provide the proportions of vehicles per range of mean speed across the various survey waves. Figure 4-7 shows that in Survey 1 ("before"), more than 70% of vehicles employ speeds in the range of >25-30 mph, whereas 14.1% of vehicles are associated with speed greater than 30 mph. However, this distribution drastically changes in Survey 2 ("after I"), where the vast majority of vehicles (78.5%) are associated with the speed band >20-25 mph, whereas the percentage of vehicles belonging to the >25-30 mph in Survey 2 drops to just 16.4%, as shown in Figure 4-8. Survey 3 showed a similar shift with Survey 2, as the percentage for the >20-25 mph band stands at 67.61%, as shown in Figure 4-9a. In Survey 4 (as shown in Figure 4-9b), a significant increase in the proportion of vehicles with speed in the range 0-20 mph is observed (compared to all previous survey waves), which is also accompanied by an increase in the proportion of vehicles with speed greater than 25 mph (compared to Survey 2).

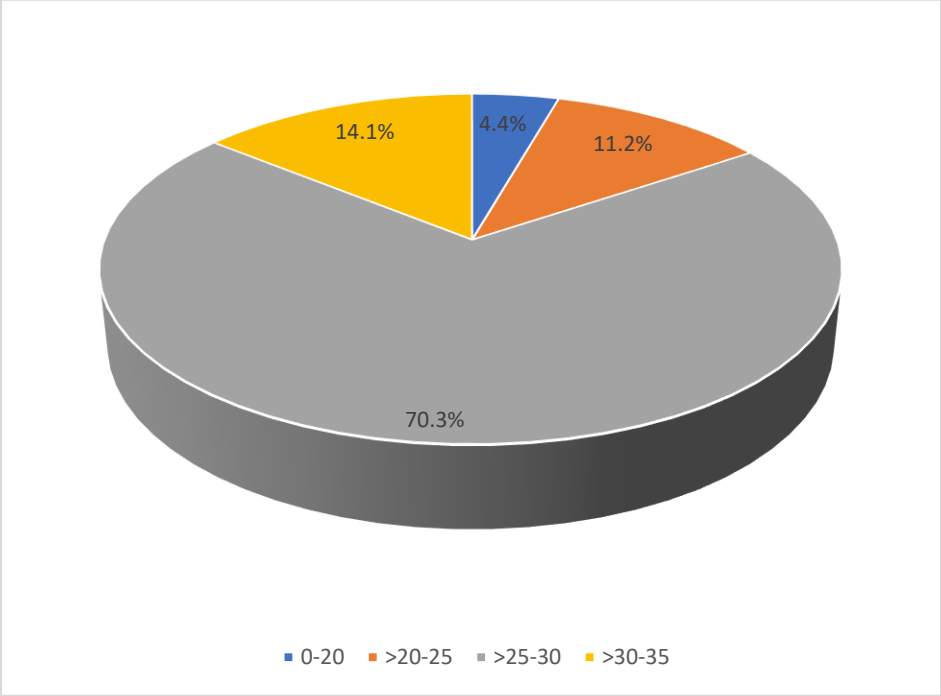


Figure 4-7: Percentage of vehicles by range of mean speed in Survey 1

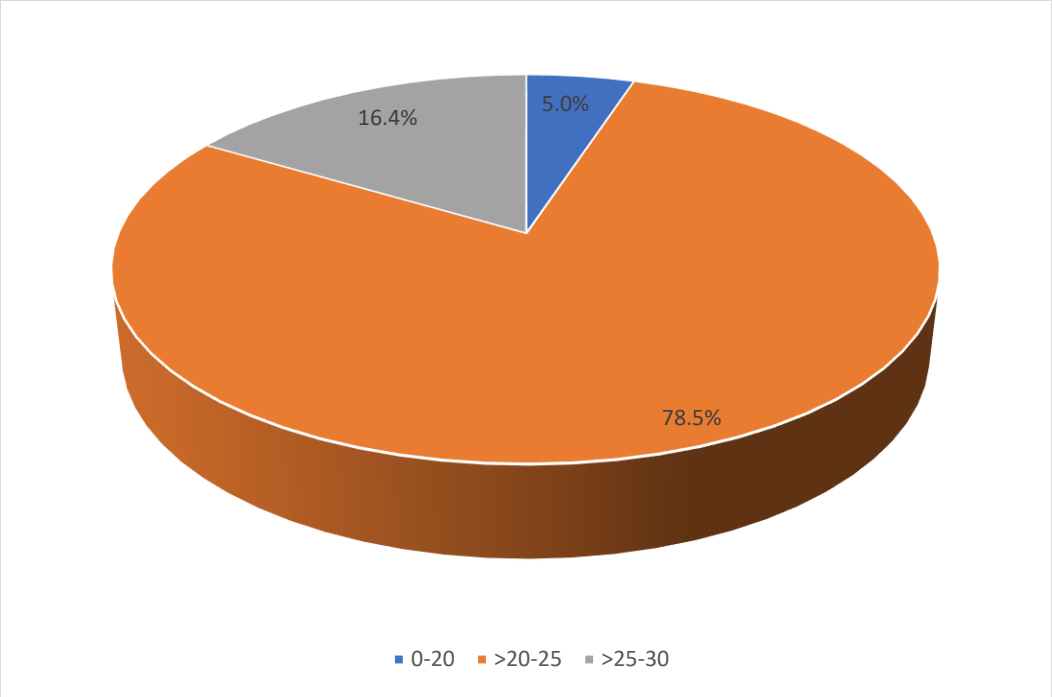


Figure 4-8: Percentage of vehicles by range of mean speed in Survey 2

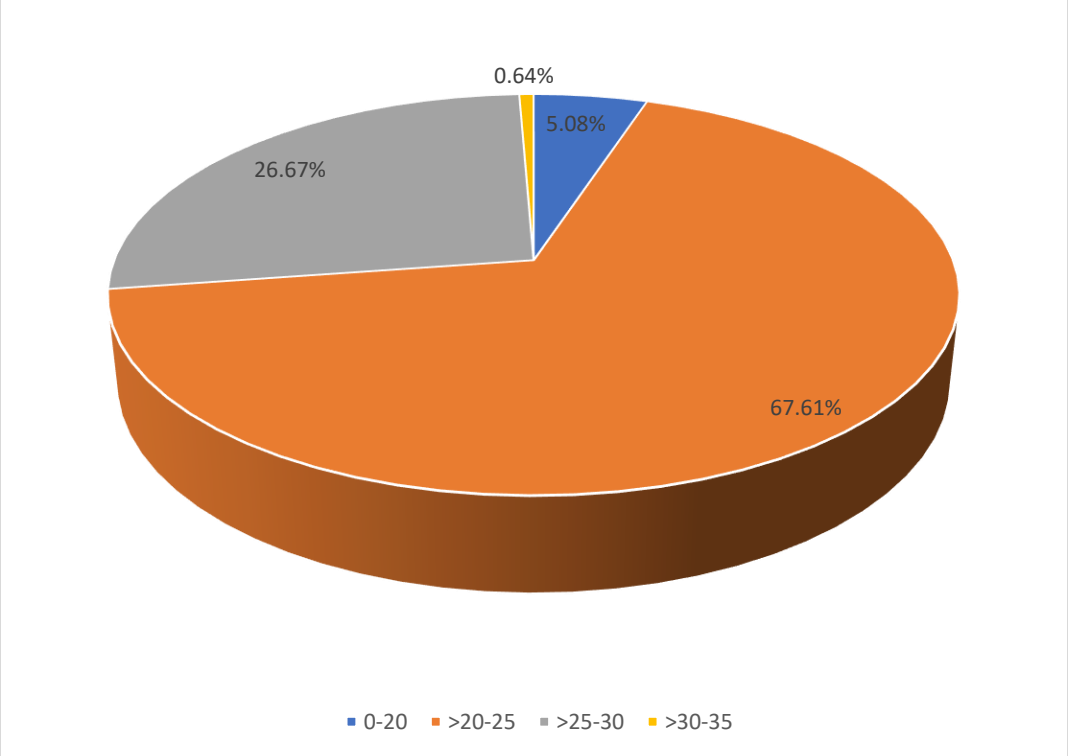


Figure 4-9a: Percentage of vehicles by range of mean speed in Survey 3

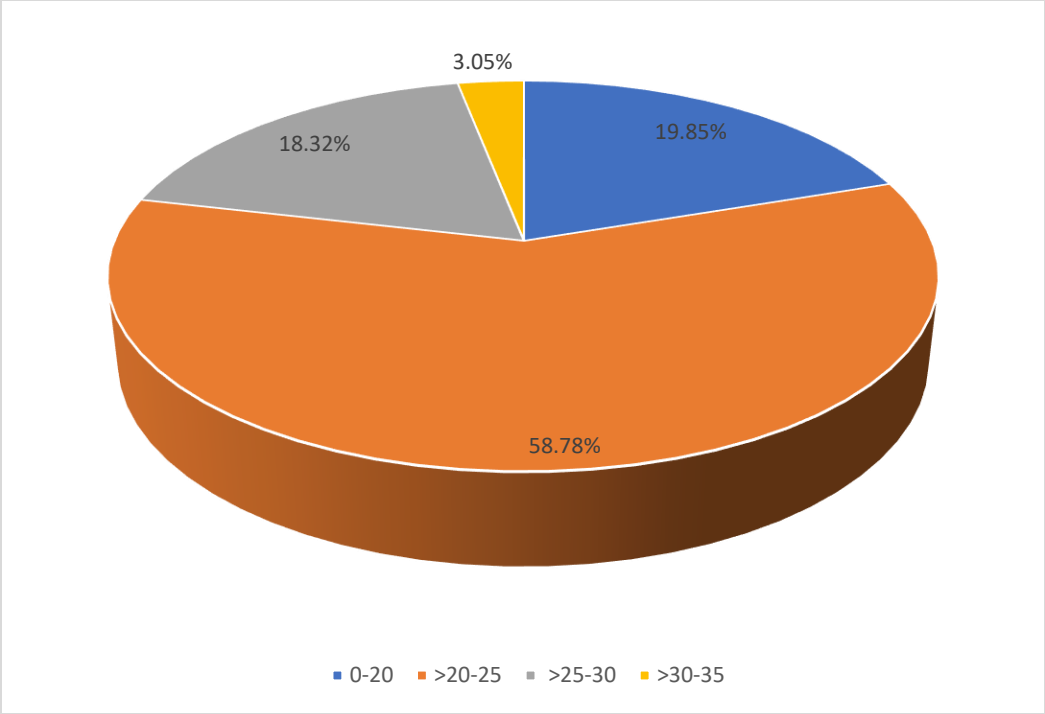


Figure 4-9b: Percentage of vehicles by range of mean speed in Survey 4

To also control for potential variations in the traffic composition "before-after I-after II" in the process of evaluation, we also explored the percentage distribution of traffic by vehicle class across the survey waves; the distribution of vehicle class proportions is presented in the Figure 4-10. Overall, no major variations are observed across survey waves, with the compact car or light goods vehicle class (Car/LGV) representing approximately 88% of traffic volume in all survey waves.

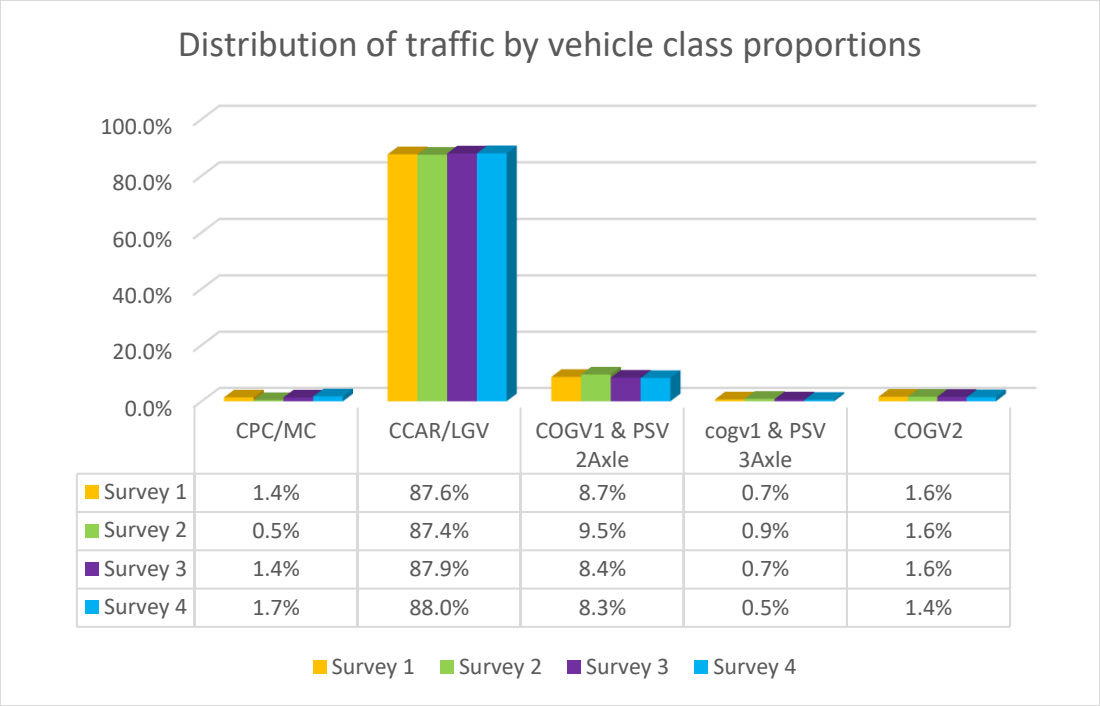


Figure 4-10: Vehicle class distribution in Survey 1, Survey 2, Survey 3 and Survey 4[2]

4.1.5 Percentage of vehicles with speed over PSL, ACPO and DFT

As discussed earlier, to offer insights into the extent of speeding behaviors across all survey waves (before and after the 20mph trial), percentages of vehicles exceeding various speeding thresholds are also investigated. These speeding thresholds are the Posted Speed Limit (PSL), the speed threshold employed by the Association of Chief Police Officers (ACPO), and the Department for Transport (DfT) threshold. The following Tables provide the descriptive statistics for each of these speeding metrics across all survey waves.

[2] PC/MC – Pedal cycle/Motorcycle; CAR/LGV – Car/Light goods vehicle; OGV1 & PSV 2AXLE - Other goods vehicle 1 & Public service vehicle (2-axle rigid vehicles); OGV1 & PSV 3AXLE - Other goods vehicle 1 & Public service vehicle (3-axle rigid vehicles); OGV2 - Other goods vehicle 2 (4-axle rigid vehicles and articulated vehicles with any number of axles)

Descriptive statistics for percentages of vehicles with speed over PSL

Survey 1 vs Survey 2

Table 4-29: Descriptive statistics for proportion of vehicles over PSL "before-after I"

>PSL	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	115	0	0.722	0.252	0.197
Survey 2	117	0.025	0.933	0.651	0.231

Survey 1 vs Survey 2 vs Survey 3

Table 4-30: Descriptive statistics for proportion of vehicles over PSL "before-after I-after II"

>PSL	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	55	0.03	0.72	0.34	0.180
Survey 2	55	0.10	0.93	0.76	0.151
Survey 3	55	0.39	0.98	0.79	0.120

Survey 1 vs Survey 2 vs Survey 4

Table 4-31: Descriptive statistics for proportion of vehicles over PSL "before-after I-after III"

>PSL	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	109	0.00	0.72	0.25	0.198
Survey 2	109	0.02	0.93	0.64	0.234
Survey 4	109	0.01	0.98	0.68	0.232

Overall, in Survey 1 (where the posted speed limit was 30 mph), more than 25% of vehicles were found with speeds exceeding the posted speed limit. This proportion is found to increase in Survey 2 (where the posted speed limit was 20 mph), with more than 65% of vehicles being observed to exceed the speed limit. In Survey 3 (where the focus of the analysis is on sites with available data across all survey waves), the average percentage of vehicles exceeding the PSL is quite similar to Survey 2. In Survey 4, and using data from 109 sites, the percentage of vehicles exceeding the PSL does not significantly vary from Survey 2, with 68% of vehicles (on average) having speeds over the PSL. The proportion of vehicles exceeding the 20mph speed limit in Survey 2 and 4 are significantly lower compared to the figures published by the DfT for 2020, where approximately 87% of cars exceeded the 20mph speed limit, but in "through routes", where free-flow conditions are more likely to be observed (Department for Transport, 2021).

Although there have been few studies of 20mph speed limits in rural locations there was a significant endeavour undertaken in Scotland in the context of trial which commenced in 1998. This involved 27 Councils across 75 sites and in addition 8 sites where detailed evaluations including interviews with residents and Councillors were undertaken (Burns et al., 2001). The report noted that 'The underlying reason for the trial is that slower speeds reduce accident rates and severity'. The percentage change motor vehicles exceeding 20mph was similar with the Scottish Borders trial in this earlier, pioneering study. The authors of this 2001 study reported that in terms of change in speed after implementation of the 20mph limits, the study found that the percentage of vehicles travelling at over 20mph fell from 68% in the 'Before' period to 62% in the 'After' period. At 46% of the sites, the average speed in the After period was below 20mph compared to 32% of sites in the Before period.

However, of note is that the 75 sites were distributed across Scotland and so there was no potential for a 'synergetic' effect whereby drivers travelling through a 20mph limit in 2001 would likely then travel into another 20mph speed limit area in a nearby settlement. This makes comparison in this regard significantly different in that if driving across the Scottish Borders Council area in 2021 the likelihood of entering into a second or third 20mph speed limit area will be much greater and therefore drivers will be much more exposed and potentially normalised to 20mph speed limits.

Descriptive statistics for percentages of vehicles with speed over the ACPO threshold

Survey 1 vs Survey 2

Table 4-32: Descriptive statistics for proportion of vehicles with speed over the ACPO threshold "before-after I"

>ACPO	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	115	0	0.379	0.067	0.076
Survey 2	117	0.002	0.688	0.338	0.150

Table 4-33: Sites with the highest proportions of speed over the ACPO threshold in Survey 1

Site Number	Location	Survey 1
120	Auchencrow	0.379
106	Traquair	0.321
8	Peebles (Kingsmeadows Rd)	0.299

Table 4-34: Sites with the highest proportions of speed over the ACPO threshold in Survey 2

Site Number	Location	Survey 1	Survey 2
8	Peebles (Kingsmeadows Rd)	0.299	0.688
77	Cove	0.147	0.677
21	Jedburgh (Oxnam Rd)	0.032	0.628

While the percentage of vehicles with speeds over PSL can inform about the overall patterns of speeding behavior, it cannot offer granular insights into the extent of speeding behaviour. The descriptive statistics for the percentage of vehicles exceeding the ACPO threshold) can offer information targeted at more severe speeding patterns. Table 4-32 shows that an increase in the percentage of vehicles exceeding the ACPO threshold is observed in Survey 2, when compared to the pre-trial level. As shown in Table 4-34, for some sites, the percentages of vehicles over the ACPO threshold are greater than 60%. For example, Tables 4-33 and 4-34 show that the site on Kingsmeadows Rd at Peebles is one of the locations with persistent speeding patterns before and after the 20mph trial, as the percentage of vehicles over the ACPO threshold climbed from almost 30% ("before") to 68.8% ("after I"). However, it should be also noted that this is a location exhibiting high speed patterns before the 20mph intervention, and it was also associated with major reductions for both mean and 85th percentile speeds after the introduction of the 20mph speed limit; in particular, the mean speed decreased by 5.4 mph in Survey 2 (compared to Survey 1), whereas the 85th percentile speed decreased by 5.7 mph.

Survey 1 vs Survey 2 vs Survey 3

Table 4-35: Descriptive statistics for proportion of vehicles with speed over the ACPO threshold "before-after I-after II"

>ACPO	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	55	0.00	0.38	0.09	0.082
Survey 2	55	0.02	0.69	0.41	0.156
Survey 3	55	0.12	0.89	0.48	0.161

Table 4-36: Sites with the highest proportions of speed over the ACPO threshold for Survey 3

Site Number	Location	Survey 1	Survey 2	Survey 3
50	Dingleton Road, Melrose	0.000	0.017	0.658
08	Kingsmeadow Road, Peebles	0.298	0.688	0.641
110	Tweedbank Drive, Tweedbank	0.030	0.341	0.602

Similar patterns are observed when comparing the proportions of vehicles exceeding the ACPO threshold "before-after I-after II", as shown in the Table 4-35. In Survey 3, the average percentage of vehicles over the ACPO threshold is similar to that for Survey 2, showing increasing trends (from 41% to 48%) though. Table 4-36 illustrates the sites with the highest percentages in Survey 3; the site on Kingsmeadow Road at Peebles continues to be one of the sites exhibiting significant speeding patterns, thus confirming the relevant findings from the analysis of data in Survey 1 and 2.

Survey 1 vs Survey 2 vs Survey 4

Table 4-37: Descriptive statistics for proportion of vehicles with speed over the ACPO threshold "before-after I-after III"

>ACPO	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	109	0.00	0.38	0.07	0.076
Survey 2	109	0.00	0.69	0.33	0.187
Survey 4	109	0.00	0.89	0.38	0.209

As shown in Table 4-37, in Survey 4, the percentage of vehicles exceeding the ACPO threshold (38%) is quite similar to that for Survey 2 (33%). However, both percentages are higher compared to the "before" levels (7%). Overall, the introduction of the 20mph speed limit seems to bear increases in the proportions of vehicles with speeds exceeding the ACPO threshold across all "after" survey waves. However, such increases are expected given the reduction of the speed limit from 30mph to 20mph; similar shifts in these metrics post-intervention are documented in relevant literature related to the implementation of 20mph schemes (Maher, 2018).

Descriptive statistics for percentage of vehicles with speeds over the DfT threshold

Survey 1 vs Survey 2

Table 4-38: Descriptive statistics for proportion of vehicles with speed over the DfT threshold "before-after I"

>DfT	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	115	0.00	0.11	0.004	0.012
Survey 2	117	0.00	0.13	0.024	0.031

Survey 1 vs Survey 2 vs Survey 3

Table 4-39: Descriptive statistics for proportion of vehicles with speed over the DfT threshold "before-after I-after II"

>DfT	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	55	0.00	0.11	0.01	0.015
Survey 2	55	0.00	0.13	0.03	0.035
Survey 3	55	0.00	0.17	0.04	0.039

Survey 1 vs Survey 2 vs Survey 4

Table 4-40: Descriptive statistics for proportion of vehicles with speed over the DfT threshold "before-after I-after III"

>DFT	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	109	0.00	0.11	0.0004	0.012
Survey 2	109	0.00	0.13	0.02	0.031
Survey 4	109	0.00	0.17	0.03	0.037

The percentage of vehicles with speed exceeding the DfT threshold is a metric that can show the extent of occurrence of serious speeding violations. As shown from Tables 4-38 to 4-40, and in line with the findings of the PSL and ACPO analysis, the percentage of vehicles exceeding the DfT speed threshold is extremely low in Survey 1 (almost 0.4%), whereas it increases in Survey 2, and becomes equal to 2.4%. In Survey 4, the percentage of vehicles with speeds exceeding the DfT threshold is higher than pre-intervention, but it remains at very low levels, being approximately equal to 3%. It should be highlighted that the specific threshold in Survey 1 (where the speed limit was 30mph) was 45mph, whereas in Surveys 2, 3, and 4 (where the speed limit was 20mph), the specific threshold was 35mph.

4.2 Distribution of speed metrics by key site attributes

This section evaluates the impact of the 20mph trial on distributions of speed metrics by focusing on key attributes of locations where the intervention took place, such as the local area, settlement type, school presence, as well as on temporal factors, such as day-of-the week and time-of-the day.

4.2.1 Speed distribution by local area

The impact of the 20mph trial on vehicle speeds in five local areas of the Scottish Borders, i.e., Tweeddale, Cheviot, Eildon, Teviot and Liddesdales, and Berwickshire is explored using the mean and 85th percentile speed distributions. In particular, we aggregated the sites belonging in each of these local areas to identify whether there are any notable spatial variations in the distributions of these key speed metrics before and after the introduction of the 20mph speed limit.

The mean speed distributions in Survey 1 ("before") and Survey 2 ("after I"), as shown in Figure 4-11, show that the "before" mean speed is clustered around higher speed bands across all local areas, and particular around the speed band >25 -30 mph. However, Figure 4-12 shows that "after I" mean speeds tend to be associated with lower speed bands, with the most pronounced clustering of sites being observed around the speed band >20-25 mph. Sites in Teviot and Liddesdale exhibit the highest proportion in this speed band with 80.0%, Cheviot has a proportion of 43.5%, and Tweeddale yields a proportion of 70%. These results indicate a significant impact of the intervention across all the local areas in the "after I" period, as a major transition of mean speeds is confirmed from higher to lower speed bands, and particularly, from the >25-30 mph band to the >20-25 mph speed band. In addition, an increase in the "after I" proportions of sites with mean speed in the band 0-20 mph, as compared to the "before" proportions, is also noticed for Cheviot, Eildon, Berwickshire and Teviot & Liddesdale.

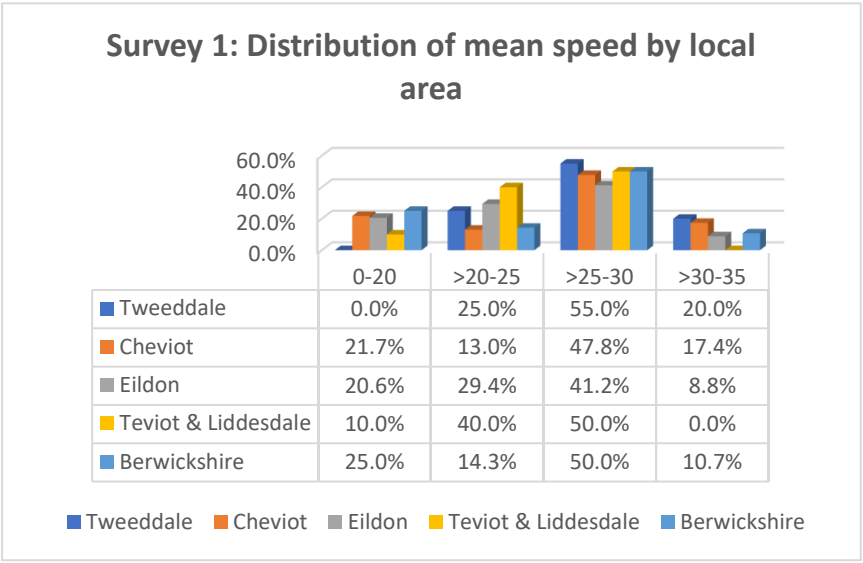
Similarly, for the 85th percentile speed, the distributions of Survey 1 ("before") and Survey 2 ("after I") in Figure 4-12 show that the "before" 85^{th} percentile speeds in all local areas are associated with higher speed bands, and especially with the >30-35 mph, with Teviot and Liddesdales having a proportion of 50.0%, Cheviot 8.7%, Tweeddale 25%, and Eildon 35.3%. However, Figure 4-12 shows that the "after I" 85^{th} percentile speeds exhibit significant reductions, with a clustering of sites being observed in the speed band >25-30 mph. All sites inTeviot and Liddesdale, and 60% of sites in Tweeddale are associated with this speed band "after I". These proportions reflect a considerable drop of the 85^{th} percentile speeds across most of the local areas

"after I", as the transition is clearly towards lower speed bands, showing a significant drop from >30-35 mph to >20-25 mph and >25-30 mph speed bands. The most pronounced shifts in lower 85th percentile speed bands are observed in Berwickshire, Eildon and Teviot & Liddesdale.

Figure 4-13 presents the mean speed distribution of sites with speed data in Survey 1 ("before"), Survey 2 ("after I") and Survey 3 ("after II") across the local areas. The "before" mean speed is relatively clustered around the >25-30 mph (Cheviot 60.0%, Berwickshire 84.6%, Eildon 57.1%) speed bands. Focusing on the "after I" mean speeds, Figure 4-13 shows that the mean speed moves towards the lower bands, as the largest proportions are identified mainly in the speed band >20-25 mph, especially for Berwickshire and Teviot & Liddesdale. In addition, the distribution of mean speeds in the "after II" state shows a propensity towards lower bands, with Berwickshire and Teviot & Liddesdale showing particularly consistent trends between Survey 2 and Survey 3. Overall, the "after II" distribution shows that the vast majority of sites have mean speeds in the >20-25 mph and >25-30 mph speed bands and that there is no local area with sites having mean speeds beyond the >25-30 mph. Cheviot and Tweeddale seem to have the highest proportions in the >25-30 mph band in both "after I" and "after II" states.

Likewise, the distributions for the 85th percentile speeds, which are presented in the Figure 4-14a, show that the "before" state is associated with larger proportions of sites in the higher speed bands. Focusing on the "after II" distribution, all local areas have their majority of sites associated with lower speed bands; Berwickshire, Eildon, and Teviot and Liddesdale exhibit the greatest proportions of 85th percentile speeds in the >25-30 mph, whereas the majority of sites (60%) in Cheviot belong to the >30-35 mph speed band.

In the "after III" state (Survey 4), the distribution of mean speeds (as shown in the Figure 4-14b) shows that for almost all local areas, the majority of sites have mean speeds in the >20-25 mph range, similar with Survey 2. Only for Cheviot, 40.9% of the locations have mean speeds in the range >25-30 mph. With regard to the distribution of 85th percentile speeds, which is presented in the Figure 4-14c, for all local areas (apart from Cheviot), the majority of locations have 85th percentile values in the range >25-30 mph, as in Survey 2, so no major changes were observed.



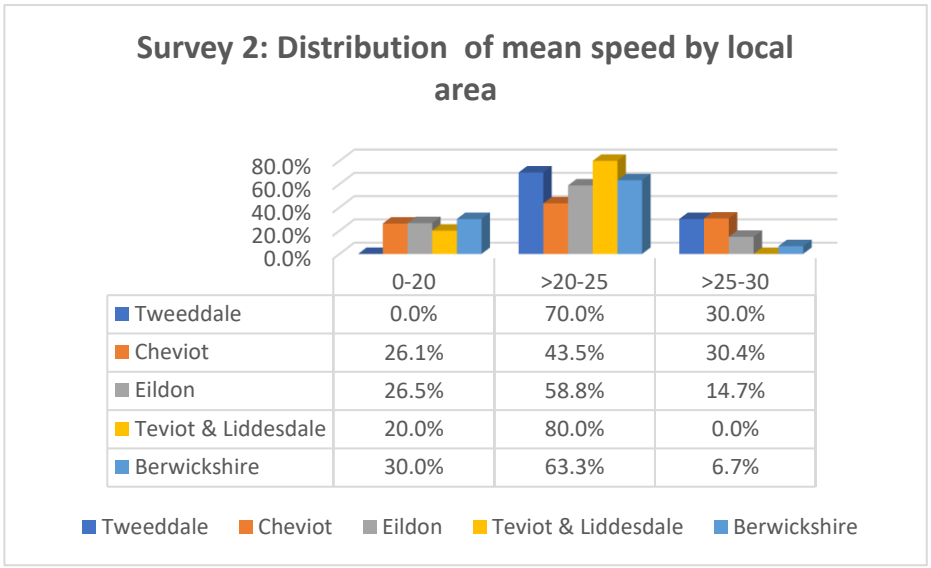
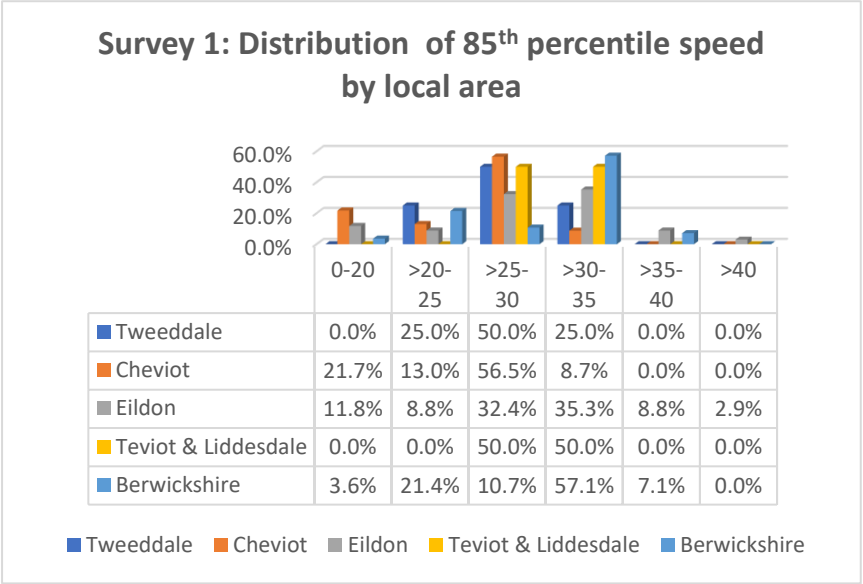


Figure 4-11: Distribution of mean speed by local area in Survey 1 ("before") and Survey 2 ("after I")



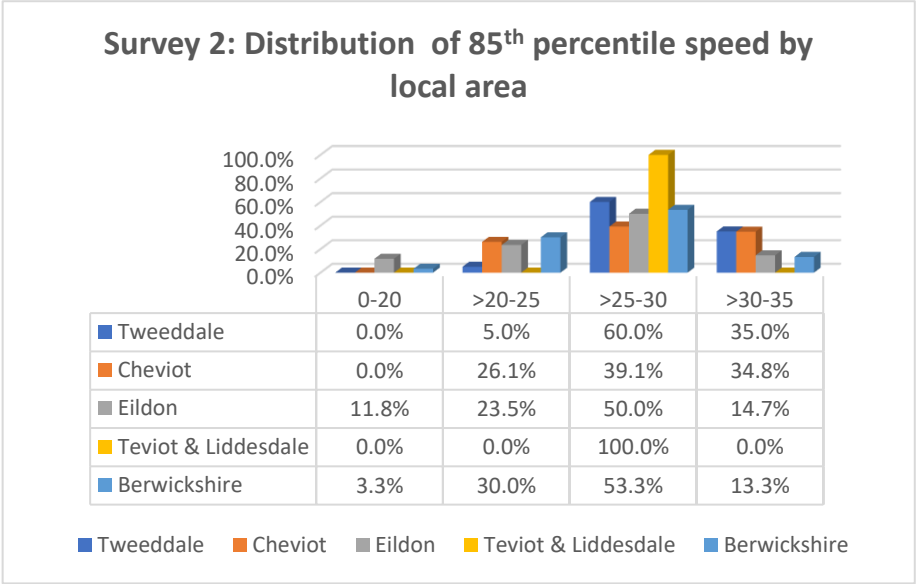


Figure 4-12: Distribution of 85th percentile speed by local area in Survey 1 ("before") and Survey 2 ("after I")

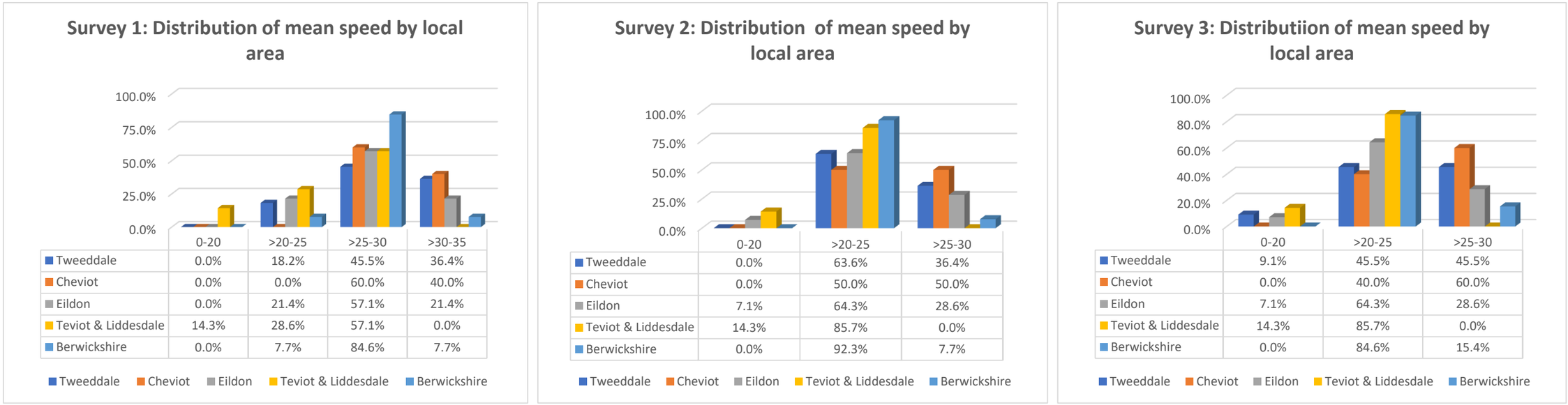


Figure 4-13: Distribution of mean speed by local area in Survey 1 (“before”), Survey 2 (“after I”) and Survey 3 (“after II”)

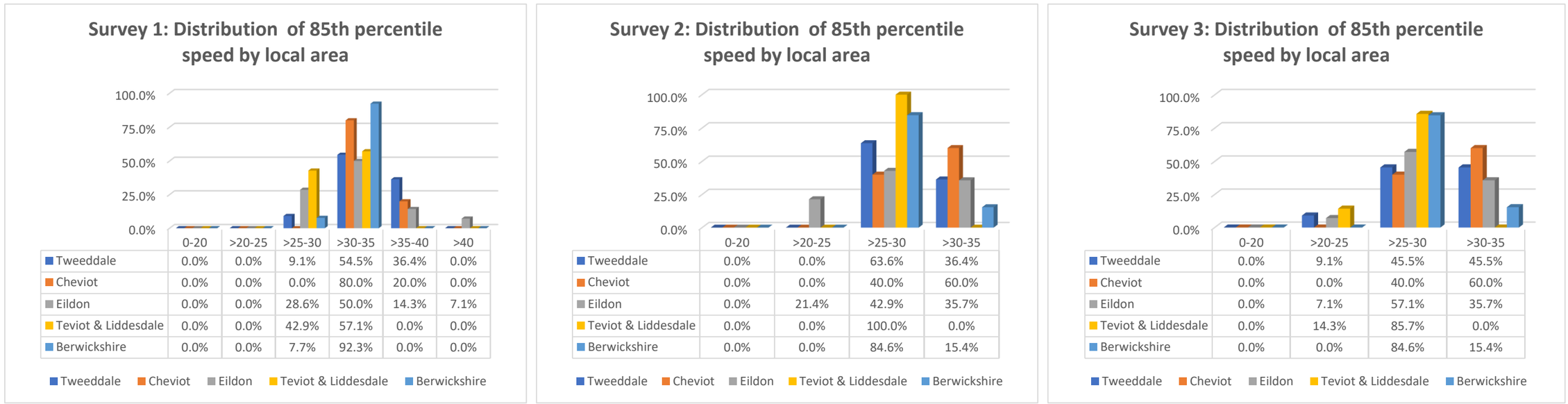
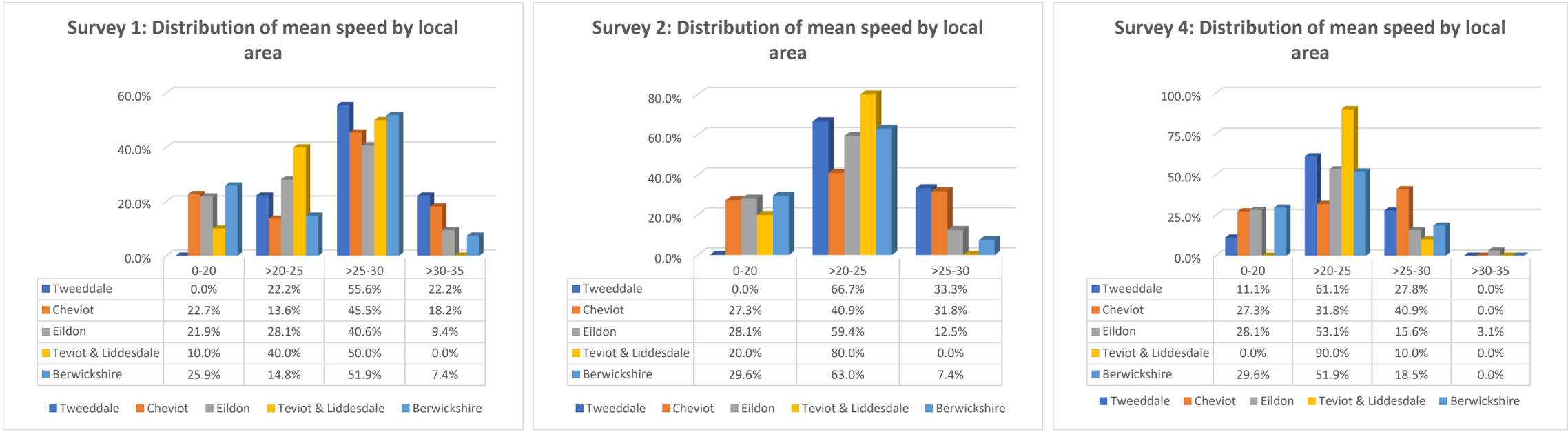


Figure 4-14a:Distribution of 85th percentile speed by local area in Survey 1 (“before”), Survey 2 (“after I”) and Survey 3 (“after II”)

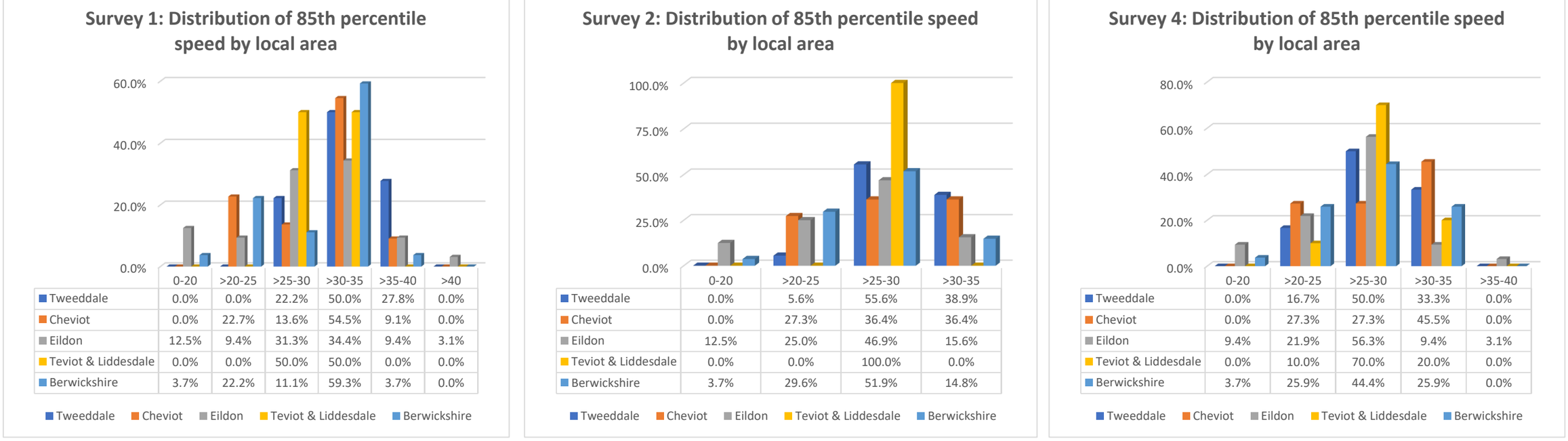


	0-20	>20-25	>25-30	>30-35
Tweeddale	0.0%	22.2%	55.6%	22.2%
Cheviot	22.7%	13.6%	45.5%	18.2%
Eildon	21.9%	28.1%	40.6%	9.4%
Teviot & Liddesdale	10.0%	40.0%	50.0%	0.0%
Berwickshire	25.9%	14.8%	51.9%	7.4%

	0-20	>20-25	>25-30
Tweeddale	0.0%	66.7%	33.3%
Cheviot	27.3%	40.9%	31.8%
Eildon	28.1%	59.4%	12.5%
Teviot & Liddesdale	20.0%	80.0%	0.0%
Berwickshire	29.6%	63.0%	7.4%

	0-20	>20-25	>25-30	>30-35
Tweeddale	11.1%	61.1%	27.8%	0.0%
Cheviot	27.3%	31.8%	40.9%	0.0%
Eildon	28.1%	53.1%	15.6%	3.1%
Teviot & Liddesdale	0.0%	90.0%	10.0%	0.0%
Berwickshire	29.6%	51.9%	18.5%	0.0%

Figure 4-14b: Distribution of mean speed by local area in Survey 1 (“before”), Survey 2 (“after I”) and Survey 4 (“after III”)



	0-20	>20-25	>25-30	>30-35	>35-40	>40
Tweeddale	0.0%	0.0%	22.2%	50.0%	27.8%	0.0%
Cheviot	0.0%	22.7%	13.6%	54.5%	9.1%	0.0%
Eildon	12.5%	9.4%	31.3%	34.4%	9.4%	3.1%
Teviot & Liddesdale	0.0%	0.0%	50.0%	50.0%	0.0%	0.0%
Berwickshire	3.7%	22.2%	11.1%	59.3%	3.7%	0.0%

	0-20	>20-25	>25-30	>30-35
Tweeddale	0.0%	5.6%	55.6%	38.9%
Cheviot	0.0%	27.3%	36.4%	36.4%
Eildon	12.5%	25.0%	46.9%	15.6%
Teviot & Liddesdale	0.0%	0.0%	100.0%	0.0%
Berwickshire	3.7%	29.6%	51.9%	14.8%

	0-20	>20-25	>25-30	>30-35	>35-40
Tweeddale	0.0%	16.7%	50.0%	33.3%	0.0%
Cheviot	0.0%	27.3%	27.3%	45.5%	0.0%
Eildon	9.4%	21.9%	56.3%	9.4%	3.1%
Teviot & Liddesdale	0.0%	10.0%	70.0%	20.0%	0.0%
Berwickshire	3.7%	25.9%	44.4%	25.9%	0.0%

Figure 4-14c: Distribution of 85th percentile speed by local area in Survey 1 (“before”), Survey 2 (“after I”) and Survey 4 (“after III”

4.2.2 Speed distribution by settlement type

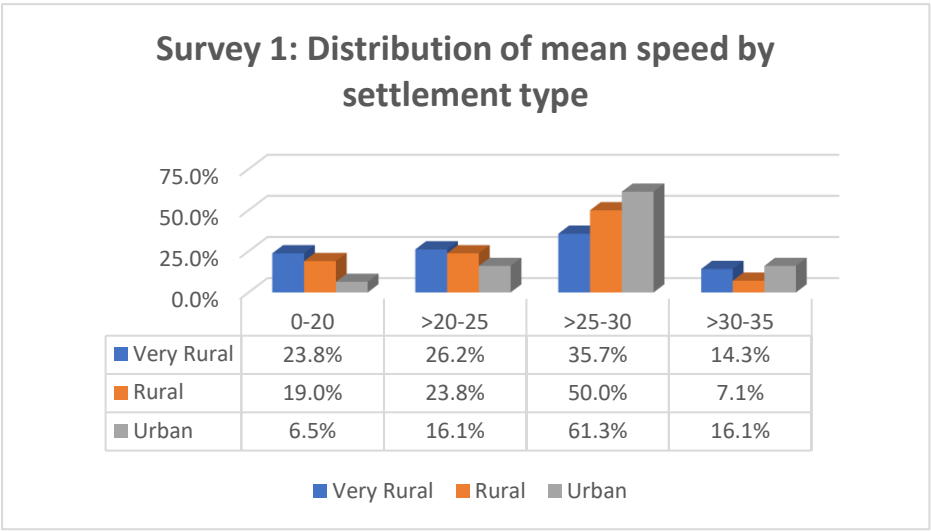
To also account for the potential impact of the settlement type on vehicle speeds before and after the 20mph trial, we also explored the variations in key speed metrics for three different types of settlements, which were defined on the basis of their built environment characteristics: very rural, rural, and urban. Information and guidance about the classification of sites by settlement type was provided by the Scottish Borders Council.

Figure 4-15 presents the mean speed distribution of sites for Survey 1 ("before") and Survey 2 ("after I") by settlement type. For this comparison, 42 sites were identified as very rural, 42 sites were identified as rural, and 31 sites were identified as urban. As expected, most sites in very rural, rural, and urban areas are associated with mean speeds in the band >25-30 mph "before", with the urban sites exhibiting a greater propensity towards this band. The same Figure also shows that the "after I" mean speeds reduce, with rural and urban areas yielding the largest proportions of sites in the >20-25 mph band, whereas the very rural sites have the greatest proportion in the 0-20 mph band (approx. 35%) across all settlement types. Overall, the "before-after I" comparison reflects significant shifts towards lower speed bands for all the settlement types, and such shifts are more evidenced in very rural areas (0-20 mph: before 23.8%, after 39.4%; >20-25 mph: before 26.2%, after 48.8%). Similarly, Figure 4-16 shows the distributions of 85th percentile speeds across settlement types for Survey 1 ("before") and Survey 2 ("after I"). The "before" 85th percentile speeds are clustered in the >25-30 mph band for the urban areas (the corresponding proportion is equal to 61.3%) whereas for very rural and rural areas, the highest proportions of sites belong to a higher band, and particularly to the >30-35 mph band (38.1% and 50%, respectively). In Survey 2, there is clear shift of 85th percentile speeds from higher to lower bands (and particularly towards the >20-25 mph and >25-30 mph bands) for all settlement types. For instance, the "before" proportions of the >25-30 mph band are 23.8% for very rural, 23.8% for rural and 61.3% for urban areas, while the corresponding "after I" proportions for very rural, rural and urban are 41.9%, 55.8% and 71% respectively. The most pronounced shift from the >30-35 mph band to the >25-30 mph band is identified for the rural sites (>25-30 mph: before: 23.8%, after 55.8%; >30-35 mph: before: 50%, after: 18.6%).

Figure 4-17 presents the comparison of the mean speed distributions for Survey 1 ("before"), Survey 2 ("after I") and Survey 3 ("after II"). The "before"-"after I"-"after II" comparison includes

12 very rural sites, 21 rural sites, and 21 urban sites, as 55 sites in total have commonly available data across Survey 1, 2 and 3. As expected, the mode of the "before" mean speed distribution falls in the >25-30 mph band for urban areas (62%), rural areas (71%) and very rural areas (50%). The "after II" distribution of mean speed suggests a significant decline in mean speeds across all settlement types, in a manner similar to the "after I" distribution; specifically, the mode of distributions for urban (67%), rural (62%), and very rural (58%) moves to the >20-25 speed band in Survey 3, suggesting a major shift towards lower speeds in the distribution. A similar distribution of mean speeds is also observed in Survey 4 ("after III"), as shown in Figure 4-18b; 69% of urban settlements and 47.5% of rural and very rural settlements have mean speeds in the >20-25 mph band.

The 85th percentile speed distributions for Survey 1 ("before"), Survey 2 ("after I") and Survey 3 ("after II") across the settlement types are presented in the Figure 4-18a. The mode of the speed distribution "before" in all area types is associated with the >30-35 speed band (71.4% for urban areas, 71.4% for rural areas, 58.3% for very rural areas). In the "after II" speed distribution, the highest proportions of sites are observed in the >25-30 mph band, especially for urban and rural areas. As to the very rural areas, the sites are equally split (50%) between the >25-30 mph and >30-35 mph bands. These results generally imply a significant shift from higher to lower speed bands across all settlement types, as compared to the "before" 85th percentile speed distribution. In the "after III" distribution (as shown in Figure 4-18c), the vast majority of urban settlements have 85th percentile speed in the >25-30 mph speed band, whereas for the rural and very rural settlements, the highest proportion of sites have 85th percentile speed that belongs in the >25-30 mph band too, but with significantly lower proportions compared to the urban areas. For rural areas, the proportion of sites with 85th percentile speeds lower than 25 mph is larger in Survey 4 compared to Survey 2. It should be noted that the "after II" and "after III" proportions in speed bands greater than 35 mph are either zero or very small, showing major reductions compared to "before", where non-negligible proportions of sites had their 85th percentile speed at such bands. Overall, the results suggest that shifts towards lower speed bands are more pronounced in urban areas, especially when focusing on the 85th percentile metric. This finding is anticipated, perhaps due to the impact of more intense traffic patterns on vehicle speeds in urban areas (Pantangi et al., 2020).



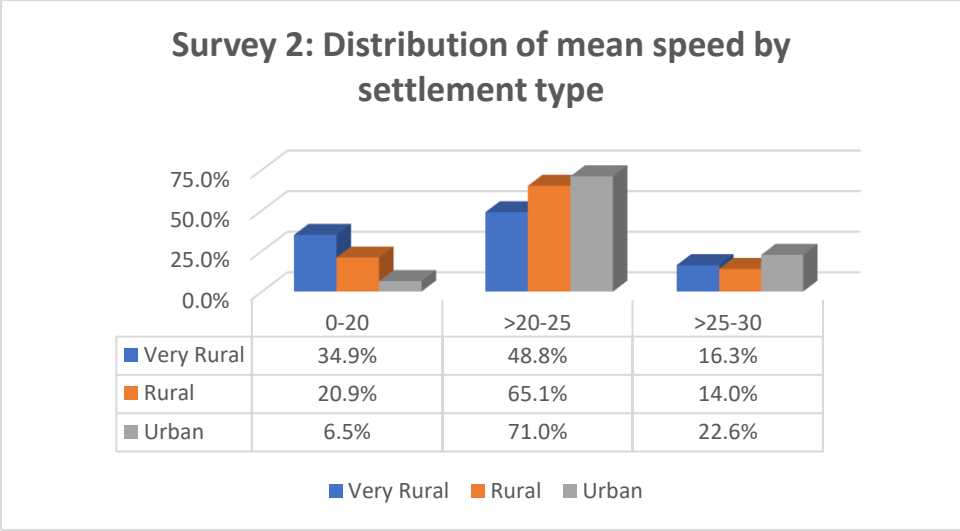
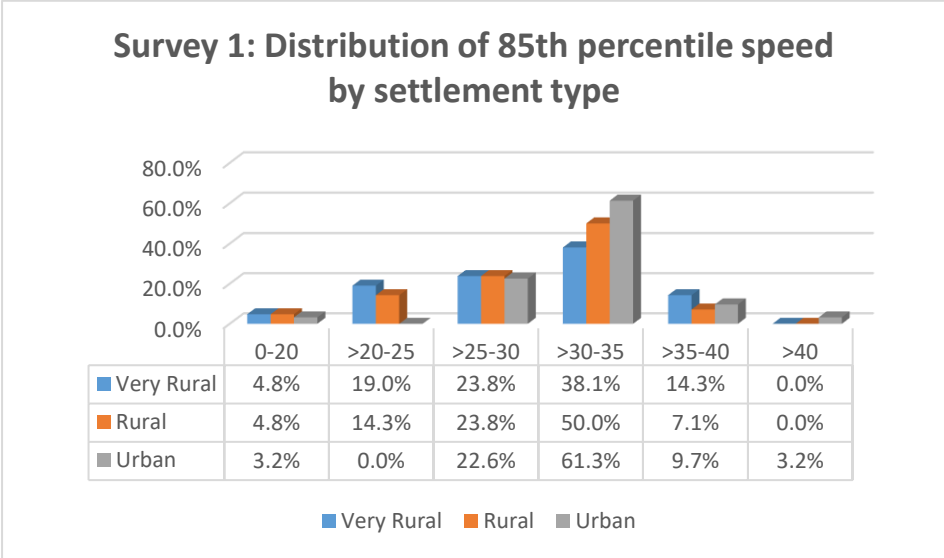


Figure 4-15: Distribution of mean speed by settlement type in Survey 1 ("before") and Survey 2 ("after I")



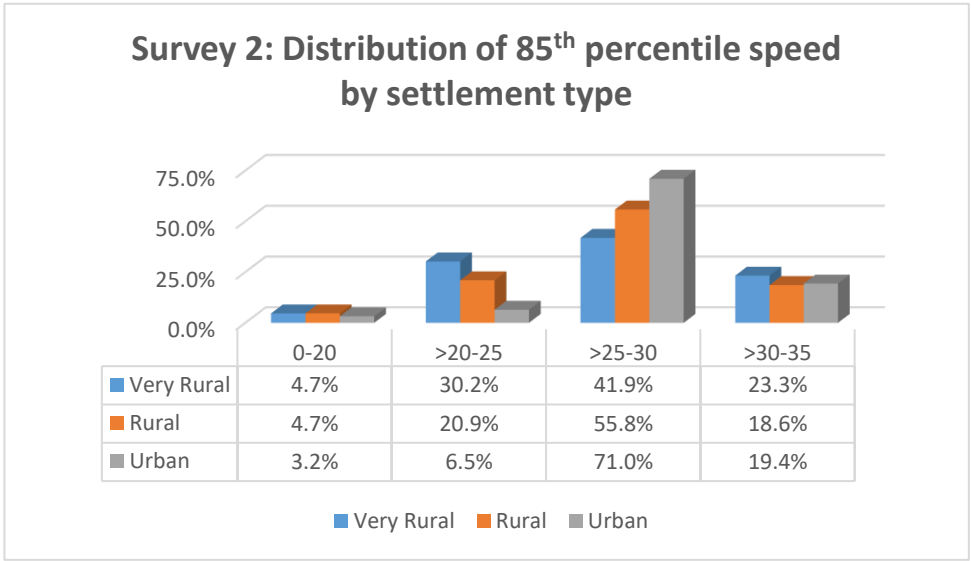
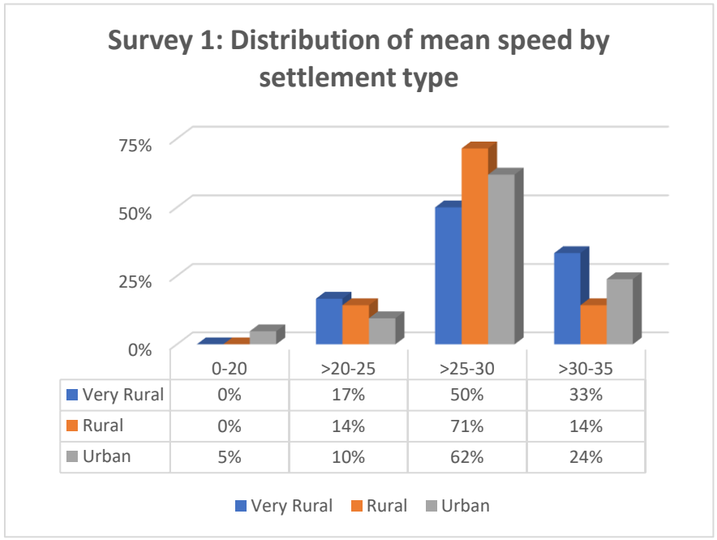
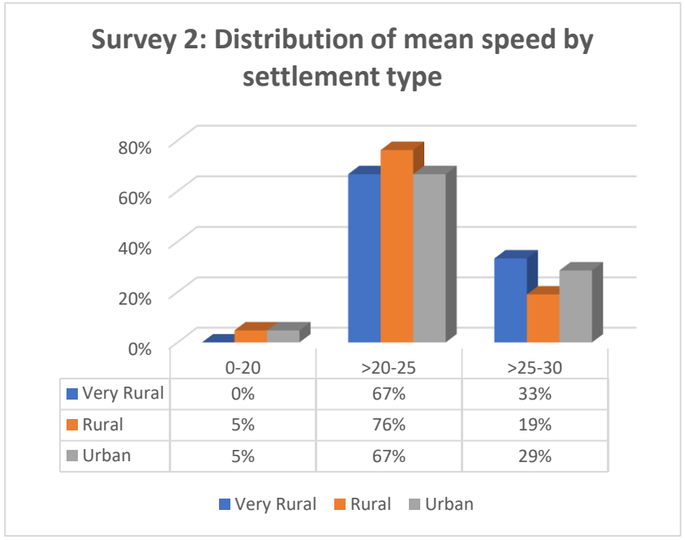


Figure 4-16: Distribution of 85th percentile speed by settlement type in Survey 1 ("before") and Survey 2 ("after I")





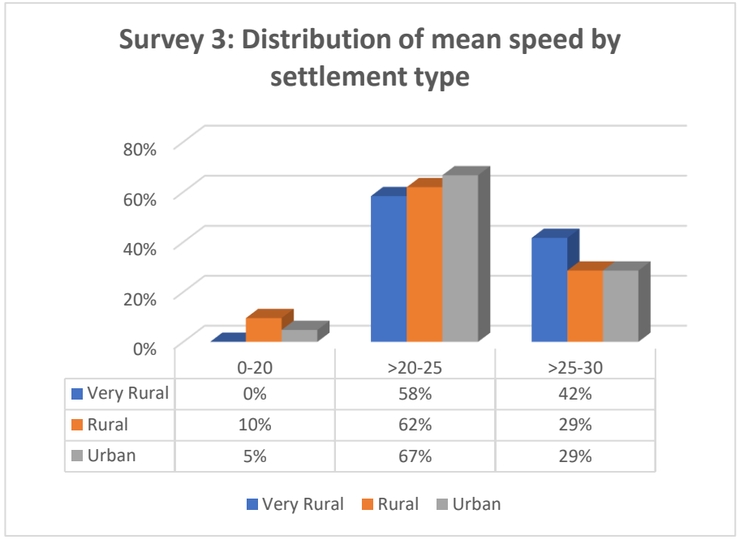
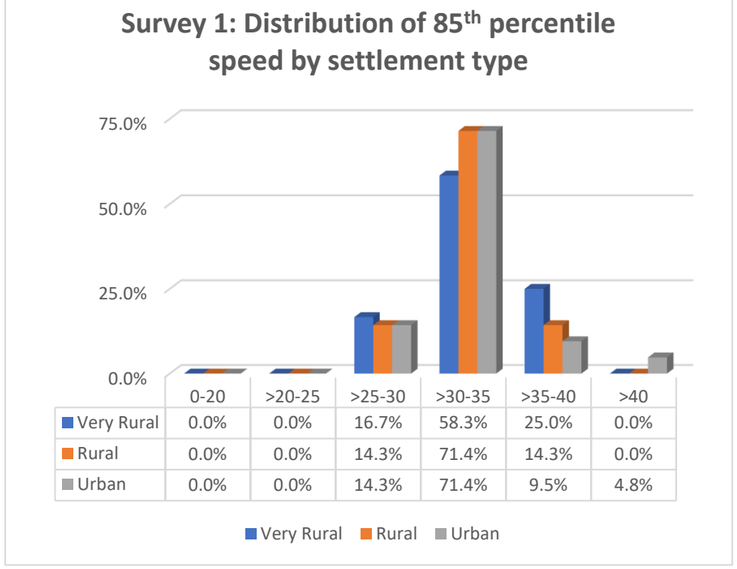
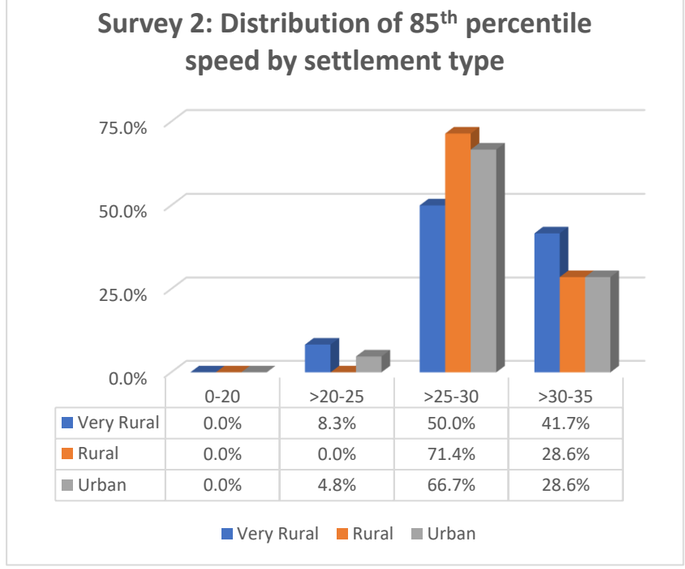


Figure 4-17: Distribution of mean speed by settlement type in Survey 1 (“before”), Survey 2 (“after I”) and Survey 3 (“after II”)





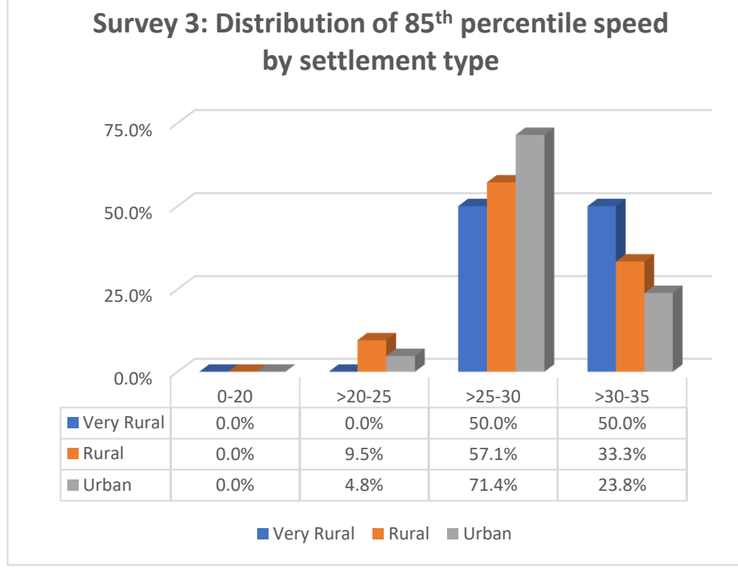
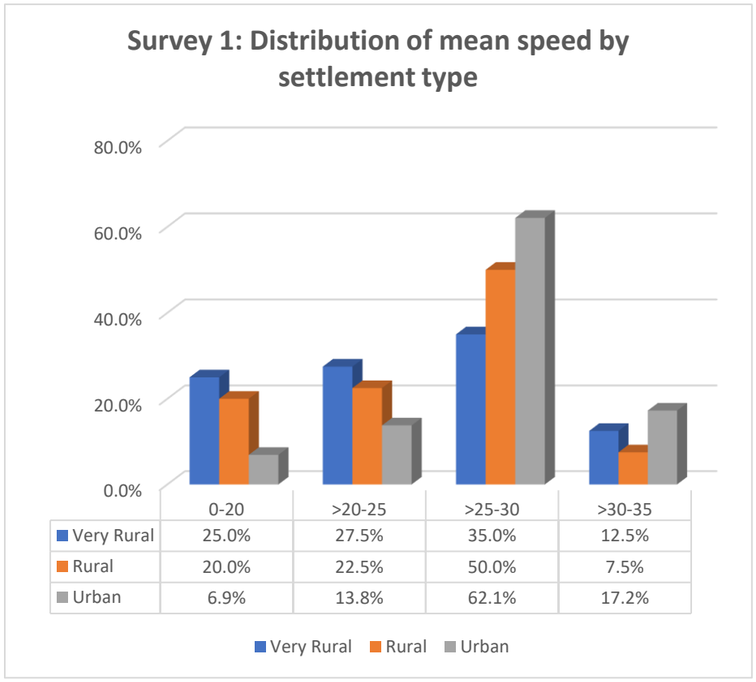
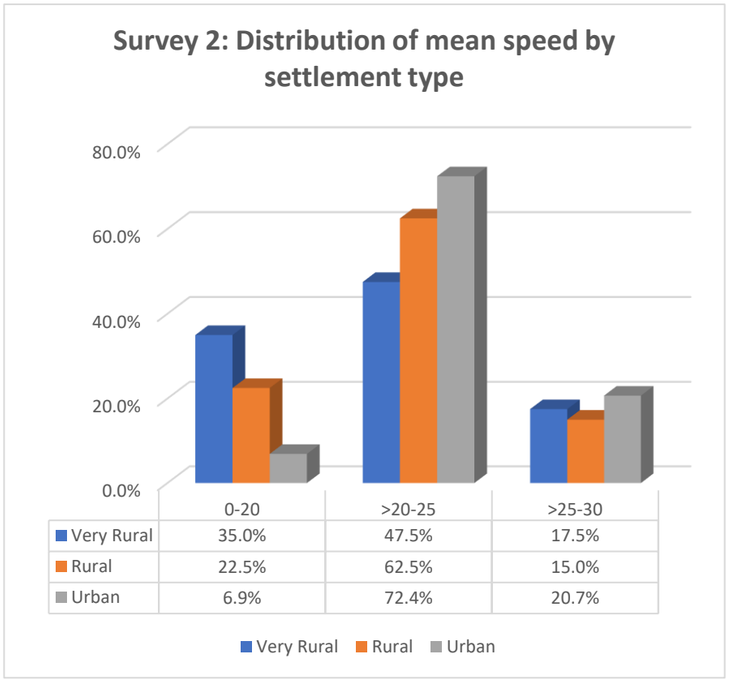


Figure 4-18a: Distribution of 85th percentile speed by settlement type in Survey 1 (“before”), Survey 2 (“after I”) and Survey 3 (“after II”)





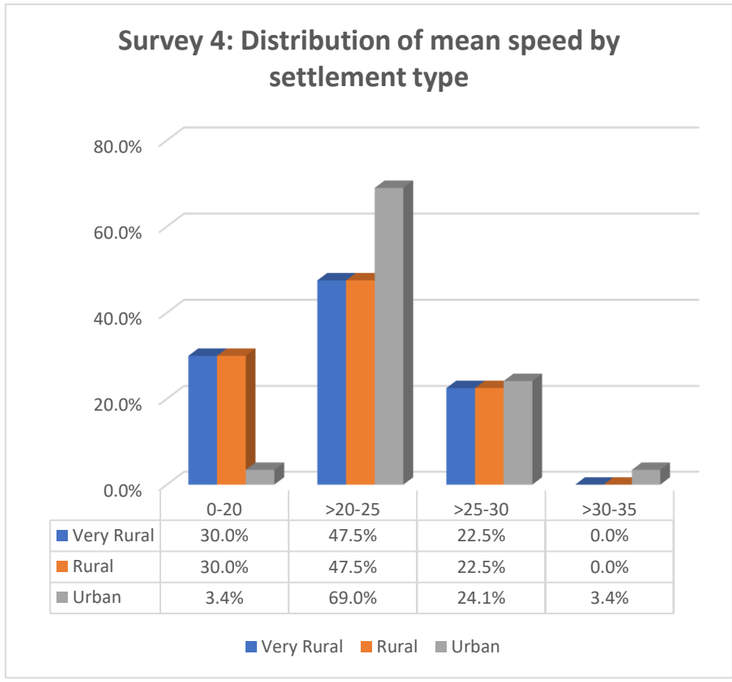
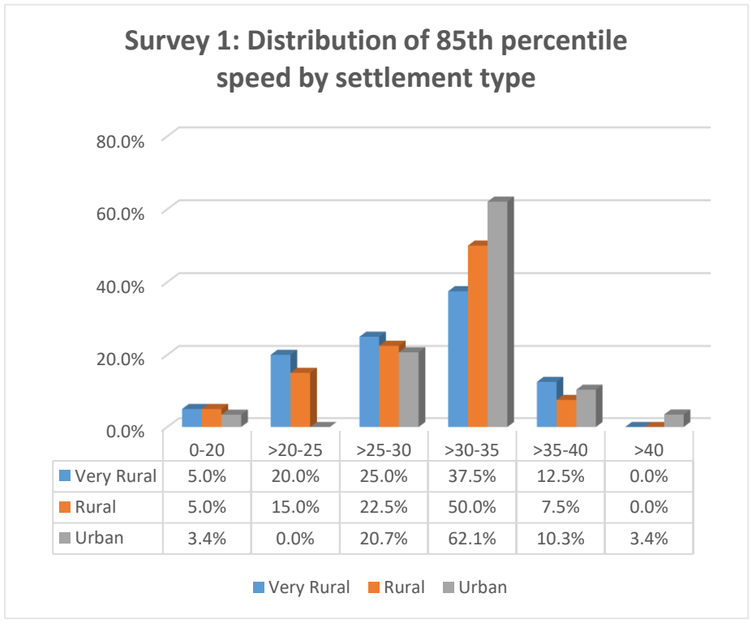
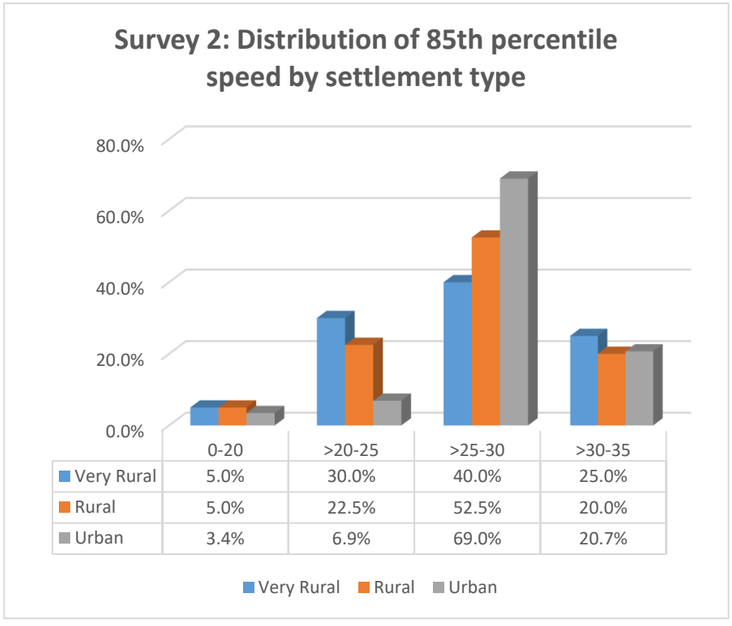


Figure 4-18b: Distribution of mean speed by settlement type in Survey 1 (“before”), Survey 2 (“after I”) and Survey 4 (“after III”)





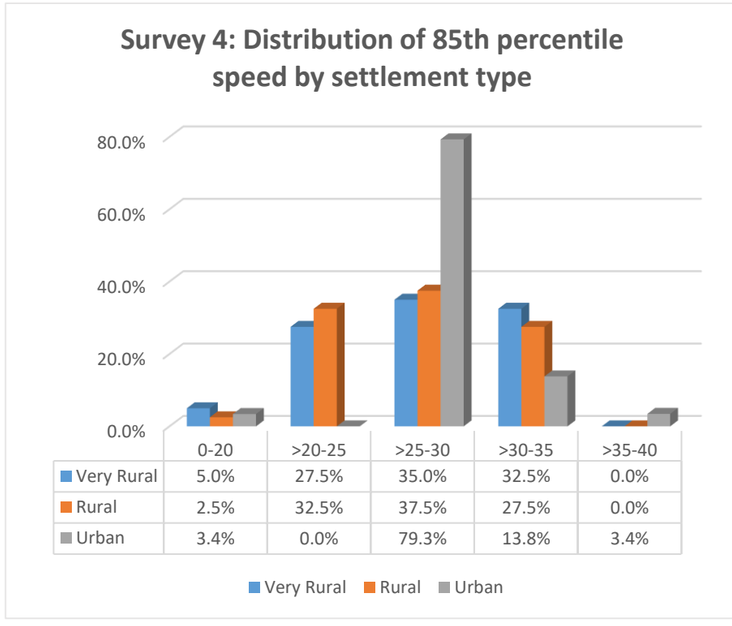


Figure 4-18c: Distribution of 85th percentile speed by settlement type in Survey 1 (“before”), Survey 2 (“after I”) and Survey 4 (“after III”)

4.2.3 Speed distribution by school presence

Given the major role of traffic speeds for the level of road safety in areas with school presence (Cleland et al., 2020), changes in the mean and 85th percentile speeds before and after the 20mph trial were also examined for such areas. For this analysis, the key criterion for the classification of sites was whether a school was present in the vicinity (within a range of 300 metres approximately) of the exact position where the speed data was collected. To verify the school presence, we virtually inspected the surrounding area of each site through images taken from Google maps and Google Earth, and we also leveraged relevant data provided by the Scottish Borders Council.

The mean speed distribution of Survey 1 ("before") and Survey 2 ("after I") for sites where a school is present in their vicinity are shown in the Figure 4-19. Out of the 115 common sites in Survey 1 and 2, 25 sites were identified having a school nearby. Figure 4-19 shows that 60% of sites with school presence yield "before" mean speeds that belong either in the >25-30 mph or the >30-35 mph band. While about 84% of sites with school presence result in "after I" mean speeds that fall either in the 0-20 mph band or the >20-25 mph band. This shows a clear reduction in mean speeds of sites with school presence between "before" and "after I". It should be noted that similar proportions per speed band were also identified for sites without school in their vicinity.

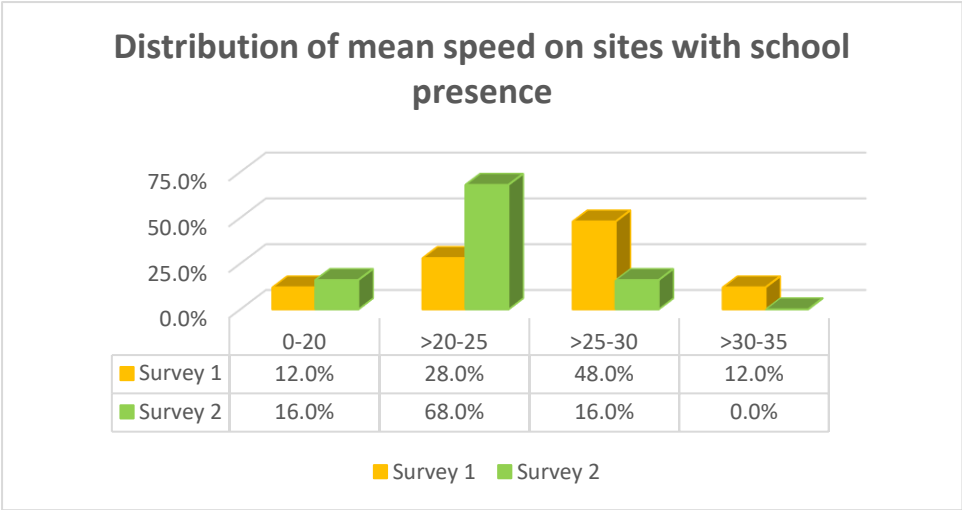
Similarly, the Figure 4-19 shows the distribution of the 85th percentile speeds in Survey 1 ("before") and Survey 2 ("after I") for sites with school presence. The "before" distribution for sites with school presence in their vicinity indicates that about 64% of sites are associated either with the >30-35 mph or >35-40 mph bands. Focusing on Survey 2, about 12% of sites have "after I" 85th percentile speeds that fall in the >20-25 mph speed band, whereas about 68% of sites fall under the >25-30 mph band. Interestingly, the proportion of sites in the band >30-35 mph dropped from 52% in Survey 1 to 20% in Survey 2. All these proportions indicate clear reductions in 85th percentile speeds "after I" compared to "before".

The Figure 4-20a presents the comparison of the mean speed distribution among Survey 1 ("before"), Survey 2 ("after I") and Survey 3 ("after II") for sites with school presence in their vicinity. Among the 55 sites with available data across the three survey waves, 17 sites were identified having a school in their proximity. Overall, about 70.5% of sites with school presence exhibit "before" mean speeds belonging either in the >25-30 mph or the >30-35 mph band. However, about 76.5% of sites have "after I" mean speeds that fall either in the 0-20 mph or the

>20-25 mph band. Focusing on the "after II" distribution, about 70.6% of sites yield mean speeds falling either under the 0-20 mph or the >20-25 mph band. The differences observed in the "after I" and "after II" distributions constitute clear evidence of the reduction of mean speeds in sites with school presence after the introduction of the 20mph speed limit, as compared to the "before" speeds. Similar proportions per speed band were also identified for sites without school in their vicinity in Survey 3.

Similarly, the Figure 4-20a shows the comparison of the 85th percentile speed distributions among Survey 1 ("before"), Survey 2 ("after I") and Survey 3 ("after II") for sites with school presence. The distribution of Survey 1 indicates that about 76.4% of sites with school in their vicinity are associated either with the >30-35 mph or the >35-40 mph speed band "before". That trend radically changes in the "after I" state, as there is no site falling in the >35-40 mph band, whereas the majority of sites (64.7%) yield 85th percentile speeds in the >25-30 mph band. Focusing on the "after II" 85th percentile speeds, approximately 11.8% of sites yield values lower or equal to 25 mph; and about 58.8% of sites are associated with the >25-30 mph speed band. Overall, both the "after I" and "after II" data reflect a significant reduction in 85th percentile speeds on sites with school presence, as compared to the corresponding "before" values. In addition, the reductions in the 85th percentile speeds are found to remain over time, as shown by the comparison of the relevant "after I" and "after II" proportions. In addition, it was found that the proportion of sites with 85th percentile speed lower than 30 mph is slightly larger for sites with school presence (70.6%) compared to sites without school presence (65.8%) in Survey 3.

The Figure 4-20b provides the comparison of mean and 85th percentile speed distributions across Survey 1, Survey 2, and Survey 4 ("after III"). For the latter, both distributions do not exhibit noticeable differences compared to Survey 2. The vast majority of sites (73.9%) with school presence have mean speed in the range >20-25 mph, whereas for 65.2% of sites, the 85th percentile speed belongs in the >25-30mph band. In addition, a small increase is observed in Survey 4 for sites having 85th percentile speed in lower speed ranges (lower than 25mph).



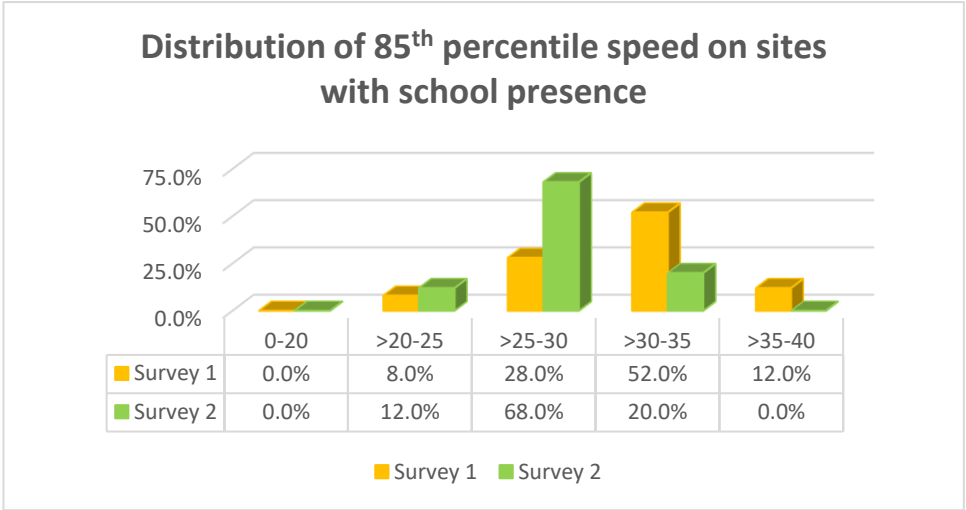
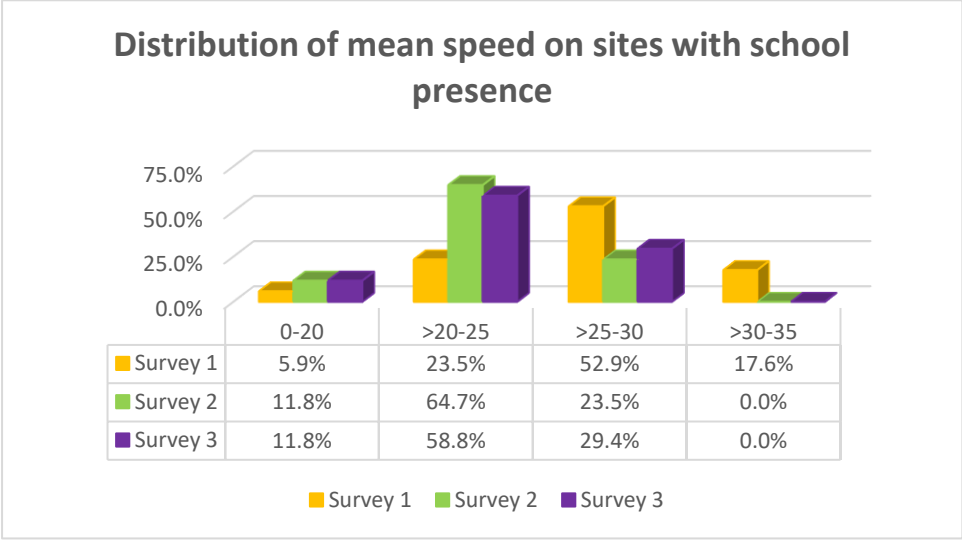


Figure 4-19: Distribution of mean speed and 85th percentile speed on sites with school presence for Survey 1 ("before") and Survey 2 ("after I")



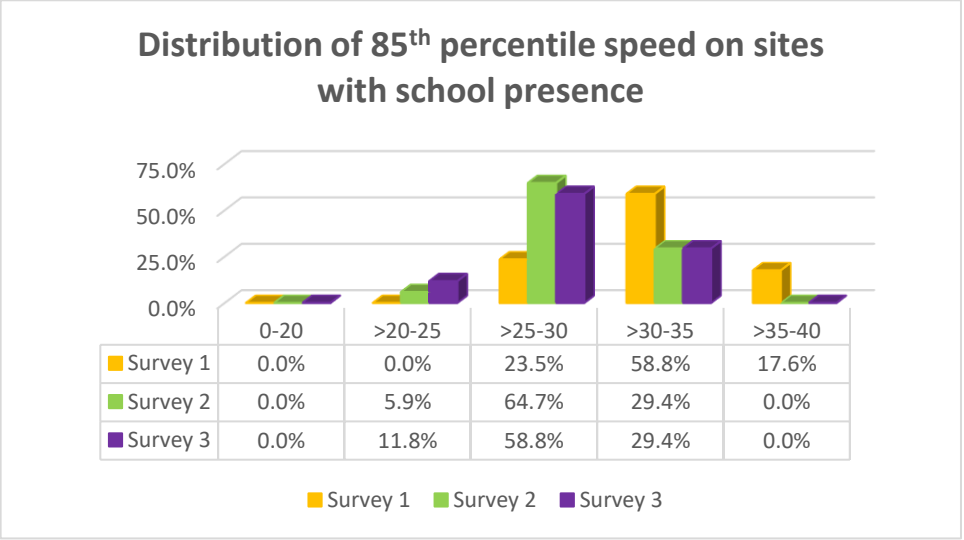
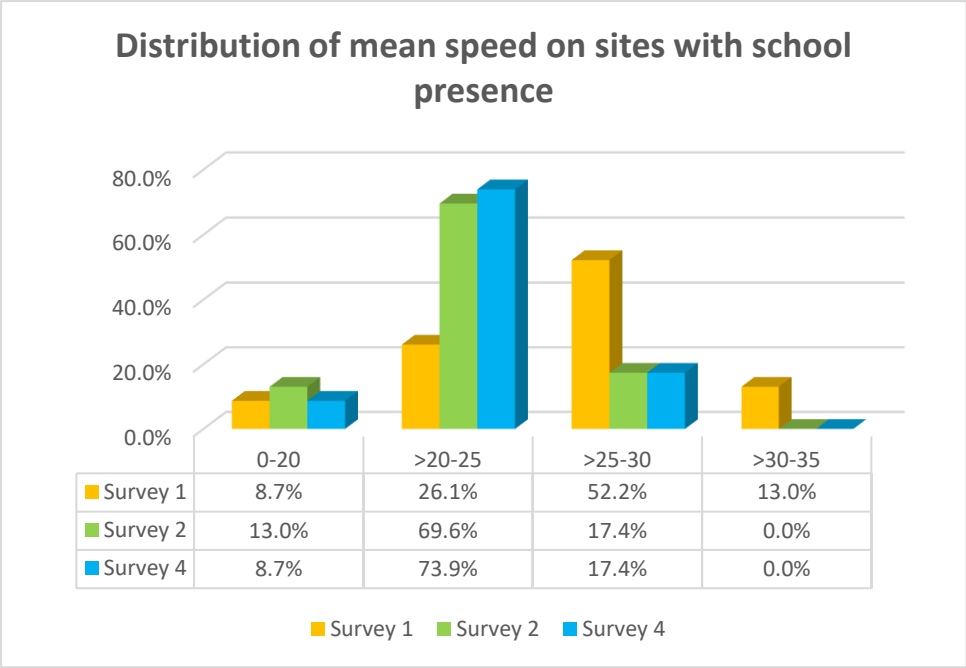


Figure 4-20a: Distribution of mean speed and 85th percentile speed on sites with school presence for Survey 1 ("before"), Survey 2 ("after I") and Survey 3 ("after II")



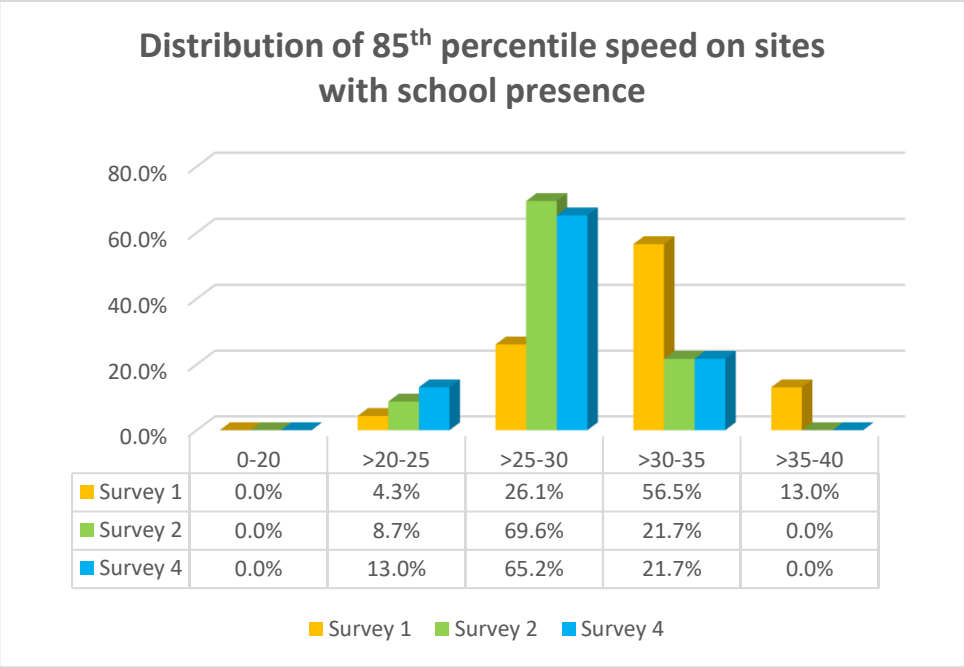


Figure 4-20b: Distribution of mean speed and 85th percentile speed on sites with school presence for Survey 1 (“before”), Survey 2 (“after I”) and Survey 4 (“after III”)

4.2.4 Speed distributions by temporal characteristics

This subsection presents the distribution of the mean and 85th percentile speeds across the survey waves considering the day of the week where the speed data was collected as key criterion of the distribution. In this context, distributions of speeds for daily, weekday, and weekend trips are calculated and discussed.

Survey 1 vs Survey 2

The Figure 4-21 presents the distributions of mean speed by day of the week for Survey 1 ("before") and Survey 2 ("after"). The main findings drawn from the comparison of the distributions are summarised below:

- The speed patterns "before" are characterized by stability overall, with the largest proportions of sites falling in the >25-30 mph band, especially during Mondays and Tuesdays. In the same days, we also noticed the lowest proportions of sites for speed bands greater than 30 mph. On Fridays and weekends, relatively larger proportions of sites (compared to the other days of the week) are observed in the >30-35 mph speed band.
- In Survey 2, the main finding arises from the practical elimination of sites associated with mean speeds greater than 30 mph across all days of the week. Compared to "before", we also observed a significant decline in the proportions of sites with mean speeds in the band >25-30 mph, and simultaneously, a major increase in the proportions of sites in the band >20-25 mph across all days of the week, with the largest increase (equal to 42.2%) being identified on Mondays. Milder increases are also observed in the proportions for the band 0-20 mph, especially during the weekends.

Figure 4-22 provides the 85th percentile distributions by day of the week in Survey 1 ("before") and Survey 2 ("after I"). The findings of the comparison do not considerably differ from those drawn for mean speeds. Particularly, in the "after I" state, we noticed (almost) elimination of sites with 85th percentile speeds in speed bands greater than 35 mph, significant reductions in the proportions of sites associated with the >30-35 mph band (especially, on Wednesdays), major increases in the band >25-30 mph, and slight increases in the proportions of sites in the band >20-25 mph.

Figures 4-23 and 4-24 provide the mean and 85th percentile speed distribution in Survey 1 and Survey 2, by contrasting weekdays against weekends. Previous research has shown that speed reductions in weekdays may differ from weekends (Pilkington et al., 2018). While for both weekdays and weekends, speed decreases are observed "after I" compared to "before", the magnitude of speed decrease is slightly greater in weekdays, as, for example, the proportion of sites with mean speed in the >25-30 mph reduced by 31.7% in weekdays, whereas the same percentage is 24.2% for weekends. However, for both cases, we observe a reduction to zero for instances with mean speed greater than 30 mph "after I". Similar inferences can be also drawn from the comparison of the 85th percentile speed distributions "before" and "after I", where we can also see major reductions in the number of sites associated with the >30 mph speed bands for both weekdays and weekends. Overall, the percentage of sites with mean and 85th percentile speeds greater than 25 mph "after I" is relatively higher in weekends compared to weekdays, which is expected given the outcomes of previous traffic safety studies in Scotland (Fountas et al., 2020).

Survey 1 vs Survey 2 vs Survey 3

Figure 4-25 presents a comprehensive overview of the mean speed distributions for sites with available data across Survey 1 ("before"), Survey 2 ("after I"), and Survey 3 ("after II") by day of the week. Between "before" and "after I", the variations of mean speeds do not differ much from what was observed in Figure 4-21. In the "after II" survey, the distribution of mean speeds is quite similar to "after I", with most sites being clustered around the >20-25 mph speed band across all days of the week. Overall, in the "after II" state, the proportions of sites with mean speed greater than 30 mph are zero (compared to a range of 15-31% "before"), the proportions of sites associated with the >20-25 mph band of mean speeds have increased (compared to "before"), whereas the proportions related to the >25-30 mph are quite lower compared to "before" but slightly higher compared to "after I" (apart from Tuesdays). Sundays are consistently associated with the largest proportions of sites in the >25-30 mph band for both "after I" and "after II" states.

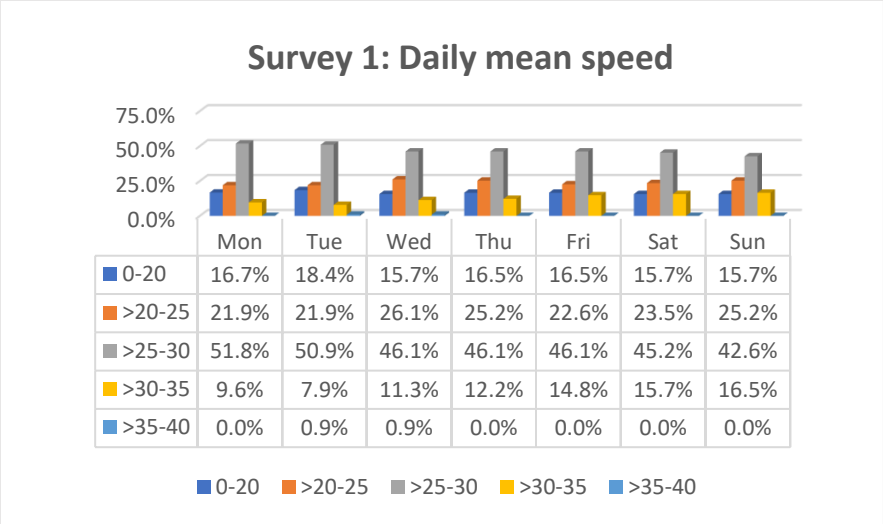
Focusing on the 85th percentile distributions across Survey 1, Survey 2, and Survey 3 (as shown in the Figure 4-26a), this does not extensively differ from the mean speed distribution. Both "after I" and "after II" distributions show significant shifts to lower speed bands compared to "before". While the majority of sites across all days of the week clustered around the >30-35 mph band "before", the "after I" and "after II" distributions show that most of the sites moved to a lower

speed band (i.e., the >25-30 mph band) after the introduction of the 20mph speed limit. Whereas, for both "after I" and "after II" states, the proportions related to the speed bands greater than 35 mph are practically zero.

Figures 4-27 and 4-28a present the "before"-"after I"-"after II" comparison of mean and 85th percentile speed distributions for weekdays versus weekends. The findings are similar to the comparison by day of the week, with Survey 3 yielding a quite similar distribution with Survey 2. Another interesting finding drawn from the Survey 3 distribution, is that the proportion of sites with mean speed less or equal to 25 mph is slightly higher in weekdays compared to weekends (70.2% versus 65.5%), whereas the corresponding proportion for the >25-30 mph is higher in the weekends (29.8% versus 34.5%). Similar trends are also observed in the 85th percentile speed distribution, where the proportion of sites associated with speed bands greater than 30 mph is slightly higher in weekends (36.4%) than in weekdays (31.2%).

Survey 1 vs Survey 2 vs Survey 4

Figure 4-26b provides the mean speed distribution across Survey1, Survey 2 and Survey 4. In Survey 4, the distribution across the days of the week does not differ significantly compared to Survey 2. Specifically, in Survey 4, slight increases are observed in the proportion of sites with mean speed in the range 0-20 mph from Monday to Friday and increases are also observed in the proportions of sites with mean speed >25-30 mph across all days of the week. Compared to Survey 1, the proportions of sites with mean speeds in the high speed ranges (>25-30 mph and >30 mph) are significantly lower in Survey 4 across all days of the week. Focusing on the 85th percentile speed distribution, which is presented in the Figure 4-26c, the situation in Survey 4 is along the same lines with Survey 2; the vast majority of sites have 85th percentile speeds lower than 30 mph across all days of the week, with Wednesday and Saturday having slightly larger proportions in the higher speed ranges, compared to the other days of the week. Overall, in Survey 4, the weekend shows a slightly greater tendency for higher speeds relative to the weekdays, as also shown in the Figure 4-28b and 4-28c, which provide the distributions of mean and 85th percentile speeds for weekdays and weekends, accordingly.



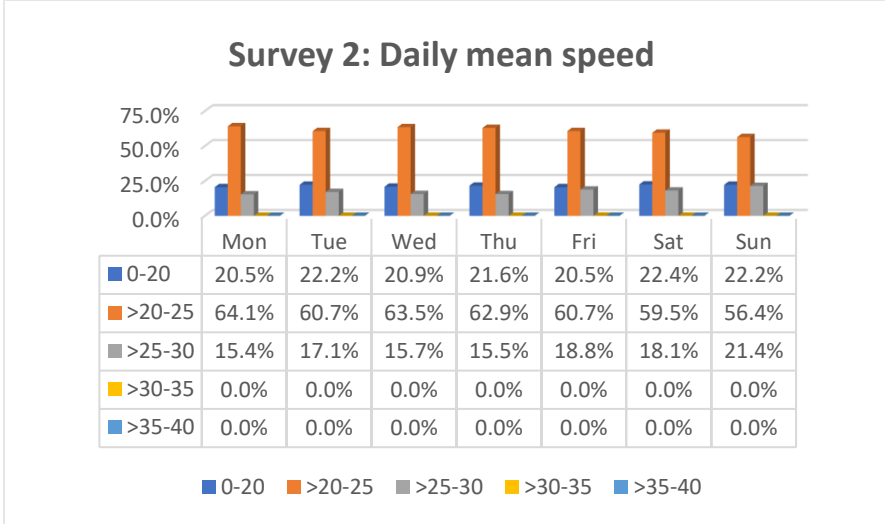
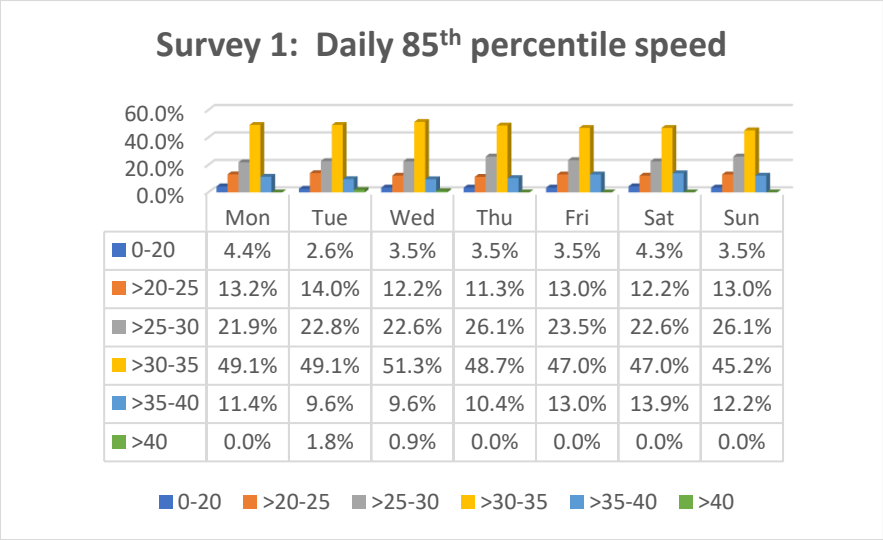


Figure 4-21: Mean speed distribution for Survey 1 and Survey 2 by day of the week



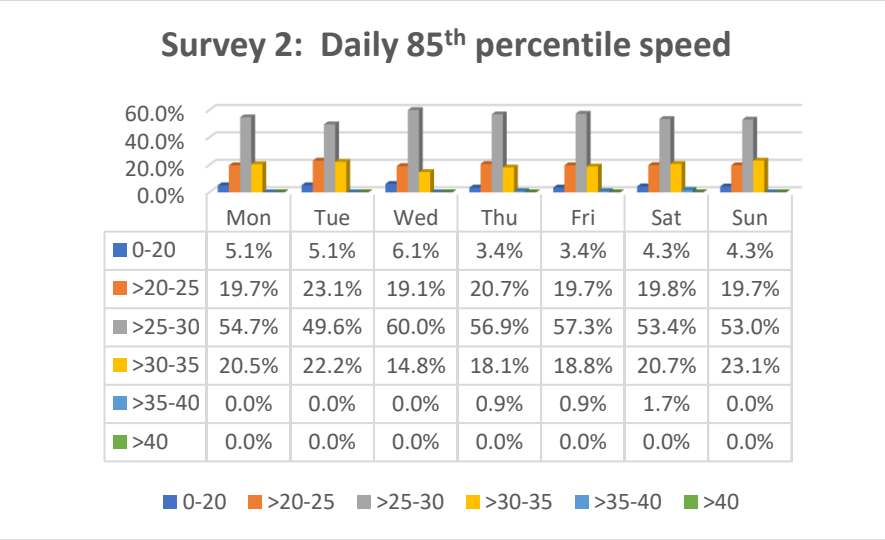
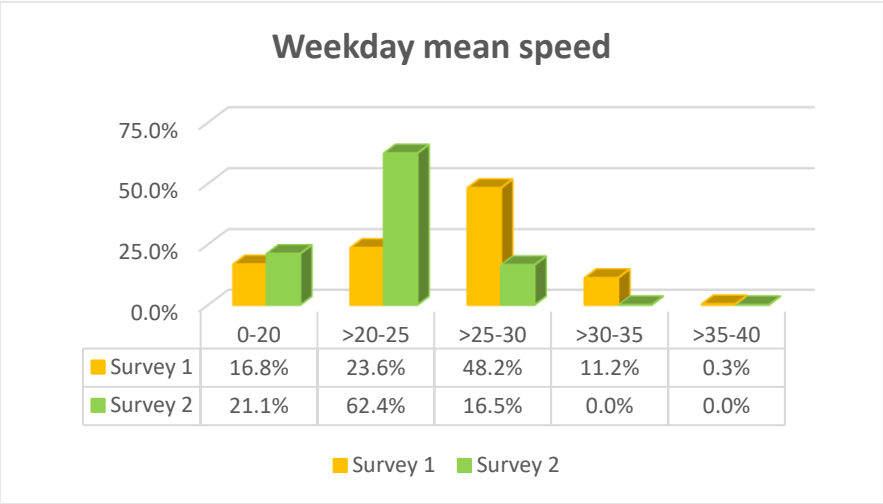


Figure 4-22: 85th percentile speed distribution for Survey 1 and Survey 2 by day of the week



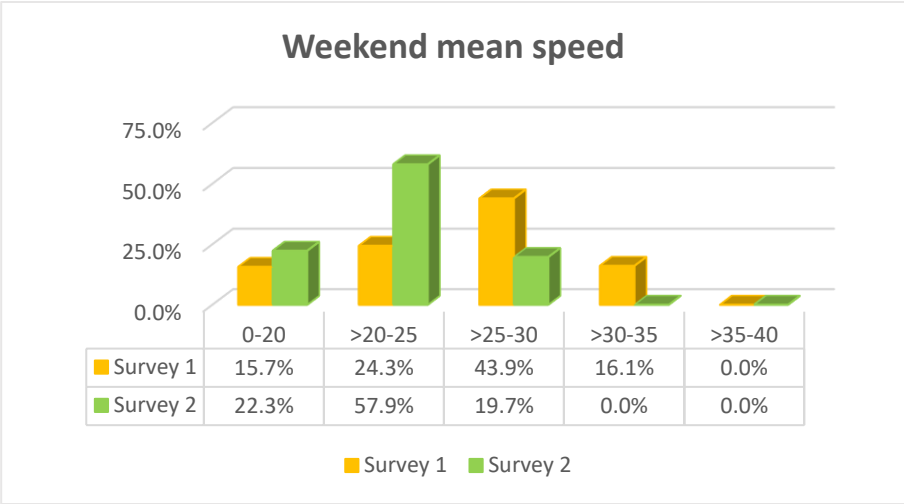
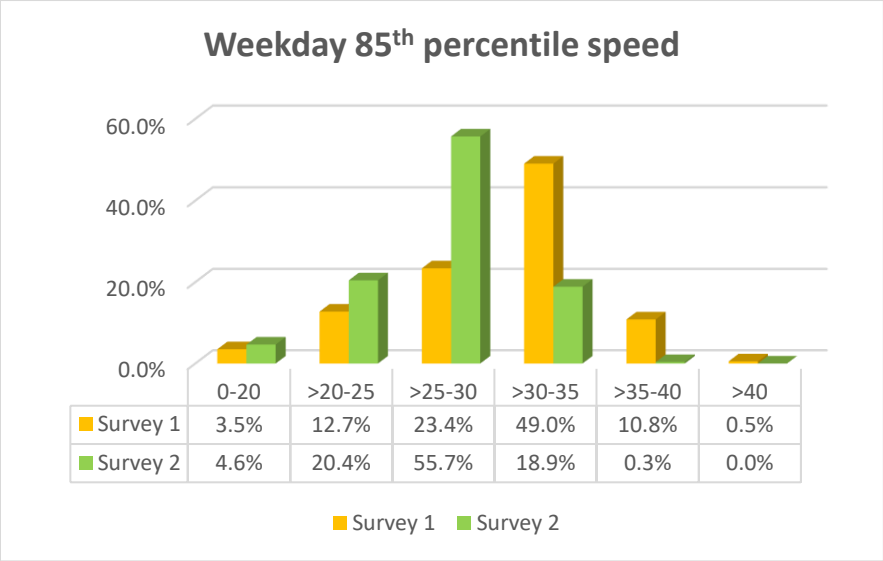


Figure 4-23: Weekday and Weekend mean speed distribution for Survey 1 and Survey 2



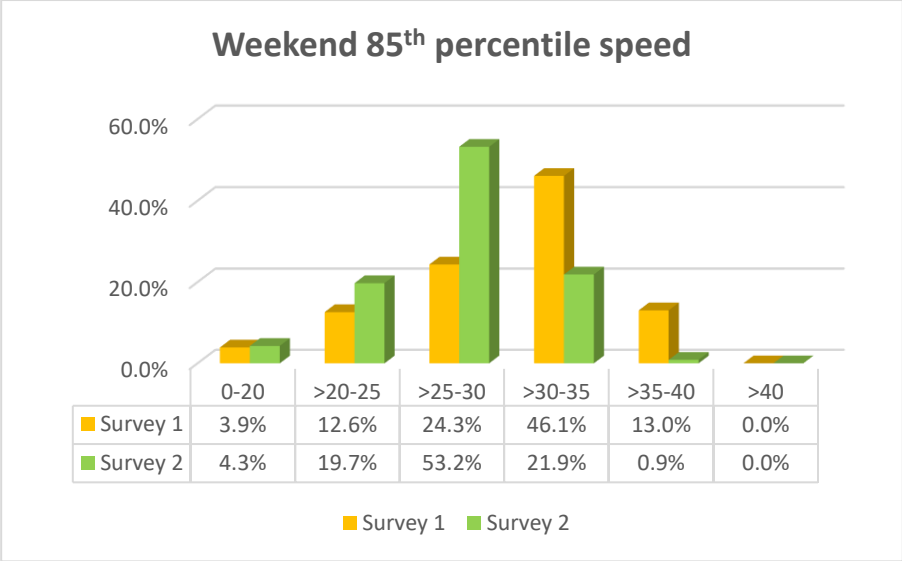
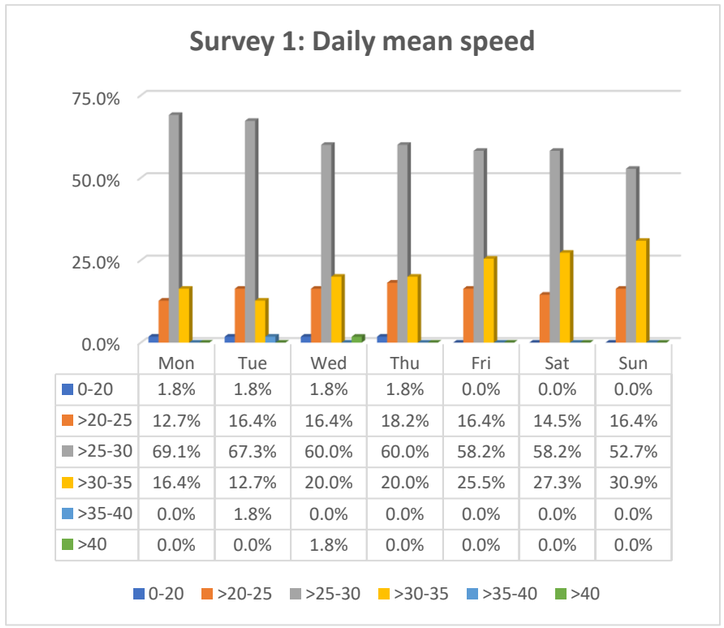
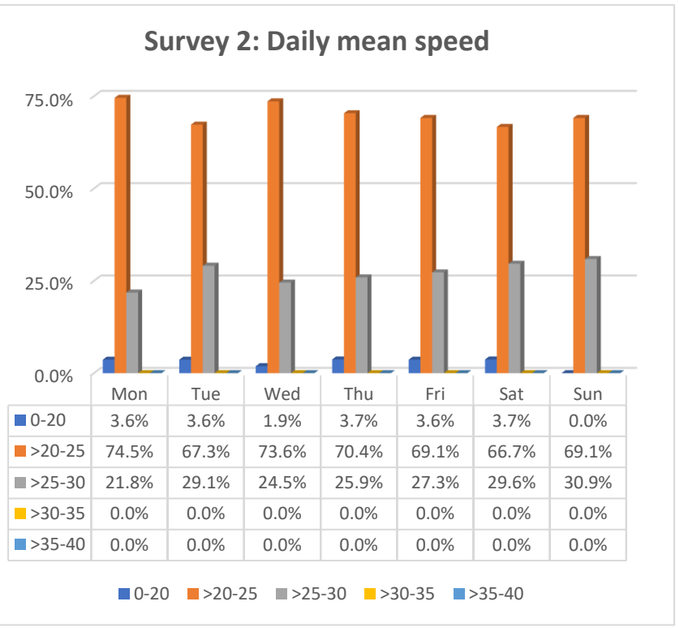


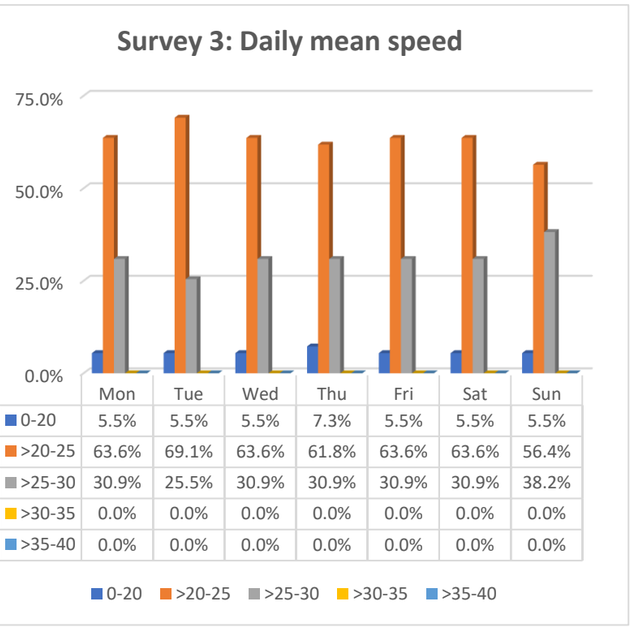
Figure 4-24: Weekday and weekend 85th percentile speed distribution for Survey 1 and Survey 2



	Mon	Tue	Wed	Thu	Fri	Sat	Sun
0-20	1.8%	1.8%	1.8%	1.8%	0.0%	0.0%	0.0%
>20-25	12.7%	16.4%	16.4%	18.2%	16.4%	14.5%	16.4%
>25-30	69.1%	67.3%	60.0%	60.0%	58.2%	58.2%	52.7%
>30-35	16.4%	12.7%	20.0%	20.0%	25.5%	27.3%	30.9%
>35-40	0.0%	1.8%	0.0%	0.0%	0.0%	0.0%	0.0%
>40	0.0%	0.0%	1.8%	0.0%	0.0%	0.0%	0.0%

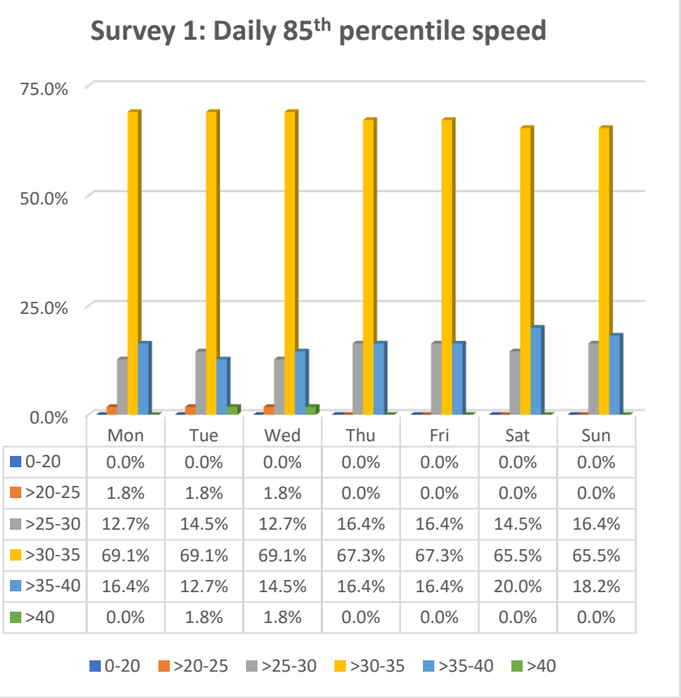


	Mon	Tue	Wed	Thu	Fri	Sat	Sun
0-20	3.6%	3.6%	1.9%	3.7%	3.6%	3.7%	0.0%
>20-25	74.5%	67.3%	73.6%	70.4%	69.1%	66.7%	69.1%
>25-30	21.8%	29.1%	24.5%	25.9%	27.3%	29.6%	30.9%
>30-35	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
>35-40	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

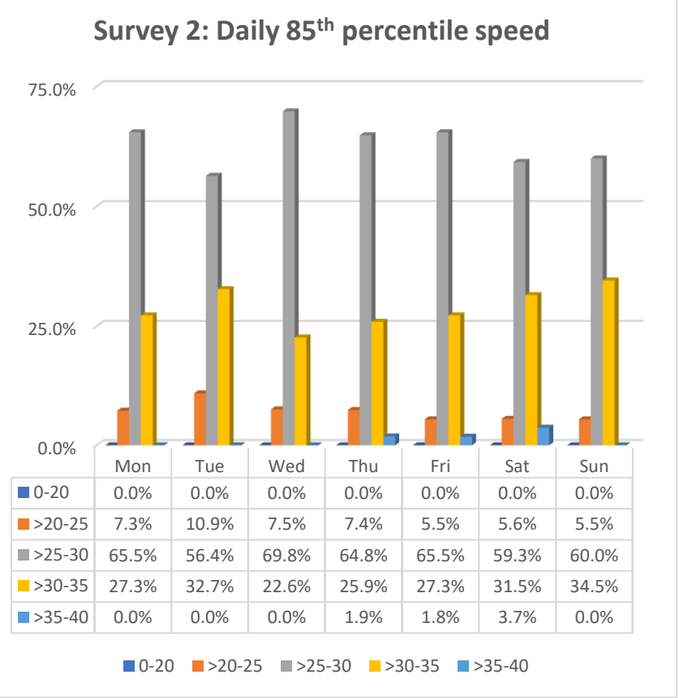


	Mon	Tue	Wed	Thu	Fri	Sat	Sun
0-20	5.5%	5.5%	5.5%	7.3%	5.5%	5.5%	5.5%
>20-25	63.6%	69.1%	63.6%	61.8%	63.6%	63.6%	56.4%
>25-30	30.9%	25.5%	30.9%	30.9%	30.9%	30.9%	38.2%
>30-35	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
>35-40	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

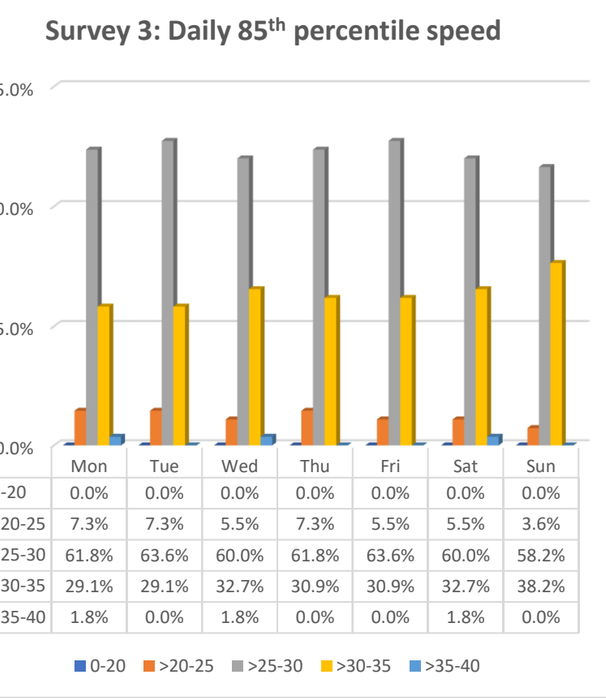
Figure 4-25: Mean speed distribution for Survey 1, Survey 2 and Survey 3 by day of the week



	Mon	Tue	Wed	Thu	Fri	Sat	Sun
0-20	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
>20-25	1.8%	1.8%	1.8%	0.0%	0.0%	0.0%	0.0%
>25-30	12.7%	14.5%	12.7%	16.4%	16.4%	14.5%	16.4%
>30-35	69.1%	69.1%	69.1%	67.3%	67.3%	65.5%	65.5%
>35-40	16.4%	12.7%	14.5%	16.4%	16.4%	20.0%	18.2%
>40	0.0%	1.8%	1.8%	0.0%	0.0%	0.0%	0.0%

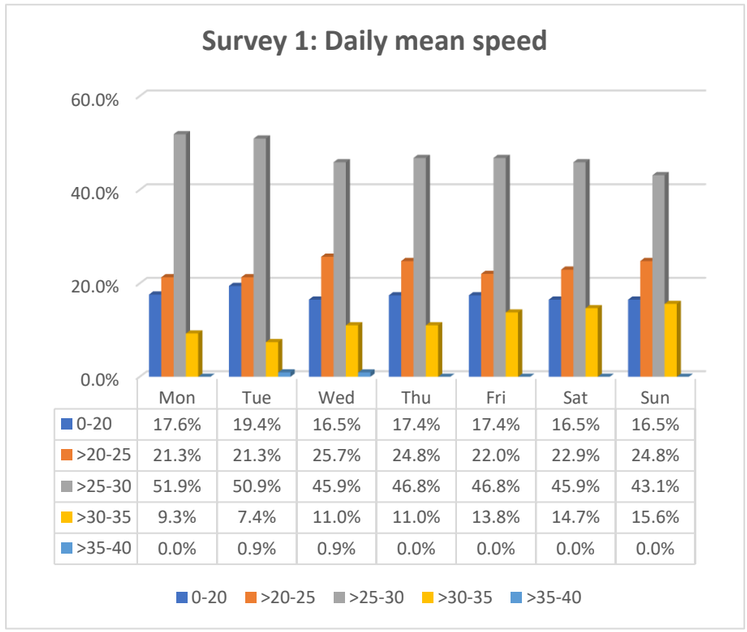


	Mon	Tue	Wed	Thu	Fri	Sat	Sun
0-20	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
>20-25	7.3%	10.9%	7.5%	7.4%	5.5%	5.6%	5.5%
>25-30	65.5%	56.4%	69.8%	64.8%	65.5%	59.3%	60.0%
>30-35	27.3%	32.7%	22.6%	25.9%	27.3%	31.5%	34.5%
>35-40	0.0%	0.0%	0.0%	1.9%	1.8%	3.7%	0.0%

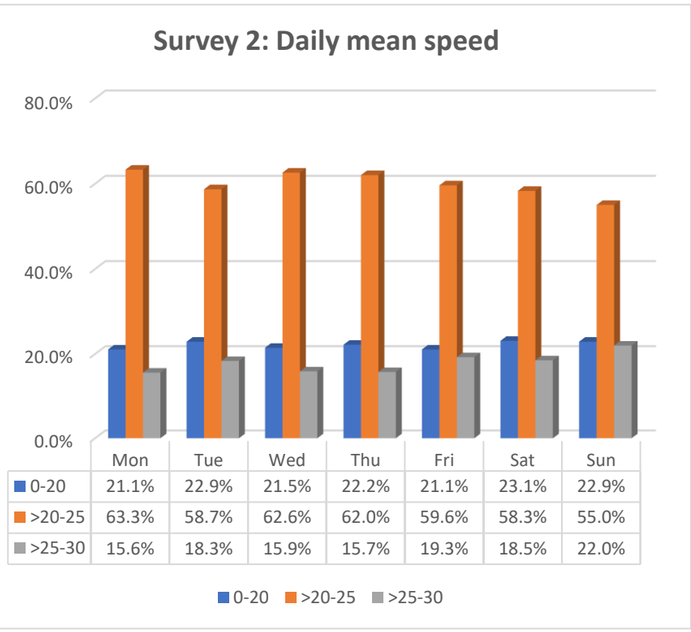


	Mon	Tue	Wed	Thu	Fri	Sat	Sun
0-20	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
>20-25	7.3%	7.3%	5.5%	7.3%	5.5%	5.5%	3.6%
>25-30	61.8%	63.6%	60.0%	61.8%	63.6%	60.0%	58.2%
>30-35	29.1%	29.1%	32.7%	30.9%	30.9%	32.7%	38.2%
>35-40	1.8%	0.0%	1.8%	0.0%	0.0%	1.8%	0.0%

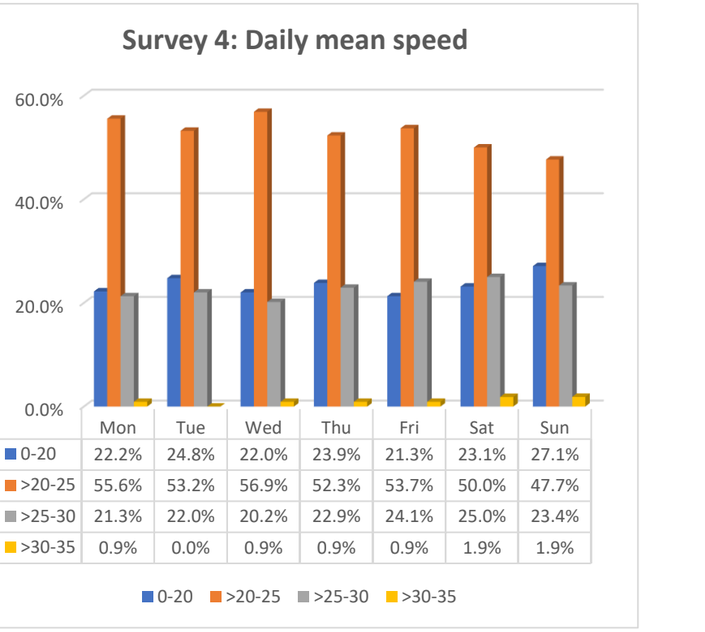
Figure 4-26a: 85th percentile speed distribution for Survey 1, Survey 2, and Survey 3 by day of the week



	Mon	Tue	Wed	Thu	Fri	Sat	Sun
0-20	17.6%	19.4%	16.5%	17.4%	17.4%	16.5%	16.5%
>20-25	21.3%	21.3%	25.7%	24.8%	22.0%	22.9%	24.8%
>25-30	51.9%	50.9%	45.9%	46.8%	46.8%	45.9%	43.1%
>30-35	9.3%	7.4%	11.0%	11.0%	13.8%	14.7%	15.6%
>35-40	0.0%	0.9%	0.9%	0.0%	0.0%	0.0%	0.0%

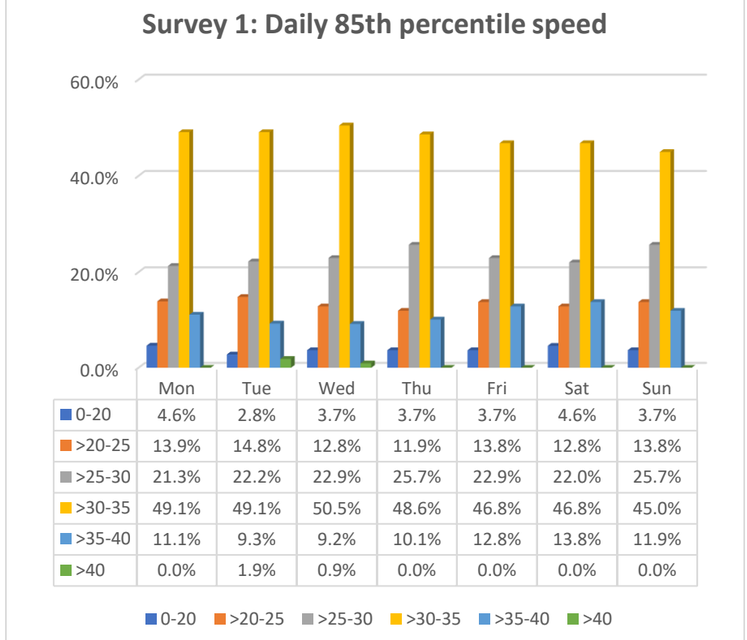


	Mon	Tue	Wed	Thu	Fri	Sat	Sun
0-20	21.1%	22.9%	21.5%	22.2%	21.1%	23.1%	22.9%
>20-25	63.3%	58.7%	62.6%	62.0%	59.6%	58.3%	55.0%
>25-30	15.6%	18.3%	15.9%	15.7%	19.3%	18.5%	22.0%

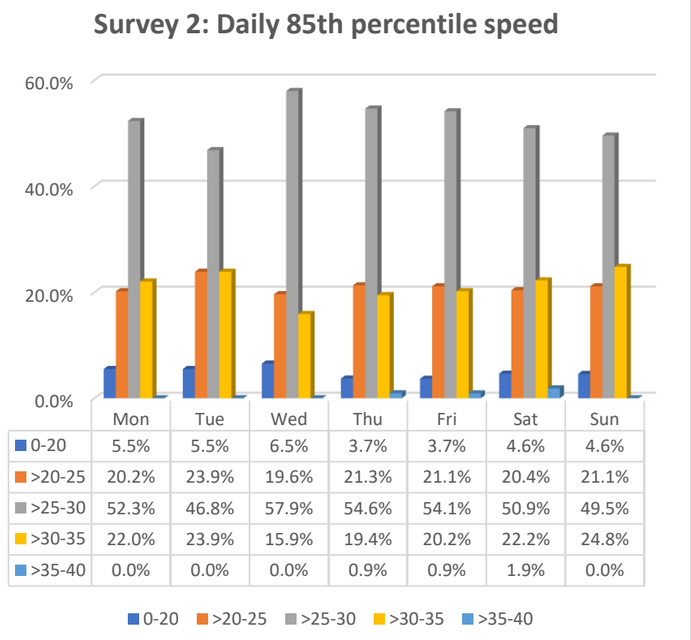


	Mon	Tue	Wed	Thu	Fri	Sat	Sun
0-20	22.2%	24.8%	22.0%	23.9%	21.3%	23.1%	27.1%
>20-25	55.6%	53.2%	56.9%	52.3%	53.7%	50.0%	47.7%
>25-30	21.3%	22.0%	20.2%	22.9%	24.1%	25.0%	23.4%
>30-35	0.9%	0.0%	0.9%	0.9%	0.9%	1.9%	1.9%

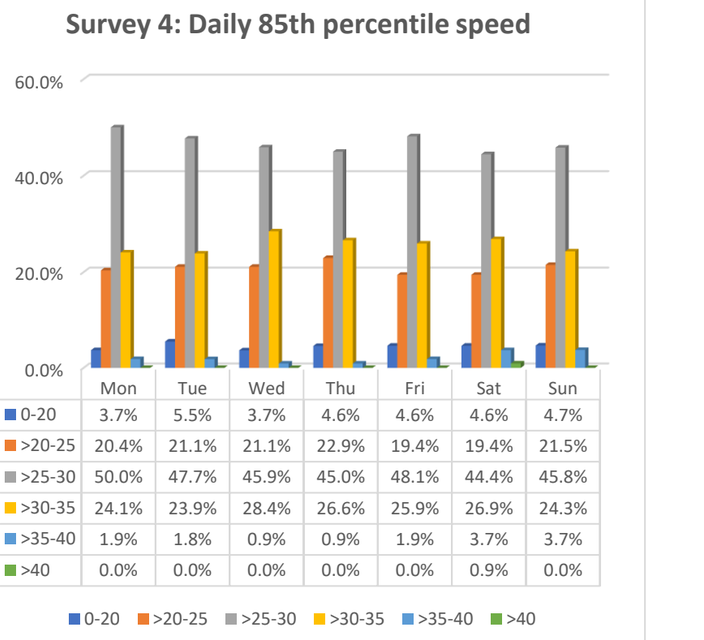
Figure 4-26b: Mean speed distribution for Survey 1, Survey 2 and Survey 4 by day of the week



	Mon	Tue	Wed	Thu	Fri	Sat	Sun
0-20	4.6%	2.8%	3.7%	3.7%	3.7%	4.6%	3.7%
>20-25	13.9%	14.8%	12.8%	11.9%	13.8%	12.8%	13.8%
>25-30	21.3%	22.2%	22.9%	25.7%	22.9%	22.0%	25.7%
>30-35	49.1%	49.1%	50.5%	48.6%	46.8%	46.8%	45.0%
>35-40	11.1%	9.3%	9.2%	10.1%	12.8%	13.8%	11.9%
>40	0.0%	1.9%	0.9%	0.0%	0.0%	0.0%	0.0%

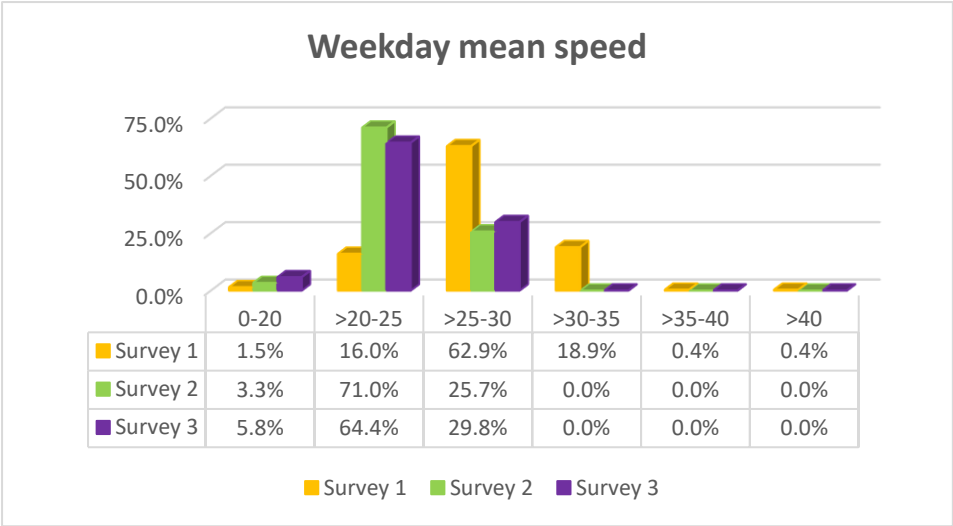


	Mon	Tue	Wed	Thu	Fri	Sat	Sun
0-20	5.5%	5.5%	6.5%	3.7%	3.7%	4.6%	4.6%
>20-25	20.2%	23.9%	19.6%	21.3%	21.1%	20.4%	21.1%
>25-30	52.3%	46.8%	57.9%	54.6%	54.1%	50.9%	49.5%
>30-35	22.0%	23.9%	15.9%	19.4%	20.2%	22.2%	24.8%
>35-40	0.0%	0.0%	0.0%	0.9%	0.9%	1.9%	0.0%



	Mon	Tue	Wed	Thu	Fri	Sat	Sun
0-20	3.7%	5.5%	3.7%	4.6%	4.6%	4.6%	4.7%
>20-25	20.4%	21.1%	21.1%	22.9%	19.4%	19.4%	21.5%
>25-30	50.0%	47.7%	45.9%	45.0%	48.1%	44.4%	45.8%
>30-35	24.1%	23.9%	28.4%	26.6%	25.9%	26.9%	24.3%
>35-40	1.9%	1.8%	0.9%	0.9%	1.9%	3.7%	3.7%
>40	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%	0.0%

Figure 4-26c: 85th percentile speed distribution for Survey 1, Survey 2, and Survey 4 by day of the week



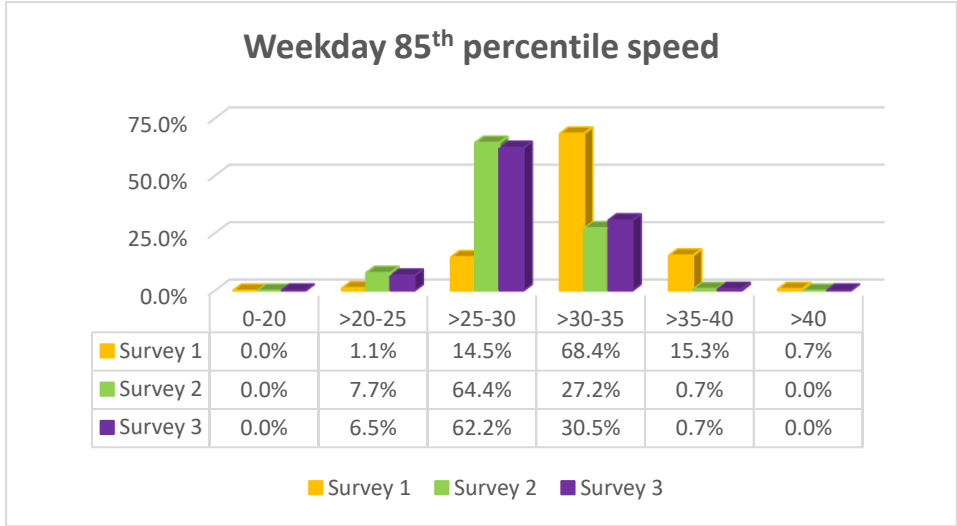
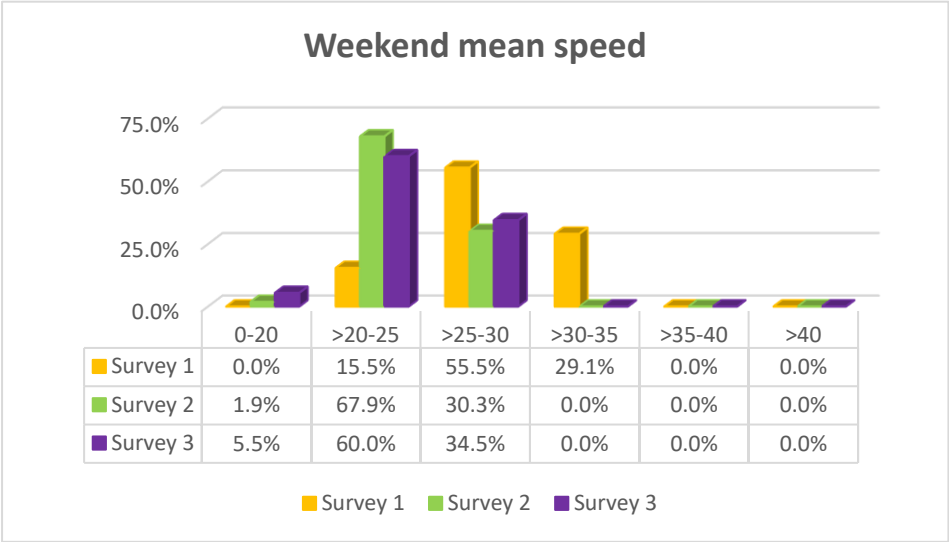


Figure 4-27: Weekday mean and 85th percentile speed distribution for Survey 1, Survey 2 and Survey 3



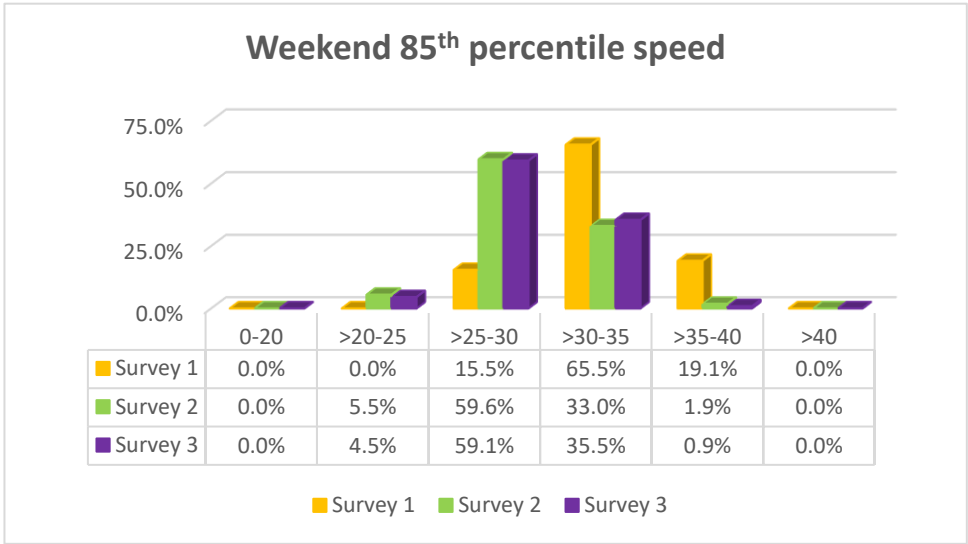
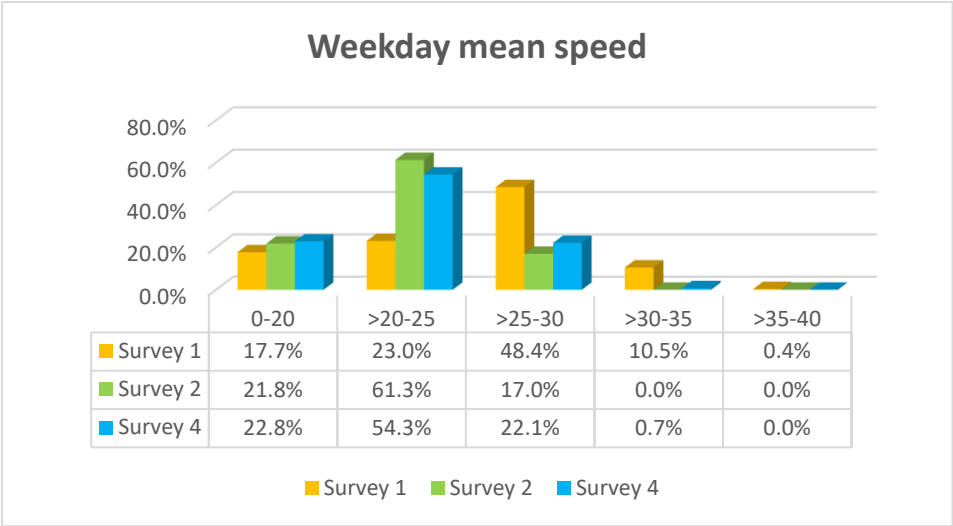


Figure 4-28a: Weekend mean and 85th percentile speed distribution for Survey 1, Survey 2 and Survey 3



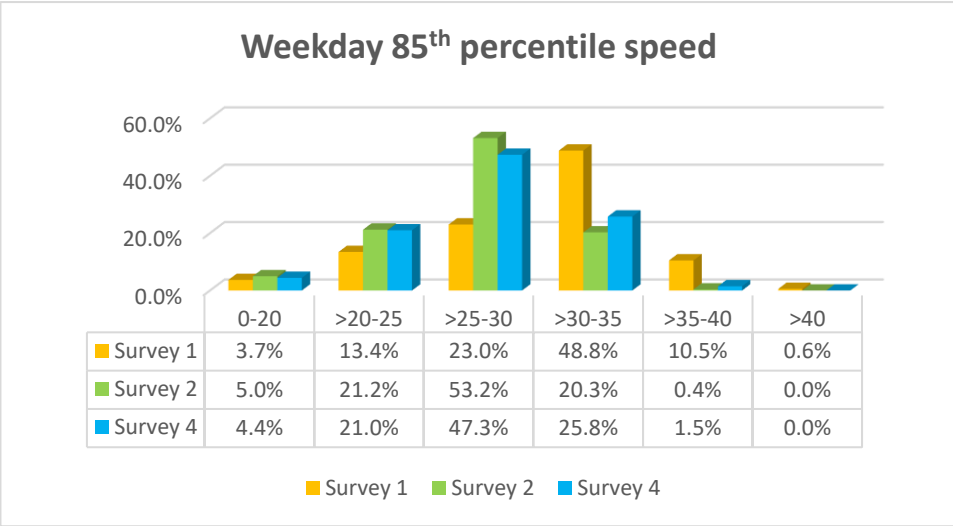
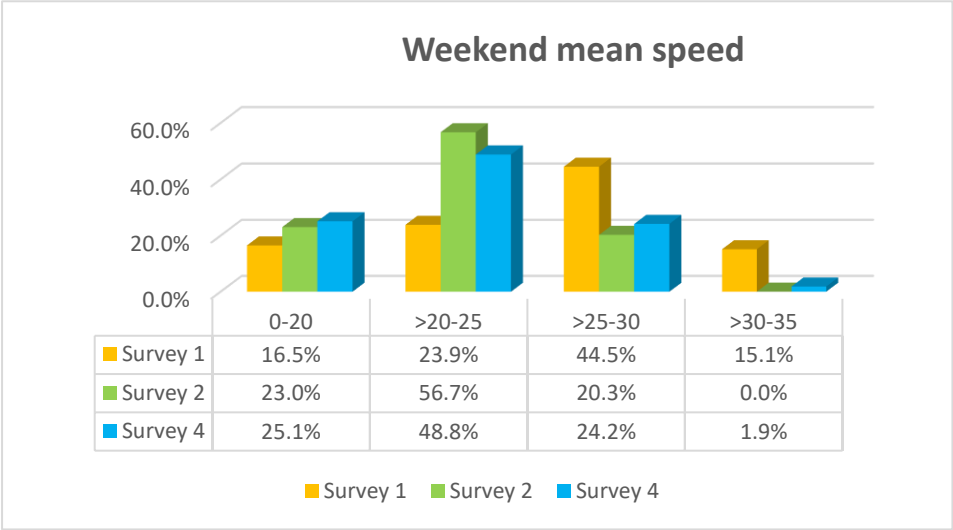


Figure 4-28b: Weekday mean and 85th percentile speed distribution for Survey 1, Survey 2 and Survey 4



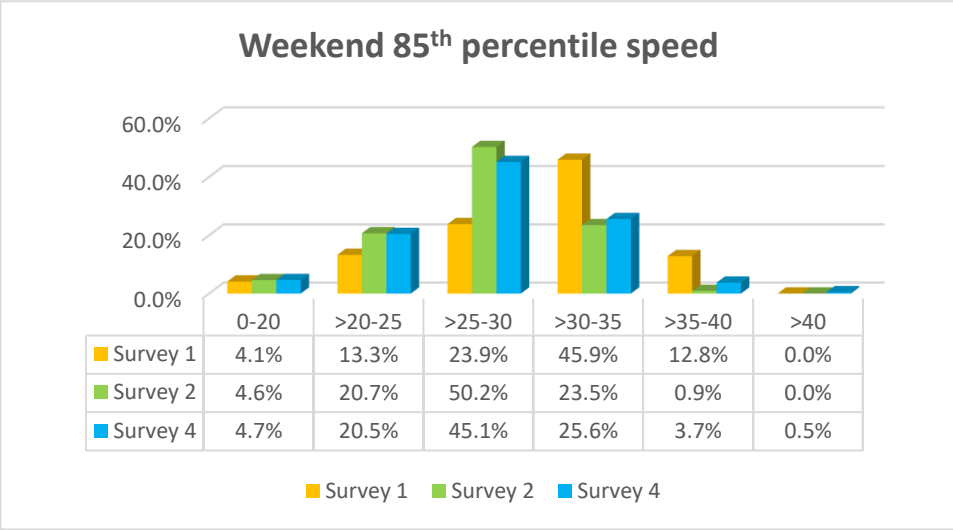


Figure 4-28c: Weekend mean and 85th percentile speed distribution for Survey 1, Survey 2 and Survey 4

4.2.5 Speed distribution by road alignment characteristics

Previous research has also proved that road alignment characteristics may have a considerable impact on driving performance, and subsequently, on speed-related decisions (Mannering and Anastasopoulos, 2016). To that end, distributions of the mean and 85th percentile speed before and after the introduction of the 20mph speed limit were analysed and compared for sites located on straight and curved segments. As in the analysis of speeds in sites with school presence, the identification of straight or curved segments was accomplished through virtual inspection of sites using images from Google maps and Google Earth.

Survey 1 vs Survey 2

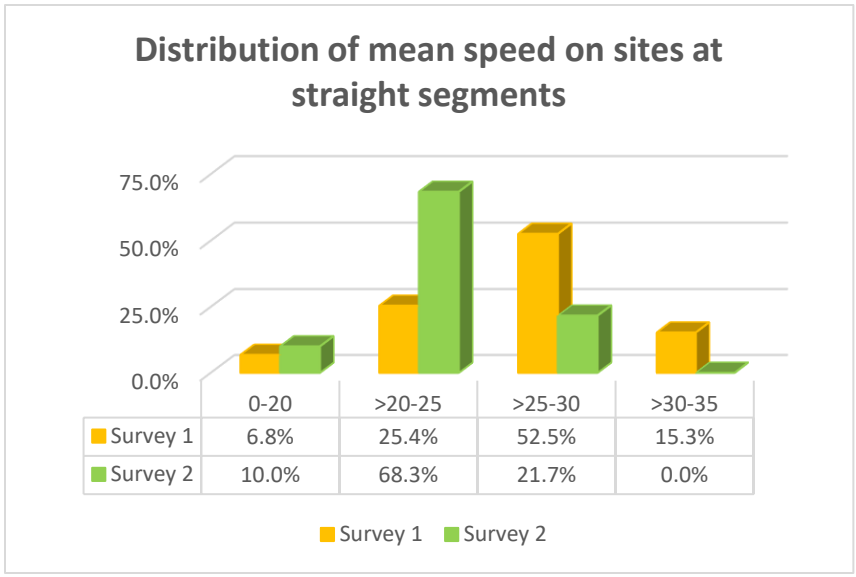
In the context of the "before"-"after I" comparison, 59 sites were identified to be located on a straight segment, whereas 56 sites were found to be located on a curved segment. The mean speed distribution in Survey 1 ("before") and Survey 2 ("after I") for sites located on straight segments are shown in the Figure 4-29. The latter shows that more than two thirds (67.8%) of the distribution of the "before" mean speed is placed above 25 mph, and particularly under the >25-30 mph and >30-35 mph speed bands. While more than three fourths (78.3%) of the "after I" distribution fall either under the 0-20 mph or the >20-25 mph speed band. This result implies a significant reduction in mean speeds between the "before" and "after I" distribution for sites located on straight segments.

Similarly, the same Figure 4-29 shows the 85th percentile speed distribution in Survey 1 ("before") and Survey 2 ("after I") for sites located on straight segments. The "before" 85th percentile speed distribution for sites located on straight roads indicates that nearly two thirds (66.1%) of the sites fall either under the >30-35 mph or the >35-40 mph band. While 71.7% of the sites fall either under the >20-25 mph or the >25-30 mph band in the "after I" state. Overall, in Survey 2, we observe significant reductions in the proportions of sites belonging in the high 85th percentile speed bands, i.e., in the >30-35 mph, >35-40 mph and >40 mph bands. For the latter two ranges, the actual "after I" proportions are equal to zero.

Likewise, the mean speed distributions in Survey 1 ("before") and Survey 2 ("after I") for sites located on curved segments are shown in Figure 4-30. From the latter, it is evident that the majority of sites "before" (51.8%) are linked with the >25-30 mph and >30-35 mph speed bands. Focusing

on the “after I” mean speed distribution, most of the sites (87.7%) fall either in the 0-20 mph or the >20-25 mph speed band. While the remaining 12.3% of the sites fall under the >25-30 mph band. The inferences drawn from the mean speed distribution is that there is a significant reduction in mean speeds on sites located on curved segments after the introduction of the 20mph speed limit. Overall, the “after I” mean speed patterns are similar for straight and curved segments, with curved segments showing more pronounced shifts towards lower speed bands.

Similarly, Figure 4-30 shows the 85th percentile speed distributions in Survey 1 (“before”) and Survey 2 (“after I”) for sites located on curved segments. The distribution in Survey 1 (“before”) indicates that 51.7% of sites are associated with the >30-35 mph and >35-40 mph bands. While the vast majority (79%) of the sites fall under lower speed bands “after I”, and specifically, under the >20-25 mph and >25-30 mph bands. These outputs suggest a notable shift to lower bands for the 85th percentile speed distribution of curved segments, similar to that observed for the straight segments. Again, the shifts to lower speed bands in Survey 2 are more pronounced for curved segments.



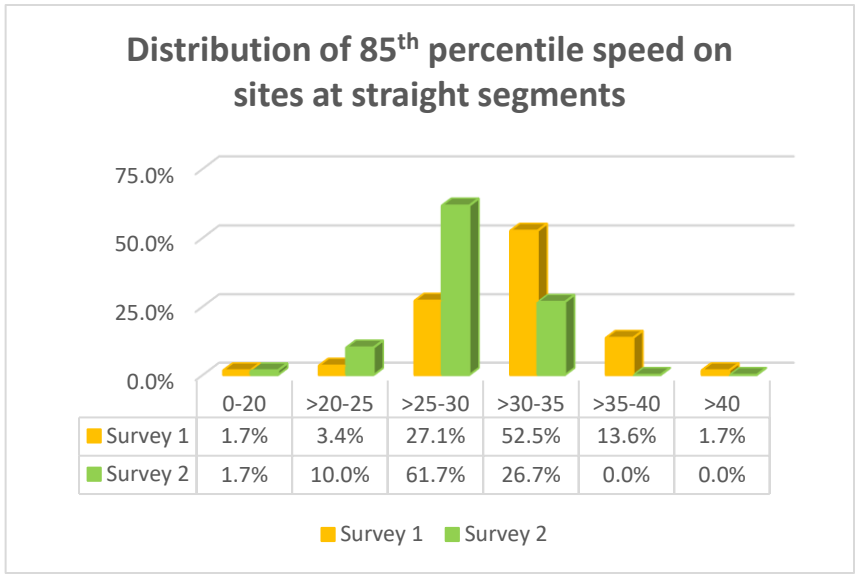
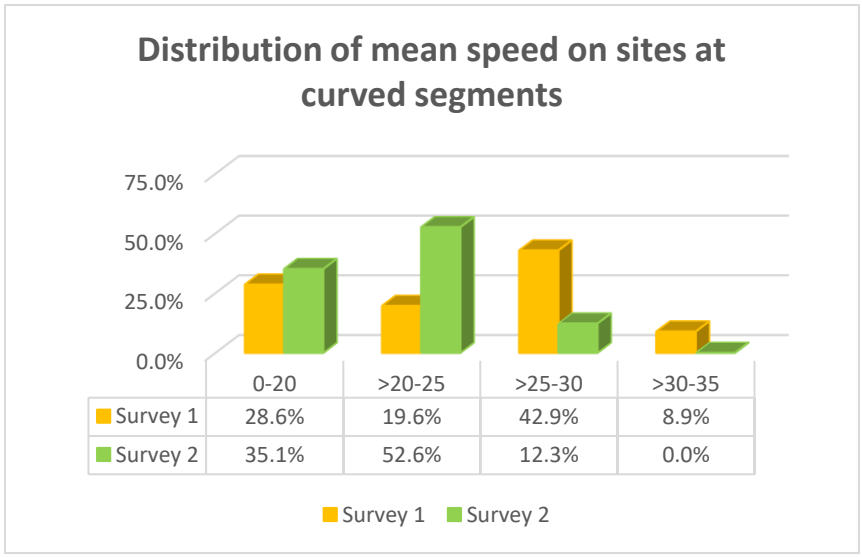


Figure 4-29: Distribution of mean speed and 85th percentile speed on sites at straight segments for Survey 1 and Survey 2



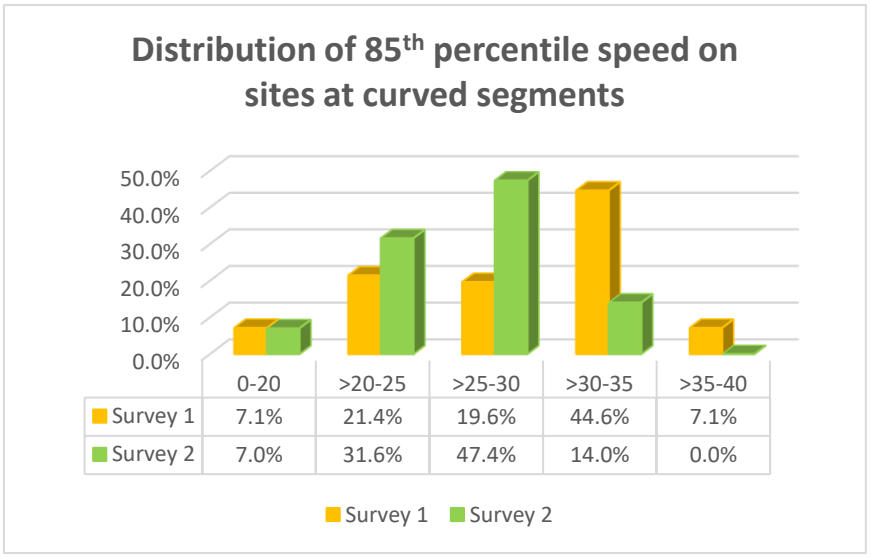


Figure 4-30: Distribution of mean speed and 85th percentile speed on sites at curved segments for Survey 1 and Survey 2

Survey 1 vs Survey 2 vs Survey 3

For this comparison, 37 sites were identified to be located on straight segments, whereas the remaining 18 sites were found to be located on curved segments. The mean speed distributions in Survey 1 ("before"), Survey 2 ("after I") and Survey 3 ("after II") for sites located on straight segments are shown in the Figure 4-31. For the "before" mean speed distributions, 78.4% of the sites fall under the >25-30 and >30-35 speed bands. For the "after I" and "after II" states, 75.7% and 70.3% of the sites, respectively, are associated with speed bands lower than 25 mph. The comparison of the distributions reveals a considerable reduction of mean speeds for both "after I" and "after II" compared to "before" for sites located on straight segments. However, a slight increase in the sites associated with the >25-30 mph band is observed "after II" relative to "after I".

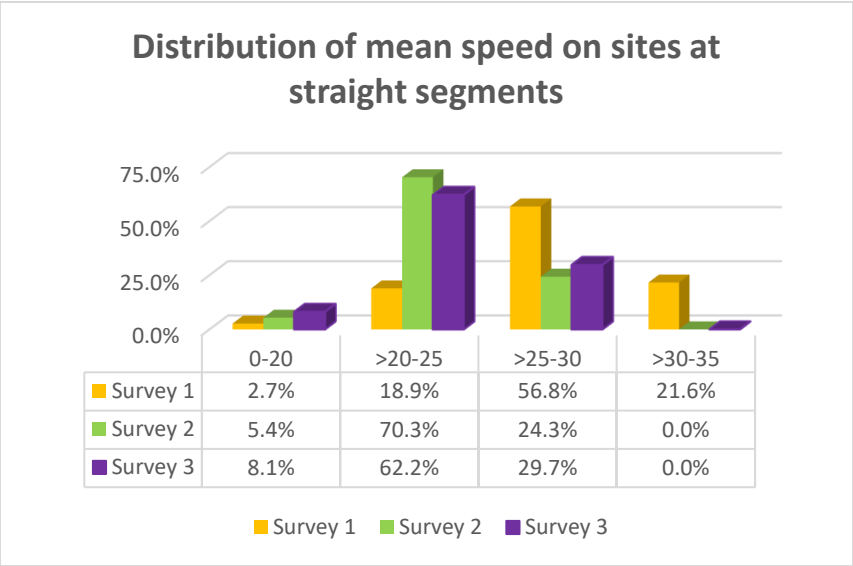
The same Figure shows the 85th percentile speed distributions in Survey 1 ("before"), Survey 2 ("after I") and Survey 3 ("after II") for sites located on straight segments. The "before" distribution indicates that the majority (78.4%) of sites have speeds belonging in the highest speed bands, i.e., the >30-35 mph, >35-40 mph and >40 mph bands. On the contrary, for "after I" and "after II" surveys, most of the sites (70.3% and 67.6%, respectively) fall under the >20-25 mph and >25-30 mph speed bands. As such, significant reductions in 85th percentile speeds are identified in both "after" states.

Focusing on sites located at curved segments, the mean and 85th percentile speed distributions across Survey 1 ("before"), Survey 2 ("after I") and Survey 3 ("after II") are shown in Figure 4-32a. For both "after I" and "after II", we observe notable shifts of mean speed towards lower speed bands (i.e., >20-25 mph and >25-30 mph). In both states, the proportion of sites with mean speed greater than 30 mph is zero compared to 22.2% "before". The 85th percentile distributions show some shifts from higher to lower speed bands, mainly from the >35-40 mph and >30-35 mph bands to the >25-30 mph band.

Survey 1 vs Survey 2 vs Survey 4

As shown in the Figure 4-32b and 4-32c, the distributions of mean and 85th percentile speeds in Survey 4 are quite similar to those for Survey 2. In Survey 4, we observe a slight increase in the sites located at straight segments that have mean speed lower or equal to 20mph. At the same time,

we also observe an increase in the proportion of curved segments that have mean speed in the range >25-30 mph. The Survey 2 and Survey 4 85th percentile distributions for both straight and curved segments are very similar, with the majority of sites having 85th percentile speeds in the >25-30 mph band.



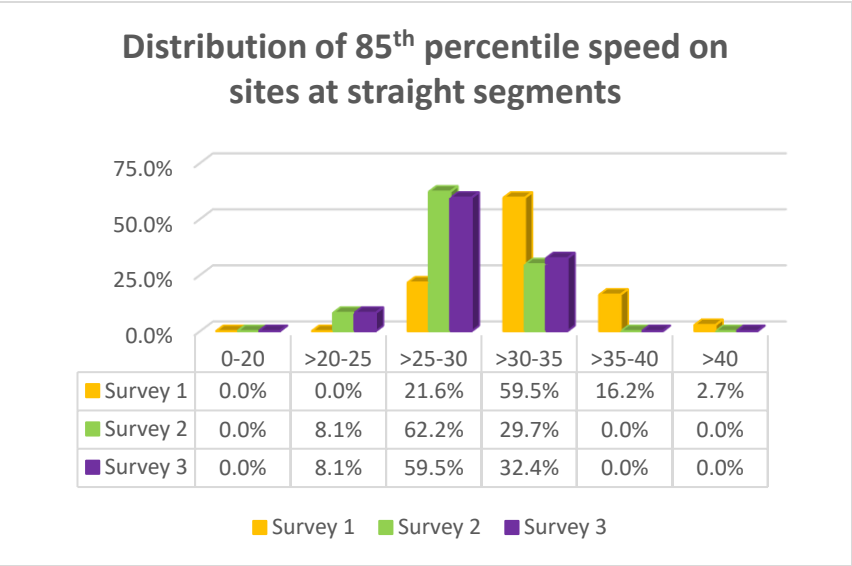
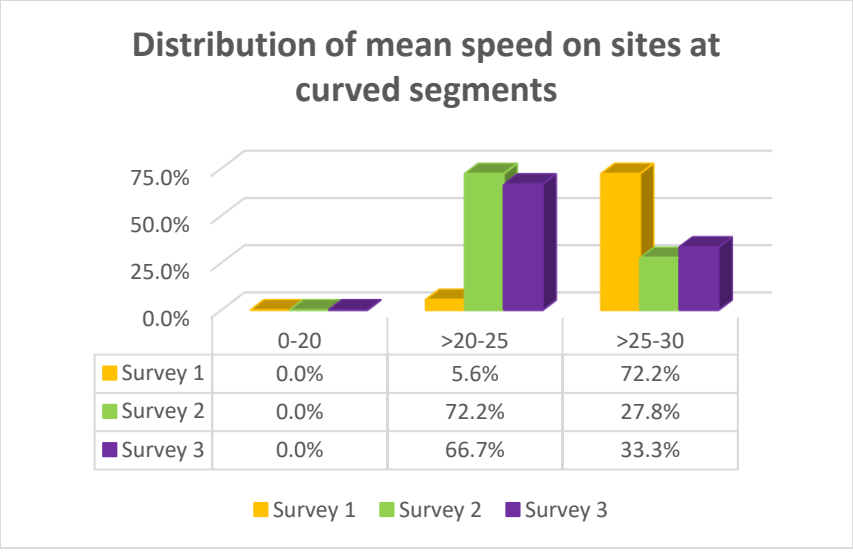


Figure 4-31: Distribution of mean speed and 85th percentile speed on sites at straight segments for Survey 1, Survey 2 and Survey 3



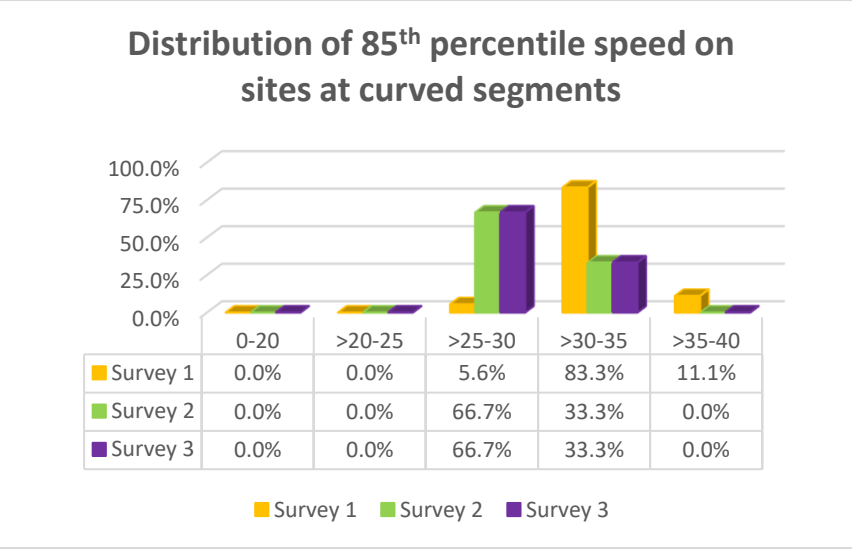
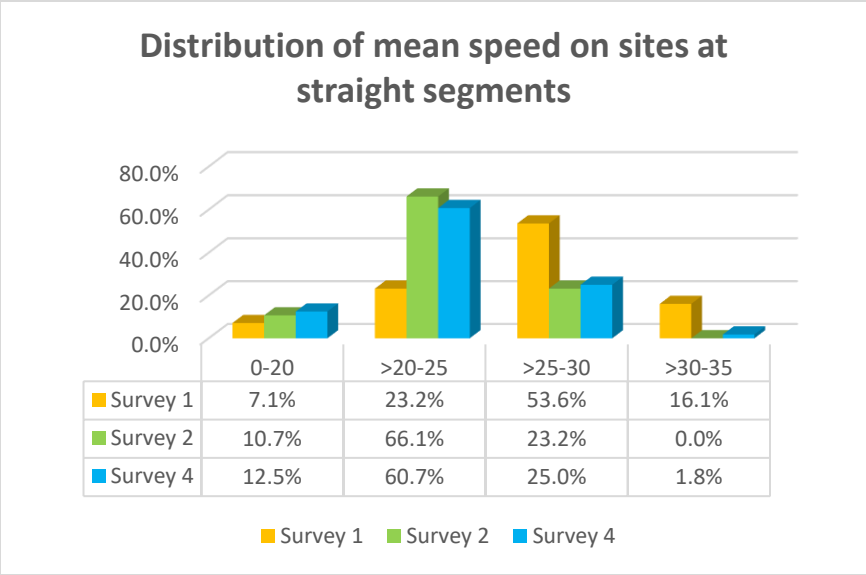


Figure 4-32a: Distribution of mean speed and 85th percentile speed on sites at curved segments for Survey 1, Survey 2 and Survey 3



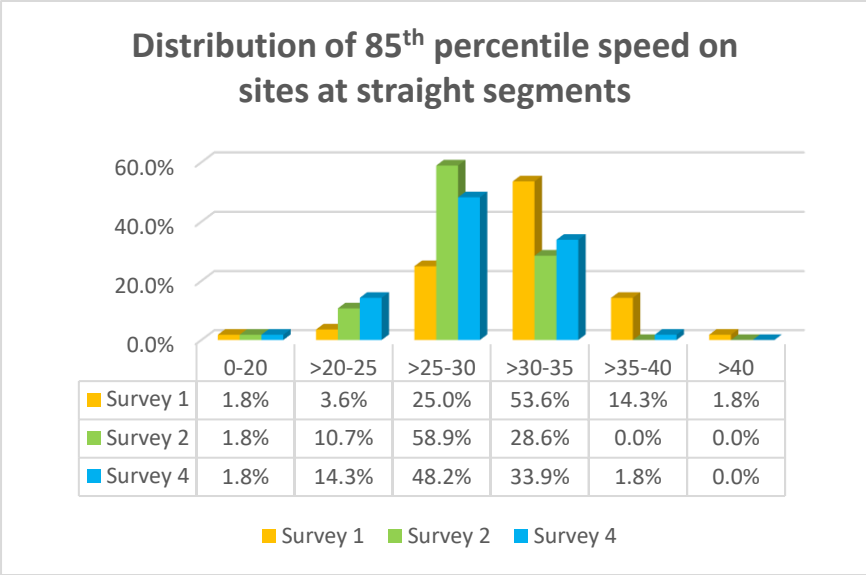
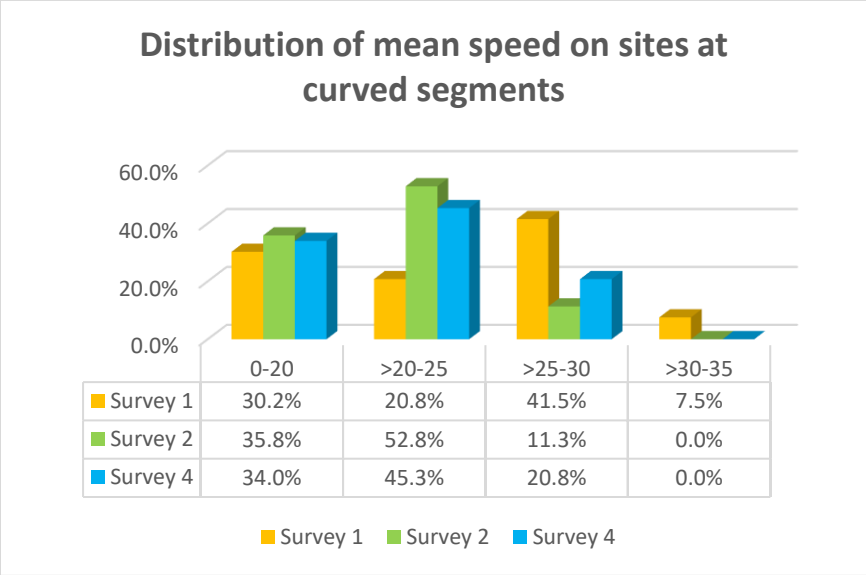


Figure 4-32b: Distribution of mean speed and 85th percentile speed on sites at straight segments for Survey 1, Survey 2 and Survey 4



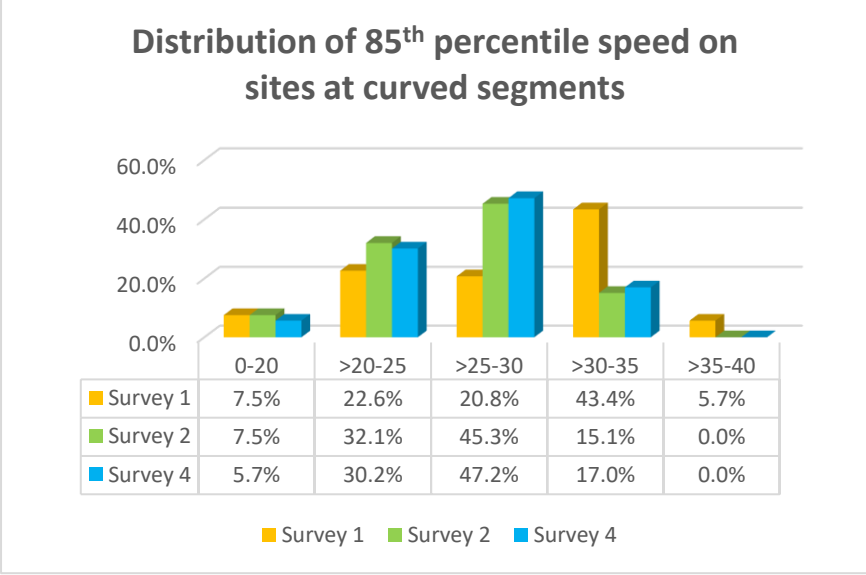


Figure 4-32c: Distribution of mean speed and 85th percentile speed on sites at curved segments for Survey 1, Survey 2 and Survey 3

4.3 Inferential Statistics and Statistical Tests

In order to further evaluate the extent of changes in vehicle speeds before and after the introduction of the 20mph speed limit in Scottish Borders, both non-parametric and parametric statistical tests were carried out to determine the statistical significance of changes for key speed metrics.

4.3.1 Non-Parametric statistical tests

Wilcoxon signed-rank tests were conducted to identify whether the "before-after" differences in mean speeds for the selected sites are statistically significant. In this context, we examine repeated measurements from the same population, i.e., the mean speeds for each site before and after the 20mph intervention. A comparative advantage of the Wilcoxon signed-rank tests relative to other non-parametric tests is that it takes into account not only the sign of the "before-after" difference (i.e., if the difference is negative or positive), but also the magnitude of the difference (Washington et al., 2020). The results of the Wilcoxon Signed Ranks tests for the "before" vs "after I" comparison are shown in the Table 4-41, whereas the outcomes of the "before"-"after I"-"after III" are provided in the Table 4-42.

Table 4-41:Wilcoxon signed-rank test for "before" vs "after I" comparison

Wilcoxon Signed Rank Test		N	Mean Rank	Sum of Ranks
Survey 2 ("after I") speed – Survey 1("before") speed	Sites with speed decrease	108[a]	60.10	6491.00
	Sites with speed increase	6[b]	10.67	64.00
	Ties	1[c]		
	Total	115		
a. Survey 2 ("after I") speed < Survey 1 ("before") speed				
b. Survey 2 ("after I") speed > Survey 1 ("before") speed				
c. Survey 2 ("after I") speed = Survey 1 ("before") speed				

Table 4-41 presents the outcomes of the comparison between "before" and "after I" mean speeds as well as the calculation of the mean ranks and sum of ranks, which constitute integral parts for the Wilcoxon signed-rank test statistics. From the comparison of mean speeds, it is evident that 108 sites saw speed decrease, while only 6 sites had speed increase in the "after I" state. However, 1 site saw no observable change in mean speed after the intervention. The p-value of the test statistic was found almost equal to zero, hence, the changes in mean speed between Survey 1 and Survey 2 are **statistically significant** at **99% level of confidence or more**. In other words, the

speed variations observed "after I" are statistically significant with greater than 99% level of confidence, as compared to "before".

Table 4-42: Wilcoxon signed-rank tests using "before"-"after I"-"after II"- "after III" data

Wilcoxon Signed Ranks Test		**N**	**Mean Rank**	**Sum of Ranks**
Survey 2 ("after I") speed – Survey 1("before") speed	Sites with speed decrease	54[a]	28.48	1538.00
	Sites with speed increase	1[b]	2	2
	Ties	0[c]		
	Total	55		
Survey 3 ("after II") speed – Survey 1("before") speed	Sites with speed decrease	52[d]	28.49	1481.50
	Sites with speed increase	2[e]	1.75	3.5
	Ties	1[f]		
	Total	55		
Survey 4 ("after III") speed – Survey 1 ("before") speed	Sites with speed decrease	101[g]	56.15	5671.00
	Sites with speed increase	7[h]	30.71	215.00
	Ties	1[i]		
	Total	109		
a. Survey 2 average speed < Survey 1 average speed				
b. Survey 2 average speed > Survey 1 average speed				
c. Survey 2 average speed = Survey 1 average speed				
d. Survey 3 average speed < Survey 1 average speed				
e. Survey 3 average speed > Survey 1 average speed				
f. Survey 3 average speed = Survey 1 average speed				
g. Survey 4 average speed < Survey 1 average speed				
h. Survey 4 average speed > Survey 1 average speed				
i. Survey 4 average speed = Survey 1 average speed				

Table 4-42 presents the outcomes of the mean speed comparisons: "before" *vs* "after I", "before" *vs* "after II" and "before" *vs* "after III". For "before" and "after I", the comparison shows that 54 out of 55 sites had speed decrease, while one site had speed increase. Between "before" and "after II", the outcomes show that 52 out of 55 sites had speed decrease, 2 sites saw a speed increase, and for one site no observable differences were identified. Focusing on the "before-after III" comparison, it is evident that 101 out of 109 sites had speed decrease, and 7 sites had speed increase. However, one site saw no change in mean speed between "before" and "after III".

Finally, the p-values for the tests reflecting comparisons “before” vs “after II” and “after I” vs “after II” are both almost equal to zero. Therefore, the observed differences in mean speed across the sites are statistically significant for all comparisons with greater than 99% level of confidence. As discussed in previous sections of this report, the limited number of cases with speed increases are identified for sites having already low mean speeds before the 20mph intervention, belonging either in the 0-20 mph band or the >20-25 mph band.

4.3.2 Parametric statistics

To evaluate the impact of the 20mph trial on vehicle speeds, at the most disaggregate level, numerous independent-sample t-tests were also carried out. To conduct these tests, the vehicle-specific speed data are necessary to be analysed; such extremely granular data, became available for a large subset of Survey 1 and Survey 2 resulting in an extensive dataset consisting of millions of observations. For further details on how such disaggregate data were processed, see the relevant discussion in the “Methods” section.

The main goal of the t-tests is to compare and assess differences in observed vehicle speeds between Survey 1 (“before”) and Survey 2 (“after I”). Given that the speed surveys were carried out throughout a week for each survey wave, the sample size used for the t-test was quite extensive for each site. To provide insights into speed differences to the greatest possible detail, the t-tests were conducted per site (where the disaggregate data was available).

The Table 4-43 provides the results of the t-tests for some selected sites with statistically significant differences in vehicle speeds before and after the introduction of the 20mph intervention across various local areas of the Scottish Borders Council. The complete results of the test for the sites with available data are provided in the Table included in the Appendix 1.

Table 4-43:T-test results for selected sites with statistically significant differences in vehicle speeds after the 20mph speed limit trial

District	Site No	Site Name	No. of Observations		Mean		SD		t_s	p
			Before	After	Before	After	Before	After		
Tweeddale	Site 01	Broughton	11848	7416	29.8	26.87	5.99	7.13	29.45	0.00
	Site 03	A703	45549	36320	29.71	24.82	4.27	5.11	146.22	0.00
	Site 04	Eddleston (Central)	45074	36599	26.94	22.64	4.33	3.89	149.29	0.00
	Site 05	A703	44856	36530	30.4	24.31	5.14	5.03	170.13	0.00
	Site 06	A72 Pirn Road, Innerleithen	42383	37072	24.58	20.86	6.71	5.53	85.62	0.00
Cheviot	Site 20	A698 Main Street	28936	23068	29.89	23.32	4.79	4.86	153.93	0.00
	Site 21	Oxnam Rd	16783	12598	28.95	24.97	4.56	4.18	77.69	0.00
	Site 23	A699 Main Street	15392	11849	30.52	24.32	5.08	5.35	96.86	0.00
	Site 24	B6401 Main Street	4319	3558	25.25	21.58	5.99	5.4	28.49	0.00
	Site 25	Unnamed Road	1909	1417	23.01	21.32	6.04	4.85	8.91	0.00
Teviot & Liddesdale	Site 64	A6088, Chesters	4736	2945	22.93	21.47	3.96	4.24	15	0.00
	Site 65	A698 Jedburgh Road, Denholm	28552	26541	28.72	23.83	5.4	5.47	105.38	0.00
	Site 67	B6399 Liddesdale Road, Hawick	11828	8722	25.53	23.11	5.03	4.87	34.74	0.00

	Site 69	B6357 North Hermitage Street	5836	3882	29.11	22.77	5.51	5.6	55.1	0.00
	Site 108	Minto	1897	1814	23.3	22.17	5.43	5.07	6.56	0.00
Berwickshire	Site 88	Gifford Road, Longformacus	2052	1317	18.64	17.77	3.58	3.3	7.3	0.00
	Site 90	A6112, Preston	15093	11264	30.05	24.5	5.11	4.96	88.82	0.00
	Site 91	B6438 Main St, Reston	4638	3609	27.34	24.2	4.51	4.54	31.23	0.00
	Site 92	B6438, St Abbs	7656	3073	20.03	20.48	4.74	4.64	-4.44	0.00
	Site 93	A6112, Main St, Swinton	9670	7635	24.97	22.53	4.68	4.11	36.46	0.00

SD- Standard Deviation, t_s - t Statistic, p – p Value

For instance, from the Table 4-43, looking at the site 1, Broughton in Tweeddale, the mean value of the vehicle speeds "before" is equal to 29.80 mph (SD=5.99), while "after I" the mean value is 26.87 mph (SD=7.13). The difference in mean speed is 2.93 mph, and this is statistically significant at a level of confidence greater than 99%, as the p-value is equal to zero. The t-statistic is equal to 29.45, which adds further evidence on the statistical difference of the vehicle speeds "before-after I". It should be noted again that the vehicle-specific speed values are required to conduct the site-by-site t-test analysis, due to the parametric nature of the test.

Similarly, for the site 93, A6112, Main Street, Swinton in Berwickshire, a statistically significant difference in mean speed is observed between "before" (M=24.97, SD=4.68) and "after I" (M=22.53, SD=4.11), at a level of confidence greater than 99% (t_s=36.46, p = 0.00). Across all sites included in the Table, statistically significant differences in vehicle speeds before and after the intervention are identified considering a greater than 99% level of confidence.

Table 4-44 provides the t-test results for sites with no statistically significant differences in vehicle speeds "before" and "after I". For these sites, p-value is greater than 0.1, which is the threshold for statistical significance at a 90% level of confidence.

Table 4-44: Sites with no significant difference in vehicle speeds between "before" and "after I" speeds

Site No	Site Name	No. of Observations		Mean		SD		t_s	p
		Before	After	Before	After	Before	After		
Site 33	Unnamed Road	768	637	21.01	20.56	6.55	5.59	1.42	0.157
Site 46	Shoestanes Rd, Heriot	749	662	15.12	15.45	4.30	4.13	-1.48	0.140
Site 84	Bankhouse, Grantshouse	581	553	18.82	18.91	5.25	5.28	-0.3	0.764
Site 107	Kirkhouse (Near Traquair)	3052	2350	25.27	25.00	6.33	6.00	1.59	0.112
Site 109	Yarrowford	793	793	18.63	18.85	4.23	4.39	-1.01	0.311

SD- Standard Deviation, t_s - t Statistics, p – p value

From the Table 4-44, looking at the site 46, Shoestanes Road, Heriot, it is clear that there is not a statistically significant difference in the vehicle speeds between "before" (M=15.12, SD=4.30) and "after I" (M=15.45, SD=4.13), as the values of t-statistic and p-value (t_s=-1.48, p =0.157) do not meet the thresholds of significance. In fact, the actual difference in mean vehicle speed "before-after I" is indeed quite small (0.33 mph). Overall, out of the 90 sites, for which t-tests were conducted, only five sites resulted in speed differences that turned out as statistically insignificant.

These sites feature minor speed differences (less or equal to 0.5 mph) and, apart from Kirkhouse (site 107), their mean speeds are below or very close to 20 mph. In other words, these are sites with already low speed patterns before the intervention, for which, the introduction of the 20mph speed limit had a minimal impact on the vehicle speeds.

As shown in Appendix 1, the other 85 sites yielded statistically significant speed differences "before-after I", almost all at a greater than 99% level of confidence. Out of these, only three sites exhibited speed increases (ranging from 0.45 to 0.9 mph), namely the Hoprig Rd /The Square, B6438, St Abbs, and the Unnamed Road, Cove, but again, for all these sites, the "before" and "after I" speeds are quite low (less or equal than 20 mph). Overall, **91.1% of sites** with available speed data for individual vehicles resulted in **statistically significant speed reductions "before – after I"**.

4.4 Further Before-After Analysis for Additional Traffic Calming Interventions

This section presents the results of the "before-after" analysis focusing on the evaluation of the impact of other interventions on vehicle speeds. Other interventions implemented alongside with the 20mph speed limit include the 20mph speed limit repeaters signs, electronic signs, buffer zones, terminal relocations, and countdowns. To evaluate the potential impact of these interventions on vehicle speeds, we conducted a case-control analysis (Aldred et al., 2018; Washington et al., 2020) to compare key speed metrics between one group of sites where the intervention is in place (case group) and another group of sites where the specific intervention has not been implemented (control group).

4.4.1 20mph speed limit repeater signs

Repeaters in place in Survey 2

20mph speed limit repeaters are typically used as an additional measure to increase drivers' awareness about the newly introduced speed limit, whereas their use has been considered as an additional tool to enhance speed limit compliance (RoSPA, 2017). Before the Survey 2 was conducted, repeaters were placed in just three sites. The descriptive statistics of the mean and 85th percentile speed before and after the installation of the repeaters for these three sites are presented in Table 4-45 and Table 4-46, respectively. Table 4-47 and Table 4-48 present the descriptive

statistics of the mean and 85th percentile speeds for sites without speed limit repeater signs in Survey 2. For both case and control groups (i.e., sites with and without repeaters, respectively), speed decreases are observed in Survey 2 and 3 compared to Survey 1, however, such decreases are larger for sites with speed limit repeater signs. However, it should be noted that the sample size of sites with repeaters installed before Survey 2 is very small, so we cannot make reliable inferences about their impact on vehicle speeds.

Table 4-45: Mean speed in sites where speed limit repeaters were in place "after I"

Mean speed	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	3	19.60	29.00	23.80	4.779
Survey 2	3	18.90	25.00	22.67	3.293
Survey 3	3	18.70	25.40	22.53	3.453

Table 4-46: 85th percentile speed in sites where speed limit repeaters were in place "after I"

85th percentile speed	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	3	26.10	33.30	28.93	3.837
Survey 2	3	25.30	29.30	27.80	2.179
Survey 3	3	24.70	29.90	27.47	2.616

Table 4-47: Mean speed in sites where speed limit repeaters were NOT in place "after I"

Mean speed	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	52	21.40	34.80	28.05	2.719
Survey 2	52	19.90	27.60	23.77	1.923
Survey 3	52	17.80	27.90	24.06	1.925

Table 4-48: 85th percentile speed in sites where speed limit repeaters were NOT in place "after I"

85th percentile speed	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	52	26.60	42.40	32.94	2.901
Survey 2	52	24.10	34.10	28.74	2.726
Survey 3	52	23.30	34.70	29.22	2.494

Repeaters in place in Survey 3

However, before Survey 3 was conducted, repeater signs were put in place in additional 22 sites. The outcomes of the descriptive statistics analysis for the mean and 85th percentile speeds for these 22 sites are presented in Table 4-49 and Table 4-50, respectively.

Table 4-49: Mean speed in sites where speed limit repeaters were in place "after II"

Mean speed	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	22	21.40	32.70	27.51	2.691
Survey 2	22	19.90	27.50	23.39	1.970
Survey 3	22	17.80	27.20	23.91	2.131

Table 4-50: 85th percentile speed in sites where speed limit repeaters were in place "after II"

85th percentile speed	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	22	28.10	37.70	32.39	2.589
Survey 2	22	24.10	34.10	28.32	2.846
Survey 3	22	24.00	33.60	29.03	2.628

For sites without having 20mph speed limit repeaters installed at any point "before-after I-after II", the descriptive statistics of mean and 85th percentile speeds are shown below (Table 4-51 and Table 4-52, respectively).

Table 4-51: Mean speed in sites where speed limit repeaters were NOT in place "after II"

Mean speed	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	30	22.60	34.80	28.44	2.716
Survey 2	30	20.20	27.60	24.05	1.872
Survey 3	30	19.30	27.90	24.17	1.789

Table 4-52: 85th percentile speed in sites where speed limit repeaters were NOT in place "after II"

85th percentile speed	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	30	26.60	42.40	33.34	3.089
Survey 2	30	24.60	34.10	29.06	2.638
Survey 3	30	23.30	34.70	29.36	2.427

From the comparison of descriptive statistics for both speed metrics, it is evident that sites with 20mph speed limit repeaters (installed between Survey 2 & 3, i.e., between "after I" and "after II") yield mean and 85th percentile speeds in the "after II" state, which do not greatly differ from those observed in "after I". The same is also observed for sites without speed limit repeaters; mean and 85th percentile speeds in the "after II" state are quite similar to the corresponding values in the "after I" state. Overall, for both cases, speed patterns do not evidently differ, hence the comparative analysis does not suggest any observable impact of repeater signs' installation on vehicle speeds.

4.4.2 Electronic Signs

Electronic signs in place in Survey 3

The "electronic signs" refer to Vehicle Activated Signs (VAS), which were also leveraged to make the drivers aware of the 20mph speed limit, and they can complement the latter in terms of traffic calming. Before Survey 3 was conducted, electronic signs have been installed in 13 sites with available speed data (case group). The descriptive statistics of the mean and 85th percentile speed before and after the installation of the electronic signs are presented in Table 4-53 and Table 4-54, respectively. For comparison purposes, similar statistics were calculated for 42 sites, where electronic signs had not been installed before Survey 3 (control group), and these are presented in Tables 4-55 and 4-56.

Table 4-53: Mean speed in sites where electronic signs were in place "after II"

Mean speed	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	13	25.20	30.80	28.37	1.801
Survey 2	13	21.10	26.20	23.74	1.441
Survey 3	13	22.20	27.00	24.15	1.424

Table 4-54: 85th percentile speed in sites where electronic signs were in place "after II"

85th percentile speed	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	13	30.00	36.70	32.96	1.950
Survey 2	13	24.10	32.80	28.51	2.389
Survey 3	13	25.50	33.10	29.04	2.218

Table 4-55: Mean speed in sites where electronic signs were NOT in place "after II"

Mean speed	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	42	19.60	34.80	27.64	3.238
Survey 2	42	18.90	27.60	23.70	2.146
Survey 3	42	17.80	27.90	23.93	2.179

Table 4-56: 85th percentile speed in sites where electronic signs were NOT in place "after II"

85th percentile speed	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	42	26.10	42.40	32.65	3.340
Survey 2	42	24.50	34.10	28.75	2.802
Survey 3	42	23.30	34.70	29.15	2.616

Focusing on sites with electronic signs, the mean and 85th percentile speeds in Survey 2 and Survey 3 are quite similar, with the actual differences being quite small. Of course, both speed metrics in Survey 3 are significantly lower compared to Survey 1. The same trend is also observed for sites that do not have electronic signs installed before Survey 3. Speed metrics in Survey 2 and 3 are very similar. In this context, we cannot identify any observable impact on vehicle speeds by comparing sites without and with electronic signs that were installed before Survey 3.

Electronic signs in place in Survey 4

Additional electronic signs were installed at 23 sites (with available data) in the period between Survey 3 and Survey 4. Table 4-57 and Table 4-58 provide the descriptive statistics of the mean and 85th percentile speed for these sites before and after the installation of the electronic signs. For comparison purposes, similar statistics were calculated for 46 sites, for which electronic signs had not been installed at the same period, and these are presented in Tables 4-59 and 4-60.

Table 4-57: Mean speed in sites where electronic signs were in place "after III"

Mean speed (mph)	N	Minimum	Maximum	Average	Std. Deviation
Survey 3	23	19.1	28.7	24.64	2.20
Survey 4	23	20.7	29.2	24.33	2.12

Table 4-58: 85th percentile speed in sites where electronic signs were in place "after III"

85th percentile speed (mph)	N	Minimum	Maximum	Average	Std. Deviation
Survey 3	23	23.9	35.7	29.84	2.71
Survey 4	23	24.7	35	29.45	2.66

Table 4-59: Mean speed in sites where electronic signs were NOT in place "after III"

Mean speed (mph)	N	Minimum	Maximum	Average	Std. Deviation
Survey 3	46	17.8	30.1	24.05	2.35
Survey 4	46	18.4	32	24.80	2.77

Table 4-60: 85th percentile speed in sites where electronic signs were NOT in place "after III"

85th percentile speed (mph)	N	Minimum	Maximum	Average	Std. Deviation
Survey 3	46	23.3	37.1	29.43	2.80
Survey 4	46	23.3	38.9	30.05	3.13

Focusing on sites **with electronic signs**, we can observe a slight reduction (in the range of 0.3-0.4 mph on average) of mean and 85th percentile speeds in Survey 4 compared to Survey 3. In contrast, for sites **without electronic signs** in Survey 4, a slight increase (in the range of 0.6-0.7 mph on average) for both mean and 85th percentile speeds is observed in Survey 4 compared to Survey 3. In fact, the comparison of descriptive statistics for sites with and without electronic signs provide some evidence on the further calming impact that may be induced by the electronic signs. In fact, their installation a few months after the introduction of the 20mph trial is found to aid maintain or even enhance the speed reductions that were gained from the new speed limit.

4.4.3 Buffers, countdowns and terminal relocation

Buffers, countdowns and terminal relocation in place in Survey 3

The last set of traffic calming measures to be evaluated is the installation of buffer zones (of either 30 or 40mph), which were accompanied by countdowns, and terminal relocations in some sites. Before Survey 3, buffers, countdowns and terminal relocation were in place in 6 sites (case group). The descriptive statistics of the mean and 85th percentile speed before and after the implementation

of these additional interventions are presented in Table 4-61 and 4-62, respectively. For comparison purposes, similar statistics were calculated for 49 sites, where these interventions had not been implemented at the same period (control group), and these are presented in Tables 4-63 and 4-64.

Table 4-61: Mean speed in sites where buffers, countdowns or terminal relocations were in place "after II"

Mean speed	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	6	26.80	30.40	29.38	1.297
Survey 2	6	22.10	26.90	24.73	1.598
Survey 3	6	23.50	27.00	25.47	1.174

Table 4-62: 85th percentile speed in sites where buffers, countdowns or terminal relocations were in place "after II"

85th percentile speed	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	6	32.90	35.30	34.18	0.989
Survey 2	6	25.50	34.10	30.18	2.884
Survey 3	6	28.10	33.10	31.00	1.850

Table 4-63: Mean speed in sites where buffers, countdowns or terminal relocations were NOT in place "after II"

Mean speed	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	49	19.60	34.80	27.62	3.058
Survey 2	49	18.90	27.60	23.58	2.010
Survey 3	49	17.80	27.90	23.80	2.029

Table 4-64: 85th percentile speed in sites where buffers, countdowns or terminal relocations were NOT in place "after II"

85th percentile speed	N	Minimum	Maximum	Average	Std. Deviation
Survey 1	49	26.10	42.40	32.54	3.178
Survey 2	49	24.10	34.10	28.51	2.639
Survey 3	49	23.30	34.70	28.89	2.495

From the comparison of the descriptive statistics provided in the previous Tables, it is identified that this set of traffic calming measures does not have any observable impact in terms of vehicle speeds "after II". In fact, for both case and control groups of sites (i.e., with and without interventions), we see minor differences in speed metrics between Survey 2 and Survey 3.

However, the sample size of sites with these interventions is limited, hence we cannot infer reliable conclusions about their impact from this comparison.

Buffers, countdowns and terminal relocation in place in Survey 4

Between Survey 3 and Survey 4, buffers, countdowns and terminal relocations were also installed in 19 sites. The descriptive statistics of the mean speed and 85th percentile speed before and after the implementation of these interventions are presented in Table 4-65 and 4-66, respectively. For comparison purposes, similar statistics were calculated for 56 sites where these interventions had not been implemented during that period, and these are presented in Tables 4-67 and 4-68.

Table 4-65: Mean speed in sites where buffers, countdowns or terminal relocations were in place "after III"

Mean speed (mph)	N	Minimum	Maximum	Average	Std. Deviation
Survey 3	19	17.80	30.10	24.42	2.482
Survey 4	19	18.40	32.00	25.48	3.331

Table 4-66: 85th percentile speed in sites where buffers, countdowns or terminal relocations were in place "after III"

85th percentile speed (mph)	N	Minimum	Maximum	Average	Std. Deviation
Survey 3	19	24.00	37.10	29.73	3.015
Survey 4	19	24.30	38.90	30.64	3.793

Table 4-67: Mean speed in sites where buffers, countdowns or terminal relocations were NOT in place "after III"

Mean speed (mph)	N	Minimum	Maximum	Average	Std. Deviation
Survey 3	56	18.70	30.50	24.07	2.21
Survey 4	56	19.30	30.50	24.07	2.03

Table 4-68: 85th percentile speed in sites where buffers, countdowns or terminal relocations were NOT in place "after III"

85th percentile speed (mph)	N	Minimum	Maximum	Average	Std. Deviation
Survey 3	56	23.30	39.40	29.38	2.970
Survey 4	56	23.30	39.10	29.34	2.828

Focusing on sites having buffer zones and other interventions in place, we saw slight increases in the mean and 85th percentile speeds after the installation of these interventions (i.e., in Survey 4 compared to Survey 3). Such increases may not be necessarily related to the installation of the buffer zones, but this trend requires further investigation in the future. For sites without having buffer zones and other interventions in place, the mean and 85th percentile speeds in Survey 4 are quite similar to their corresponding values in Survey 3.

4.5 Impact of Traffic Volumes on Vehicle Speeds

To identify the potential impact of traffic volumes on vehicle speeds in combination with the impact of the 20mph trial, we also conducted a regression analysis. The regression analysis can show the impact of variations in traffic volumes on vehicle speeds, while controlling, at the same time, for the impact of the 20mph speed limit. The traffic volumes saw a major decrease (31% on average) in Survey 2 (1820 vehicles/day on average) compared to Survey 1 (2383 vehicle/days on average), probably due to the COVID-19 measures and travel restrictions that were in place during the period where the Survey 2 data was collected. During the period of Survey 4, where a significant portion of the measures have been lifted, we observed a major increase in traffic volumes, with the average value being 2506 vehicles/day (5% increase compared to Survey 1).

The dependent variable in the analysis was the mean speed of each site across Survey 1, Survey 2, and Survey 4 – these are the surveys with the largest amount of commonly available data (i.e., 109 locations per survey wave). We estimated a linear regression model using an Ordinary Least Squares approach (Washington et al., 2020). The results of the regression analysis are presented in the Table 4-69.

Table 4-69: Estimation results of the linear regression model of mean speeds

Independent variable	Coefficient	Standard Error	t-stat	p-value
Constant	24.4537	0.37	66.77	0.00
Average traffic volume (vehicles/day)	0.0004	0.00	5.95	0.00
20mph indicator (1 if 20mph limit is present, 0 otherwise)	-2.8356	0.40	-7.07	0.00

The results show that both average traffic volume and 20mph speed limit are statistically significant (at a greater than 99% level of confidence) factors of mean vehicle speeds, as they both resulted in coefficients with high t-stats and low p-values. However, the impact of traffic on vehicle speeds is minimal as the relevant coefficient is practically equal to zero; the actual meaning of the coefficient is that an increase of traffic volume by one vehicle will increase the mean speed by 0.0004 mph.

The coefficient for the 20mph speed limit indicator is significantly larger in magnitude compared to the coefficient for traffic volume, suggesting that for sites with 20mph speed limits, the mean speed is expected to reduce by 2.84 mph. We also tried other variables as controlling factors in the regression model (e.g., level of COVID-19 restrictions being in place), but these did not produce statistically significant coefficients.

5 Summary of Findings and Conclusions

5.1 Summary of Findings

This study focused on the evaluation of the impact of the 20mph speed limit intervention and other associated traffic calming measures in the area of Scottish Borders. Upon a thorough descriptive and statistical analysis of both aggregate and individual vehicle speed data, the following key findings have been drawn:

- Following the introduction of the 20mph speed limit, speed reductions were observed for the vast majority of locations. The mean speed was found to reduce by 3.1 (approx.) mph on average a few weeks after the introduction of the speed limit.
- Similar decrease was also observed for the 85th percentile speed. The decrease was equal to 3.2 mph (approx.) a few weeks after the introduction of the 20mph speed limit.
- Smaller reductions in mean and 85th percentile speeds were identified in locations exhibiting lower speed patterns before the intervention. For example, a few weeks after the introduction of the 20mph speed limit, sites with mean speed in the range of 0-20 mph before the intervention yielded an average reduction of 0.65 mph.
- Substantial speed reductions were observed in sites with high-speed patterns before the intervention. For example, at locations with mean speed in the range of >30-35 mph before the intervention, the average speed reduction was approximately equal to 5.4 mph a few weeks after the introduction of the new speed limit.
- The cross-tabulation analysis showed that the majority of locations moved to lower bands of mean speed after the introduction of the 20mph speed limit, especially the locations exhibiting mean speeds in the range of >25-30 mph and >30-35 mph before the intervention.
- Using speed data collected 5 to 6 months after the intervention, the descriptive statistics analysis showed that reductions in mean and 85th percentile speeds are largely maintained over time.
- The analysis of speed data collected 7 to 8 months after the intervention further confirmed that speed reductions are largely maintained over time. At this period, the mean speed was

lower by 2.7 mph (approximately) compared to the mean speed before the intervention. The 85th percentile speed was found to reduce by 2.6 mph (approximately) compared to its counterpart before the intervention.

- In a period 7 to 8 months after the intervention, the largest speed reductions were observed for sites having mean speed >25 mph before the intervention. The lowest reductions are observed for sites having already low speeds (<20 mph) before the intervention.
- Proportions of vehicles with speed greater than the speed limit and other speeding thresholds (ACPO, DfT) are larger post-intervention. The same pattern is observed across all "after" survey waves. Such increases are line with previous experience on 20mph interventions in the UK.
- Non-parametric statistical tests carried out across all survey waves showed that speed changes are statistically significant, and that speed distributions in the "after" survey waves statistically differ compared to "before".
- Site-by-site parametric t-tests were also conducted using, disaggregate vehicle speed data, with their results suggesting that "before-after" speed changes are statistically significant at a greater than 99% level of confidence for the vast majority of locations.
- Changes in key speed metrics before and after the intervention were observed across various local areas in the Scottish Borders.
- Speed reductions were identified in all settlement types, including very rural, rural, and urban areas after the intervention. Particularly, the vast majority of urban locations were found to yield mean speeds in the range of >20-25 mph after the introduction of the 20mph speed limit.
- Significant speed reductions were also observed in locations with a school in their vicinity. While, before the 20mph intervention, the majority of these location had mean speeds greater than 25 mph, most of these sites appear to have mean speeds lower than 25 mph, at a shorter or longer term after the intervention.
- Speed reductions were noted for both weekdays and weekends after the implementation of the 20mph intervention. However, slightly greater decreases were observed in weekdays.
- No major differences were observed in the speed reduction patterns between straight and curved segments. Speed reductions were observed for both groups of sites.

- Upon a control-case analysis, we did not identify any observable impact on vehicle speeds that could be attributed to the installation of speed limit repeater signs a few months after the onset of the 20mph trial.
- The installation of Vehicle Activated Signs (VAS) displaying the speed of the vehicles (referred to as "electronic signs" in this report) was found to be associated with slight reductions of mean and 85th percentile speeds. That trend was evident in sites where the VAS were installed between 6 and 8 months after the introduction of the 20mph speed limit.
- The installation of buffer zones and other interventions (e.g., countdowns, terminal relocations) was not found to induce any further calming impact on vehicle speeds.
- Fluctuations in traffic volumes were observed across the period of the 20mph trial, mainly due to varying level of COVID-19 travel restrictions that were in place over time. Upon the estimation of a linear regression model, which simultaneously controlled for the impact of the 20mph intervention, it was identified that traffic volumes have a statistically observable, yet minimal impact on vehicle speeds.

5.2 Policy Implications

Over the past decades, communities across Scotland have requested that their local road authorities 'do something to tackle speeding'. We know from past research, including the British Crime Survey, that speeding is seen as the most anti-social behaviour among residents (Poulter & McKenna, 2007). Speeding traffic consistently came out as the antisocial behaviour perceived to be the greatest problem, whether respondents were male or female, young, middle aged, or elderly This new research is the first of its kind in the UK to address the introduction of 20mph speed limits in wholly rurally based settlements, and likely any rural areas in other High Income Countries, where conditions may be similar.

The speed reductions recorded after the pre-intervention Survey 1 provided the baseline data showing a remarkable and persistent level of speed reduction across the multiple sites, which has largely held constant across the 3 post-intervention surveys. As the results show, substantial speed reductions were observed at sites with high-speed behaviours before the intervention. For example, at locations with mean speeds previously in the range of >30-35 mph the speed reduction was

greatest. Small reductions were reported at locations where the pre-intervention speeds were lower. These results triangulate well with previous 20mph speed limit schemes, such as those reported for cities including Edinburgh and Bristol. The results confirm then that where initial speeds were highest this is where the greatest reductions occurred and that this holds true whether 20mph speed limits are implemented in large cities or smaller settlements including villages.

The evidence from the Scottish Borders area shows that 20mph speed limits introduction in place of previous 30mph speed limits are successful at reducing speeds driven at least over a period of 8 months post-implementation. The results help to fill an evidence gap regarding 20mph speed limits and rural settlements. Moreover, as previous research has shown that for rural roads there is an average 4% reduction in collisions with each 1mph reduction in average speed (Finch et al., 1994; Taylor et al., 2000), this suggests that increased application of 20mph speed limits is likely to help with the ambitions of the national Road Safety Framework to reduce casualties (Transport Scotland, 2021). The Framework contains a battery of targets ranging from the headline 50% reduction in people killed and seriously injured by 2030 to intermediate targets including a 40% reduction in pedestrians killed or seriously injured. It is acknowledged that casualty numbers were reported to be relatively low across villages and other small settlements across the Scottish Borders. Even so any further reductions would obviously be welcomed in terms of loss of life averted and avoidance of serious or slight injuries and the consequence burden on the NHS as well as avoidance of productivity loss that such casualties bear.

Moreover, the Framework sets its own ambitions within a wider policy framework where, over the 20-year period, significant societal changes are required, including a reduction in the demand for unsustainable travel. This was epitomised by the Scottish Government's commitment to reduce car kilometres by 20% by 2030.[3] The Road Safety Framework stated that:

> "By 2032 and in a post COVID-19 era, the pendulum will have swung away from the dominance of private car use, particularly single occupancy, to a society which has embraced more walking, wheeling, cycling, public transport and shared transport options, particularly in urban settings."

[3] Securing a green recovery on a path to net zero: climate change plan 2018–2032 – update Securing a green recovery on a path to net zero: climate change plan 2018–2032 - update - gov.scot (www.gov.scot) accessed 24th August 2021.

The impact on casualties of 20mph speed limits in rural areas has been less studied yet the Scottish Executive 20mph speed limit trial reported in 2001, noted earlier, did report on changes in casualties as a result of a 20mph speed limit trial at 75 sites (Burns et al., 2001). Accident data was provided by Councils for 59 sites. It showed the number in each severity category of accident recorded during the period before implementation, which was an average of 35 months, and for a period of time after implementation, which was 15 months. The authors stated that:

> "The results showed a considerable drop in the number of recorded accidents per year after the introduction of the 20mph scheme, but there is also a significant reduction in severity with serious and fatal reduced from 20% to 14%. (p ii)."

This pioneering study seems almost to have been forgotten about despite the highly positive overall results which included attitudinal data. It demonstrated strong local support for the concept of reduced speed limits: the percentage of respondents who considered that the introduction of a trial 20mph scheme had been "absolutely correct" rose from 54% in the 'Before' survey to 64% in the 'After' survey.

20mph speed limits in place of 30mph speed limits can be described as a positive if 'small dose' intervention to reduce the risk of harm or injury from road traffic. However, road traffic speeds also affect how people feel including their choices of how to travel locally as well as general feelings about how they feel to live and move around their locality. Such views cannot be assessed through speed surveys. While the COVID-19 pandemic has affected the ability to gather representative survey samples as to the reported attitudes and behaviours of residents since the introduction of the 20mph speed limits, there is some limited evidence gathered by the Scottish Borders Council that the interventions have improved quality of life, and that more primary school aged children are likely to travel independently and travel to school actively (if they live within 2 miles of school) than before the 20mph speed limits were introduced. A School Child Travel Survey completed by 936 parent/carers in June 2021 did report that as a result of the 20mph speed limit, their child was more likely to travel independently out of school hours, such as going to visit friends and family, going to a play park, or cycling. The net change was a 19% increase.

Highway authorities, public health practitioners, researchers, and advocates for sustainable transport, among others across Scotland have been keen to learn the lessons from this progressive approach taken forward by SBC. The result provide encouragement to consider 20mph as the

default in rural settlements. This report comes shortly after the issuing of the Draft Shared Policy Programme between the Scottish Government and the Scottish Green Party.[4] The first draft of the agreement contained a commitment to support growth in active travel which included the agreement that:

> "all appropriate roads in built up areas will have a safer speed limit of 20 mph by 2025. A task group will be formed to plan the most effective route for implementation."[5] P10

In the UK Highway Code, a built-up area is a settled area in which the speed limit of a road is automatically 30 mph (48 km/h). These roads are known as 'restricted roads' and are identified by the presence of street lights. Thus, built-up areas include rural settlements such as across Scottish Borders Council area where the 20mph speed limit intervention has been trialled. This gives further support to local highway authorities that implementing 20mph speed limits in such settlements is supported by national policy. Moreover, it leaves an opening for a revisiting of Mark Ruskell, MSP's Bill, the Proposed Restricted Roads (20mph Limit) (Scotland) Bill lodged in November 2017. This Bill was voted down in 2019. It proposed a default 20mph speed limit for Restricted Roads across Scotland.

Outside of Scotland but within the UK, perhaps especially in Wales where work progresses to implement default 20mph in place of current 30mph across settlements on restricted roads, there is particular interest in learning lessons from SBC as this rural dimension and the insights and the results will inform Welsh practice. Beyond the UK there is also keen interest in the results given the prior evidence gap for the effectiveness or otherwise of 20mph speed limits in rural areas across High Income Countries. Moreover, this supports the 3rd Global Ministerial Conference on Road Safety held in Stockholm (The Stockholm Declaration) which agreed a commitment to 20mph as default.[6]

[4] Cooperation Agreement between the Scottish Government and the Scottish Green Party Parliamentary Group - gov.scot (www.gov.scot) accessed 12th November 2021.
[5] Scottish Government and Scottish Green Party: draft shared policy programme - gov.scot (www.gov.scot) accessed 12th November 2021.
[6] stockholm-declaration-english.pdf (d3n8a8pro7vhmx.cloudfront.net) accessed 12th November 2021.

5.3 Limitations and Future Research

There are some limitations to the results presented in this report, which should be taken into account while interpreting the outcomes of this study. Such limitations can also set the basis of future research, especially on the long-term evaluation of similar 20mph interventions.

In terms of data availability, while a significant amount of spot speed data was used for the evaluation, such data may not provide extensive information about the variations in speed that are expected throughout journeys. Future research could use journey speed data to factor in the potential impact of such variations, which may be induced by several exogenous factors (e.g., built or physical environment, traffic, weather, human factors, and so on). However, the collection of such data is not straightforward, and it may require the use of sensors and GPS trajectory data. The use of journey speed data could also help better monitoring the compliance of drivers with the 20mph speed limit in the long term. A long-term evaluation of such large-scale intervention should be accompanied with regular data collection and monitoring of speeding behaviour over time in order to identify and address any potential regression-to-the-mean effects (Barnett et al., 2005).

Furthermore, disaggregate vehicle speed data were available for the majority of sites in Survey 1 and Survey 2 resulting to a dataset with millions of individual observations. Future research could foster the use of even more disaggregate data, and for more sites, which could enable the development of complex statistical models, which can account for the effect of unobserved heterogeneity, i.e., unobserved factors that may have an impact on vehicle speeds (Mannering and Anastasopoulos, 2016).

Caution should be exercised on the interpretation of findings related to the effectiveness of other traffic calming interventions, such as the repeater signs, electronic signs and buffer zones. Specifically, limitations may arise from the unbalanced or scarce sample sizes that were evident, in some cases, among groups of sites where the interventions were (or were not) in place. Given that randomisation of sites was not possible, selection bias may be present to some extent in the data used for the comparative analysis. The effectiveness of such traffic calming measures requires further investigation in the future with continuous and systematic data collection and monitoring over time.

Future research can also consider the impact of the 20mph interventions on safety dimensions different from the vehicle speeds. These may include metrics related to the frequency and injury severity of collisions. Due to the timeline of the specific evaluation study, this type of analysis was not possible, but future research devoted to the long-term evaluation of 20mph interventions may focus on the evolution of collision metrics over time, not only for motorised road users, but also for vulnerable road users (e.g., pedestrians and cyclists).

There is little evidence, even for urban areas, as to whether 20mph speed limit introduction can make a contribution to changes in travel mode choice away from habitual car use. This is largely because of the size, duration and design of studies, which has meant that it has not been possible to assess whether mode shift away from car use has occurred. In rural areas, the likelihood is that because distances are longer between destinations the opportunities for travel behaviour change will be less. In addition, the public transport services are not as widely available as in cities and denser urban contexts, and this makes behaviour change even more challenging. However, there is some evidence from studies that 20mph speed limit implementation enables some people to feel able to go out of their home and walk more. The research for SBC suffered as a result of the pandemic with the inability to undertake face-to-face and door-to-door surveys in order to generate a statistically representative sample of views from residents living in settlements where 20mph speed limits were introduced in late 2020. Therefore, there is a need for greater use of qualitative as well as quantitative research in order to assess any changes in travel behaviour over time and the rationale for any travel behaviour change or lack of change. Research into travel behaviour change itself has also shown that after an intervention there is often a lag time before people change travel behavior (Panter and Oglivie, 2017). This supports the view that at least repeat cross sectional studies are required across a number of years post intervention in order to understand both whether travel behaviour change away from car use happens and if so, by how much, as well as tracking the stability or otherwise of the lower speeds driven, as manifested at 8 months post intervention.

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Appendices

Appendix 1

Site No	Site Name	No. of Observations		Mean		SD		SE		t_s	p	DF	CV
		Before	After	Before	After	Before	After	Before	After				
Site 01	Broughton	11848	7416	29.8	26.87	5.99	7.13	0.0551	0.0828	29.45	0	19262	1.6449
Site 03	A703	45549	36320	29.71	24.82	4.27	5.11	0.02	0.0268	146.22	0	81867	1.6449
Site 04	Eddleston (Central)	45074	36599	26.94	22.64	4.33	3.89	0.0204	0.0204	149.29	0	81671	1.6449
Site 05	A703	44856	36530	30.4	24.31	5.14	5.03	0.0243	0.0263	170.13	0	81384	1.6449
Site 06	A72 Pirn Road, Innerleithen	42383	37072	24.58	20.86	6.71	5.53	0.0326	0.0287	85.62	0	79453	1.6449
Site 07	B709 Leithen Road	8173	6183	24.47	23.66	5.39	5.43	0.0597	0.0691	8.91	0	14354	1.645
Site 08	B7062 Kingsmeadow Road	11431	10468	30.72	25.29	6.76	5.74	0.0632	0.0561	64.31	0	21897	1.6449
Site 09	A703 Edinburgh Road	53626	40293	25.29	22.9	4.62	4.38	0.0199	0.0218	80.65	0	93917	1.6449
Site 11	A72 Neidpath	28358	21290	27.4	22.99	6.7	5.87	0.0398	0.0402	78.05	0	49646	1.6449
Site 12	A701	14173	10520	40.75	30.7	6.56	8.44	0.0551	0.0823	101.46	0	24691	1.6449
Site 13	A72	8570	6420	32.69	27.47	5.15	5.75	0.0556	0.0718	57.46	0	14988	1.645
Site 14	A72 Peebles Road	29655	29655	29.21	24.4	4.27	4.74	0.0248	0.0275	129.66	0	59308	1.6449
Site 16	B6461 Duns Road	1000	1000	30.11	26.09	5.79	6.28	0.183	0.1987	14.89	0	1998	1.6456
Site 17	B6400	3533	2994	27.59	25.01	5.93	5.34	0.0997	0.0976	18.44	0	6525	1.6451
Site 18	A698 Main Street	18380	12743	28.57	21.92	4.58	4.16	0.0338	0.0368	132.99	0	31121	1.6449
Site 19	Main Street	2656	2491	28.09	23.97	5.94	5.36	0.1153	0.1074	26.14	0	5145	1.6451
Site 20	A698 Main Street	28936	23068	29.89	23.32	4.79	4.86	0.0282	0.032	153.93	0	52002	1.6449
Site 21	Oxnam Rd	16783	12598	28.95	24.97	4.56	4.18	0.0352	0.0373	77.69	0	29379	1.6449
Site 23	A699 Main Street	15392	11849	30.52	24.32	5.08	5.35	0.041	0.0491	96.86	0	27239	1.6449
Site 24	B6401 Main Street	4319	3558	25.25	21.58	5.99	5.4	0.0912	0.0906	28.49	0	7875	1.645
Site 25	Unnamed Road	1909	1417	23.01	21.32	6.04	4.85	0.1384	0.1289	8.91	0	3324	1.6453

SD- Standard Deviation, SE – Standard Error, t_s - t Statistics, p – p Value, DF – Degree of Freedom, CV- Critical Value

Site No	Site Name	No. of Observations		Mean		SD		SE		t_s	p	DF	CV
		Before	After	Before	After	Before	After	Before	After				
Site 26	Unnamed Road	566	387	17.89	17.14	4.47	4.07	0.1879	0.2068	2.7	0.007	951	1.6465
Site 27	C78, Smailholm	8003	6815	32.24	26.67	6.48	6.33	0.0725	0.0766	52.82	0	14816	1.645
Site 28	B6350	12611	7428	36.64	33.18	5.5	5.73	0.049	0.0665	41.83	0	20037	1.6449
Site 31	B6364 Main Street	7904	6921	29.55	25.67	4.92	4.91	0.0553	0.059	48.01	0	14823	1.645
Site 32	B6401 Cheviot Place	4315	3432	28.48	25.26	6.47	6.24	0.0985	0.1065	22.21	0	7745	1.6451
Site 33	Unnamed Road	768	637	21.01	20.56	6.55	5.59	0.2365	0.2213	1.42	0.157	1403	1.6459
Site 34	Unnamed Road, Ashkirk	3389	2704	20.05	19.15	3.87	3.53	0.0665	0.0679	9.49	0	6091	1.6451
Site 36	A72 Vine Street	32303	28739	27.88	23.08	3.66	4.02	0.0204	0.0237	153.41	0	61040	1.6449
Site 37	B6394 Main Street	9163	8053	15.64	14.24	3.08	2.96	0.0322	0.033	30.39	0	17214	1.6449
Site 38	A6105	23364	14769	29.58	25.51	5.18	4.82	0.0339	0.0396	78.01	0	38131	1.6449
Site 39	Main Street, Ettrickbridge	2922	2194	23.03	21.86	5.74	5.2	0.1061	0.1111	7.63	0	5114	1.6452
Site 40	Old Stage Road	1065	829	21.36	19.93	6.88	6.28	0.2109	0.2179	4.72	0	1892	1.6457
Site 41	B6374 Melrose Road, Galashiels	53315	52001	29.62	23.11	4.56	3.91	0.0198	0.0171	248.66	0	105314	1.6449
Site 42	Scott Street	42612	42612	23.73	20.93	4.77	4	0.0231	0.0194	92.94	0	85222	1.6449
Site 43	A7 Abbotsford Road	128740	115609	27.16	21.09	4.27	3.76	0.0119	0.0111	373.67	0	244347	1.6449
Site 44	Windyknowe Road, Galashiels	11978	11978	25.86	22.38	4.53	3.93	0.0414	0.0359	63.48	0	23954	1.6449
Site 45	B6360 Main St, Gattonside	17177	14875	29.78	23.86	4.89	4.68	0.0373	0.0384	110.68	0	32050	1.6449
Site 46	Shoestanes Rd, Heriot	749	662	15.12	15.45	4.3	4.13	0.157	0.1604	-1.48	0.140	1409	1.6459
Site 47	Thirlestane Dr, Lauder	3667	2592	16.87	14.56	3.17	3.04	0.0523	0.0598	29.1	0	6257	1.6451
Site 48	B6362 Stow Rd, Lauder	13547	3757	34.77	26.48	9.37	6.37	0.0805	0.1038	63.07	0	17302	1.6449
Site 49	B6359 Main St, Lilliesleaf	3631	3631	20.59	19.45	5.72	4.62	0.095	0.0766	9.35	0	7260	1.6451

SD- Standard Deviation, SE – Standard Error, t_s - t Statistics, p – p Value, DF – Degree of Freedom, CV- Critical Value

Site No	Site Name	No. of Observations		Mean		SD		SE		t_s	p	DF	CV
		Before	After	Before	After	Before	After	Before	After				
Site 52	Main Street, Midlem	3551	3059	23.5	21.75	6.08	5.36	0.102	0.097	12.41	0	6608	1.6451
Site 53	B6361 Main Street, Newstead	4163	3459	21.78	20.66	4.75	4.18	0.0736	0.0711	10.88	0	7620	1.6451
Site 55	Station Road, Oxton	3392	3392	22.25	20.68	5.44	4.77	0.0934	0.0819	12.64	0	6782	1.6451
Site 56	Unnamed Road	862	862	15.15	14.84	3.49	3.49	0.1189	0.1188	1.83	0.067	1722	1.6457
Site 57	A707 Linglie Road, Selkirk	9723	5334	35.72	32.95	7.05	7.15	0.0715	0.0979	22.82	0	15055	1.645
Site 59	Bleachfield Road, Selkirk	15070	11268	24.74	22.49	5.04	4.43	0.0411	0.0418	38.51	0	26336	1.6449
Site 60	A7 Galashiels Road	56061	24090	29.62	23.88	3.88	4.59	0.0164	0.0296	169.74	0	80149	1.6449
Site 61	A7, Stow (North)	53513	22561	26.77	23.5	4.41	4.57	0.0191	0.0304	91.09	0	76072	1.6449
Site 64	A6088, Chesters	4736	2945	22.93	21.47	3.96	4.24	0.0575	0.0782	15	0	7679	1.6451
Site 65	A698 Jedburgh Road, Denholm	28552	26541	28.72	23.83	5.4	5.47	0.032	0.0336	105.38	0	55091	1.6449
Site 67	B6399 Liddesdale Road, Hawick	11828	8722	25.53	23.11	5.03	4.87	0.0462	0.0521	34.74	0	20548	1.6449
Site 69	B6357 North Hermitage Street	5836	3882	29.11	22.77	5.51	5.6	0.0721	0.0898	55.1	0	9716	1.645
Site 70	B6437 Main St, Allanton	8520	7194	29.26	22.42	4.99	5.1	0.0541	0.0601	84.61	0	15712	1.645
Site 71	B6355, Ayton	10018	8653	25.75	21.78	5.01	4.29	0.0501	0.0461	58.32	0	18669	1.6449
Site 72	Unnamed Rd, Burnmouth	5650	3226	27.54	24.44	5.15	5.38	0.0686	0.0947	26.54	0	8874	1.645
Site 73	Crosshill/Kirkgate, Chirnside	5929	5268	18.38	17.5	3.16	2.95	0.0411	0.0406	15.25	0	11195	1.645
Site 74	Hoprig Rd /The Square	3044	2940	19.01	19.91	4.1	4.25	0.0743	0.0783	-8.37	0	5982	1.6451
Site 76	Duns Road, Coldsteam	9108	7940	28.11	22.76	5.36	4.93	0.0561	0.0553	67.81	0	17046	1.6449
Site 77	Unnamed Road, Cove	2173	754	14.47	15.18	3.64	3.86	0.078	0.1405	-4.37	0	2925	1.6454
Site 78	A6105 Langtongate, Duns	28455	26039	28.82	22.82	6.04	4.78	0.0358	0.0296	129.23	0	54492	1.6449

SD - Standard Deviation, SE – Standard Error, t_s - t Statistics, p – p Value, DF – Degree of Freedom, CV- Critical Value

Site No	Site Name	No. of Observations		Mean		SD		SE		t_s	p	DF	CV
		Before	After	Before	After	Before	After	Before	After				
Site 79	B6461 Main Street, Eccles	10873	10029	31	24.31	6.16	5.33	0.0591	0.0532	84.19	0	20900	1.6449
Site 80	A1107, Eyemouth	23653	15069	28.54	23.74	4.29	4.25	0.0279	0.0346	107.94	0	38720	1.6449
Site 81	Unnamed Road, Foulden	1331	1331	23.35	22.64	6.97	5.78	0.191	0.1586	2.85	0.004	2660	1.6454
Site 82	A6105, Foulden	18045	13493	37.36	31.85	5.26	5.78	0.0392	0.0497	87.04	0	31536	1.6449
Site 83	Main Street, Gavinton	2153	2153	28.59	23.71	5.43	5.22	0.1169	0.1125	30.04	0	4304	1.6452
Site 84	Bankhouse, Grantshouse	581	553	18.82	18.91	5.25	5.28	0.2176	0.2246	-0.3	0.764	1132	1.6462
Site 85	Duns Road between Queens Row & The Avenue Greenlaw	17091	16998	29.95	24.87	5.47	5.21	0.0418	0.0399	87.87	0	34087	1.6449
Site 86	B6461 Main Street	9770	7936	26.79	22.29	5.44	4.55	0.055	0.051	59.99	0	17704	1.6449
Site 87	A6112, Lennel	4911	3557	28.75	23.4	5.84	5.65	0.0833	0.0947	42.38	0	8466	1.645
Site 88	Gifford Road, Longformacus	2052	1317	18.64	17.77	3.58	3.3	0.0791	0.0908	7.3	0	3367	1.6453
Site 90	A6112, Preston	15093	11264	30.05	24.5	5.11	4.96	0.0416	0.0467	88.82	0	26355	1.6449
Site 91	B6438 Main St, Reston	4638	3609	27.34	24.2	4.51	4.54	0.0662	0.0756	31.23	0	8245	1.645
Site 92	B6438, St Abbs	7656	3073	20.03	20.48	4.74	4.64	0.0542	0.0837	-4.44	0	10727	1.645
Site 93	A6112, Main St, Swinton	9670	7635	24.97	22.53	4.68	4.11	0.0475	0.047	36.46	0	17303	1.6449
Site 94	B6456, Westruther	2911	2911	26.15	22.81	5.44	5.3	0.1008	0.0982	23.7	0	5820	1.6451
Site 105	South Parks	6550	6304	22.63	20.8	4.73	4.26	0.0584	0.0536	23.06	0	12852	1.645
Site 106	Traquair	4463	3248	29.02	26.34	7.34	7.35	0.1099	0.129	15.84	0	7709	1.6451
Site 107	Kirkhouse (Near Traquair)	3052	2350	25.27	25	6.33	6	0.1145	0.1237	1.59	0.112	5400	1.6451
Site 108	Minto	1897	1814	23.3	22.17	5.43	5.07	0.1246	0.1191	6.56	0	3709	1.6453
Site 109	Yarrowford	793	793	18.63	18.85	4.23	4.39	0.1503	0.1558	-1.01	0.311	1584	1.6458

SD- Standard Deviation, SE – Standard Error, t_s - t Statistics, p – p Value, DF – Degree of Freedom, CV- Critical Value

Site No	Site Name	No. of Observations		Mean		SD		SE		t_s	p	DF	CV
		Before	After	Before	After	Before	After	Before	After				
Site 111	Cotgreen Road	3522	3522	19.06	17.29	3.78	3.45	0.0637	0.0582	20.49	0	7042	1.6451
Site 112	Oxnam	2178	2178	28.03	25.08	5.85	5.86	0.1254	0.1255	16.62	0	4354	1.6452
Site 114	Unnamed Road, Lanton	1092	985	18.68	18.2	3.69	3.96	0.1117	0.1263	2.85	0.005	2075	1.6456
Site 115	B6356, Clintmains	2463	1327	28.11	21.75	5.23	4.35	0.1054	0.1195	39.91	0	3788	1.6453
Site 116	B6356, Bemersyde	1517	839	20.97	19.85	5.12	4.88	0.1315	0.1686	5.23	0	2354	1.6455
Site 117	Unnamed Road, Hume	1349	1272	27.41	25.07	6.11	5.7	0.1664	0.1599	10.17	0	2619	1.6454
Site 120	Auchencrow	593	593	20.7	18.38	5.39	4.3	0.2212	0.1766	8.2	0	1184	1.6461
Site 121	Nether Blainslie (Near Lauder)	1299	890	26.38	23.71	8.36	6.8	0.232	0.2281	8.19	0	2187	1.6456

SD- Standard Deviation, SE – Standard Error, t_s - t Statistics, p – p Value, DF – Degree of Freedom, CV- Critical Value