Mornington Peninsula
Speed Limit Change Evaluation

VICTORIA State Government | Department of Transport

Executive Summary

Background

Mornington Peninsula Shire Council (MPSC) has demonstrated strong leadership role in adopting and applying the Safe System approach to improve road safety in the Mornington Peninsula. In 2019, the Mornington Peninsula Shire had experienced significant road trauma, with the second most deaths of any municipality recorded in Victoria behind the large regional city of Greater Geelong. By the end of 2019, over 200 people had sustained serious injuries and 12 people had died on Peninsula roads - a large increase from the two lives lost in MPSC in 2018. In addition, in the period 2014-2021, MPSC was the equal worst Victorian municipality for road deaths with 64 people killed.

To reduce long term crash risk on the road network, MPSC initiated a large-scale speed limit reduction trial. Beginning in early 2020, the two-year trial has involved the implementation of speed limit reductions on 33 high speed sealed local roads (35 individual corridor segments) within the municipality.

The speed limit reduction trial is supported by Road Safety Victoria (RSV) and the program evaluation is being led by Safer Roads. The Safer Speeds on High Speed Local Government Area (LGA) Roads evaluation framework has been developed by Safer Roads for the short-term evaluation of speed limit changes on LGA roads to support the evaluation during the trial period. The framework outlines the evaluation objectives, methodology and key performance indicators which are centred around reducing speeds and increasing proportion of motorists travelling below the safe (target) speed of 80 km/h.

The evaluation methodology used in the MPSC trial is slightly different to the methods proposed in the aforementioned evaluation framework, as the before data was collected before the evaluation framework was finalised. Nonetheless a robust understanding of the impact of speed limit change on vehicle speeds and fatal and serious injury crash reductions was established from this trial.

Evaluation Objectives and Method

The objective of this evaluation was to assess the following observed and expected outcomes from the trial:

- Reduction in free flow mean speeds associated with a
  - Speed limit change from 100 km/h to 80 km/h (Trial 1 - 20 treated routes and 17 control routes)
  - Speed limit change from 90 km/h to 80 km/h (Trial 2 - 15 treated routes and one control route))
- Changes in the proportion of motorists travelling below 80 km/h (target of "below 80 km/h" proportion) and below 100 km/h (target “upper bound” proportion)
- Estimated fatal and serious injury (FSIs) reductions expected from the speed limit change.
- Changes in speed limit compliance associated with the speed limit changes.

Before speed data were collected in December 2019. Three periods of After speed data have also been collected, in May 2020 (After 1 Period), November 2020 (After 2 Period) and November/ December 2021 (After 3 Period). Speed, speed limit and safe (target) speed compliance changes were investigated at the program and project (individual route) levels.

Key Findings

The findings of the study are:

1) There is very strong evidence that an average 5 km/h mean operating speed reduction has been achieved after two years of the speed limit being reduced from 100 km/h to 80 km/h (20 km/h drop) across MPSC, with the most recent ‘After’ reductions exceeding the corresponding ‘After’ reductions observed at 6 months and 12 months after the speed limit changes. Even though there is a trend towards increasing reductions in mean speed with time, no statistically reliable differences are yet evident among the three After periods.
2) The 5 km/h drop in operating speed is similar to other evaluations of speed limit reductions from 100 km/h to 80 km/h.
3) An even greater mean speed reduction of 7 km/h was observed after two years for a subset of roads that carry more than an average of 1000 vehicles per day.

4) Across all after periods, a higher speed reduction of 8 km/h was observed on a subset of Trial 1 roads that had an operating speed of 85 km/h or higher in the Before case, and therefore a higher risk of FSI crashes.
5) The After 3 speed reductions, which were greater than the After 1 speed reductions, confirm that the reduction observed in After 1 (which was greater than After 2) was not due to the novelty of a new speed limit and supplementary "New Limit" speed signs that were only present during After 1.
6) There is some evidence that the mean free flow speeds have reduced by 3 km/h as a result of the speed limit reduction of 90 km/h to 80 km/h. However, this is considered an interim result, as it was not possible to determine whether there is a need to adjust this result using control route data. Regardless, the result exceeds the outcome expected for a 10km/h speed limit reduction.
7) Even though there is very strong evidence to suggest a drop in mean speeds from before to all after periods, there is little evidence to suggest reductions from After 1 to After 2 and from After 1 and After 3. However, there is strong evidence to suggest that mean speeds have dropped from After 2 to After 3.
8) That speed limit compliance rates reduced significantly from Before to After 1 when the speed limits were dropped to 80 km/h. This was particularly noticeable where the speed limits were reduced from 100 km/h to 80 km/h, with 64% of the drivers complying with the new speed limit in After 3 compared to 93% in the Befotre period. However, there is very strong evidence to suggest that speed limit compliance has improved from After 2 to After 3.
9) For the roads where the speed limits were dropped from 90 km/h to 80 km/h, the compliance rates were higher than the 100 km/h to 80 km/h trial. However, over one-third of drivers were still exceeding the speed limit.
10) That the number of drivers travelling below the target speed of 80 km/h (Target Speed Proportion) increased significantly for both the 100 km/h to 80 km/h and 90 km/h to 80 km/h speed changes. In both cases over 60% of drivers were under the target speed of 80 km/h in the after periods, compared to 42% and 46%, respectively, in the before period. Similar to speed limit compliance, there is some evidence to suggest that the proportion of drivers travelling within the target speed has improved from After 2 to After 3. This is an important outcome from a Safe System perspective, as the greater numbers of drivers now travelling below these targeted, much safer speeds have substantially reduced the risk of FSI crashes.
11) For the 100 km/h to 80 km/h trial, the average predicted reduction in FSI's is approximately 20% (control corrected), with some routes showing reductions as high as 39%. For the 90 km/h to 80 km/h routes the reductions are likely to be less, with an average FSI reduction of 15% across the treated routes.
12) Consistent with the predicted, actual observations from the two years prior to the implementation of trial and the 24 months of data afterwards demonstrate a control corrected 20% approximate reduction in casualties, including no fatalities compared to eight in the two years prior. Whilst encouraging, a well-designed before and after study of FSIs after 5 years should be conducted to confirm whether the predicted FSI reductions were accurate across the full sample of roads.

Next steps

1) Large-scale changes in speed behaviour take time and cannot easily be identified or demonstrated in the short term. However, findings of this two-year evaluation are encouraging. It is recommended that further after data are collected at regular intervals to monitor speeds at trial routes. As more lower speed limits are introduced, and other supporting actions like education campaigns and targeted enforcement occur, then speeds are likely to come down further as they have in previous speed limit changes 60km/h to 50 km/h and 100 km/h to 80 km/h in Victoria. Even small reductions in travel speeds have been found to produce disproportionately larger reductions in the risks of fatal and serious injuries.
2) It is assumed that road policing was affected by COVID-19, with police resources being diverted to other forms of policing during the after periods. It is therefore plausible that further improvements in speed limit compliance can be expected as road policing returns to normal enforcement levels.
3) It is plausible that, over time, compliance will increase, even without enforcement or other interventions. Systemic driver behaviour and speed choice might take time to adjust, especially as long term drivers with ingrained habits are replaced by new drivers in the system.

Contents

Tables

Figures

Appendices

Mornington Peninsula Speed Limit Change Evaluation

Quality Assurance Information

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1. Introduction

Mornington Peninsula Shire Council (MPSC) has demonstrated strong leadership role in adopting and applying the Safe System approach to improve road safety in the Mornington Peninsula. In 2019, the Mornington Peninsula Shire had experienced significant road trauma, with the second most deaths of any municipality recorded in Victoria behind the large regional city of Greater Geelong. By November 2019, over 200 people had sustained serious injuries and 12 people had died on Peninsula roads - a large increase from the two lives lost in MPSC in 2018. In addition, in the period 2014-2021, MPSC was the equal worst Victorian municipality for road deaths with 64 people killed.

As part of reducing long term crash risk on the road network, MPSC initiated a large-scale speed limit reduction trial. Beginning in early 2020, the two-year trial has involved the implementation of speed limit reductions on 33 high speed sealed local roads (35 road corridor segments) within the municipality. The trial routes are shown in Figure 1-1**.**

Mornington Peninsula offers a unique environment in which to undertake and evaluate this speed trial. Local high-speed roads across the Mornington Peninsula are considered something of a cul-de-sac. Visitors to the region, who make a significant contribution to the economy, often don't know their destination, stopping at places of interest on winding roads. These roads are unlikely to receive infrastructure treatments in the foreseeable future and so the introduction of safer speed limits that match the environment of these roads is the most suitable treatment to reduce risks on these roads for both visitors and the local community.

The focus of this study is on understanding how effective these speed limit reductions have been on;

- Reducing free flow mean speeds;
- Increasing proportion of motorists travelling below a target speed of 80 km/h; and
- Reducing the proportion of traffic travelling above 100 km/h (unsafe speed for these corridors)
- Change in compliance with the new speed limit;

The results of this study will help inform decisions on where to target further speed limits changes in municipalities across Victoria.

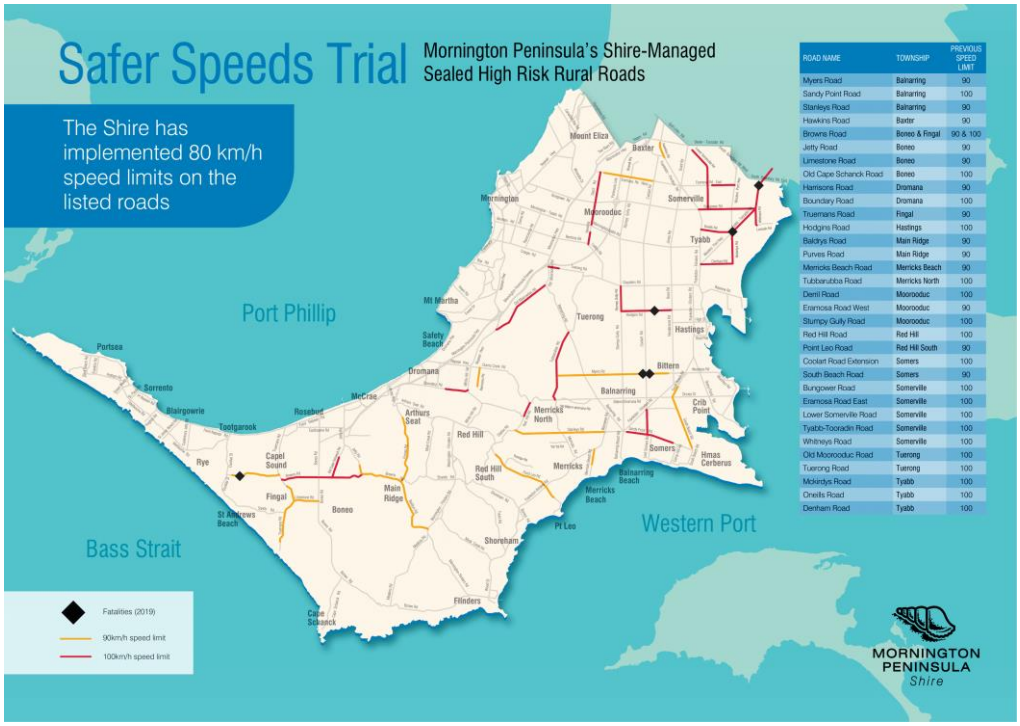


Figure 1-1 Speed limit reduction trial roads

The speed limit reduction trial is supported by Road Safety Victoria (RSV) and the program evaluation is being led by Safer Roads. Safer Speeds on High Speed Local Government Area (LGA) Roads evaluation framework has been developed by Safer Roads for the short-term evaluation of speed limit changes on Local Government Area (LGA) roads, outlining the evaluations objectives, methodology and key performance indicators that are to be used to measure success. Additionally, the framework outlines the key statistical methods and survey design methodology for undertaking these evaluations.

The evaluation methodology used in the Mornington Peninsula trial is slightly different to the methods proposed in the LGA evaluation framework, as the before data was collected prior to the framework being produced and has some limitations. Nevertheless, it has been possible to work within the limitations to understand the speed changes and likely crash savings associated with this speed management trial.

1.1 Evaluation Objectives and Method

The objective of this evaluation was to assess the following observed and expected outcomes from the trial:

- Reduction in free flow mean speeds associated with a
  - Speed limit change from 100 km/h to 80 km/h (Trial 1 - 20 treated and 17 controls)
  - Speed limit change from 90 km/h to 80 km/h (Trial 2 - 15 treated and 1 control)
- Changes in speed limit compliance associated with the speed limit changes
- Changes in proportion travelling the target of "below 80 km/h" and “below 100 km/h” speeds
- Estimated Fatal and Serious Injury crash reductions expected from the speed limit change

This analysis will inform three of the following objectives and key performance indicators of the evaluation framework shown in Table 1-1. The fourth objective, around community acceptance, has been assessed in a separate study. An additional safety indicator has been added by the project working group, which is the compliance with the desired target speed of 80 km/h. While often compliance with the speed limit may deteriorate after a speed limit reduction occurs, what is of more importance is whether more drivers are travelling below the target Safe System speed, which in this case is 80 km/h.

Table 1-1 Evaluation Framework Objectives and KPIs

Treatment trial objectives	Objectives KPIs
Effectiveness in achieving safer speeds	Speed reduction along corridor (using spot speed data)
Increase Speed Limit compliance	Increased (or decreased) speed limit compliance.
Has community acceptance been met	Perceived safety impacts of speed limit changes
	List of potential improvements for future speed limit changes
Maximise Safe System alignment: minimise crash severity and likelihood. Short term analysis (hence no crash analysis)	Estimated reduction in severe crashes (deaths and serious injuries) for each route
	Estimated reduction in crash rates at each survey location

2. Data Collection

This study involved the collection and processing of a large amount of speed and traffic volume data. This section of the report discusses the process that was used to collect, collate and clean this data so it could be used in the analysis.

2.1 Data Extraction

Speed and traffic flow data was collected for each of the study routes (Treated (T) and Control (C)) using tube count technology. Safer Roads provided data in ECO format (After 3 data was provided in ECO and CSV format) for analysis. MetroCount[1] software was used to convert the ECO files into a data format that can be analysed in Minitab/ R, the statistical software's used in this project.

Tube counts were recorded at four times:

1) "Before", Nov/Dec 2019, before COVID-19 pandemic forced travel restrictions.
2) "After 1", May 2020, so at the onset of COVID-19 (when traffic counts are reduced due to travel restrictions),
3) "After 2", November 2020, a period after Covid -19 (when traffic counts were less than pre-COVID-19 levels, and
4) "After 3", November/ December 2021, well after COVID-19 related travel restrictions were lifted.

Speed data on each vehicle was collected for 59 routes over the four periods (this accounted for approximately eight million rows of speed observations). A FME model was developed to collate and filter speed data for analysis. Feature Manipulation Engine (FME) is a platform that streamlines the translation of spatial data between geometric and digital formats and is extremely efficient when processing large datasets. The FME model was used to remove:

- Data that was not free flow speed (headway lower than 4 seconds as guided by VicRoads[2]),
- Data that was collected at incorrect locations,
- Any before data collected after the speed limit change date and
- Data that was corrupted due to technical issues (tube becoming unattached or vandalised).

Other data from previous projects

In addition to the MPSC speed limit trial data, SRIP data was provided by Safer Roads from the following projects to see if this data could be used in the before and after analysis:

- Mass Action Curve (MAC) - Before and after data collected 2016/2017, mix of treatments, with some control routes that might be of use and
- Top 20 projects - Before data collected 2017/2018 for the top 20 roads barrier implementation project, after data to be collected this year

After a review this data was not used in this study. The two controls in the MAC project were not considered compatible route stereotypes or speed limits to the route types in this study. Within the top 20 projects, six control routes had a compatible stereotype to Trial 1 (five 100 km/h routes) and Trial 2 (one 90 km/h route). It was not necessary to add any further Trial 1 controls, as there are adequate routes for this speed limit. The one 90 km/h control route unfortunately overlaps with a Trial 2 treatment route (in this study) and therefore cannot be used. Irrespective of their compatibility none of the six routes currently have comparable 'after' speed data available.

2.2 Data Correction and Cleaning

Once the dataset was compiled using FME, it was necessary to do further cleaning of the speed data. Plotting the speed data profiles at each location (as shown in Appendices 1 and 2) and comparing the before profile to the after profile revealed the following data issues:

[1] https://metrocount.com/

[2] Advice on Data Collection and Analysis Strategy for Safer Travel Speeds on Country Roads, VicRoads 2016

i) Corrupted speed data not known at previous stage (e.g. at South Beach Road)

ii) Correcting for slow traffic entering or exiting side roads, which was reducing free flow speeds.

As shown in **Table 2-1** a significant number of routes had to be investigated further and addressed accordingly. The statistical method used to correct for slow traffic is discussed in **Appendix C**. This method was only used for routes that demonstrated an obvious bimodal profile to preserve the integrity of the raw speed data distribution.

Table 2-1 Reinvestigated treatment (T) / control (C) routes

Route	DoT ID	Trial	Action	Reason
Merricks Beach Road	19	2 Treated	Keep	The tube count detached for most of the Before collection period. Only have 3 days of data.
South Beach Road	29	2 Treated	Keep	Deleted the following periods which showed a lower speed. Potentially due to TMP temp speed limit as congestion was not a factor. 5/12 7:30am to 16:30pm 6/12 7:10am to 14:45pm 9/12 8:00am to 12:00pm
White Hill Road	57	2 Control	Keep	Fix Bimodal distribution. The tube location is 70m from an intersection therefore will have turning vehicles bringing down the mean / free flow speed.
Tubbarubba Road	21	1 Control	Keep	Deleted the following periods which showed a lower speed. Potentially due to TMP temp speed limit as congestion was not a factor. 28/11 7:05am to 15:30pm 3/12 7:15am to 14:35pm 4/12 8:00am to 14:30pm
Lower Somerville Road	32	1 Treated	Keep	Fix Bimodal distribution. The tube location is close to Drovers Lane therefore will have turning vehicles bringing down the mean / free flow speed.
Old Moorooduc Road	36	1 Treated	Keep	No obvious issues with the data.
Derril Road	23	1 Treated	Keep	Deleted the following period which showed a lower speed. 28/11 9:12am to 11:18am. Current Google Street View (2008) shows a narrow road, which requires drivers to slow down to pass an oncoming vehicle. The road has been upgraded since - yet still requires vehicles to slow down to allow oncoming vehicles to pass.
Tyabb-Tooradin Road	34	1 Treated	Keep	No obvious issues with the data.
St Huberts Road	50	1 Control	Keep	Fix Bimodal distribution. Close to three or four vineyard entrances. Increase in turning traffic bringing down the After 2 speeds.
Denham Road	40	1 Treated	Keep	Concerns were raised about the validity of After 3 Week 1 data where the speed limit signs were down. Only week 1 was used after testing whether week 1 speeds were lower than week 2.
Yal Yal Road	18	1 Control	Remove	A discarded Trial 1 route. Not suitable for a control route due to slow speeds due to a narrow carriageway.

Route	DoT ID	Trial	Action	Reason
Old Bittern-Dromana Road	20	1 Control	Remove	A discarded Trial 1 route. Not suitable for a control route due to slow speeds due to a narrow carriageway
Binnak Way	22	1 Control	Remove	A discarded Trial 1 route. Not suitable for a control route due to slow speeds due to a narrow carriageway
Paringa Road	26	1 Control	Remove	A discarded Trial 1 route. Not suitable for a control route due to slow speeds due to a narrow carriageway
Lumeah Road	33	1 Control	Remove	A discarded Trial 1 route. Not suitable for a control route due to slow speeds due to a narrow carriageway
Mornington-Flinders Road	58,59	1 Control	Keep	Concerns were raised whether these two controls were too close to the treated routes. A statistical testing confirmed that the mean speed at these routes are no different from the other controls therefore the proximity to the treated is not concerning.
Limestone Road	10	2 Treated	Keep	No obvious sign of slower speeds in Before compared to After 1, After 2 and After 3.

2.3 Analysis Input

Table 2-2 summarises the number of filtered routes that were used in the analysis.

Table 2-2 Trial data summary

Scenario	Treated		Control			Total
	Trial 1	Trial 2	80	90 (Control for Trial 2)	100 (Control for Trial 1)	
MPSC Speed Limit Trial	25*	15*	1	1	17	59
Discounted	5	0	1	0	0	6
Analysis	20	15	0	1	17	53

*Browns Road from Spring Lane to Purves Road had four trial routes. From East to west, Browns Road had a Trial 2 route, a Trial 1 route, a temporary 80 km/h section, followed by another Trial 2 route. In this analysis each route has been treated as individual routes.

The speed limit on the following four Trial 1 control corridors was changed from 100 km/h to 80 km/h between A2 and A3. These corridors are excluded from any A3 comparisons. The corresponding paired treated corridors will not be used as paired treated corridors in A3 reducing the number of paired routes from (12,12) to (9,9).

- 59 Cardinia Road
- 54 Old Healesville Road
- 55 Boneo Road (Boneo)
- 56 Boneo Road (Cape Shanck)

Supplementary observations & assumptions

It is worth noting that "New Speed Limit" signs were present during After 1 and not in After 2 and After 3. The presence of signage could have influenced driver behaviour/ speeds in the After 1 period. No information on police enforcement was provided. Therefore it is assumed that the level of police enforcement during the trial was no different to the level of enforcement prior to the trial.

3. Statistical Design & Sampling of Analysis

In this study the effectiveness of two different speed limit changes on operating speeds are assessed. In Trial 1 the speed limits of several routes have been reduced from 100 to 80 km/h. In Trial 2 the speed limits have been reduced from 90 to 80 km/h. To enable the use of control routes, data has also been collected on a number of routes where the speed limit has stayed unchanged. For all but one of these control routes the speed limit was 100 km/h (with one having a 90 km/h speed limit).

A statistical survey design was not developed before the first set of speed counts were collected (the before counts). Hence it has been necessary to work within the constraints of the available data. Analysis has been undertaken using the entire datasets for each trial and for a selected number of treated and control routes that best fit within a standard statistical design framework. Further details on the analysis follows.

Differences in speed at the four time periods were of interest as illustrated in **Figure 3-1**.

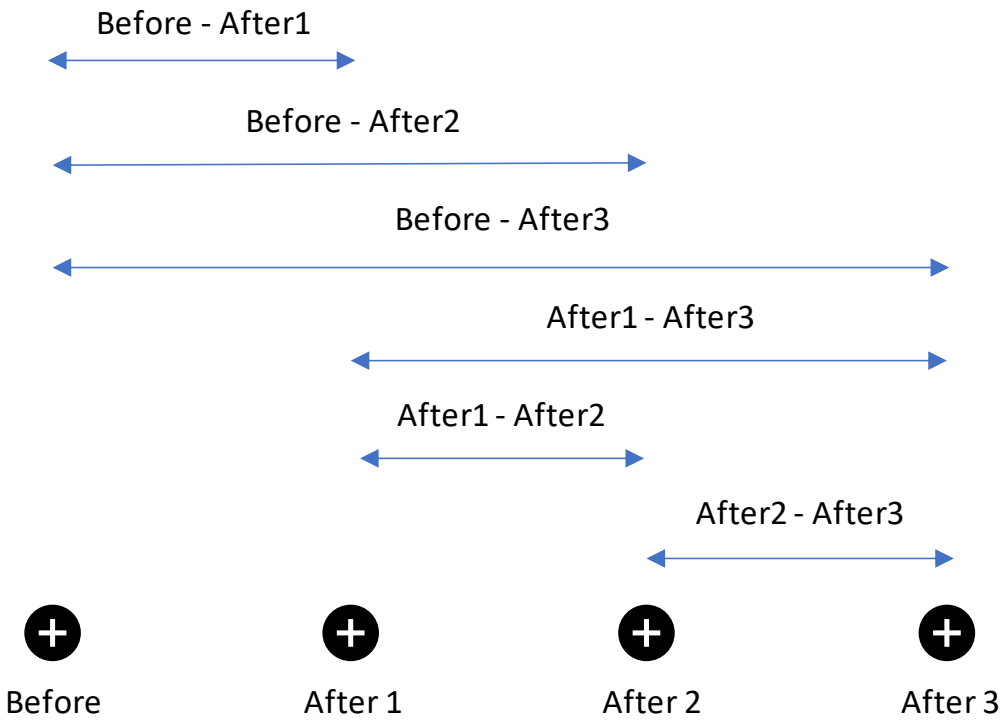


Figure 3-1 A timeline showing the four data collection periods

3.1 Trial 1 (100 km/h to 80 km/h)

To test for control-corrected mean speed differences between the four periods, there were three assessment options:

1) As a two population trial (20T, 17C) or (20T, 13C) for After 3 comparisons
2) As a single population paired trial (12T, 12C) or (9T, 9C) for After 3 comparisons
3) As a two population trial (ignoring the pairing) (12T, 12C) or (9T, 9C for After 3 comparisons)

First the analysis uses the full data set to understand the overall effectiveness of the Trial 1 program (100 km/h to 80 km/h). As mentioned in section 2.2, five control routes were discarded, leaving just 37 routes altogether, which is Trial 1

(20,17) scenario. Consequently, the analysis uses the most carefully designed trial (with some uniformity of routes), Trial 1 Controlled Before After (CBA) (12,12) study. The third analysis was also a 2-population design (ignoring the pairing) to check the efficacy of the pairing. When comparing After 3 to any other period, the sample for option two and three has been reduced to 9,9 given the removal of four controls.

The single population paired Trial 1 routes are listed in **Table 3-1**. It was not possible to randomly assign treatment and control to paired routes, so the trial remains a "quasi" experimental design. It should therefore be kept in mind that factors other than the speed limit change could account for differences found between treatment and control routes.

Table 3-1 Trial 1 routes (paired)

Treated No.	Treated Name	Corresponding Control No.	Corresponding Control Name
2	Sandy Point Road	42	Manks Road
11	Old Cape Schanck Road	59	Mornington-Flinders Road
13	Boundary Road	52	Dalry Road
15	Hodgins Road	56	~~Boneo Road~~
21	Tubbarubba Road	54	~~Old Healesville Road~~
25	Stumpy Gully Road	58	Mornington-Flinders Road
28	Coolart Road Extension	45	Bunyip River Road
30	Bungower Road	49	~~Cardinia Road~~
31	Eramosa Road East	43	Warneet Road
32	Lower Somerville Road	48	Seven Mile Road
36	Old Moorooduc Road	44	Thirteen Mile Road
40	Denham Road	46	Tooradin Station Road

*Crossed out controls were removed in After 3 comparisons

An additional eight treated routes and five control routes were available in the full dataset for Trial 1. These are listed in **Table 3-2**. Note that five control routes initially in the set for Trial 1 were eliminated as unsuitable due to the mean speeds being lower than other routes, due to a narrow carriageway. An analysis was undertaken of this larger dataset treated as Trial 1 (20,17) or (20,13) in After 3. Confidence intervals were produced for changes in control-corrected mean free-flow speed.

Table 3-2 The additional 13 routes (8 treated and 5 control) available for Trial 1

Treated No.	Treated Name	Control No.	Control Name
7	Browns Road - Boneo	47	Heads Road
23	Derril Road	50	St Huberts Road
34	Tyabb-Tooradin Road	51	Gulf Road
35	Whitneys Road	53	Gruyere Road
37	Tuerong Road	55	~~Boneo Road (Cape Shanck)~~
38	Mckirdys Road		
39	O'neills Road		
41	Red Hill Road		

*Crossed out controls were removed in After 3 comparisons

3.2 Trial 2 (90 to 80 km/h)

In this trial there is no pairing, simply 15 treated routes and only one control route. Two options were investigated for mean speed change, though they differ from those for Trial 1, since in Trial 2 there is no pairing:

1) As a single population (15T) trial - ignoring the control.

2) As a two population trial (15T,18C) - here the single Trial 2 control is grouped with adjusted 100 km/h controls.

During the analysis it was identified that the one control that was available for 90 km/h was not a suitable control route for the majority of treated routes due to its unexpected speed changes. It is unusual in these types of assessment to only have a single control route. In most cases there would be as many control routes as treated routes, or a lot more than one route. However, given that there are much fewer 90 km/h routes in Victoria than there are 100 km/h routes, and that the team setting up the study did not collect data at more than one 90 km/h control route in the 'before' period, it is necessary to continue the analysis with available data. The Trial 2 routes including the control route are listed in **Table 3-3**.

Table 3-3 Trial 2 routes

DoT ID	Road Name	Route Type	Speed Change
1	Myers Road	Trial	90-80
3	Stanleys Road	Trial	90-80
4	Hawkins Road	Trial	90-80
5	Browns Road	Trial	90-80
8	Browns Road	Trial	90-80
9	Jetty Road	Trial	90-80
10	Limestone Road	Trial	90-80
12	Harrisons Road	Trial	90-80
14	Truemans Road	Trial	90-80
16	Baldrys Road	Trial	90-80
17	Purves Road	Trial	90-80
19	Merricks Beach Road	Trial	90-80
24	Eramosa Road West	Trial	90-80
27	Point Leo Road	Trial	90-80
29	South Beach Road	Trial	90-80
57	White Hill Road	Control	90

Table 3-4 summarises the number of treated/ control routes that were used in the evaluation analysis.

Table 3-4 Final analysis summary

Corridors per period	Trial 1 100 to 80 km/h		Trial 2 90 to 80 km/h	
	Before, After 1 and After 2	After 3	Before, After 1 and After 2	After 3
All Treated	20	20	15	15
All Control	17	13	1	1
Paired Treated	12	9	0	0
Paired Control	12	9	0	0

4. Trial 1 Speed Analysis (100 km/h to 80 km/h)

4.1 Mean Free Flow Speed, Graphical Analysis

A graphical presentation, using parallel coordinates plots, of the effect of Trial 1 is presented in **Figure 4-1** and **Table 4-1** It shows that free flow speeds at the 20 treated routes reduced by approximately 6km/h in the first six months and then increased slightly (~1km/h) in the second six months and finally reduced by a similar amount (~1km/h) by After 3, whereas the control routes (red) had a reduction in speed (~2km/h) from Before through to After 3. Note that Before, After 1 and After 2 has 17 controls however After 3 has only 13.

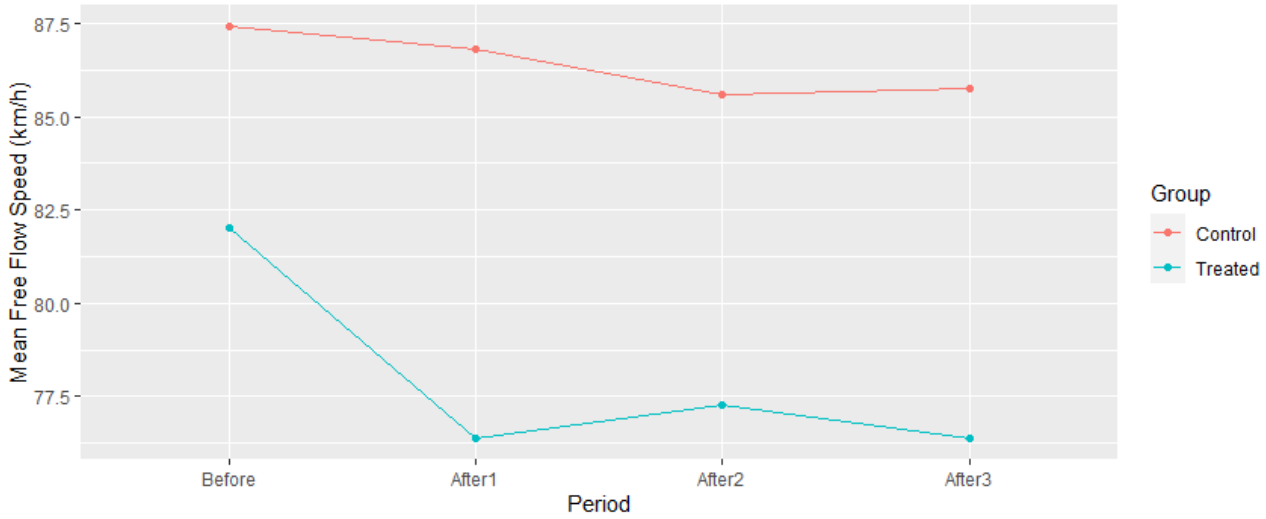


Figure 4-1 Trial 1 mean free flow speed against period

Table 4-1 Trial 1 mean free flow speed against period

Trial Group	Before (20,17))	After 1 (20,17))	After 2 (20,17))	After 3 (20,13))
Treated	82.02	76.39	77.30	76.37
Control	87.42	86.82	85.61	85.76

Figure 4-2 and **Figure 4-3** shows the change in free flow speeds for all treated and control routes. The purpose of these plots is to show the general pattern across the two groups and the variation from route to route. The plots show that mean speeds for control routes are broadly consistent across the four periods, while treated speeds drop from Before to After 3 with some fluctuation in After 1 and 2. The variability between treatment and control routes demonstrates the importance of using multiple routes. This variability between control routes is why it is not suitable to just use a single control route in Trial 2.

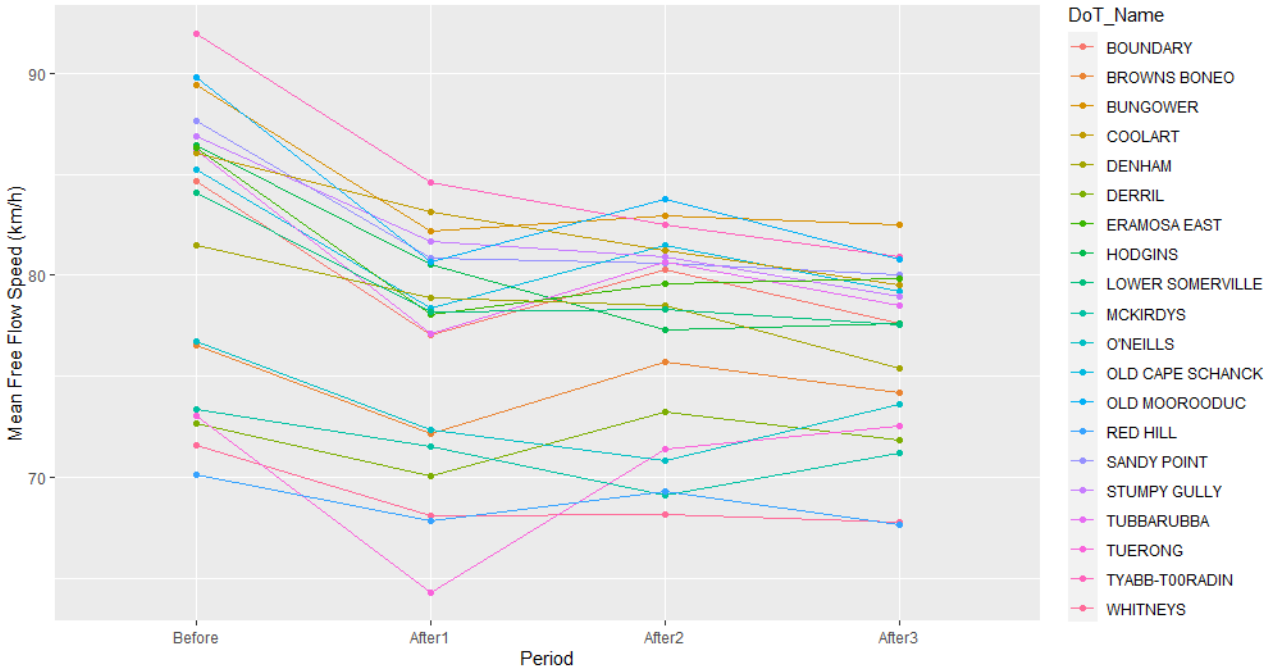


Figure 4-2 Trial 1 treated mean free flow speeds

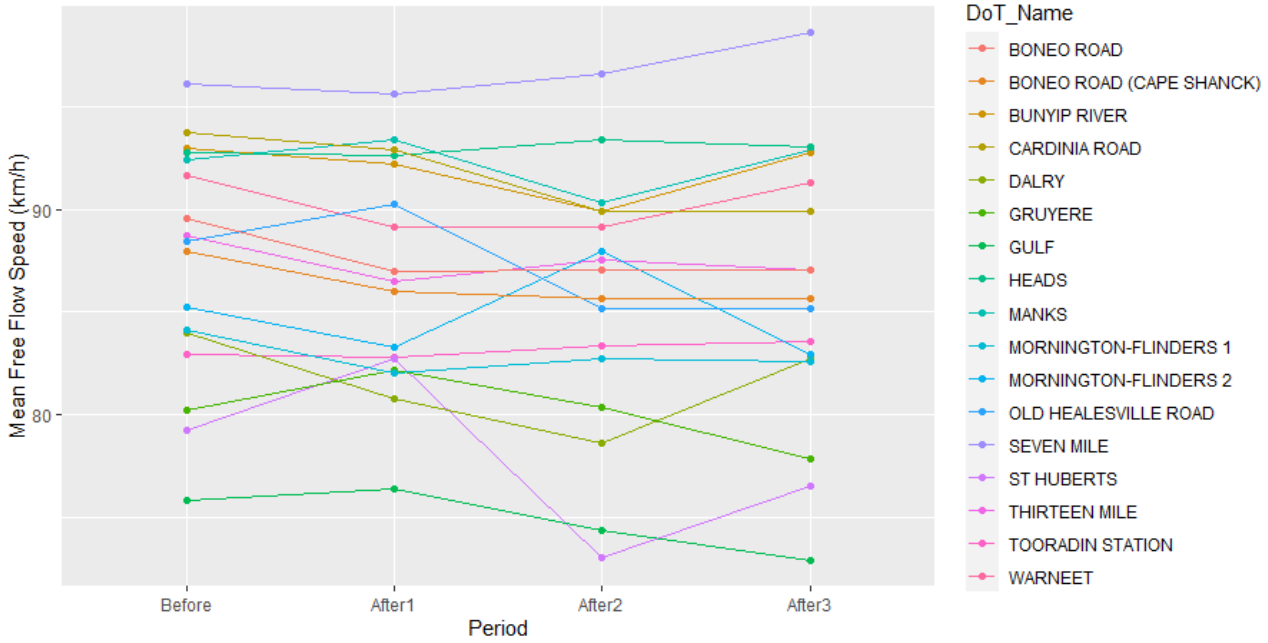


Figure 4-3 Trial 1 control mean free flow speeds

Free flow speed vs traffic volume

Figure 4-4 shows two distinct groups within the treated routes, one with a lower mean speed across the four periods than the other. To investigate whether higher volume roads have a higher mean speed due to better engineered roads, the treated routes were split into the two groups based on traffic flow. Routes were grouped as “High” if the traffic flow was greater than 1000 vehicles per day or “Low” if not. **Figure 4-5** shows the treated routes split by traffic flow. Other than a couple of high flow routes, most high flow routes (shown in red) have a higher mean free flow speed than the low flow routes shown in blue. A statistical t- test was conducted to see whether there was a difference in mean speeds between the two groups which confirmed that there is a difference in mean speeds between the two groups. The

statistical analysis is included as **Appendix C**. A similar observation was not observed across the control routes as shown in **Figure 4-5.** Therefore, the control routes were not grouped by traffic flow.

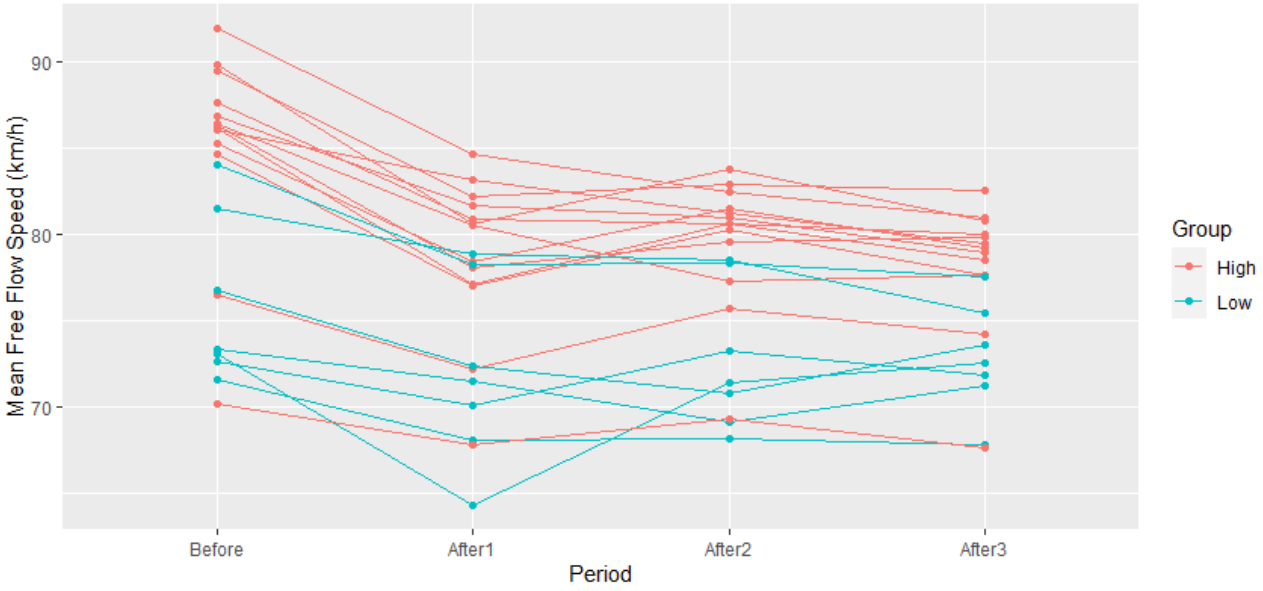


Figure 4-4 Treated mean free flow speed by traffic flow grouping

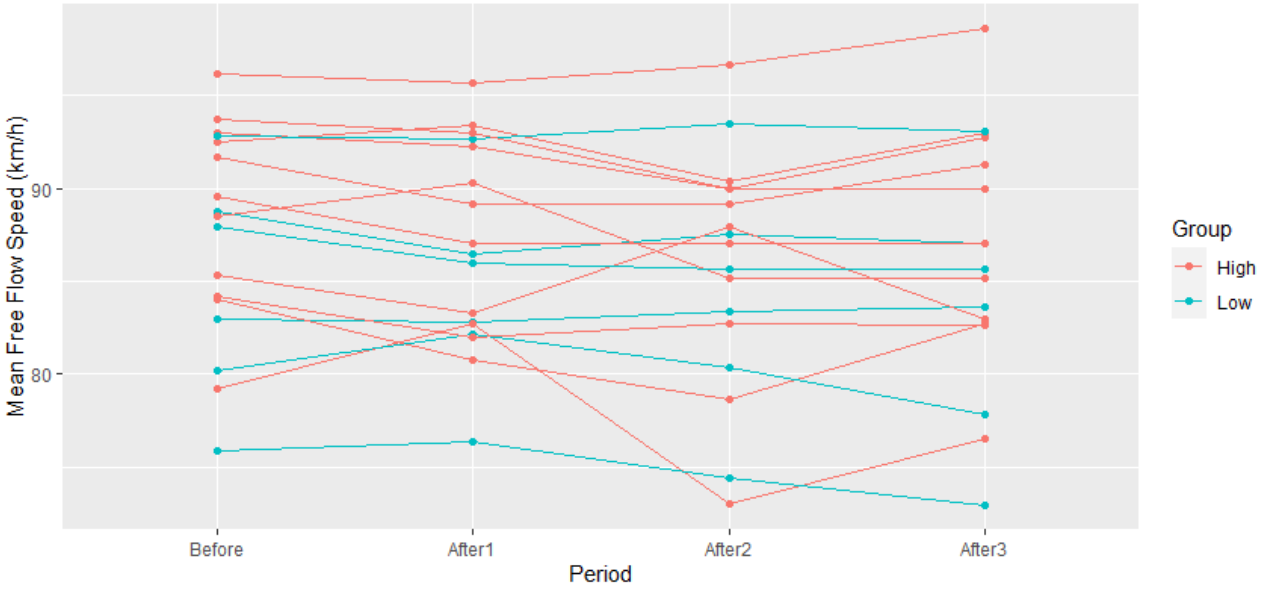


Figure 4-5 Control mean free flow speed by traffic flow grouping

After correcting the treatment speed changes using the controls, speed reductions between each period were calculated.

Did COVID-19 impact mean speeds?

Due to COVID-19 travel restrictions across Victoria and driver behaviour changes, a noticeable reduction in traffic flow was observed in the After 1 period. Concerns were raised by the Safer Roads team that this reduction in traffic flow may have influenced the free flow speeds of the trial in the After 1 period. Naturally, with the reduction of traffic flow, there was an expectation that the free flow speeds might have been higher in After 1 than After 2 where traffic flows returned to near normal levels. The analysis shows the opposite. The mean speeds were lower in After 1 than in After 2 but returned to the same as After 1 in After 3. Nonetheless, the evaluation team is confident that the use of control routes would address COVID-19 to a certain degree. However, the full impact of COVID-19 on travel and vehicle speeds cannot

be fully understood due to the lack of data/ research. The evaluation team has followed the correct evaluation procedure in this evaluation therefore confident that the effects of COVID-19 have been satisfactorily accounted for.

It seems that drivers initially dropped their speeds by a larger amount and then over time the speeds creeped upwards (After 2) and dropped again (After 3) due to readjustment or enforcement. This may be due to motorists being more cautious initially or being concerned they may be caught speeding above the lower speed limit. The presence of "new speed limit" signs at After 1 may have helped bringing speeds down. With time, motorists tend to adjust to the new speed limit, and in this case, this has led to a modest increase in speeds. The "new speed limit" signs were removed prior to After 2 and After 3 collections. Collecting data during multiple after periods is important to understand the initial and long-term effectiveness of speed limit changes.

The statistical analysis in the next section will confirm whether these fluctuations are random or whether there was a difference between the after period mean speeds.

4.2 Mean Free Flow Speed, Statistical Analysis

As mentioned in Section 3.1, three analysis options were used to assess the change in the free flow mean speed as a result of the speed limit change:

1. As a two population (all routes) (20T, 17C) trial or (20T,13C) in After 3.
2. As a single population paired (12T, 12C) trial or (9T,9C) in After 3.
3. As a two population (ignoring the pairing) (12T, 12C) trial or (9T,9C) in After 3.

Understanding results

The difference between before speeds and after speeds are statistically significant if a hypothesis test indicates it is unlikely to have occurred by chance. To assess statistical significance, it's best to examine the test's p-value. If the p-value is less than a specified significance level (95% or 0.05), it can be declared that the difference is statistically significant and reject the test's null hypothesis that there is no difference. A significance level of 95% indicates a 5% risk of concluding that a difference exists between means, when there is no actual difference. Similarly, a significance level of 99% indicates a 1% risk of concluding that a difference exists between means when there is no actual difference.

Analysis results

Each of the following tables summarises the results of the three analysis approaches to determining the effect on mean speeds drops from 100 km/h to 80 km/h. All estimates are corrected using controls.

For the two population (20,17) design, the mean speed has reduced by 4.70km/h from Before to After 1. For the paired (12T,12C) design, the mean speed has reduced by 5.24km/h from Before to After 1. A p-value ~0 suggests that the reduction in speed between the two periods is a statistically significant result and that there is strong evidence to reject the null hypothesises that there is no difference between the before and after mean speeds. It also appears that the paired (12,12) results are almost identical to the two population (2 pops) (12,12) study, which suggests the pairing of routes was effective.

Table 4-2 Before - After 1 corrected for controls

Test Option	Drop (km/h)	p-value	95% CI
2 pops (20,17)	4.70	0.000 (***)	(3.35, 6.05)
Paired (12,12)	5.24	0.000 (***)	(3.66, 6.82)
2 pops (12,12)	5.24	0.000 (***)	(3.66, 6.83)

Table 4-3 Before - After 2 corrected for controls

Test Option	Drop (km/h)	p-value	95% CI
2 pops (20,17)	2.94	0.001 (***)	(1.31, 4.56)
Paired (12,12)	3.92	0.000 (***)	(2.51, 5.32)

2 pops (12,12)	3.92	0.000 (***)	(2.28, 5.56)

In the Before to After 3 comparisons in **Table 4-4**, the mean speed for the (20,13) design has dropped by 4.76km/h and the (9,9) design by 6.62km/h. All statistically significant results. The slightly smaller confidence interval for the two pop (9,9) than the paired (9,9) suggest the pairing was not as effective as in the (12,12) sample.

Table 4-4 Before – After 3 corrected for controls

Test Option	Drop (km/h)	p-value	95% CI
2 pops (20,13)	4.76	0.0000 (***)	(3.40, 6.13)
Paired (9,9)	6.62	0.0000 (***)	(5.32, 7.92)
2 pops (9,9)	6.62	0.0000 (***)	(5.85, 7.38)

The addition of the treatment (8 routes) and control routes (5 routes) in the Trial 1 (20,17) two population analysis result in a smaller reduction in the mean speed of ~4.7km/h and ~2.9km/h to After 1 and After 2 respectively. **Figure 4-6** and **Figure 4-7** show that the additional (8,5) routes on average have slower 'before' speeds than the other routes in the analysis. They appear to represent a different population than that from the originally selected 24 (12,12) routes.

These were typically narrower roads or had a slower speed due to horizontal alignment. **Figure 4-6** shows that the average speeds for the 12 paired (blue) treated routes in Trial 1 compared to the 8 additional treated routes (red), from Before to After periods. The original 12 show a clear difference in mean speeds.

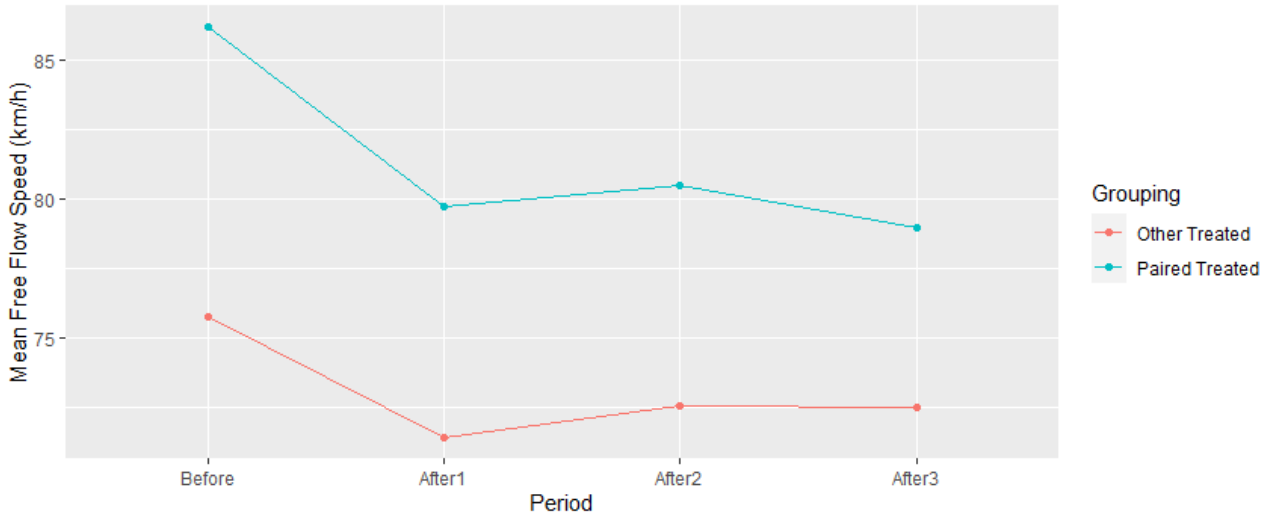


Figure 4-6 Average FFS - paired treatment routes vs extra treatment routes

In a similar way, **Figure 4-7** shows that the average mean speed of the 12 paired control routes (blue) is greater than the average mean speed of the five additional control routes (red). This demonstrates that in expanding from the (12,12) study to the (20,17) study, the population being studied has changed, hence the lesser speed reduction for the (20,17) than the (12,12).

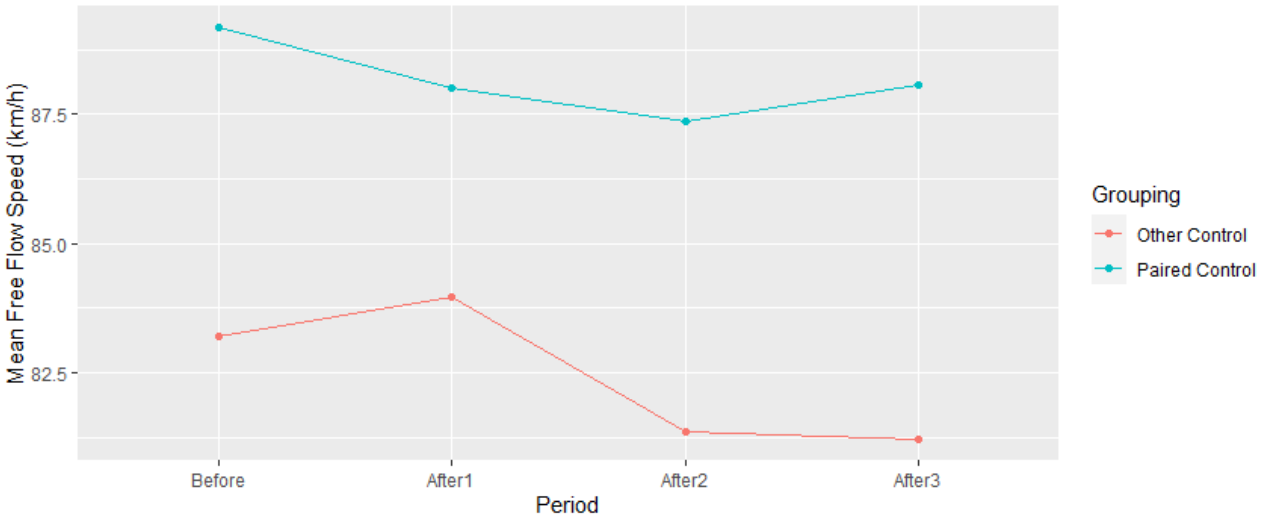


Figure 4-7 Average FFS - Paired controls vs extra controls

Table 4-5 shows that, for the (12,12) designs, the mean speed has increased by approximately 1.3km/h from After 1 to After 2. A p-value ~0.2 suggests that the increase in speed between the two periods is not a statistically significant result. The same could be said about the two population (2 pops) (20,17) study, which has weak evidence to support an increase. Regardless the (2 pops) (20,17) results should be treated with caution given the concerns with the additional corridors which was explained above.

Table 4-5 After 1 - After 2 corrected for controls

Test Option	Drop (km/h)	p-value	95% CI
2 pops (20,17)	-1.76	0.040 (*)	(-3.44, -0.09)
Paired (12,12)	-1.33	0.206 (NS)	(-3.49, 0.84)
2 pops (12,12)	-1.33	0.194 (NS)	(-3.38, 0.73)

Table 4-6 shows that there is no evidence to suggest a 0.35km/h increase in mean speed between After 1 and After 3 for the 2 pop (20,13) scenario. However, there is some evidence to suggest a reduction of ~2km/h for the (9,9) design. To the contrary there is very strong evidence to suggest a reduction of 1.5km/h for the (20,13) design and a 2.7km/h drop for the (9,9) design for the After 2 to After 3 comparisons.

Table 4-6 After 1 – After 3 corrected for controls

Test Option	Drop (km/h)	p-value	95% CI
2 pops (20,13)	-0.35	0.5734 (NS)	(-1.61, 0.92)
Paired (9,9)	1.86	0.0064 (*)	(0.69, 3.04)
2 pops (9,9)	1.86	0.0217(NS)	(0.36, 3.37)

Table 4-7 After 2 – After 3 corrected for controls

Test Option	Drop (km/h)	p-value	95% CI
2 pops (20,13)	1.50	0.0005 (***)	(0.75, 2.25)
Paired (9,9)	2.68	0.0050 (*)	(1.06, 4.29)
2 pops (9,9)	2.68	0.0001 (***)	(1.78, 3.57)

4.3 Mean Free Flow Speed by Traffic Flow Analysis

In this section the treated routes have been split in to two based on the traffic flow and analysed for the mean speed drop from Before to After 3. Controls were not split into two groups as there was no statistical evidence to split controls as explained in Appendix D.

Table 4-8 summarises the results for the High flow group, which compares 13 treated routes to all 13 controls. There is significant evidence to suggest a ~6km/h drop in mean speeds from Before to After 3 for the (13,13) design. The drop in speed is greater at 6.9km/h for the (9,9) design. **Table 4-9** shows that that the drop in speed for the low volume group (7,13) was only 2.4km/h. Therefore, this analysis confirms that routes with a higher traffic flow had a greater drop in mean speeds than the routes with a low traffic flow. This is as expected given the low volume routes had a lower before mean speed to begin with and significant reductions are unlikely as many speeds in the before are close to or below the new speed limit of 80 km/h.

Table 4-8 Before – After 3 corrected for controls (High volume group)

Test Option	Drop (km/h)	p-value	95% CI
2 pops (13,13)	6.03	0.0000 (***)	(4.59, 7.48)
Paired (7,7)	6.86	0.0000 (***)	(5.10, 8.62)
2 pops (7,7)	6.83	0.0000 (***)	(5.87, 7.79)

Table 4-9 Before – After 3 corrected for controls (Low volume group)

Test Option	Drop (km/h)	p-value	95% CI
2 pops (7,13)	2.40	0.0360 (*)	(0.21, 4.59)
Paired (2,2)	5.77	0.1050 (NS)	(-6.43, 17.97)
2 pops (2,2)	5.79	0.0229 (*)	(3.12, 8.57)

4.4 Mean Free Flow Speed, Findings

The paired trials marginally produces the more confident result (i.e. with the narrowest 95% confidence interval) for the Before to After comparisons. This indicates that the pairings of treatment and control were somewhat successful.

Inclusion of all the suitable surveyed routes produces generally a tighter confidence interval estimate, but lesser mean speed reduction estimates than the paired design are seen. This was expected as the 13 additional routes were different in terms of cross-section (i.e. typically narrower) and/or alignment than the 24 routes used in the first two methods. It is to be expected that the speed limit changes will have different effects on operating speeds on rural roads with different characteristics and, in particular, lower operating speeds.

The Before-After 3 findings (after 24 months) are considered most important results as the traffic volumes are not affected as much by COVID-19 restrictions on movements (during lockdowns) as the After 1 and potentially during After 2 speeds. After 1 speed were influenced by the presence of “new speed limit” signs which may have affected travel speeds. After 3 speeds are also more likely to be reflective of longer-term operating speeds than the After 1/2 speeds. This is because the After 1 speeds were collected during a settling down period than normally occurs when speed limits are first introduced. The presence of new speed limit signs may have also influenced driver behaviour.

After 3 comparisons confirm that the trial has been successful in reducing the mean free flow speeds in the longer run.

The key findings of Trial 1 (100 km/h to 80 km/h) based on Before versus After 3 are:

- The analysis does show that a 20km/h speed limit change (from 100 km/h to 80 km/h) has been effective in reducing mean operating speeds on average on all roads across all periods.
- The analysis shows that an average 4.76km/h speed reduction has occurred from Before to After 3 the highest drop across the three before to after comparisons.
- The speed reduction is greater on the 13 high volume roads at 6km/h compared to 2.4km/h on seven low volume roads.
- Even though there is very strong evidence to suggest a drop in mean speeds from before to all after periods, there is little evidence to suggest reductions between the three after periods, which may suggest that mean free flow speeds are settling and enforcement and/ or other interventions are required to achieve further speed reductions.

5. Trial 2 Speed Analysis

5.1 Mean Free Flow Speed, Graphical Analysis

Similar to Trial 1, graphics analogous for Trial 2 are presented below. **Figure 5-1** shows the treatment mean speed decreases from 80 km/h to 76km/h in After 1 and then increases to ~77km/h in After 2/ After 3. It also shows that the single control mean speeds changes from 84km/h to 83km/h in After 1 and then to 80 km/h After 2 and back up to ~82km/h in After 3. This single control, if used, accentuates the treatment effect, indicating the need for reliable control information. In this case one control is not considered suitable for the analysis. **Figure 5-2** shows almost all treated routes show a reduction in speed from Before to After 1 and a mix of ups and downs from After 1 to After 2 to After 3.

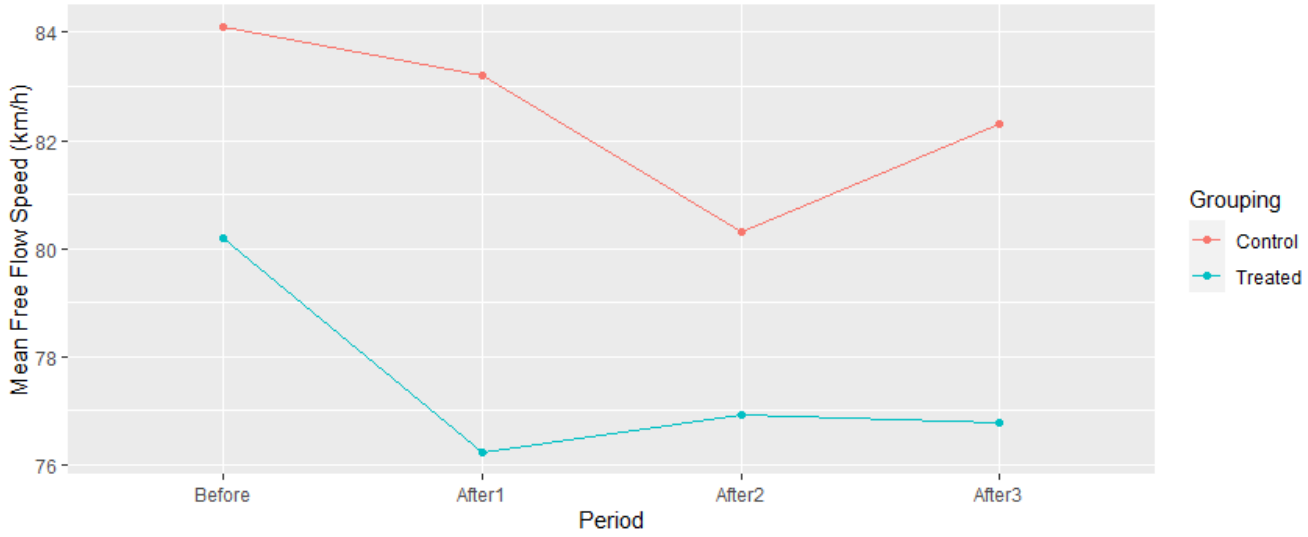


Figure 5-1 Treated routes (15) behave as for Trial1; the single control is problematic

Table 5-1 Trial 1 speeds per period

Trial Group	Before (15,1)	After 1 (15,1)	After 2 (15,1)	After 3 (15,1)
Treated (not corrected for controls)	80.18	76.21	76.92	76.77
Control	84.1	83.2	80.3	82.3
Treated (corrected with one control and 100 km/h controls (16)	78.42	78.36	78.15	77.55

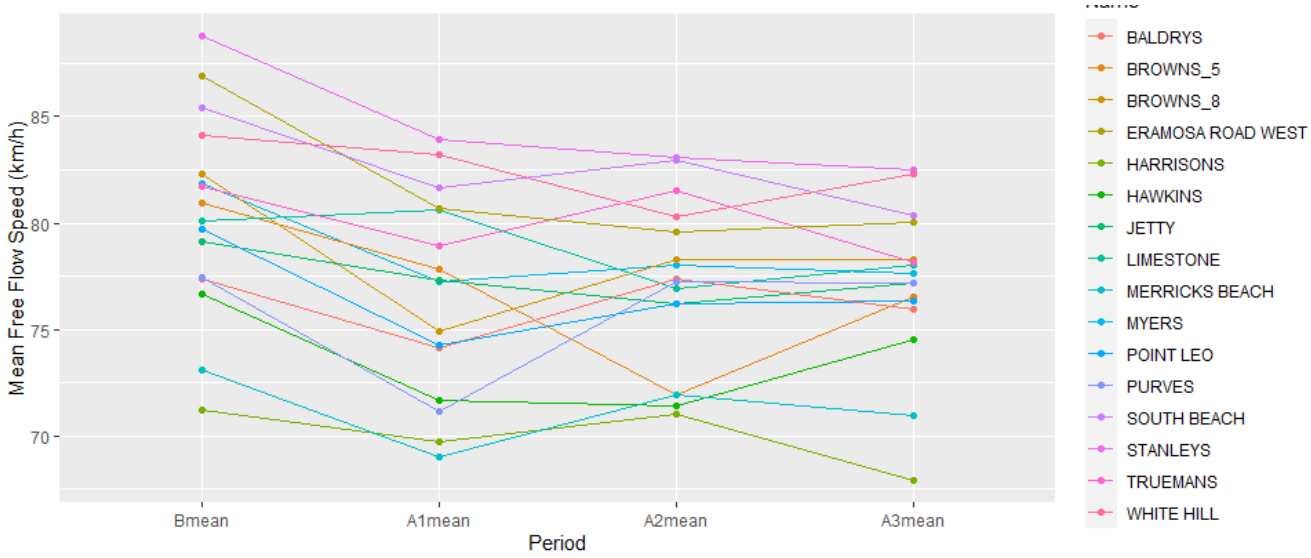


Figure 5-2 Trial 2 individual route mean speeds (Red Treatment, Blue Control)

5.2 Free Flow Speed, Statistical Analysis

Table 5-2 summarises the mean free flow speed results of Trial 2. The single population analysis without the control is considered most accurate analysis. The Before to all After period mean speed reductions are statistically significant (95% level) however the changes in mean speed between the After periods are not statistically significant (95% level).

Table 5-2 Trial 2 mean free flow speed results

Scenario	Population	Drop (km/h)	p-value	95% CI
Before – After 1	1 pop (15) (no control)	3.96	0.000 (***)	(2.82, 5.11)
Before – After 2	1 pop (15) (no control)	3.26	0.000 (***)	(1.75, 4.78)
Before – After 3	1 pop (15) (no control)	3.40	0.000 (***)	(2.41, 4.40)
After 1 - After 2	1 pop (15) (no control)	-0.70 i.e. a rise	0.379 (NS)	(-2.37, 0.96)
After 1 – After 3	1 pop (15) (no control)	-0.559	0.375(NS)	-1.87, 0.75
After 2 – After 3	1 pop (15) (no control)	0.145	0.796 (NS)	-1.0,1.33

5.3 Additional Non-standard Analysis

Control routes are used to measure the change in speed on routes over time and therefore control for any general increase or decrease in speeds that may occur between the 'before' and the 'after' time periods. Given the large sample of 100 km/h control routes, it was decided to use this data to understand changes in speed over time for the 90 km/h routes. While there may be a slight difference in the change in speed on a 100 km/h or a 90 km/h road over a period of time (due to different speed limit compliance rates and due to enforcement activities), the need to apply some level of adjustment to reflect operating speed changes over time outweighs the slight inaccuracies of using 100 km/h controls in Trial 2. These adjusted speeds do provide a conservative estimate of the change in operating speeds expected by reducing the speed limit. The following analysis was conducted.

1) As a two population (15T, 18C) trial (1 control from this trial and the 17 controls from Trial 1 scaled by a factor of 0.9).

Table 5-3 summarises the mean free flow speed results of Trial 2 with controls analysis. Similar to the no control analysis, the mean speed reduction from Before to all after periods is statistically significant. However there appears to be an increase in mean speed from After 1 to After 3 albeit only After 1 to After 3 change has some statistical significance.

Table 5-3 Trial 2 Before – After comparisons

Scenario	Population	Drop (km/h)	p-value	95% CI
Before – After 1	2 pops (15,18)	3.38	0.000 (***)	(2.02, 4.75)
Before – After 2	2 pops (15,18)	1.77	0.047 (*)	(-0.02, 3.51)
Before – After 3	2 pops (15,18)	2.53	0.000 (***)	(1.54, 3.53)
After 1 - After 2	2 pops (15,18)	-1.62	0.093 (NS)	(-3.52, 0.29)
After 1 – After 3	2 pops (15,18)	-1.365	0.042 (*)	(-2.7, -0.05)
After 2 – After 3	2 pops (15,18)	-0.453	0.426 (NS)	(-1.64, 0.72)

5.4 Mean Free Flow Speed, Findings

The key findings from Trial 2 (90 km/h to 80 km/h) findings are:

- Changing the speed limit from 90 km/h to 80 km/h at the 15 routes has led to a reduction in mean speeds.
- The mean free flow speed (not controlled) reduction is 3.4km/h after 24 months (this is statistical significance at 95% level).
- If control corrected (with 100 km/h controls), the mean free flow speed reduction is 2.5km/h after 24 months (this is statistical significance at 95% level).

6. Trial 1 (100 to 80 km/h) Compliance Analysis

One of the key objectives of the evaluation framework was to assess whether the change in speed limits has decreased the speed limit compliance, as has occurred at other locations where speed limits have been dropped. This involves calculating the proportion of drivers traveling below the speed limit before and after the change in speed limit was implemented. What is of even more interest to road safety professionals is whether the proportion of vehicles below the target (or desired) speed of 80 km/h (called Target speed) has increased and whether the proportion of drivers travelling above 100 km/h has decreased. A speed of 100 km/h is considered unsafe for most of these LGA routes. This is because crash benefits are associated with lower route operating speeds, not lower speed limits. What is most important is more drivers travelling below safer or target road speeds (in this case below 80 km/h). However poor compliance with new speed limits can indicate the need for additional speed enforcement or infrastructure changes and is also of interest.

This section analyses the speed limit compliance, target speed (80 km/h) proportions and high speed (100 km/h) proportions of Trial 1, accounting for any changes at controls routes between the before and after period.

6.1 Compliance, Graphics Analysis

Speed Limit Compliance

First, graphics for speed limit compliance at the Before, and the three after time points were investigated. **Figure 6-1** shows that compliance is 93%, 63%, 57% and 64% for Treated routes and 86%, 86%, 88% and 85% for Control routes (respectively in the Before, After 1, After 2 and After 3 collection periods). As expected, **Figure 6-1** shows that compliance drops markedly for Treated routes (from Before to After 1). It drops further slightly (from After 1 to After 2) however increases beyond A1 compliance by After 3.

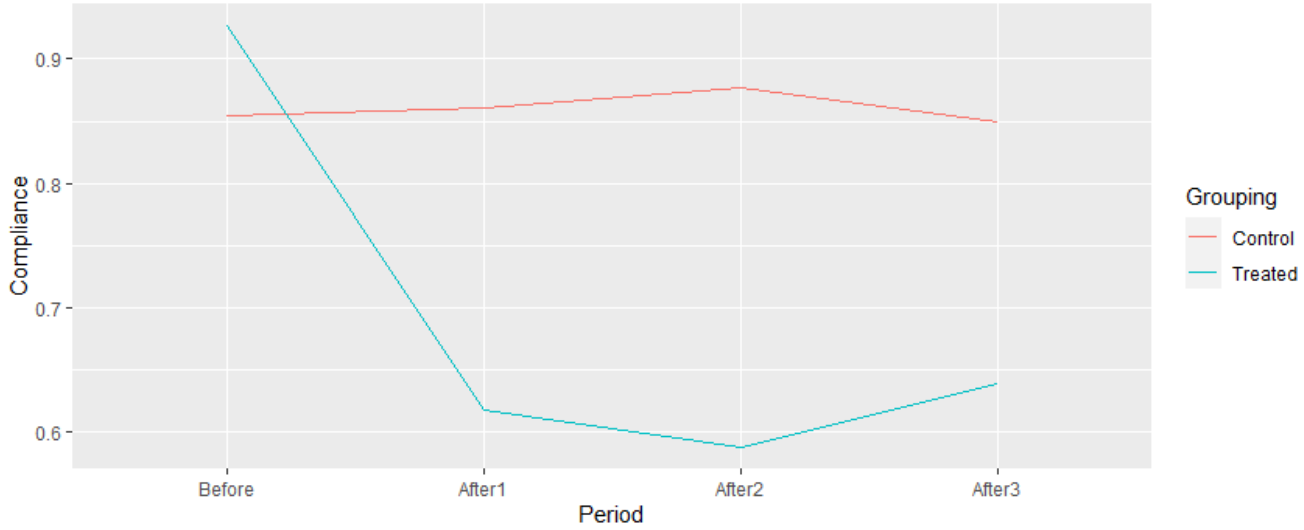


Figure 6-1 Trial 1 speed limit compliance

Table 6-1 Trial 1 Compliance

Grouping	Before compliance	After 1 compliance	After 2 compliance	After 3 compliance
Treated	**0.93**	**0.62**	**0.59**	**0.64**
Control	**0.85**	**0.86**	**0.88**	**0.85**

Figure 6-2 shows the compliance by individual route labelled with their name. All treated routes have a lower level of compliance in After 1 than Before. There is a mix of rises and falls in compliance from After 1 to After 2. By After 3 compliance has improved from After 2 for most routes.

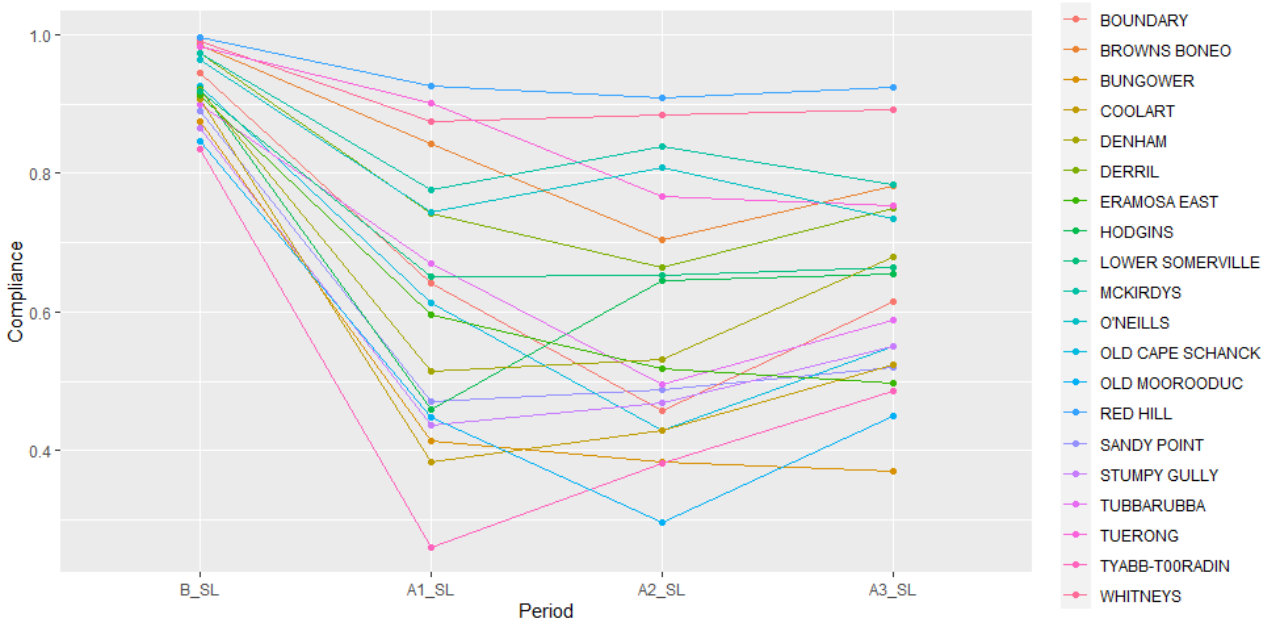


Figure 6-2 Trial 1 compliance by route name

Target Speed Proportion

As requested by Safer Roads, the proportion of traffic travelling below the new speed limit (80 km/h) herein referred to as Target Speed proportion was also reported at the Before, and the three after periods (**Figure 6-3)**. To reduce the risk of death or serious injury on these roads it is desirable that the majority of drivers travel below this target speed. Safe System research indicates that operating speeds of 80 km/h or lower significantly reduces the risk of death or serious injury in head-on collisions compared with 100 km/h or higher.

Mean target speed proportion (blue) at treated routes improves (to After 1) then slightly worsens (from After 1 to After 2) and rises again by After 3. Target speed proportion at control routes (which have a 100 km/h speed limit) increased from 28% to approximately 33% from the Before to After 2/ After 3.

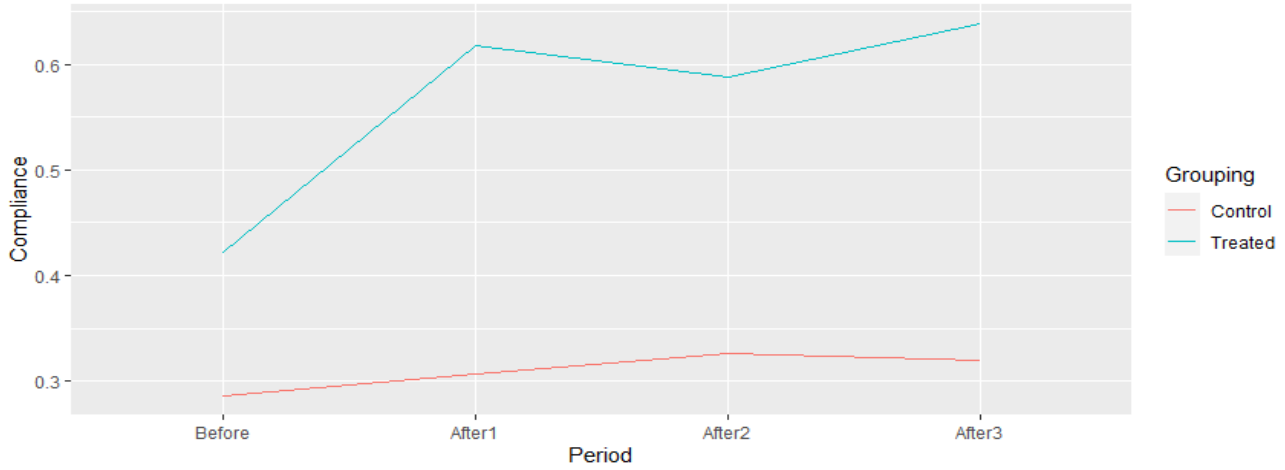


Figure 6-3 Trial 1 target speed (80 km/h) proportion

Table 6-2 Trial 1 target speed (80 km/h) proportion

Grouping	Before	After 1	After 2	After 3
Treated	**0.42**	**0.62**	**0.59**	**0.64**
Control	**0.29**	**0.31**	**0.33**	**0.32**

Figure 6-4 shows the target speed proportion at a route level). Target speed proportion for treatment routes rises from Before to After 1 however drops from After 1 to After 2, back to the same levels as Before for some routes.

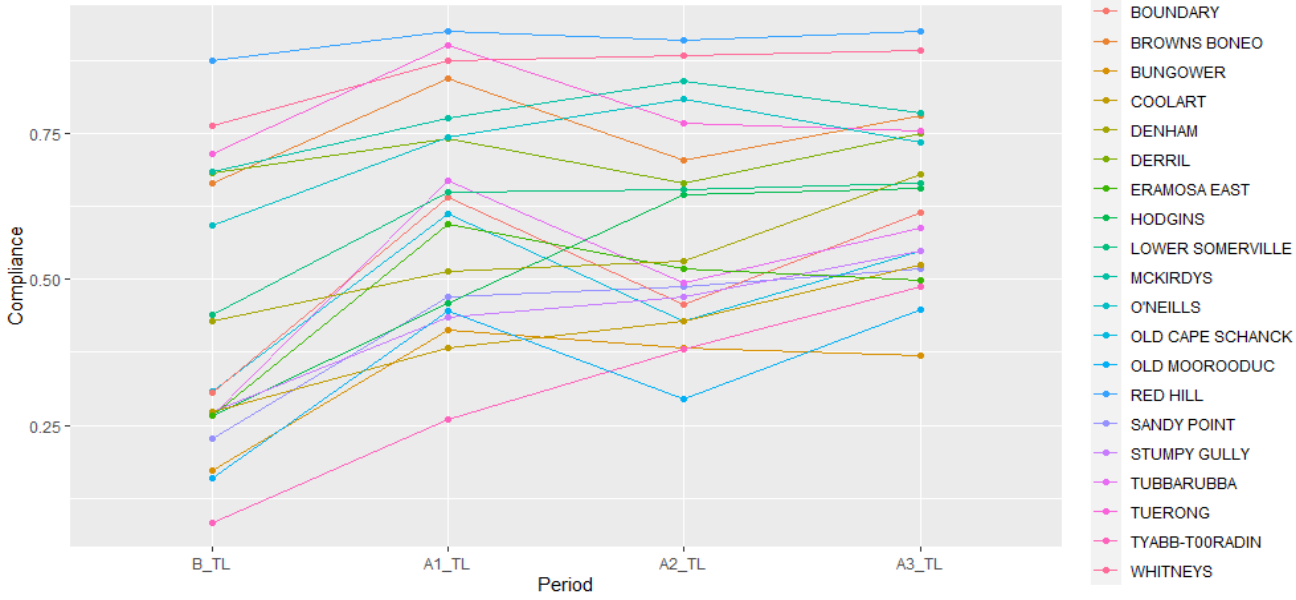


Figure 6-4 Trial 1 target speed (80 km/h) proportion by route

High Speed Proportion

The Mornington Peninsula Shire Safer Speeds Evaluation Working Group is also interested in understanding whether the proportion of motorists traveling at high speeds have reduced as a result of the speed limit change trial. Therefore, the proportion of motorists travelling below 100 km/h was also analysed. A high speed threshold of 100 km/h was used as the proportion of motorists travelling above 110km/h or higher was too small to make a meaningful comparison between periods.

Figure 6-5 shows that the proportion of motorists travelling below 100 km/h has steadily increased from Before to After 3 whereas the controls show some fluctuation in the After periods. **Figure 6-6** shows how high speed proportion has changes across the treated routes.

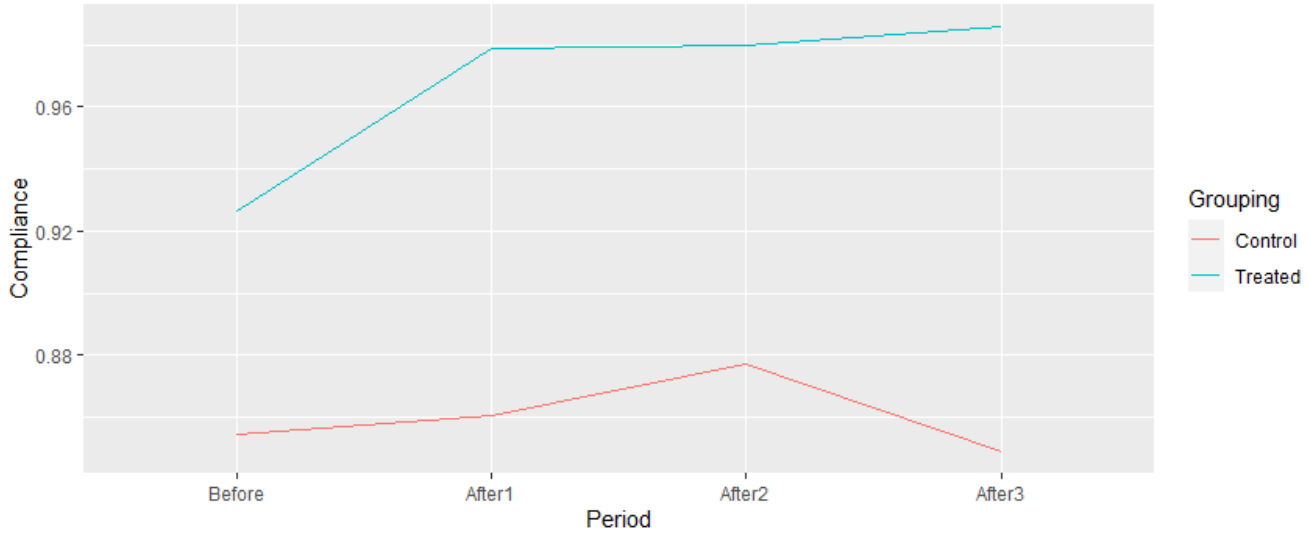


Figure 6-5 High speed (100 km/h) proportions

Table 6-3 High speed (100 km/h) proportions

Grouping	Before	After 1	After 2	After 3
Treated	0.93	0.98	0.98	0.99
Control	0.85	0.86	0.88	0.85

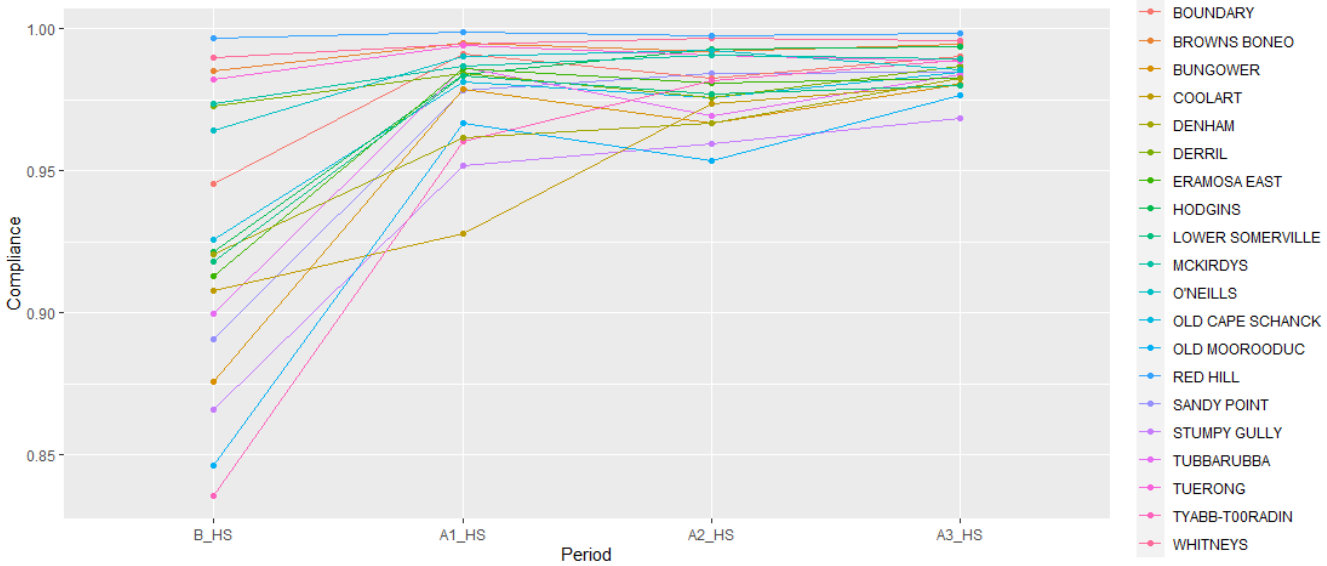


Figure 6-6 Trial 1 high speed (100 km/h) proportion by route

6.2 Compliance, Statistical Analysis

When analysing mean speed changes and correcting them for control routes, the differences of differences is used. This is expressed in the form:

(Treated Before - Treated After 1) - (Control Before - Control After 1)

Compliances are probabilities and must be handled multiplicatively rather than additively. When analysing compliance ratios rather than differences, ratios of ratios rather than differences of differences are used. The logs of the ratios are taken to achieve additivity and so normality, hence the methods used with means can be applied. The ratios are "odds" of an event, hence compliance with a speed limit.

It is fortunate that a compliance can be turned into odds and vice versa. For example, compliance of 0.9 means that the odds of complying are 9 to 1, i.e. a passing vehicle complies 9 times out of 10.

For now, it is necessary to remember that the analogue of the "5km/h drop" for mean speeds, a difference of differences, is a ratio of odds, always a positive number, for example "0.1". In the context of this trial, this will mean that the odds drop to one tenth of the starting odds when the speed limit changes. A full description of the use of odds and odds ratios, and the way in which odds ratios determine the drop in compliance, is given in **Appendix C**.

Speed limit compliance

Compliance analysis for Trial 1 uses all treated routes and the control routes for correction. The results are presented below in **Table 6-4**. It is critical to remember that the lower the odds ratio, the bigger the drop in compliance (i.e. 1 means no change in compliance). The table shows that there have been large drops in speed limit compliance from Before to the three After periods. However, there is very strong evidence that speed limit compliance has improved from After 2 to After 3. The more familiar absolute drops in compliance are tabulated later in **Section 5**.

Table 6-4 Speed limit Compliance statistical analysis results

Scenario	Population	Corrected odds ratio	p-value	95% CI
Before - After 1 i.e. using (B-A1)(T-C)	2 pop (20,17)	0.09	0.000 (***)	(0.07, 0.12)
Before - After 2 i.e. using (B-A2)(T-C)	2 pop (20,17)	0.05	0.000 (***)	(0.03, 0.08)
Before - After 3 i.e. using (B-A3)(T-C)	2 pop (20,13)	0.11	0.000 (***)	(0.08, 0.17)
After 1 - After 2 i.e. using (A1-A2)(T-C)	2 pop (20,17)	0.57	0.022 (*)	(0.35, 0.92)
After 1 – After 3 i.e. using (A1-A3)(T-C)	2 pop (20,13)	1.14	0.298	(0.87, 1.40)
After 2 – After 3 i.e. using (A2-A3)(T-C)	2 pop (20,13)	1.67	0.000 (***)	(1.41, 1.86)

Target speed proportion (80 km/h)

Target Speed Proportion analysis for Trial 1 uses all routes and also uses the control routes for correction. The results are presented below in **Table 6-5**. This table shows that more drivers are 'complying' with the 80 km/h target speed (higher odd ratios), which means the crash risk has been reduced. Importantly, there is also very strong evidence to suggest that target speed proportion has improved from After 2 to After 3.

Table 6-5 Target speed (80 km/h) proportion statistical analysis results

Scenario	Population	Corrected odds ratio	p-value	95% CI
Before - After 1 i.e. using (B-A1)(T)	2 pop (20,17)	2.33	0.000 (***)	(1.84, 2.93)
Before - After 2 i.e. using (B-A2)(T)	2 pop (20,17)	1.76	0.000 (***)	(1.32, 2.36)
Before - After 3 i.e. using (B-A3)(T-C)	2 pop (20,13)	2.843072	0.000 (***)	2.01, 3.68
After 1 - After 2 i.e. using (A1-A2)(T)	2 pop (20,17)	0.76	0.066 (NS)	(0.56, 1.02)
After 1 – After 3 i.e. using (A1-A3)(T-C)	2 pop (20,13)	1.18	0.181 (NS)	(0.91, 1.46)
After 2 – After 3 i.e. using (A2-A3)(T-C)	2 pop (20,13)	1.39	0.0005 (***)	(1.20, 1.58)

High speed proportion (100 km/h)

High speed proportion analysis for Trial 1 uses all routes and also uses the control routes for correction. The results are presented below in **Table 6-6**. This table shows that almost all drivers are driving below 100 km/h speed (higher odd ratios), which means the crash risk has been reduced. Importantly, there is also very strong evidence to suggest that high speed proportion has improved from After 2 to After 3.

Table 6-6 High speed (100km/h) proportion statistical analysis results

Scenario	Population	Corrected odds ratio	p-value	95% CI
Before - After 3 i.e. using (B-A3)(T-C)	2 pop (20,13)	5.15	0.000 (***)	(3.45, 6.85)
After 1 – After 3 i.e. using (A1-A3)(T-C)	2 pop (20,13)	1.41	0.059 (NS)	(0.98, 1.84)
After 2 – After 3 i.e. using (A2-A3)(T-C)	2 pop (20,13)	1.76	0.000 (***)	(1.49, 2.03)

6.3 Discussion of Trial 1 Compliance Results

The analysis shows there is very strong evidence to suggest that control-corrected speed limit compliance has decreased from Before to all after periods (statistically significance at 95% level). There is also very strong evidence to suggest that speed limit compliance has increased from After 2 to After 3. Regardless, compliance with the 80 km/h speed limits would be expected to naturally improve as drivers continue to adjust to the new speed limits. Police enforcement and consideration of road design changes in the future could also assist improve compliance.

While the speed limit compliance may have deteriorated, more drivers are travelling below the target speed level of 80 km/h in all After periods. Indeed, there is very strong evidence to suggest that control-corrected target speed (80 km/h) 'compliance' has increased (statistically significance at 95%).

There is also very strong evidence to suggest that control-corrected high speed proportion has increased from Before to After 3 (statistically significance at 95%).

This shows that the speed limit change is reducing the risk of deaths and serious injuries at higher speeds, by getting more drivers to travel below 80 km/h and below 100 km/h.

7. Trial 2 (90 to 80 km/h) Compliance Analysis

7.1 Compliance, Graphics Analysis

Speed limit compliance

Similar to Trial 1, first, graphics for compliance at the Before and three after time points were investigated. **Figure 7-1** shows that compliance is 83%, 65%, 62% and 64% for Treated routes and 79%, 80%, 86% and 92% for the one control route (respectively in the Before, After 1, After 2 and After 3 collection periods). **Figure 7-1** shows that compliance drops markedly for Treated routes (from Before to After 1). It drops further slightly from After 1 to After 2 and increases slightly by After 3

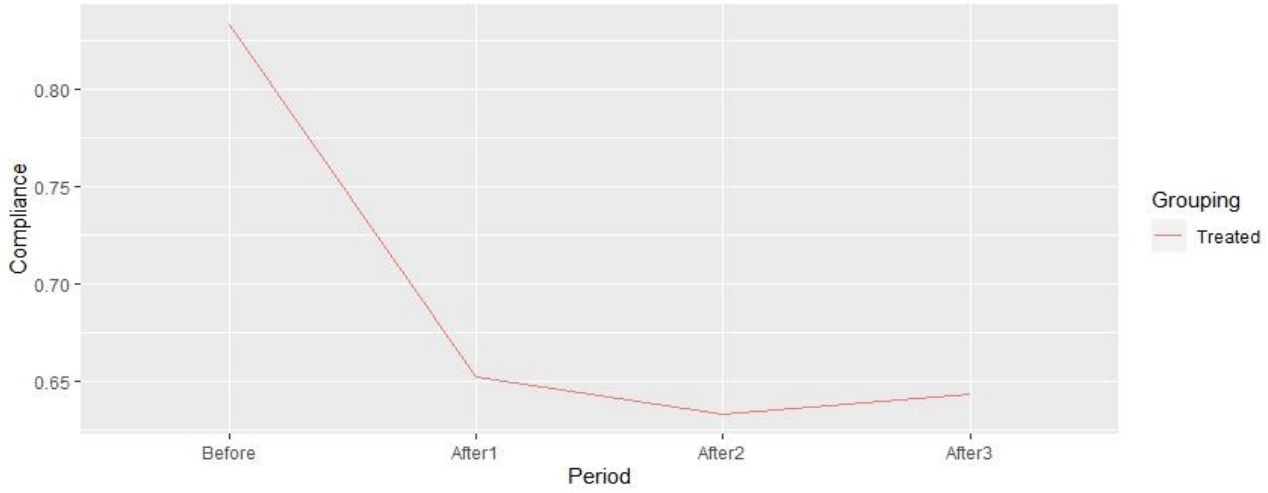


Figure 7-1 Trial 2 speed limit compliance

Table 7-1 Trial 2 speed limit compliance

Grouping	Before speed compliance	After 1 compliance	After 2 compliance	After 3 compliance
Treated	**0.83**	**0.65**	**0.63**	**0.64**

Figure 7-2 shows the compliance by individual route. Compliance for individual routes show that all 15 treated routes show a drop in compliance from Before to After 1, then fluctuates between the After periods.

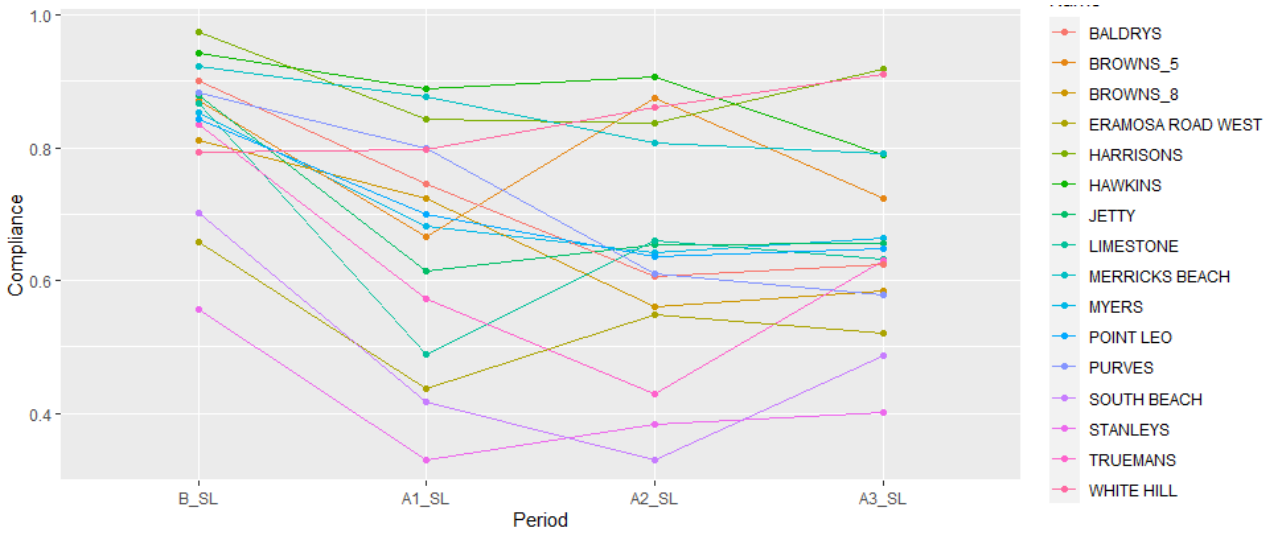


Figure 7-2 Trial 2 compliance by individual route

Target speed proportion (80 km/h)

A graphical examination of Target speed proportion at the Before and After time points in shown in **Figure 7-3.** Target speed proportion is 47%, 65%, 63% and 64% for the treated routes respectively in the Before, After 1, After 2 and After 3 collection periods.

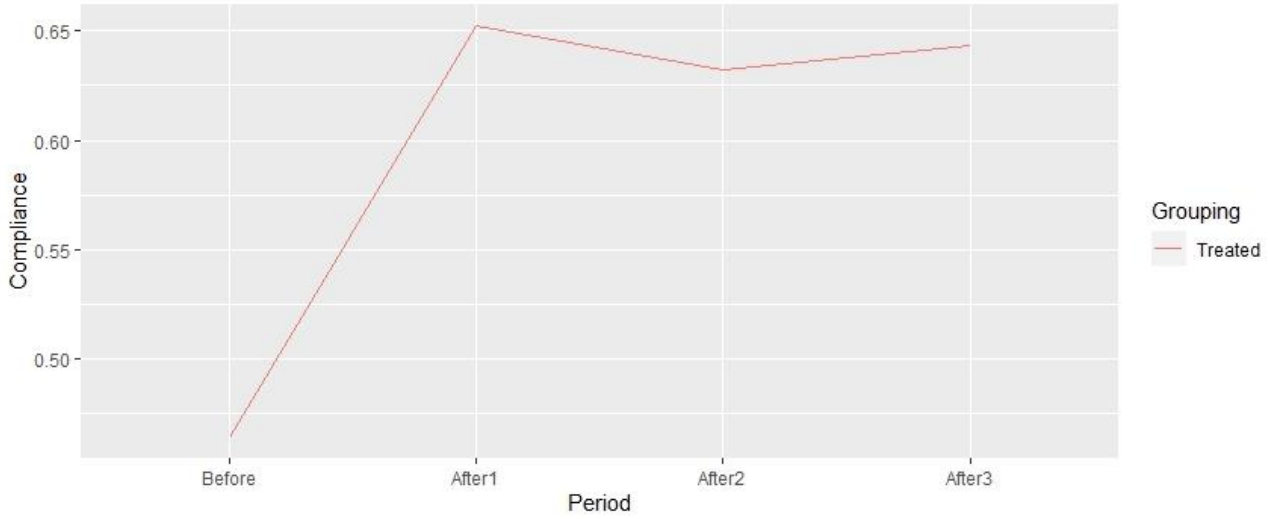


Figure 7-3 Target speed (80 km/h) proportion (Trial 2)

Table 7-2 Target speed (80 km/h) proportion (Trial 2)

Group	Before c proportion	After 1 proportion	After 2 proportion	After 3 proportion
Treated	**0.46**	**0.65**	**0.63**	**0.64**

Figure 7-4 shows target speed proportion for individual routes. Target speed proportion rises from Before to After 1 for all routes however is a mix of rises and drops from After 1 to After 2 to After 3.

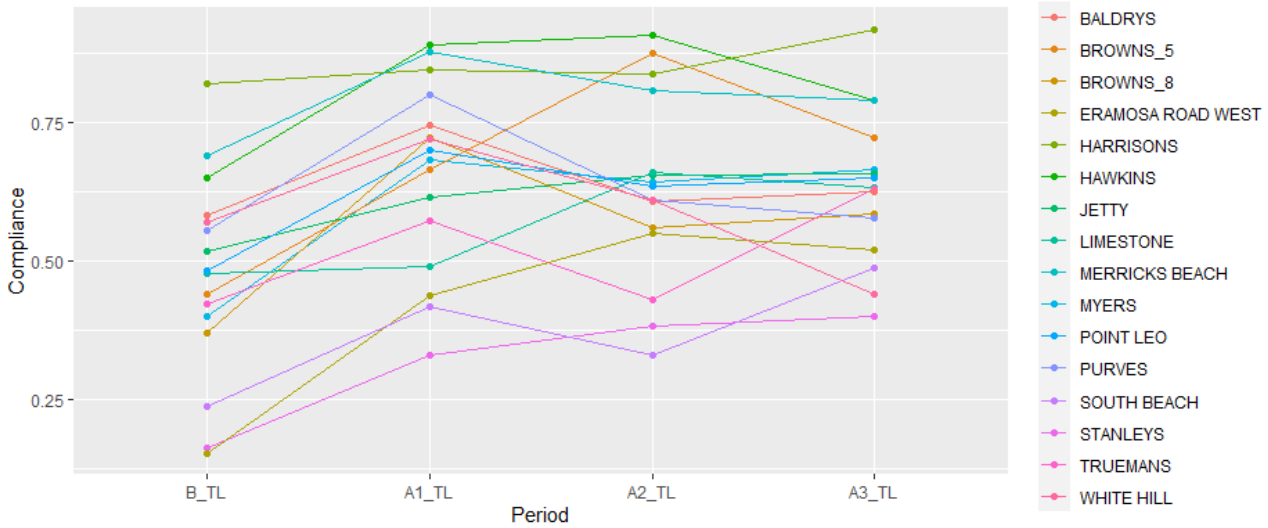


Figure 7-4 Trial 2 target speed (80 km/h) proportion by route

High speed proportion (100 km/h)

A graphical examination of High Speed (100 km/h) Compliance at the Before and After time points in shown in **Figure 7-5**. High speed proportion gradually increases from 97% to ~99% over the trial period.

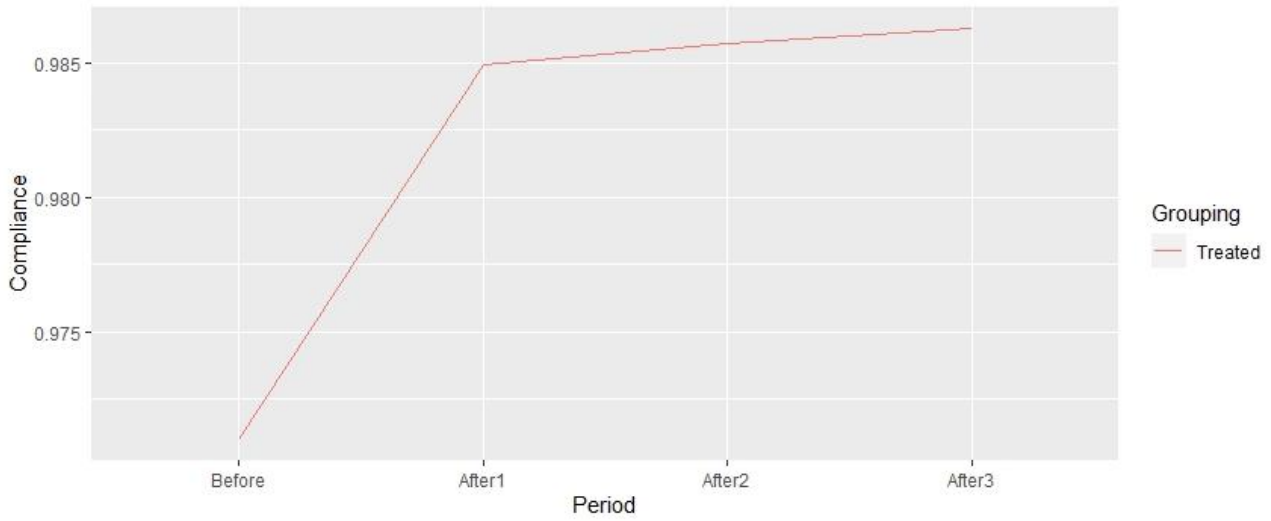


Figure 7-5 Trial 2 High speed (100 km/h)proportion (Trial 2)

Table 7-3 Trial 2 High speed (100 km/h) proportion (Trial 2)

Grouping	Before c proportion	After 1 proportion	After 2 proportion	After 3 proportion
Treated	**0.971**	**0.9850**	**0.9857**	**0.9863**

Figure 7-6 shows high speed proportion for individual routes. Proportions gradually increases from 97% to ~99% over the trial period. Worth noting that South beach Road had a significant increase in the proportion of traffic travelling below 100 km/h however still has more than 4% travelling above 100 km/h. Such roads should be targeted for enforcement or infrastructure changes.

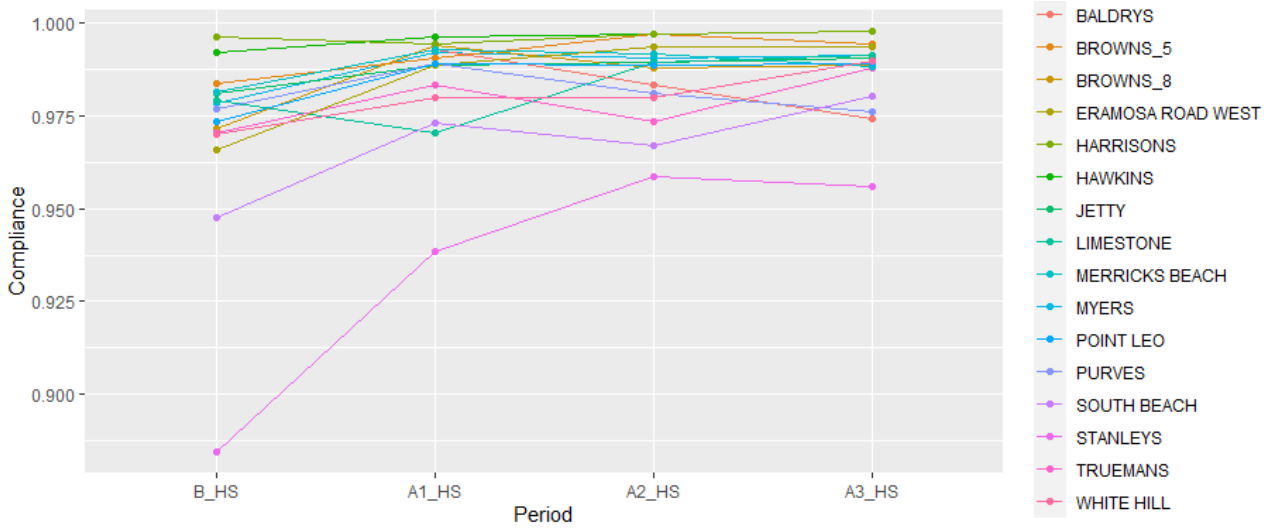


Figure 7-6 Trial 2 High speed (100 km/h) proportion by route

7.2 Trial 2 (90 to 80 km/h) Compliance, Statistical Analysis

The results in this section are based on the 15 treated routes of Trial 2. Like the mean speed analysis, the results were not adjusted based on the single control route. **Table 7-4** to **Table 7-6** show the analysis for the speed limit, target speed and high speed proportion respectively.

Table 7-41 Trial 2 speed limit compliance output

Scenario	Population	Uncorrected odds ratio	p-value	95% CI
Before - After 1 i.e. using (B-A1)(T)	1 pop (15)	0.34	**0.000 (***)**	(0.26,0.43)
Before - After 2 i.e. using (B-A2)(T)	1 pop (15)	0.31	**0.000 (***)**	(0.22,0.42)
Before - After 3 i.e. using (B-A3)(T)	1 pop (15)	0.33	**0.000 (***)**	(0.27, 0.39)
After 1 - After 2 i.e. using (A1-A2)(T)	1 pop (15)	0.92	0.589 (NS)	(0.66,1.28)
After 1 – After 3 i.e. using (A1-A3)(T)	1 pop (15)	1.06	0.657 (NS)	(0.77, 1.35)
After 2 – After 3 i.e. using (A2-A3)(T)	1 pop (15)	1.14	0.349 (NS)	(0.83, 1.45)

Table 7-5 Trial 2 Target speed (80 km/h) proportion output

Scenario	Population	Uncorrected odds ratio	p-value	95% CI
Before - After 1 i.e. using (B-A1)(T)	1 pop (15)	2.46	**0.000 (***)**	(1.92,3.15)
Before - After 2 i.e. using (B-A2)(T)	1 pop (15)	2.26	**0.000 (***)**	(1.57,3.26)
Before - After 3 i.e. using (B-A3)(T)	1 pop (15)	2.51	**0.000 (***)**	(1.85, 3.17)
After 1 - After 2 i.e. using (A1-A2)(T)	1 pop (15)	0.92	0.589 (NS)	(0.66,1.28)
After 1 – After 3 i.e. using (A1-A3)(T)	1 pop (15)	1.06	0.657 (NS)	(0.77, 1.35)
After 2 – After 3 i.e. using (A2-A3)(T)	1 pop (15)	1.14	0.349 (NS)	(0.83, 1.45)

Table 7-6 Trial 2 High speed (100 km/h) proportion output

Scenario	Population	Uncorrected odds ratio	p-value	95% CI
Before - After 3 i.e. using (B-A3)(T)	1 pop (15)	2.32	**0.000 (***)**	(1.71, 2.93)
After 1 – After 3 i.e. using (A1-A3)(T)	1 pop (15)	1.28	0.221 (NS)	(0.81, 1.74)
After 2 – After 3 i.e. using (A2-A3)(T)	1 pop (15)	1.07	0.585 (NS)	(0.81, 1.32)

7.3 Discussion of Trial 2 Compliance Results

From **Table 7-4** there is very strong evidence to suggest that the speed limit compliance has decreased from Before to the After periods (this is statistically significance at 95% level). Speed limit compliance has stabilised to ~65% based on

the three after period results. Hence there is a need to either undertake speed enforcement or change the design of the road to improve the speed limit compliance.

A positive result is that there is very strong evidence to suggest that the target speed (80 km/h) compliance has increased from Before to the after periods (this is statistically significance at the 95% level). Similarly, there is very strong evidence to suggest that the proportion of motorists travelling above 100 km/h has declined from Before to After 3 especially on higher before speed roads. The effect of this increase in Target speed proportion is a lowering in the risk of death and serious injuries in crashes.

8. Program Level Results Summary

The key results of the program level study are summarised in this section.

8.1 Change in Free Flow Mean Speeds

The main finding of the speed analysis is that the free flow speed decreases from Before to After periods for both trials (this is a statistically significant result at the 95%ile level). However, some of the decrease observed in the first six months (from Before to After 1) has been eroded in the second 12-month period (Before to After 2) however returned in the After 3 period. This often occurs as motorists over time adjust to the speed limit change, after a settling down period. Due to COVID-19, and the associated lockdowns in Victoria, there were also a lot fewer vehicles surveyed in the After 1 period. The results achieved in the After 3 period are better able to represent the ongoing driver behaviour changes that have occurred due to the speed limit changes. The results are summarised in **Table 8-1.** This shows the speeds have reduced by around 4.75km/h at all routes and around 6.6km/h for the homogenous and higher speed 9 treated routes analysed.

Table 8-1 Free flow speeds comparison

Mean Speeds (a positive value is a drop, a negative value is a rise, in km/h)				
Interval	Trial 1 all routes	Trial 1 paired sample	Trial 2 (15,0)	Trial 2 (15,18)
Before to After 1	4.70	5.24	3.96	3.38
Before to After 2	2.94	3.92	3.26	1.77
Before to After 3	4.76	6.62	3.40	2.53

8.2 Speed Limit compliance and Target Speed (80 km/h) proportion

The changes in the speed limit compliance are shown in **Table 8-2**. An explanation of how this was calculated is given in **Appendix C**. **Table 8-2** shows the decrease in compliance across periods for the two trials. Decreases in compliance are higher in Trial 1 than in Trial 2, which is to be expected given the larger drop in speed limit (20km/h compared to 10km/h). This may be a result of having already dropped the speed limit from 100 km/h to 90 km/h initially at these Trial 2 routes, or maybe due to the design (e.g. road width) of the sample of roads. These routes need to be a focus of attention for passive or active speed enforcement or road layout changes, e.g. marking of narrower traffic lanes.

Table 8-2 Speed limit compliance change

Compliance changes		
Interval	Trial 1 – Control corrected	Trial 2 (15,0)
Before to After 1	93% to 51%	83% to 65%
Before to After 2	93% to 37%	83% to 63%
Before to After 3	93% to 64%	83% to 64%

The comparison of target speed proportion is shown in **Table 8-3**, which shows that for both trials, the target speed proportion increases from Before to After periods (this is statistically significant). In other words, more drivers are travelling below the target speed of 80 km/h after the speed limit change were made. Again, a focus of attention should be the roads which had the 20km/h speed limit drop, where approximately 35% of drivers are still travelling above the target speed.

Table 8-3 Target (desirable) speed (80 km/h) proportion change

Target proportion changes		
Interval	Trial 1 (20,17) – Control corrected	Trial 2 (15,0)
Before to After 1	42% to 62%	45% to 65%
Before to After 2	42% to 59%	45% to 63%

Before to After 3	42% to 64%	45% to 64%

The comparison of high speed proportion is shown in **Table 8-4**, which shows that for both trials, the target proportion increases from Before to After periods (this is statistically significant). In other words, more drivers are travelling below the 100 km/h after the speed limit change were made.

Table 8-4 High speed (100 km/h) proportion change

High Speed proportion changes		
Interval	Trial 1 (20,17) – Control corrected	Trial 2 (15,0)
Before to After 3	93% to 99%	97% to 99%

9. Project Level Analysis (Speed & Compliance/ proportion)

The free flow speed changes across the four survey periods are shown in **Table 9-1** and

Table 9-2. For Trial 1 treatment routes, before to after period speed changes has been calculated with and without the adjustment.

As expected, on most routes the mean speeds reduced when the speed limit reduced. However, there were some routes (additional routes) where the speeds went up or did not change (adjusted results). This is often called speed targeting and can occur on routes which have existing (Before) mean speeds that are close to or below the new speed limit. Of the routes where mean speeds decreased there is a lot of variability. The change in the mean speeds is dependent on the 'Before' treatment operating speeds, which are normally a result of the road and road-side characteristics of the route. This variability demonstrates the importance of undertaking an assessment over a large enough sample of routes, as has occurred in MPSC.

Table 9-1 Trial 1 Project Summaries

DoT ID and description	Before	After 1	After 2	After 3	B-A1	B-A2	B-A3	B-A1 Adjusted	B-A2 Adjusted	B-A3 Adjusted
2- Sandy Point Road	87.67	80.87	80.59	80.04	6.80	7.08	7.63	6.28	5.62	6.74
7 - Browns Road	76.52	72.16	75.72	74.18	4.36	0.80	2.35	3.84	-0.66	1.46
11 - Old Cape Schanck Road	85.25	78.41	81.49	79.23	6.84	3.76	6.02	6.32	2.30	5.13
13 - Boundary Road	84.65	77.03	80.26	77.62	7.63	4.39	7.04	7.11	2.93	6.15
15 - Hodgins Road	86.42	80.56	77.29	77.64	5.86	9.13	8.77	5.34	7.67	7.89
21 - Tubbarubba Road	86.17	77.12	80.64	78.53	9.05	5.53	7.63	8.53	4.07	6.75
23 - Derril Road	72.68	70.09	73.27	71.86	2.59	-0.59	0.82	2.07	-2.05	-0.06
25 - Stumpy Gully Road	86.89	81.66	80.94	78.95	5.24	5.95	7.94	4.72	4.49	7.06
28 - Coolart Road Extension	86.07	83.15	81.23	79.51	2.92	4.84	6.56	2.40	3.38	5.67
30 - Bungower Road	89.45	82.21	82.92	82.53	7.25	6.53	6.92	6.73	5.07	6.04
31 - Eramosa Road East	86.34	78.09	79.59	79.82	8.25	6.75	6.52	7.73	5.29	5.63
32 - Lower Somerville Road	84.08	78.21	78.34	77.56	5.86	5.74	6.51	5.34	4.28	5.63
34 - Tyabb-Tooradin Road	91.98	84.62	82.49	80.95	7.36	9.50	11.03	6.84	8.03	10.15
35 - Whitneys Road	71.57	68.12	68.14	67.79	3.45	3.43	3.78	2.93	1.97	2.89
36 - Old Moorooduc Road	89.82	80.65	83.77	80.77	9.17	6.05	9.05	8.65	4.58	8.16
37 - Tuerong Road	73.05	64.29	71.43	72.52	8.77	1.62	0.53	8.25	0.16	-0.35
38 - Mckirdys Road	73.34	71.50	69.12	71.22	1.85	4.22	2.12	1.33	2.76	1.23
39 - Oneills Road	76.76	72.37	70.83	73.61	4.39	5.93	3.15	3.87	4.47	2.27
40 - Denham Road	81.50	78.89	78.52	75.41	2.62	2.99	6.09	2.10	1.52	5.20
41 - Red Hill Road	70.15	67.84	69.32	67.65	2.31	0.83	2.50	1.79	-0.64	1.61

Table 9-2 Trial 2 Project Summaries

DoT ID and description	Before Mean Free Flow Speed	After 1 Mean Free Flow Speed	After 2 Mean Free Flow Speed	After 3 Mean Free Flow Speed	B-A1 Mean Free Flow Speed Change	B-A2 Mean Free Flow Speed Change	B-A3 Mean Free Flow Speed Change
1 - Myers Road	81.89	77.28	78.05	77.65	4.61	3.84	4.24
3 - Stanleys Road	88.76	83.93	83.07	82.50	4.83	5.69	6.26
4 - Hawkins Road	76.69	71.66	71.41	74.52	5.03	5.28	2.17
5 - Browns Road	80.95	77.86	71.93	76.53	3.09	9.02	4.42
8 - Browns Road	82.31	74.94	78.31	78.26	7.37	4.00	4.04
9 - Jetty Road	79.12	77.33	76.22	77.17	1.79	2.90	1.95
10 - Limestone Road	80.13	80.62	76.93	78.03	-0.49	3.20	2.10
12 - Harrisons Road	71.24	69.75	71.01	67.93	1.49	0.23	3.31
14 - Truemans Road	81.72	78.91	81.56	78.16	2.81	0.16	3.57
16 - Baldrys Road	77.36	74.17	77.37	75.94	3.19	-0.01	1.42
17 - Purves Road	77.44	71.18	77.25	77.17	6.26	0.19	0.27
19 - Merricks Beach Road	73.09	69.01	71.91	70.97	4.08	1.18	2.13
24 - Eramosa Road West	86.89	80.67	79.58	80.07	6.22	7.31	6.81
27 - Point Leo Road	79.69	74.27	76.23	76.37	5.42	3.46	3.32
29 - South Beach Road	85.40	81.65	82.96	80.35	3.75	2.44	5.05

The following tables summarise the project level speed limit compliances, target speed and high speed (100 km/h) proportions for Trial 1 and Trial 2 respectively.

Table 9-3 Trial 1 project level speed limit compliance

DoT ID and description	Before Speed Limit Compliance	After 1 Speed Limit Compliance	After 2 Speed Limit Compliance	After 3 Speed Limit Compliance
2- Sandy Point Road	89%	47%	49%	52%
7 - Browns Road	99%	84%	70%	78%
11 - Old Cape Schanck Road	93%	61%	43%	55%
13 - Boundary Road	95%	64%	46%	62%
15 - Hodgins Road	92%	46%	65%	66%
21 - Tubbarubba Road	90%	67%	50%	59%
23 - Derril Road	97%	74%	66%	75%
25 - Stumpy Gully Road	87%	44%	47%	55%
28 - Coolart Road Extension	91%	38%	43%	52%
30 - Bungower Road	88%	41%	38%	37%
31 - Eramosa Road East	91%	60%	52%	50%
32 - Lower Somerville Road	92%	65%	65%	66%
34 - Tyabb-Tooradin Road	84%	26%	38%	49%
35 - Whitneys Road	99%	87%	88%	89%

DoT ID and description	Before Speed Limit Compliance	After 1 Speed Limit Compliance	After 2 Speed Limit Compliance	After 3 Speed Limit Compliance
36 - Old Moorooduc Road	85%	45%	30%	45%
37 - Tuerong Road	98%	90%	77%	75%
38 - Mckirdys Road	97%	78%	84%	78%
39 - Oneills Road	96%	74%	81%	73%
40 - Denham Road	92%	51%	53%	68%
41 - Red Hill Road	100%	93%	91%	93%

Table 9-4 Trial 2 project level speed limit compliance

DoT ID and description	Before Speed Limit Compliance	After 1 Speed Limit Compliance	After 2 Speed Limit Compliance	After 3 Speed Limit Compliance
1 - Myers Road	85%	68%	64%	66%
3 - Stanleys Road	56%	33%	38%	40%
4 - Hawkins Road	94%	89%	91%	79%
5 - Browns Road	87%	67%	87%	72%
8 - Browns Road	81%	72%	56%	58%
9 - Jetty Road	88%	61%	65%	66%
10 - Limestone Road	87%	49%	66%	63%
12 - Harrisons Road	98%	84%	84%	92%
14 - Truemans Road	84%	57%	43%	63%
16 - Baldrys Road	90%	75%	61%	62%
17 - Purves Road	88%	80%	61%	58%
19 - Merricks Beach Road	92%	88%	81%	79%
24 - Eramosa Road West	66%	44%	55%	52%
27 - Point Leo Road	84%	70%	64%	65%
29 - South Beach Road	70%	42%	33%	49%

Table 9-5 Trial 1 project level target speed (80 km/h) proportions

DoT ID and description	Before Target speed (80 km/h) proportions	After 1 Target speed (80 km/h) proportions	After 2 Target speed (80 km/h) proportions	After 3 Target speed (80 km/h) proportions
2- Sandy Point Road	23%	47%	49%	52%
7 - Browns Road	66%	84%	70%	78%
11 - Old Cape Schanck Road	31%	61%	43%	55%
13 - Boundary Road	31%	64%	46%	62%
15 - Hodgins Road	27%	46%	65%	66%
21 - Tubbarubba Road	27%	67%	50%	59%
23 - Derril Road	68%	74%	66%	75%
25 - Stumpy Gully Road	27%	44%	47%	55%
28 - Coolart Road Extension	27%	38%	43%	52%

DoT ID and description	Before Target speed (80 km/h) proportions	After 1 Target speed (80 km/h) proportions	After 2 Target speed (80 km/h) proportions	After 3 Target speed (80 km/h) proportions
30 - Bungower Road	17%	41%	38%	37%
31 - Eramosa Road East	27%	60%	52%	50%
32 - Lower Somerville Road	44%	65%	65%	66%
34 - Tyabb-Tooradin Road	8%	26%	38%	49%
35 - Whitneys Road	76%	87%	88%	89%
36 - Old Moorooduc Road	16%	45%	30%	45%
37 - Tuerong Road	71%	90%	77%	75%
38 - Mckirdys Road	68%	78%	84%	78%
39 - Oneills Road	59%	74%	81%	73%
40 - Denham Road	43%	51%	53%	68%
41 - Red Hill Road	87%	93%	91%	93%
Average	42.2%	61.8%	58.7%	63.8%

Table 9-6 Trial 2 project level target speed (80 km/h) proportions

DoT ID and description	Before Target speed (80 km/h) proportions	After 1 Target speed (80 km/h) proportions	After 2 Target speed (80 km/h) proportions	After 3 Target speed (80 km/h) proportions
1 - Myers Road	40%	68%	64%	66%
3 - Stanleys Road	16%	33%	38%	40%
4 - Hawkins Road	65%	89%	91%	79%
5 - Browns Road	44%	67%	87%	72%
8 - Browns Road	37%	72%	56%	58%
9 - Jetty Road	52%	61%	65%	66%
10 - Limestone Road	48%	49%	66%	63%
12 - Harrisons Road	82%	84%	84%	92%
14 - Truemans Road	42%	57%	43%	63%
16 - Baldrys Road	58%	75%	61%	62%
17 - Purves Road	55%	80%	61%	58%
19 - Merricks Beach Road	69%	88%	81%	79%
24 - Eramosa Road West	15%	44%	55%	52%
27 - Point Leo Road	48%	70%	64%	65%
29 - South Beach Road	24%	42%	33%	49%
Average	46.4%	65.2%	63.3%	64.3%

Table 9-7 Trial 1 project level high speed (100 km/h) proportions

DoT ID and description	Before High speed (100 km/h) proportions	After 1 High speed (100 km/h) proportions	After 2 High speed (100 km/h) proportions	After 3 High speed (100 km/h) proportions
2- Sandy Point Road	89%	98%	98%	98%
7 - Browns Road	99%	100%	99%	99%
11 - Old Cape Schanck Road	93%	98%	98%	98%
13 - Boundary Road	95%	99%	98%	99%
15 - Hodgins Road	92%	98%	99%	99%
21 - Tubbarubba Road	90%	99%	97%	98%
23 - Derril Road	97%	98%	98%	99%
25 - Stumpy Gully Road	87%	95%	96%	97%
28 - Coolart Road Extension	91%	93%	97%	98%
30 - Bungower Road	88%	98%	97%	98%
31 - Eramosa Road East	91%	99%	98%	98%
32 - Lower Somerville Road	92%	92%	92%	92%
34 - Tyabb-Tooradin Road	84%	96%	98%	99%
35 - Whitneys Road	99%	99%	100%	100%
36 - Old Moorooduc Road	85%	97%	95%	98%
37 - Tuerong Road	98%	99%	99%	99%
38 - Mckirdys Road	97%	99%	99%	99%
39 - Oneills Road	96%	99%	99%	99%
40 - Denham Road	92%	96%	97%	98%
41 - Red Hill Road	100%	100%	100%	100%
Average	92.7%	97.6%	97.7%	98.3%

Table 9-8 Trial 2 project level high speed (100 km/h) proportions

DoT ID and description	**Before** High speed (100 km/h) proportions	**After 1** High speed (100 km/h) proportions	**After 2** High speed (100 km/h) proportions	**After 3** High speed (100 km/h) proportions
1 - Myers Road	98%	99%	99%	99%
3 - Stanleys Road	88%	94%	96%	96%
4 - Hawkins Road	99%	100%	100%	99%
5 - Browns Road	98%	99%	100%	99%
8 - Browns Road	97%	99%	99%	99%
9 - Jetty Road	98%	99%	99%	99%
10 - Limestone Road	98%	97%	99%	99%
12 - Harrisons Road	100%	99%	100%	100%
14 - Truemans Road	97%	98%	97%	99%
16 - Baldrys Road	98%	99%	98%	97%
17 - Purves Road	98%	99%	98%	98%

DoT ID and description	**Before** High speed (100 km/h) proportions	**After 1** High speed (100 km/h) proportions	**After 2** High speed (100 km/h) proportions	**After 3** High speed (100 km/h) proportions
19 - Merricks Beach Road	98%	99%	99%	99%
24 - Eramosa Road West	97%	99%	99%	99%
27 - Point Leo Road	97%	99%	99%	99%
29 - South Beach Road	95%	97%	97%	98%
Average	97.1%	98.5%	98.6%	98.6%

Furthermore, **Table 9-9** and **Table 9-10** provide a guide on how to interpret the individual route (project) graphical and statistical summaries of **Appendix A** and **Appendix B**.

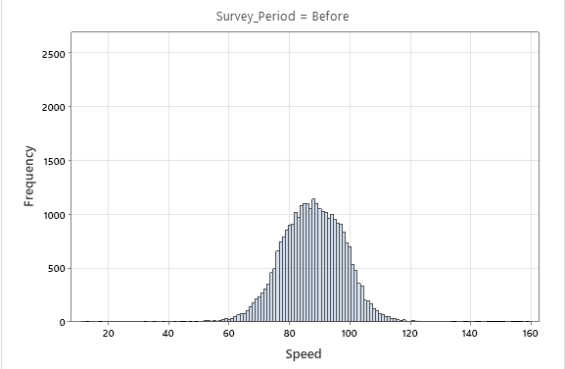
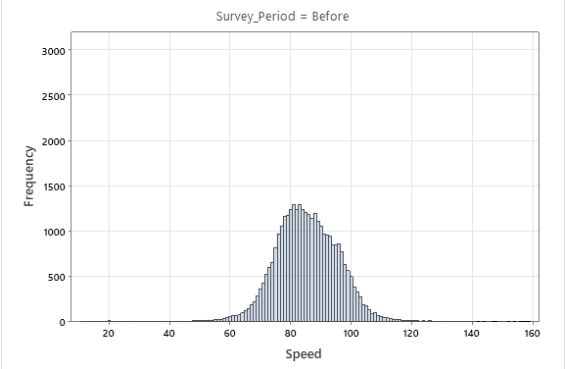
Appendix A and **Appendix B** provides route summaries for each treatment route. The details provided for each route are in the following structure:

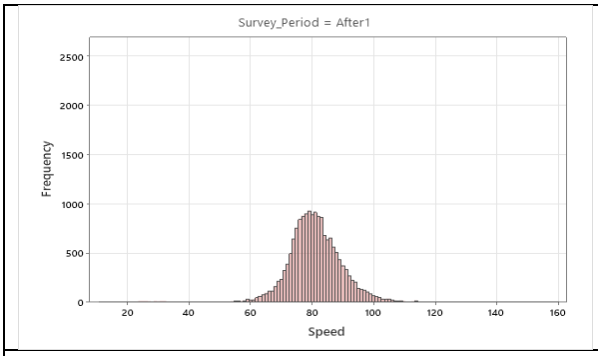
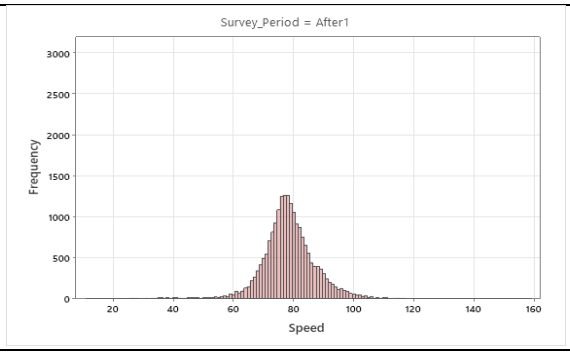
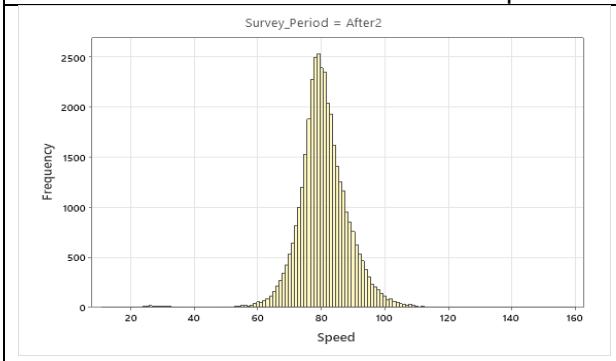
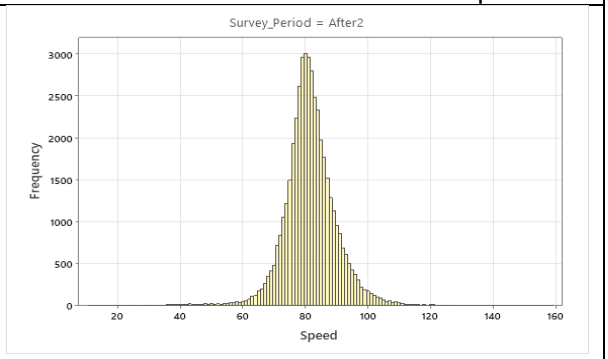
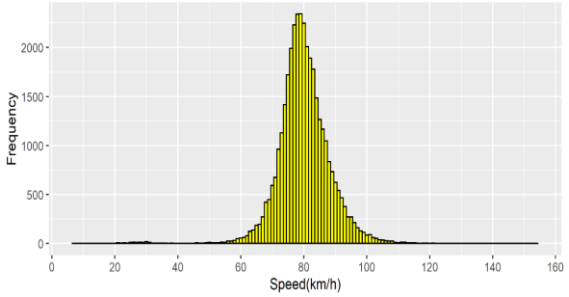
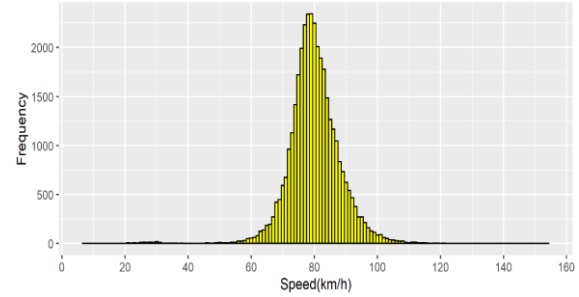
Route Name and DoT ID

Table 9-9 Project level results format

A histogram of all speeds measured in the Before period **N**: Total number of vehicles **Mean**: Histogram mean **SD**: Histogram Standard Deviation (confidence intervals are wider when N is smaller) **Compliance**: Proportion of vehicles complying with current speed limit **Target Speed Proportion**: Proportion of vehicles complying with the eventual lower speed limit (i.e. speed <= 80)
A histogram of all speeds measured in the After 1 period N, Mean, SD, Comp All as above
A histogram of all speeds measured in the After 2 period N, Mean, SD, Comp All as above
A histogram of all speeds measured in the After 3 period N, Mean, SD, Comp All as above

Table 9-10 Project level results example output

Sandy Point Road DoT ID 2 (T)	**Old Cape Schanck Road DoT ID 11 (T)**
	
N 29830 Mean 87.67 SD 10.69	N 32975 Mean 85.25 SD 11.17
Compliance 0.89 Target Compliance 0.23	Compliance 0.93 Target Compliance 0.31

	
N 16981 Mean 80.87 SD 9.38 Comp 0.47	N 20316 Mean 78.41 SD 9.76 Comp 0.61
	
N 37653 Mean 80.59 SD 8.68 Comp 0.49	N 45774 Mean 81.49 SD 9.06 Comp 0.43
Survey_Period = After3 	Survey_Period = After3 
N 36000 Mean 80.04 SD 8.62 Comp/ TC 0.59	N 36000 Mean 80.04 SD 8.62 Comp/ TC 0.59

10. Fatal & Serious Injury Reductions

10.1 Estimated Reductions

A strong relationship has been established (through research) between vehicle speed and the risk of fatal or serious injuries. The initial research by Nilsson (1981) developed power models relating various levels of injury severity to speed. Nilsson (1981) found that increases in fatal crashes are related to the 4th power of the increase in mean speed and increases in serious casualty crashes (those involving fatal or serious injury) according to the 3rd power. The research by Nilsson has been reviewed and tweaked by a large number of researchers, including Elvik (2004) and Elvik (2009). Based on a Meta-analysis of well-controlled studies, Elvik (2009) found that the power estimate for fatalities to be 4.67 and serious injuries to be 3.5. Elvik (2009) power estimate has been used as the primary method to calculate FSI reductions for the MPSC trial.

Table 10-1 summarises the estimated change in FSI for each Trial 1 route. For Trial 1 DoT route 2, the FSI reduction is 25% from Before to After 3. **Table 10-2** summarises the estimated change in risk for Trial 2 routes. For Trial 2 DoT route 1, the FSI reduction is 17% from Before to After 3.

Overall, the assessment shows that the FSI crash reduction is likely to be approximately 20% for Trial 1 and 15% for Trial 2. This is a result of reducing the mean speeds across the rural road network and reducing the higher end speeds by a greater amount (over 100 km/h proportion).

Table 10-1 Trial 1 Expected 5 year FSI Reduction estimates

DoT ID and name	Fatalities (5 years)	Serious Casualties (5 years)	After 3 FSIs Reduction	After 3 FSIs
2- Sandy Point Road	1	2	25%	2
7 - Browns Road	1	1	7%	2
11 - Old Cape Schanck Road		2	20%	2
13 - Boundary Road	0	1	24%	1
15 - Hodgins Road		4	29%	3
21 - Tubbarubba Road		2	25%	1
23 - Derril Road		6	0%	6
25 - Stumpy Gully Road			26%	0
28 - Coolart Road Extension		2	22%	2
30 - Bungower Road		3	22%	2
31 - Eramosa Road East			22%	0
32 - Lower Somerville Road			22%	0
34 - Tyabb-Tooradin Road	1	5	34%	4
35 - Whitneys Road			14%	0
36 - Old Moorooduc Road		1	29%	1
37 - Tuerong Road			-2%	0
38 - Mckirdys Road			6%	0
39 - Oneills Road		1	10%	1
40 - Denham Road			21%	0
41 - Red Hill Road		2	8%	2
Trial 1 Summary	3	32	20%	28

Table 10-2 Trial 2 Expected 5 year FSI Reduction

DoT ID and Name	Fatalities (5 years)	Serious Casualties (5 years)	After 3 FSIs Reduction	After 3 FSIs
1 - Myers Road	2	7	17%	7
3 - Stanleys Road	1	3	23%	3
4 - Hawkins Road		5	10%	5
5 - Browns Road	1	2	18%	2
8 - Browns Road	0	2	17%	2
9 - Jetty Road			9%	0
10 - Limestone Road		3	9%	3
12 - Harrisons Road		3	16%	3
14 - Truemans Road			15%	0
16 - Baldrys Road	0	3	6%	3
17 - Purves Road			1%	0
19 - Merricks Beach Road			10%	0
24 - Eramosa Road West			26%	0
27 - Point Leo Road		10	14%	9
29 - South Beach Road			20%	0
Trial 2 Summary	4	38	15%	36

10.2 Actual Reductions

Actual observations from the two years prior to the implementation of the trial and the 24 months after demonstrate a control corrected 20% reduction in casualties, including no fatalities compared to eight in the two years prior. Whilst encouraging, a well-designed before and after study of FSIs after 5 years should be conducted to confirm whether the predicted FSI reductions were accurate across the full sample of roads. The results are shown in **Table 10-3**.

Table 10-3 Estimated actual FSi reduction

Route	Before Period Start Date	Project Start Date	Before Period Casualties	Project End Date	After Period End Date	After Casualties All	Before Rate	After Rate	Reduction Rate
Treated	1/11/2017	1/11/2019	38	1/01/2020	30/06/2021	9	19.01	6.02	-68.33%
Controls	1/11/2017	1/11/2019	23	1/01/2020	30/06/2021	9	11.51	6.02	-47.68%

11. Conclusions and Recommendations

11.1 Study Limitations & Conclusions

Study Limitations

There have been some limitations in the study design (in the Before data) and a change in travel patterns due to COVID-19. Given the impact of COVID-19 on the traffic volumes observed during the After 1 and After 2 periods (i.e. much lower traffic volumes, it is recommended that more reliance on the differences observed between the Before and the After 3 period. This is based on the information that traffic patterns have settled down to a pre-COVID level. In addition, the After 1 period may have been influenced by the settling down period that can occur when new speed limits are introduced and not reflect the more permanent behaviour change in terms of speed selection on the study routes.

The main limitation of this study is the lack of 90 km/h controls for the 90 to 80 km/h speed limit changes. There was only one 90 km/h control route monitored in the Before period (due to lack of suitable control routes within the area). This is not considered sufficient to enable a reliable adjustment of the before and after results at the treated routes to address any underlying changes in speeds. Hence the results of the 90 to 80 km/h speed limit changes should be considered an interim result until such a time that additional before and after studies are undertaken in Victoria of this speed change.

Alternatively, a cross-sectional study could be undertaken by the DOT Safer Roads team comparing speeds of routes with 80 km/h and 90 km/h speed limits. Such a study, if undertaken carefully may help in predicting the benefits of this 10km/h drop in speed limit. However, we think such a study would have several limitations given the complex relationship between speed, road design and road-side design, and would strongly recommend that further before and after studies should be undertaken to provide a more robust result for lowering speed limits on 90 km/h roads.

Conclusions

The findings of the study are:

1) There is very strong evidence that an average 5 km/h mean operating speed reduction has been achieved after two years of the speed limit being reduced from 100 km/h to 80 km/h (20 km/h drop) across MPSC, with the most recent 'After' reductions exceeding the corresponding 'After' reductions observed at 6 months and 12 months after the speed limit changes. Even though there is a trend towards increasing reductions in mean speed with time, no statistically reliable differences are yet evident among the three After periods.
2) The 5 km/h drop in operating speed is similar to other evaluations of speed limit reductions from 100 km/h to 80 km/h.
3) An even greater mean speed reduction of 7 km/h was observed after two years for a subset of roads that carry more than an average of 1000 vehicles per day.
4) Across all after periods, a higher speed reduction of 8 km/h was observed on a subset of Trial 1 roads that had an operating speed of 85 km/h or higher in the Before case, and therefore a higher risk of FSI crashes.
5) The After 3 speed reductions, which were greater than the After 1 speed reductions, confirm that the reduction observed in After 1 (which was greater than After 2) was not due to the novelty of a new speed limit and supplementary "New Limit" speed signs that were only present during After 1.
6) There is some evidence that the mean free flow speeds have reduced by 3.4 km/h as a result of the speed limit reduction of 90 km/h to 80 km/h. However, this is considered an interim result, as it was not possible to determine whether there is a need to adjust this result using control route data. Regardless, the result exceeds the outcome expected for a 10km/h speed limit reduction.
7) Even though there is very strong evidence to suggest a drop in mean speeds from before to all after periods, there is little evidence to suggest reductions from After 1 to After 2 and from After 1 and After 3. However, there is strong evidence to suggest that mean speeds have dropped from After 2 to After 3.
8) That speed limit compliance rates reduced significantly from Before to After 1 when the speed limits were dropped to 80 km/h. This was particularly noticeable where the speed limits were reduced from 100 km/h to 80 km/h, with over 64% of the drivers complying with the new speed limit in After 3 compared to 93% in the Before period. However, there is very strong evidence to suggest that speed limit compliance has improved from After 2 to After 3.

9) For the roads where the speed limits were dropped from 90 km/h to 80 km/h, the compliance rates were higher than the 100 km/h to 80 km/h trial. However, over one-third of drivers were still exceeding the speed limit.

10) That the number of drivers travelling below the target speed of 80 km/h (Target Speed Proportion) increased significantly for both the 100 km/h to 80 km/h and 90 km/h to 80 km/h speed changes. In both cases over 60% of drivers were under the target speed of 80 km/h in the after periods, compared to 42% and 46%, respectively, in the before period.. Similar to speed limit compliance, there is some evidence to suggest that the proportion of drivers travelling within the target speed has improved from After 2 to After 3. This is an important outcome from a Safe System perspective, as the greater numbers of drivers now travelling below these targeted, much safer speeds have substantially reduced the risk of FSI crashes.

11) For the 100 km/h to 80 km/h trial, the average predicted reduction in FSI's is approximately 20% (control corrected), with some routes showing reductions as high as 39%. For the 90 km/h to 80 km/h routes the reductions are likely to be less, with an average FSI reduction of 15% across the treated routes.

12) Actual observations from the two years prior to the implementation of the trial and the 24 months after demonstrate a control corrected 20% reduction in casualties, including no fatalities compared to eight in the two years prior. Whilst encouraging, a well-designed before and after study of FSIs after 5 years should be conducted to confirm whether the predicted FSI reductions were accurate across the full sample of roads.

11.2 Recommended Improvements

There are minor shortcomings with this research that have impacted on the accuracy of the results. The two key shortcomings are

i) Not having a (statistically) designed experiment and associated speed survey program before doing the 'Before' surveys and

ii) the impact of COVID-19 on traffic flows, and hence, potentially travel speeds, in the first after period. These issues are discussed below along with possible improvements to this study or in future programs of this type.

Survey design issues

In statistical research, treatment (speed limit reduction) would be randomly allocated across the broader network and are not imposed on a pre-determined set of roads within MPSC. The 'control' roads which were to be compared with the speed reduced roads would be a similar sample. However, in speed management, treatment corridors are chosen based on other factors such as location, cross section and usage that are not random, therefore a representative sample was chosen that did equal the number of roads with speed reductions. Nevertheless, the evaluation process used, which is often used in these type of studies, still enables a robust evaluation to occur.

Evaluations should always aim to conduct a properly designed experiment where controls are carefully selected at the design stage of the trial. When designing an experiment, it is important to begin with a clear description of the set of routes, including treated and control routes required for the proposed statistical method being applied, e.g. paired route comparison. This was a problem in Trial 1, for example, where the paired routes experience a similar reduction in speeds (of around 6km/h (Before to After 2)), while the other treated routes (eight) had a much lower reduction in speed (3km/h), bringing down the average reduction to 4.8km/h (Before to After 2).

This is even more evident for Trial 2 where only one 90 km/h control route was surveyed. The reason for control routes is to measure the change in speed on routes over time and therefore control for any general increase or decrease in speeds that may occur between the 'before' and the 'after' time periods. In the case of Trial 1, there were enough controls and these were successfully used to take into account the changes in speeds over time and to provide a better estimate of the overall change in operating speeds. This was not the case in Trial 2, where there was only one control route and a single route was not considered suitable for adjusting the operating speeds at the treated routes.

Additional Surveys and Further Analysis

The outcome of this limitation in the study is that the results of the 90 to 80 km/h speed limit changes can only be treated as interim. There are two options to confirm this result. One option is to identify suitable other routes (at least 10) where there is a 90 km/h speed limit and an intention to drop the speed to 80 km/h, and repeat the before and after study on those routes.

The alternative approach is to do a cross-sectional study. In this type of study at least 20 routes with similar characteristics (typical local authority high speed road) are selected, half of which have a 90 km/h speed limit and half with an 80 km/h speed limit and speed counts collected. The difference in speeds between the two groups are then compared and the difference used to infer what the benefits would be of a speed limit change from 90 km/h to 80 km/h. While the cross-sectional approach is something that might be able to be done more quickly, it is generally considered less desirable than a before and after study, as it can be hard to pull together routes that have similar characteristics. With the limited number of similar designed routes with 90 km/h speed limits in Victoria, this may be difficult to do in the short term.

COVID-19 effects on after data

Due to COVID-19 travel restrictions across Victoria and driver behaviour changes, a noticeable reduction in traffic flow was observed in the After 1 period compared to Before period. This meant there was a concern that the reduction in flow could potentially influence the free flow speed distributions of the trial in After 1. Naturally, with the reduction of traffic flow, the free flow speeds were expected to increase on two-way two-lane rural roads due to less side friction caused by vehicles travelling in the opposite direction and vehicles turning in and out of side streets. It is plausible that the observed speeds could have been lower in a pre COVID-19 environment. Nonetheless, the evaluation team is confident that the use of control routes would address COVID-19 to a certain degree. However, the full impact of COVID-19 on travel and vehicle speeds cannot be fully understood due to the lack of data/ research. The evaluation team has followed the correct evaluation procedure in this evaluation therefore confident that the effects of COVID-19 have been satisfactorily accounted for.

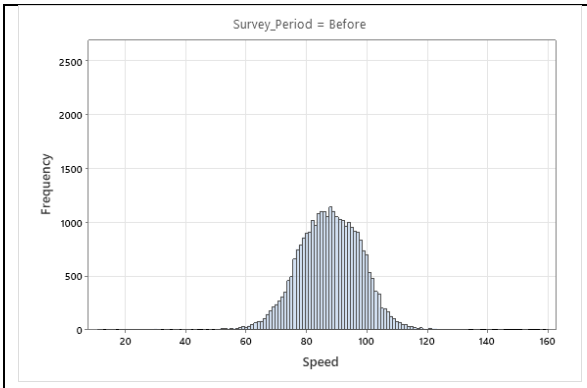
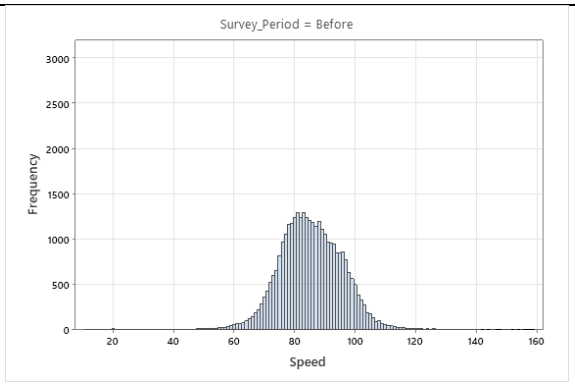
To the contrary, the statistical analysis showed that the mean speed actually increased from After 1 to After 2. So it seems that perhaps COVID-19 has not impacted on the speeds on the survey roads, as expected. It is important to be cautious during COVID-19, not to collect After data when traffic volumes are low, i.e. not during strict lockdown periods. The third After data collection occurred when traffic volumes were closer to normal levels (around 80 to 90%).

Other Recommendations

Our other recommendations follow:

1) Large-scale changes in speed behaviour take time and cannot easily be identified or demonstrated in the short term. However, findings of this two-year evaluation are encouraging. It is recommended that further after data are collected at regular intervals to monitor speeds at trial routes. As more lower speed limits are introduced, and other supporting actions like education campaigns and targeted enforcement occur, then speeds are likely to come down further as they have in previous speed limit changes 60km/h to 50 km/h and 100 km/h to 80 km/h in Victoria. Even small reductions in travel speeds have been found to produce disproportionately larger reductions in the risks of fatal and serious injuries.
2) There was a lot of data cleaning required in this study – the more that data errors can be picked up automatically following data collection, the less work is required in cleaning the data before the analysis can occur.
3) In future studies of this type, it is important to include the evaluation team in the survey design stage where possible (and use the appropriate evaluation framework), i.e. before the Before data is collected and the changes are made to the speed limits – to ideally use a more controlled design experiment where possible.
4) It is appreciated that often it is difficult to find the perfect location to install counters whilst avoiding all side roads as, as well as trying to avoid steep gradients, curves and school zones and find a location to secure the counter equipment. In future studies it is important to take care with identifying where speed counts should be collected so that they represent the typical speed on the road. This includes collecting data away from side roads/ major accesses and not where vehicles may be accelerating or decelerating departing or approaching an intersection wherever possible.
5) Conduct a before and after study of crashes after 5 years and confirm whether the predicted FSI reductions were accurate across the full sample of roads.
6) Due to the lack of control routes, the results of the 90 to 80 km/h speed limit changes can only be treated as interim. However, the observed speed drop is consistent with previous similar evaluations and is acceptable to use this result to inform future speed limits changes (90 km/h to 80 km/h).

Appendix A.
Trial 1 Treated Routes Free Flow Speed Summaries

Sandy Point Road DoT ID 2 (T)	Old Cape Schanck Road DoT ID 11 (T)
	
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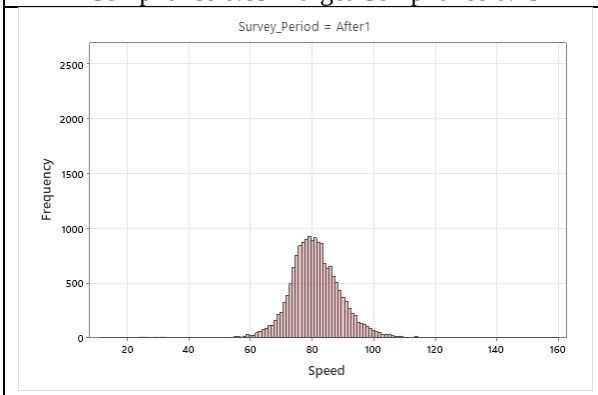
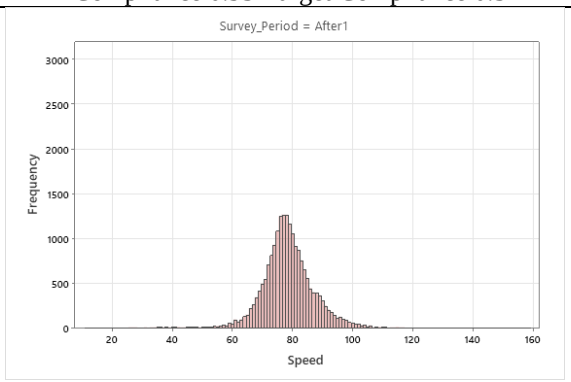
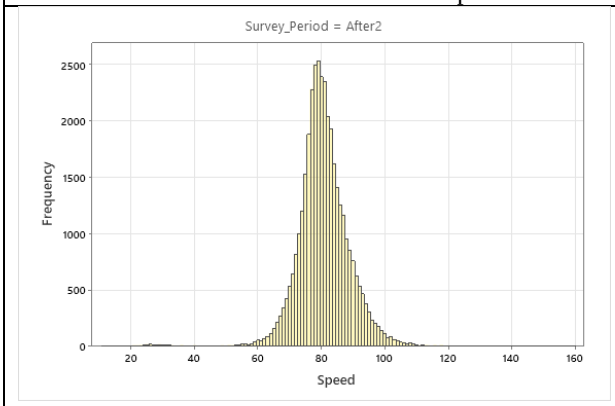
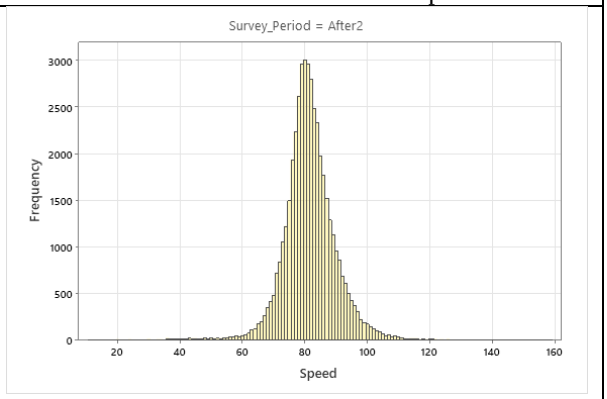
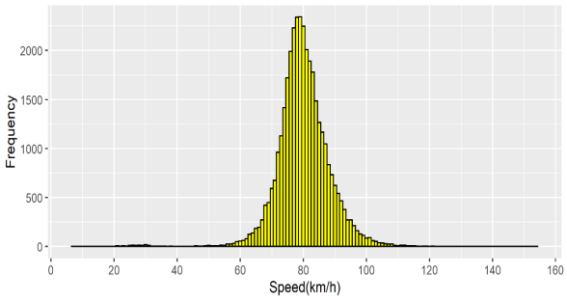
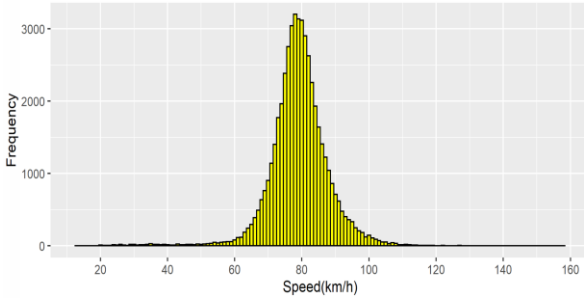
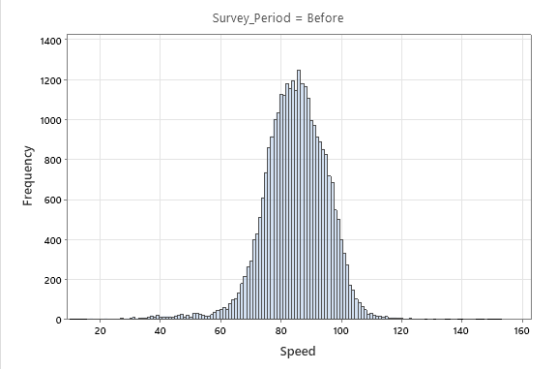
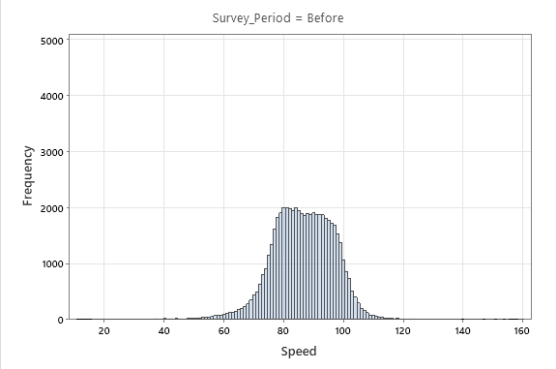
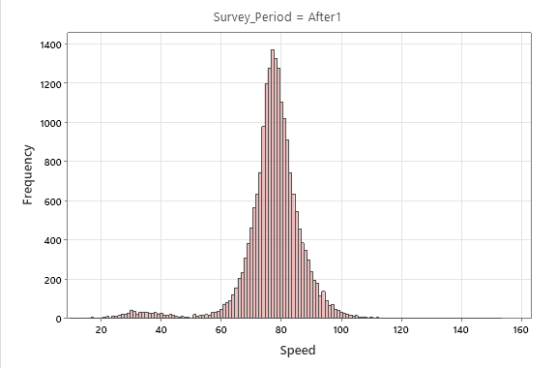
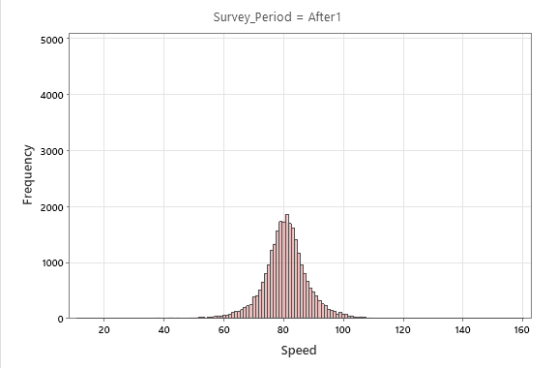
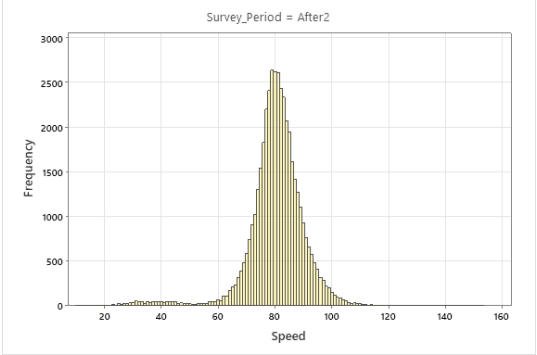
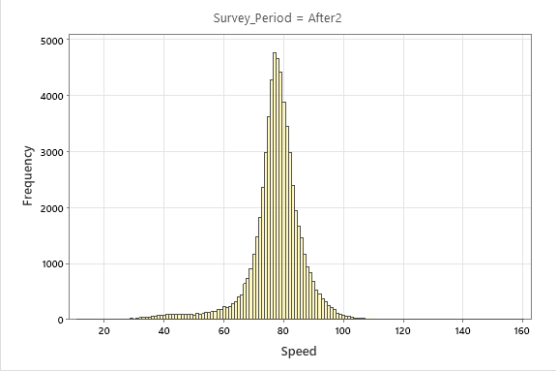
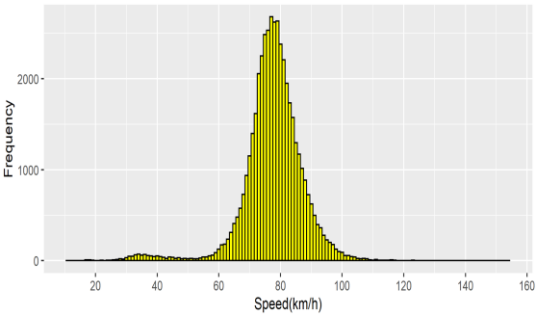
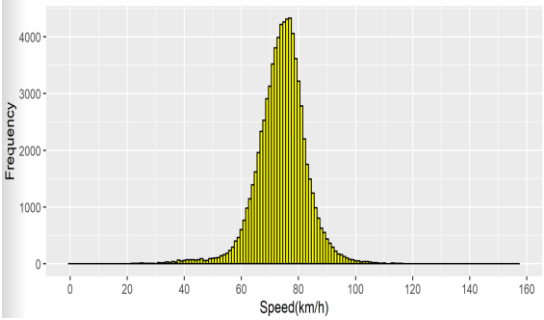
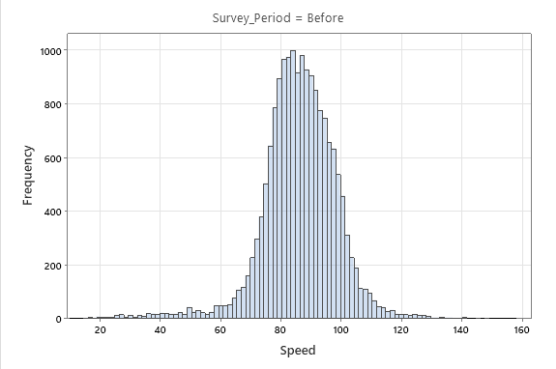
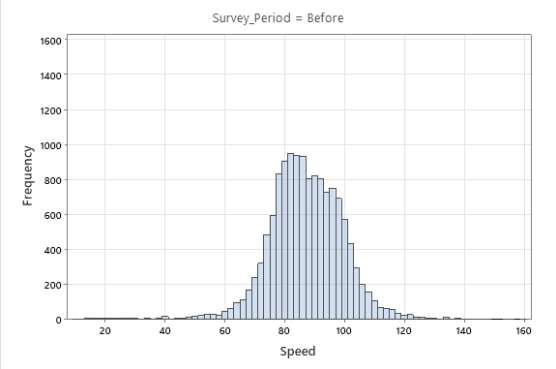
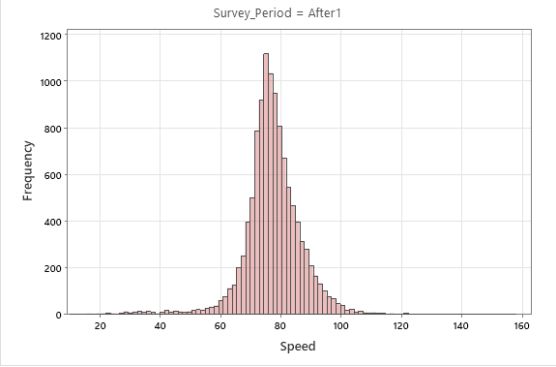
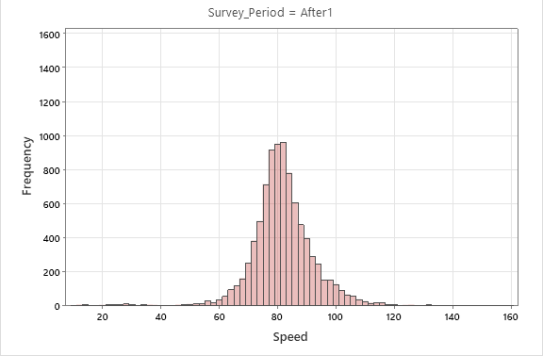
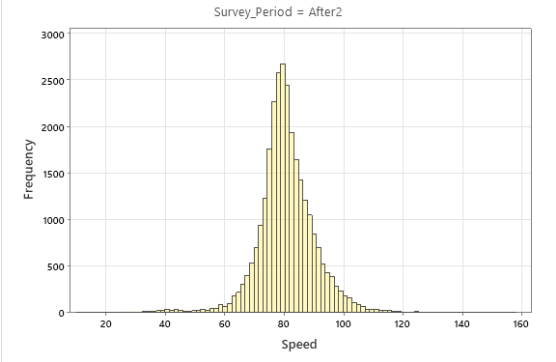
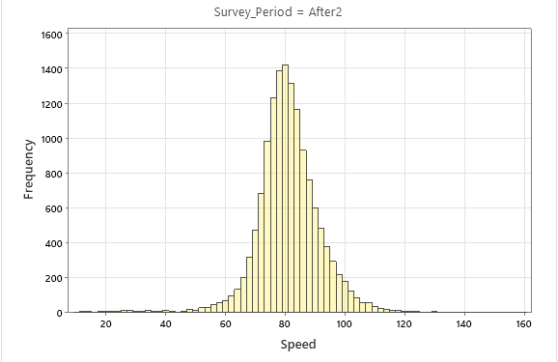
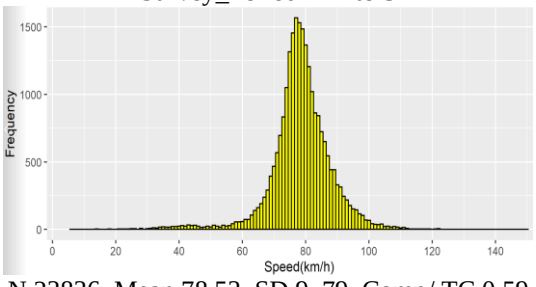
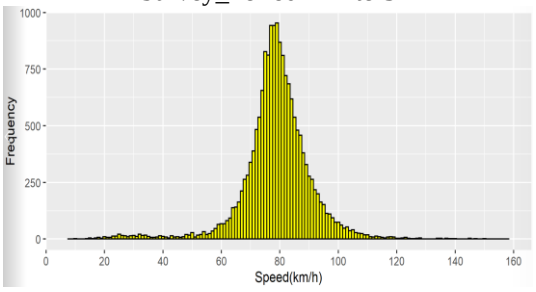
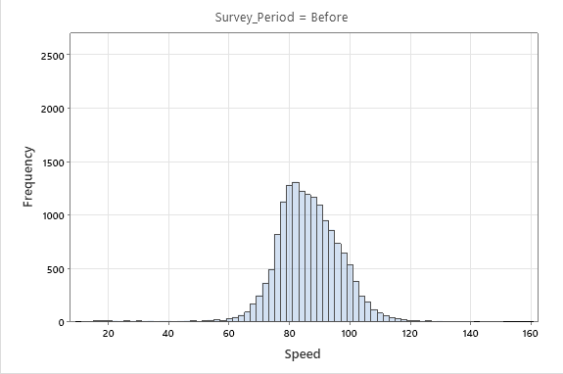
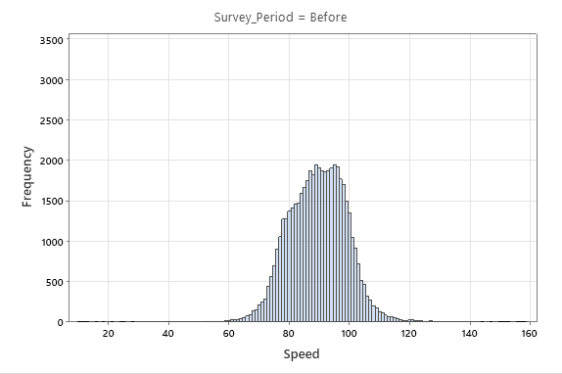
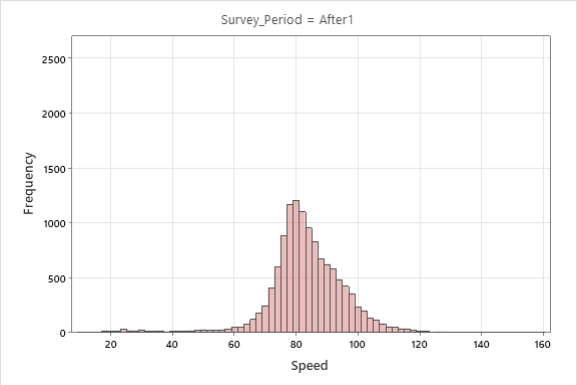
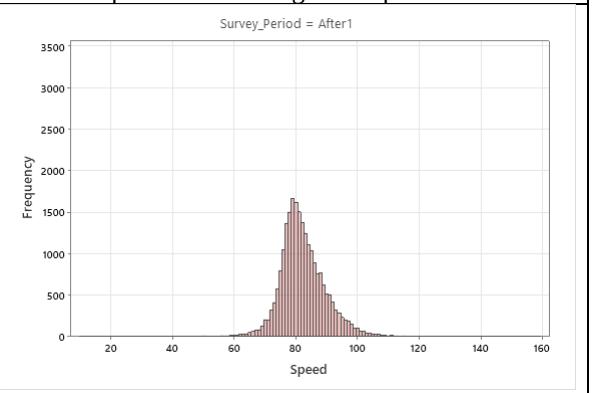
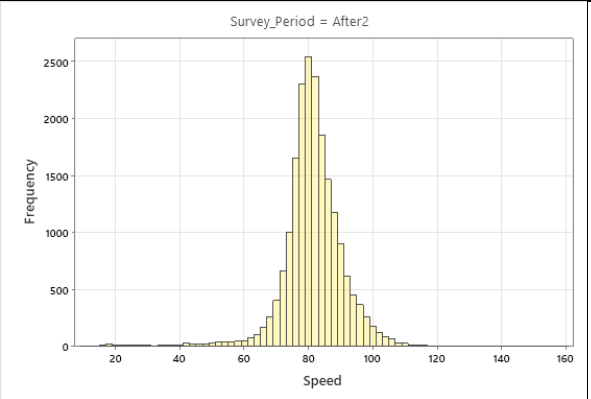
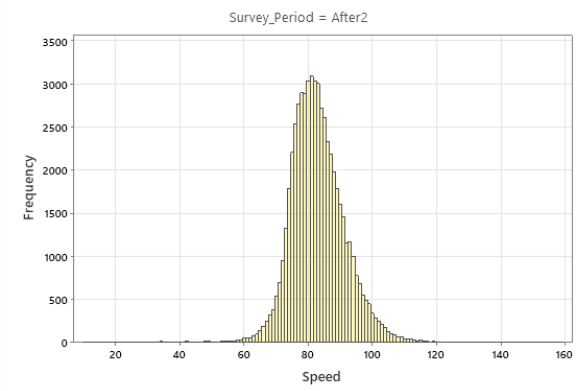
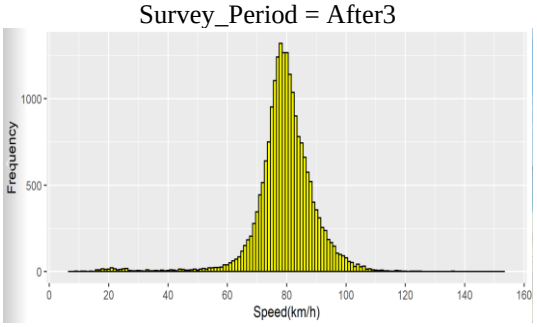
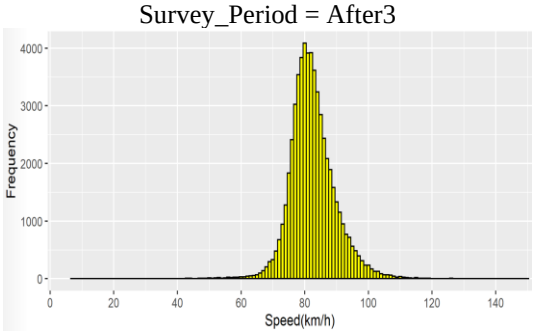
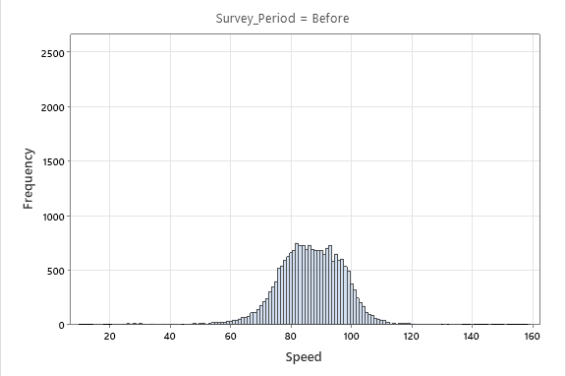
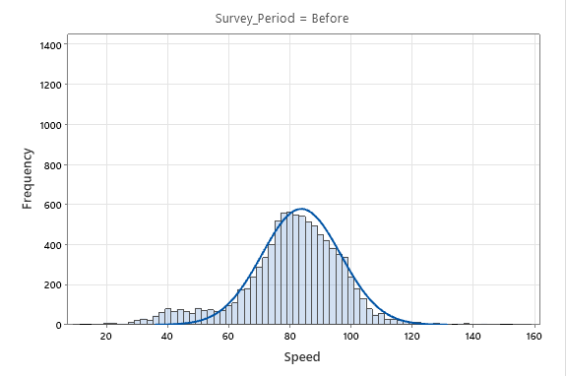
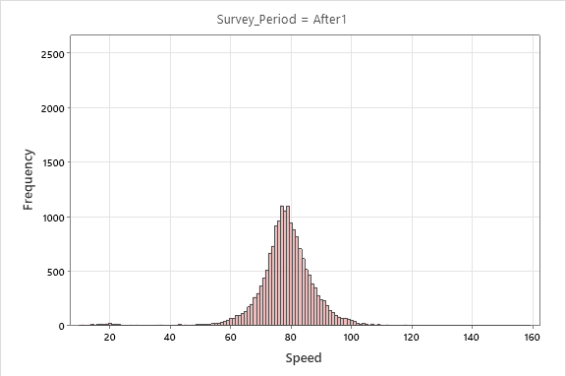
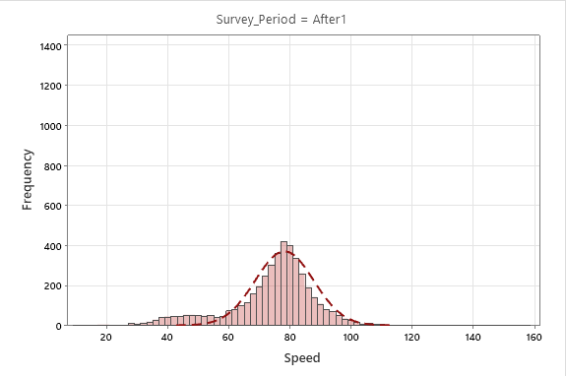
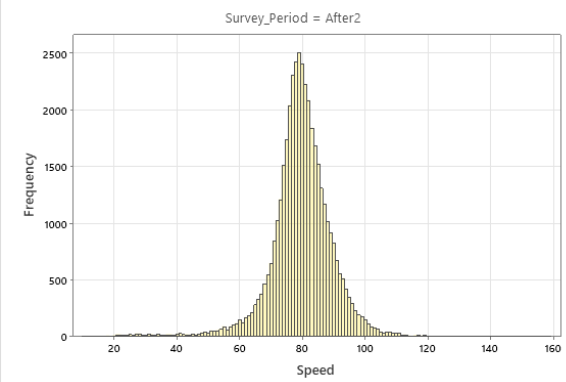
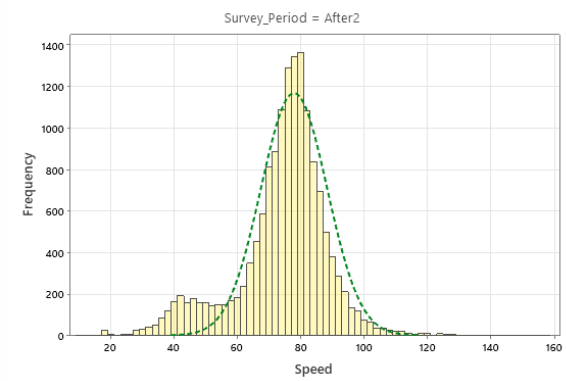
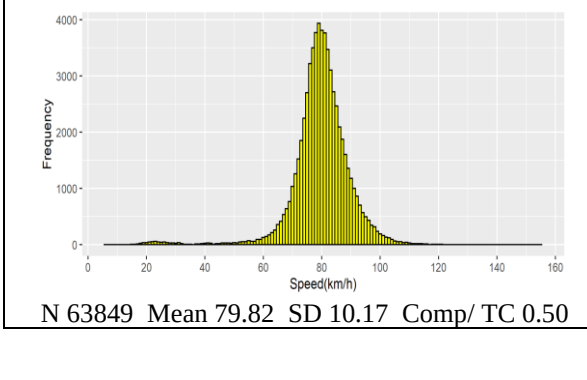
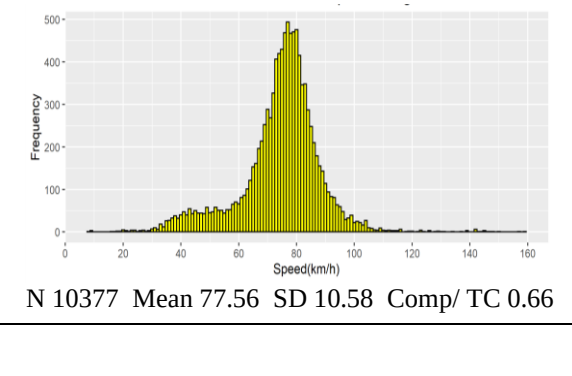
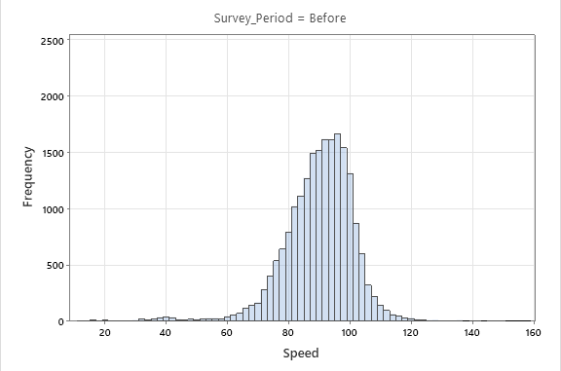
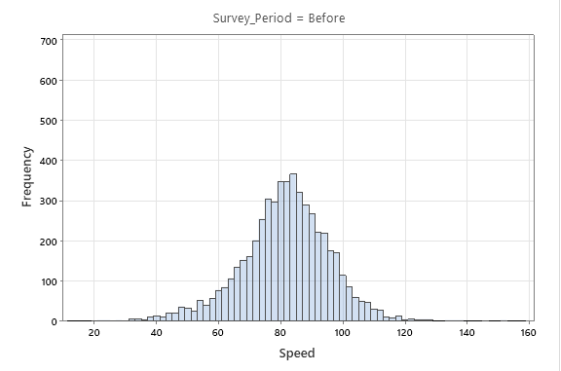
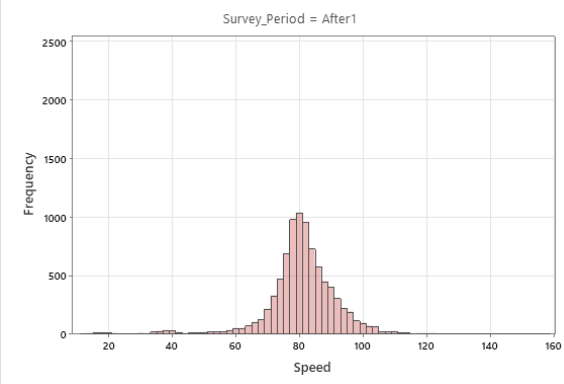
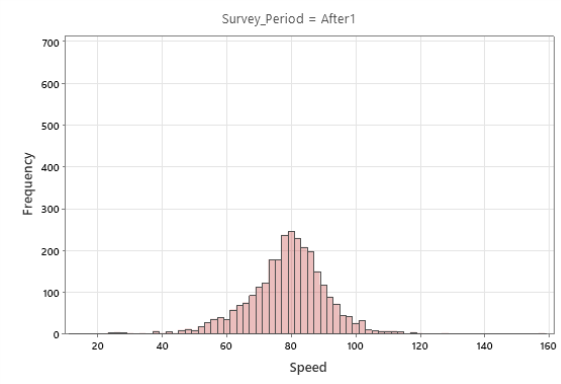
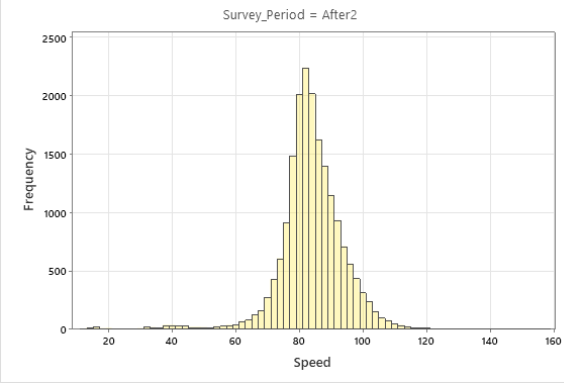
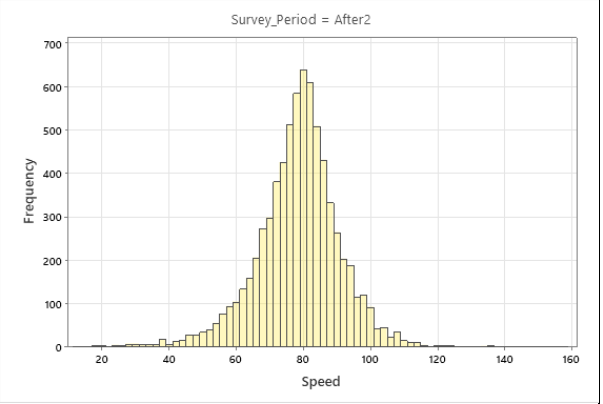
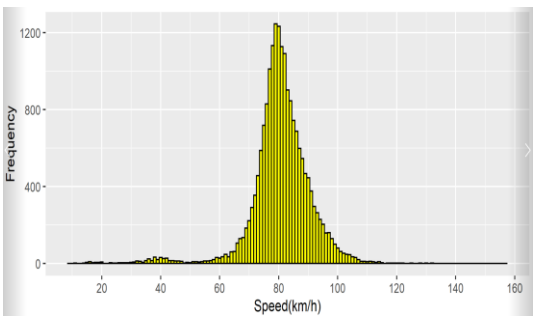
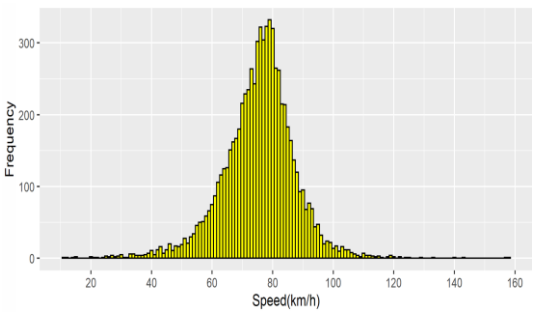
	
N 16981 Mean 80.87 SD 9.38 Comp/ TC 0.47	N 20316 Mean 78.41 SD 9.76 Comp/ TC 0.61
	
N 37653 Mean 80.59 SD 8.68 Comp/ TC 0.49	N 45774 Mean 81.49 SD 9.06 Comp/ TC 0.43
Survey_Period = After3	Survey_Period = After3
	
N 36000 Mean 80.04 SD 8.62 Comp/ TC 0.59	N 49474 Mean 79.23 SD 9.09 Comp/ TC 0.55

Boundary Road DoT ID 13 (T)	Hodgins Road DoT ID 15 (T)
	
N 30074 Mean 84.65 SD 10.83 Compliance 0.95 Target Compliance 0.31	N 55577 Mean 86.42 SD 10.69 Compliance 0.92 Target Compliance 0.27
	
N 20236 Mean 77.03 SD 10.80 Comp 0.64	N 26696 Mean 80.56 SD 8.51 Comp 0.46
	
N 43936 Mean 80.26 SD 10.54 Comp 0.46	N 63360 Mean 77.29 SD 9.53 Comp 0.65
Survey_Period = After3	Survey_Period = After3
	
N 76879 Mean 74.18 SD 8.98 Comp/ TC 0.78	N 58705 Mean 77.64 SD 8.01 Comp/ TC 0.66

Tubbarubba Road DoT ID 21 (T)	Stumpy Gully Road DoT ID 25 (T)
	
N 17573 Mean 86.17 SD 12.55 Compliance 0.90 Target Compliance 0.27	N 13788 Mean 86.89 SD 13.41 Compliance 0.87 Target Compliance 0.27
	
N 11347 Mean 77.12 SD 10.08 Comp 0.67	N 8967 Mean 81.66 SD 11.51 Comp 0.44
	
N 28751 Mean 80.64 SD 10.05 Comp 0.50	N 14247 Mean 80.94 SD 11.47 Comp 0.47
Survey_Period = After3	Survey_Period = After3
	
N 23836 Mean 78.53 SD 9. 79 Comp/ TC 0.59	N 17233 Mean 78.95 SD 12.21 Comp/ TC 0.55

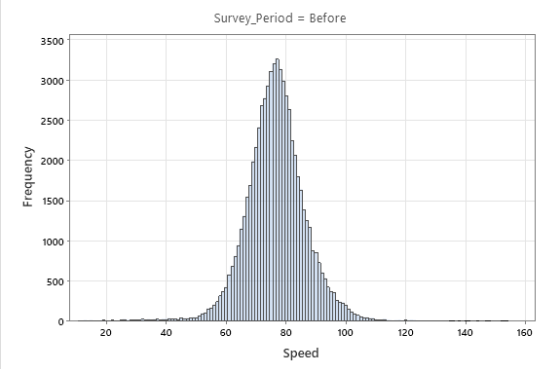
Coolart Extension Road DoT ID 28 (T)	Bungower Road DoT ID 30 (T)
	
N 15945 Mean 86.07 SD 11.58 Compliance 0.91 Target Compliance 0.27	N 49404 Mean 89.45 SD 9.90 Compliance 0.88 Target Compliance 0.17
	
N 12435 Mean 83.15 SD 13.08 Comp 0.38	N 23246 Mean 82.21 SD 8.04 Comp 0.41
	
N 19868 Mean 81.23 SD 10.31 Comp 0.43	N 58082 Mean 82.92 SD 8.91 Comp 0.38
Survey_Period = After3 	Survey_Period = After3 
N 20782 Mean 79.51 SD 10.58 Comp/ TC 0.52	N 57423 Mean 82.53 SD 7.38 Comp/ TC 0.37

Eramosa Road East DoT ID 31 (T)	Lower Somerville Road DoT ID 32 (T)
	
N 20291 Mean 86.34 SD 11.46 Compliance 0.91 Target Compliance 0.27	N 9344 Mean 83.70 SD 12.89 Compliance 0.90 Target Compliance 0.39
	
N 17426 Mean 78.09 SD 10.73 Comp 0.60	N 4446 Mean 78.35 SD 9.58 Comp 0.57
	
N 41725 Mean 79.59 SD 10.25 Comp 0.52	N 15360 Mean 78.03 SD 10.48 Comp 0.58
	
N 63849 Mean 79.82 SD 10.17 Comp/ TC 0.50	N 10377 Mean 77.56 SD 10.58 Comp/ TC 0.66

Old Moorooduc Road DoT ID 36 (T)	Denham Road DoT ID 40 (T)
	
N 20306 Mean 89.82 SD 11.88 Compliance 0.85 Target Compliance 0.16	N 5317 Mean 81.50 SD 14.42 Compliance 0.92 Target Compliance 0.43
	
N 8761 Mean 80.65 SD 12.12 Comp 0.45	N 2861 Mean 78.89 SD 13.11 Comp 0.51
	
N 18737 Mean 83.77 SD 10.62 Comp 0.30	N 7235 Mean 78.52 SD 12.60 Comp 0.53
	
N 19296 Mean 80.77 SD 10.54 Comp/ TC 0.45	N 38327 Mean 74.86 SD 12.31 Comp/ TC 0.67

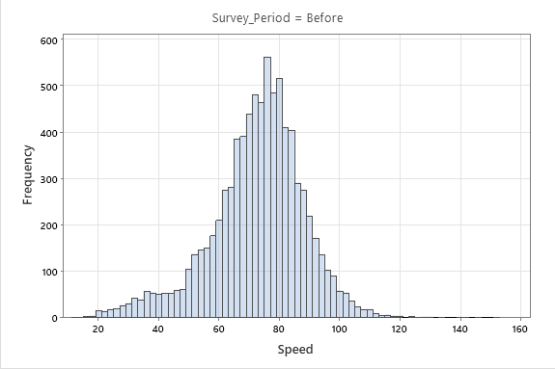
The 8 unpaired 100-80 Trial 1 treated sites are summarised now.

Browns Road - Boneo DoT ID 7 (T)

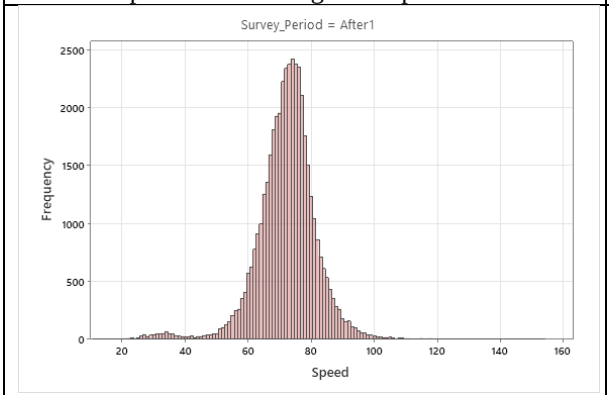


N 65797 Mean 76.52 SD 10.26
Compliance 0.99 Target Compliance 0.66

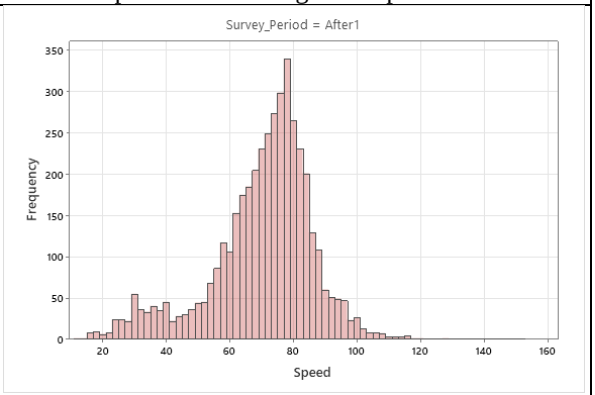
Derril Road DoT ID 23 (T)



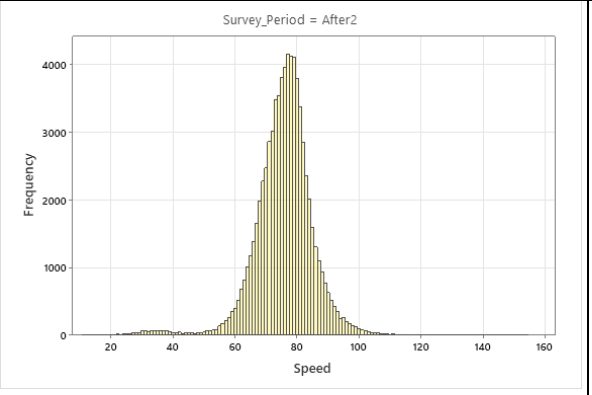
N 8162 Mean 72.68 SD 15.70
Compliance 0.97 Target Compliance 0.68



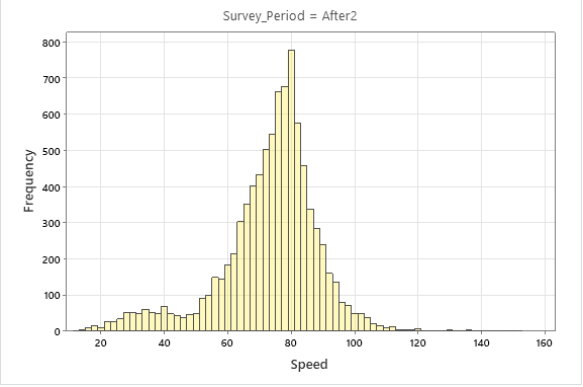
N 43757 Mean 72.16 SD 9.84 Comp 0.84



N 4282 Mean 70.09 SD 16.34 Comp 0.74

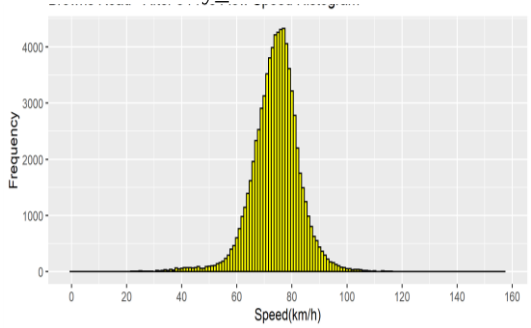


N 74089 Mean 75.72 SD 9.71 Comp 0.70



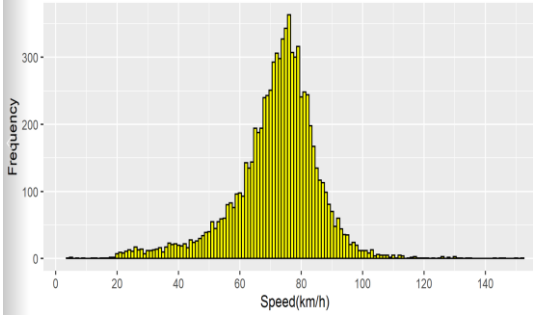
N 8873 Mean 73.27 SD 15.76 Comp 0.66

Survey_Period = After3

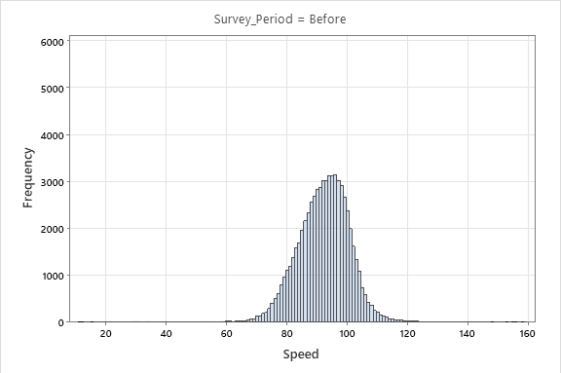
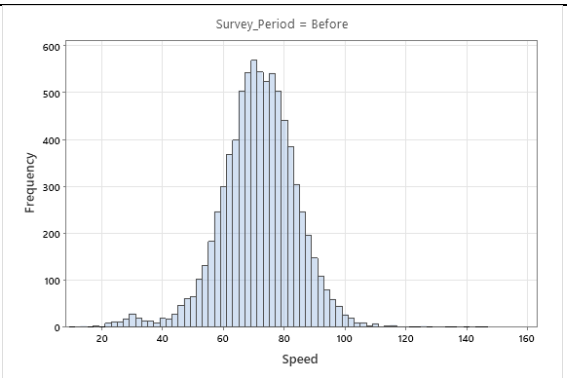
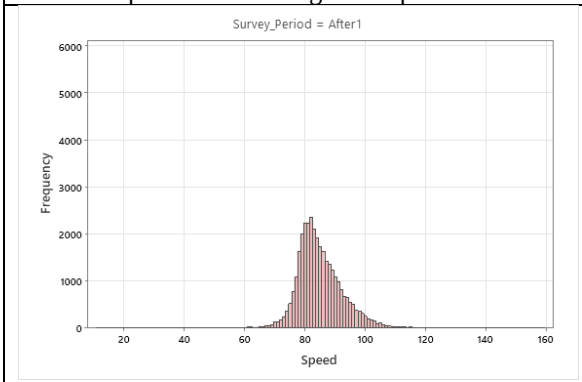
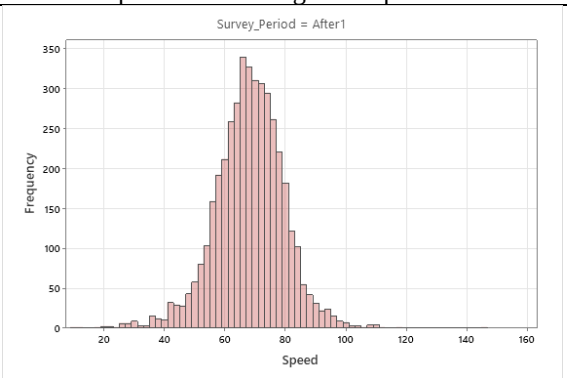
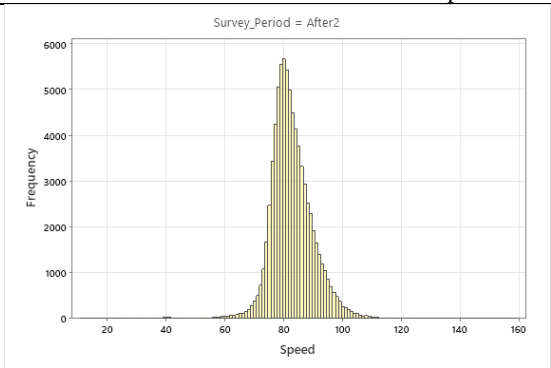
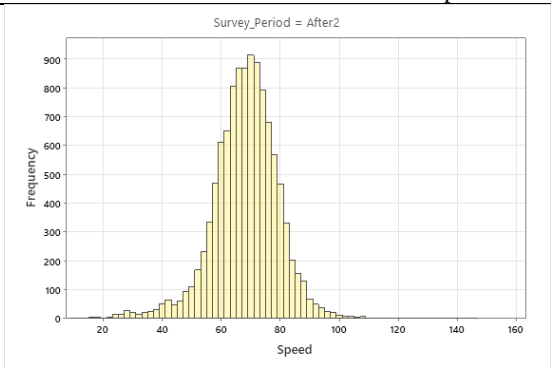


N 76879 Mean 74.18 SD 8.98 Comp/ TC 0.78

Survey_Period = After3



N 8096 Mean 71.86 SD 14.08 Comp/ TC 0.75

Tyabb-Tooradin Road DoT ID 34 (T)	Whitneys Road DoT ID 35 (T)
	
N 65492 Mean 91.98 SD 9.37 Compliance 0.84 Target Compliance 0.08	N 7959 Mean 71.57 SD 12.67 Compliance 0.99 Target Compliance 0.76
	
N 33780 Mean 84.62 SD 8.78 Comp 0.26	N 4243 Mean 68.12 SD 11.51 Comp 0.87
	
N 78416 Mean 82.49 SD 7.86 Comp 0.38	N 11029 Mean 68.14 SD 11.14 Comp 0.88
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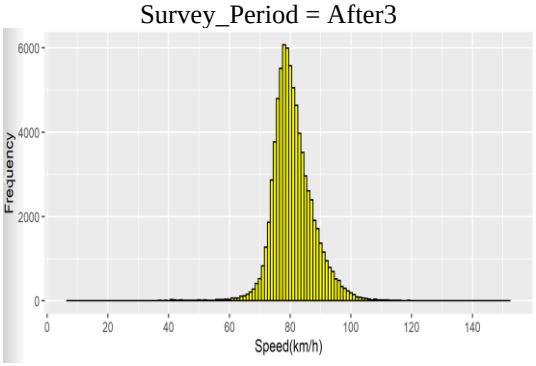
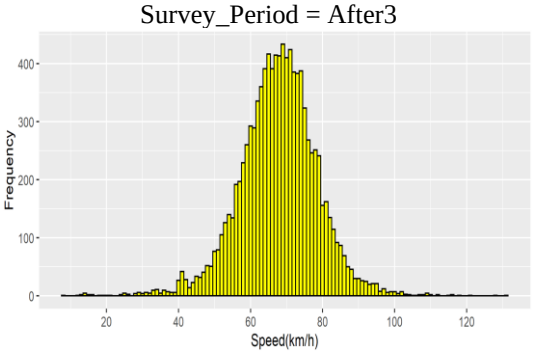
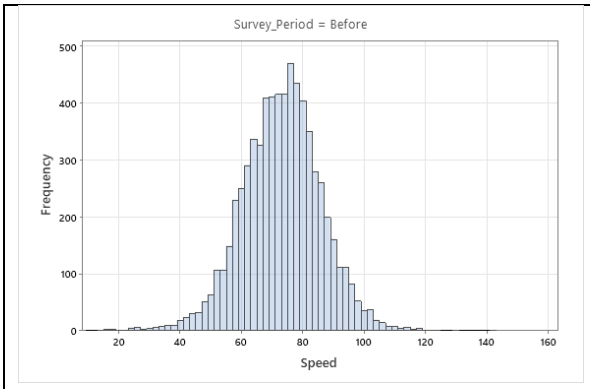
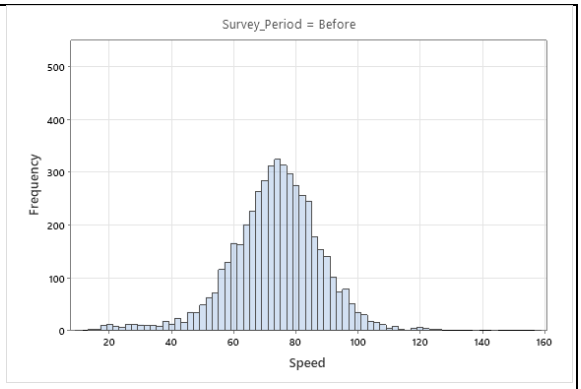
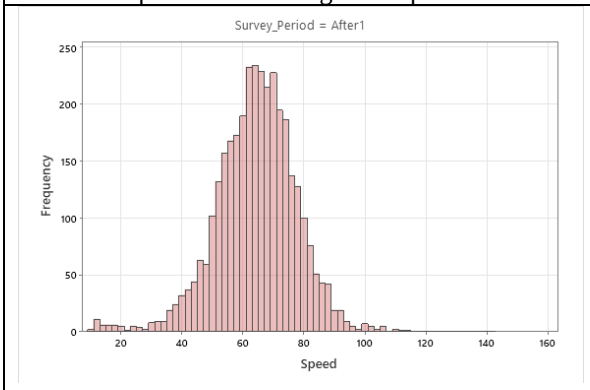
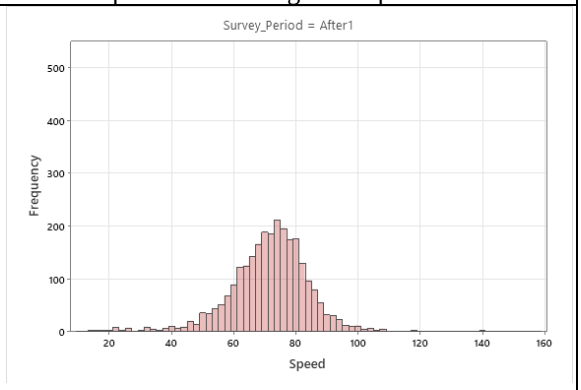
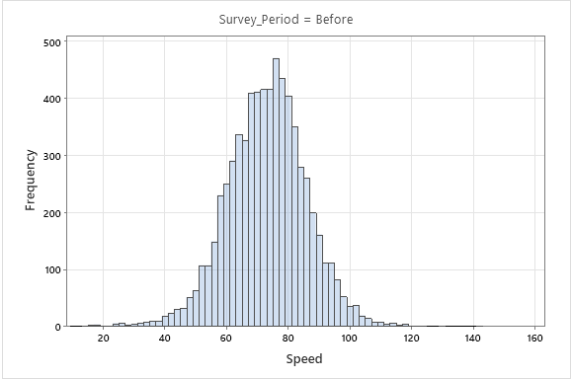
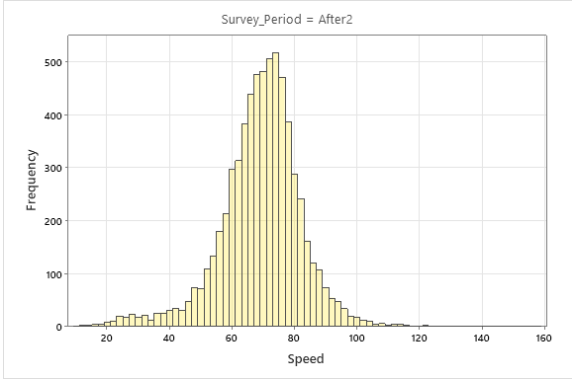
	
N 77582 Mean 80.95 SD 7.17 Comp/ TC 0.49	N 10205 Mean 67.79 SD 10.87 Comp/ TC 0.89

Tuerong Road DoT ID 37 (T)	McKirdys Road DoT ID 38 (T)
	
N 6785 Mean 73.05 SD 12.89 Compliance 0.98 Target Compliance 0.71	N 4938 Mean 73.34 SD 14.86 Compliance 0.97 Target Compliance 0.68
	
N 3449 Mean 64.29 SD 13.31 Comp 0.90	N 2637 Mean 71.50 SD 13.32 Comp 0.78
	
N 6682 Mean 71.43 SD 12.68 Comp 0.77	N 6618 Mean 69.12 SD 13.11 Comp 0.84
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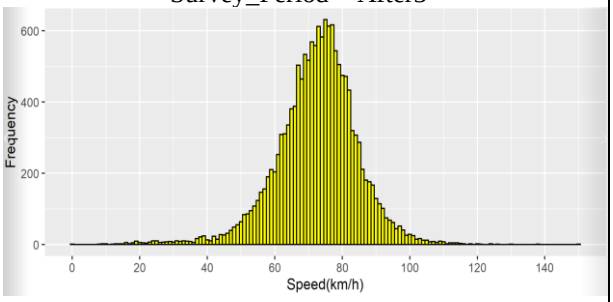
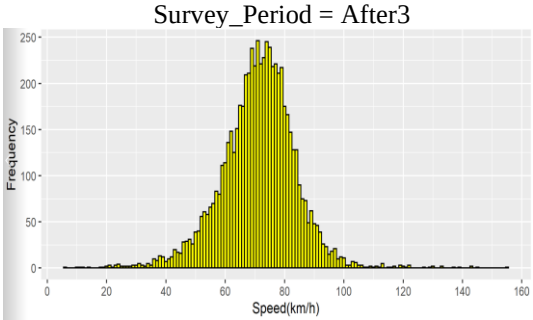
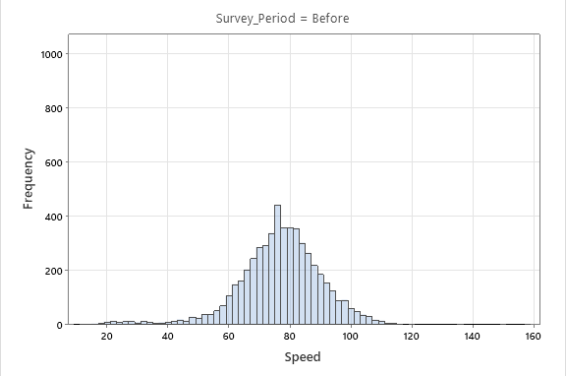
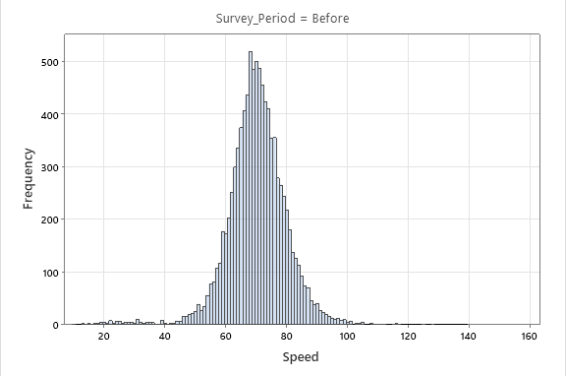
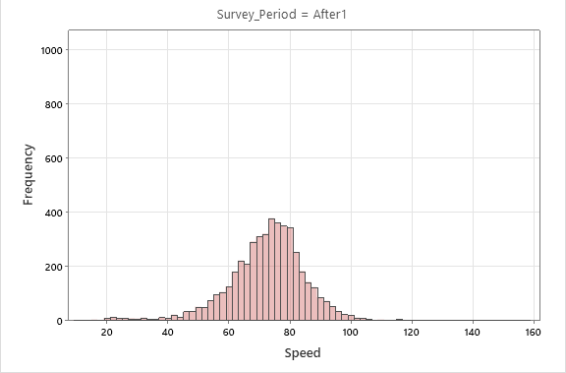
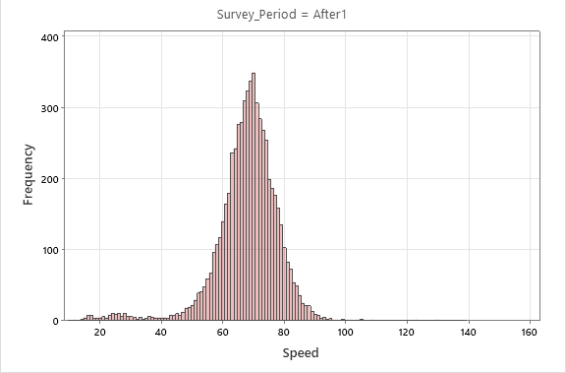
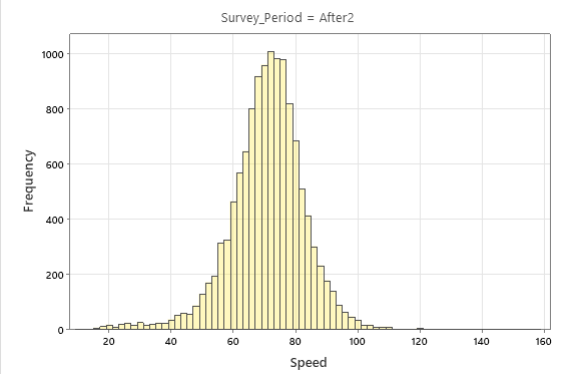
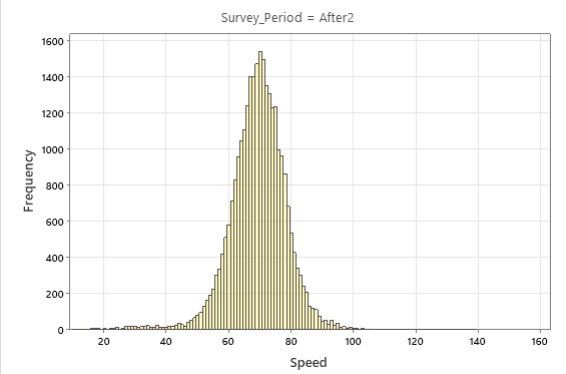
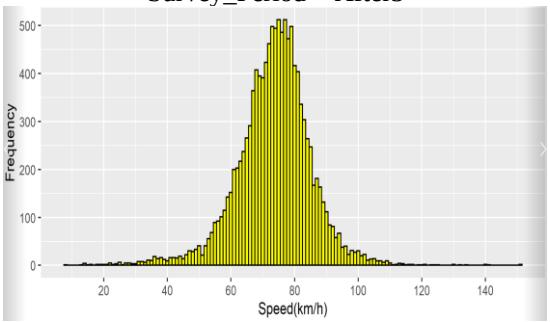
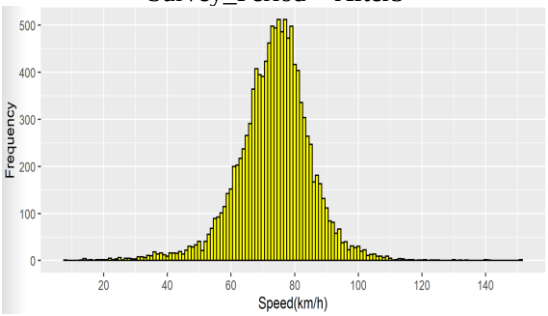
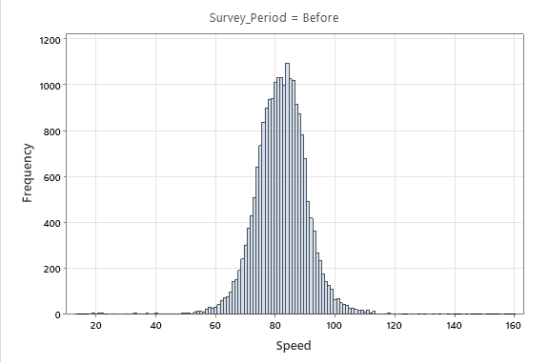
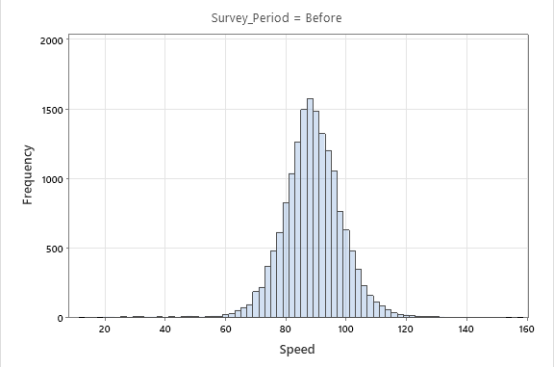
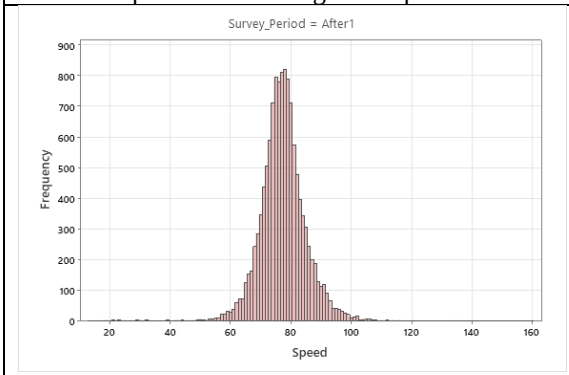
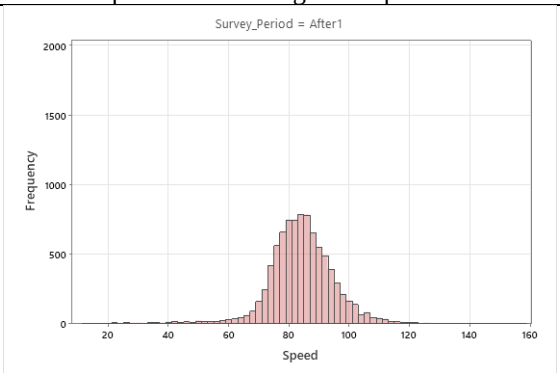
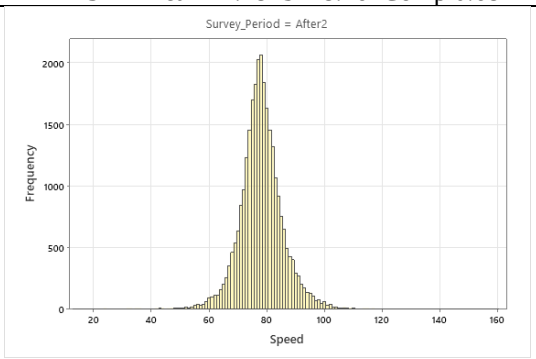
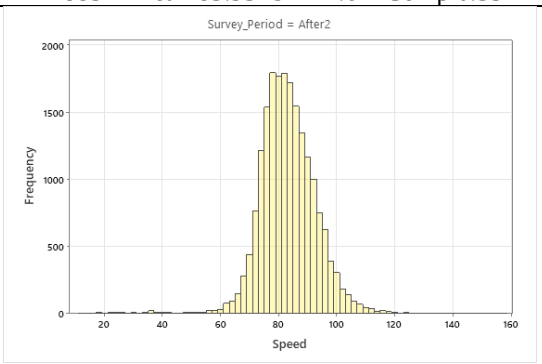
	
N 15157 Mean 72.52 SD 12.18 Comp/ TC 0.75	N 6328 Mean 71.22 SD 12.64 Comp/ TC 0.78

O'Neills Road DoT ID 39 (T)	Red Hill Road DoT ID 41 (T)
	
N 5351 Mean 76.76 SD 13.97 Compliance 0.96 Target Compliance 0.59	N 9534 Mean 70.15 SD 9.82 Compliance 1.00 Target Compliance 0.87
	
N 4687 Mean 72.37 SD 12.84 Comp 0.74	N 6199 Mean 67.84 SD 10.42 Comp 0.93
	
N 12576 Mean 70.83 SD 12.08 Comp 0.81	N 28475 Mean 69.32 SD 9.38 Comp 0.91
Survey_Period = After3	Survey_Period = After3
	
N 11960 Mean 73.61 SD 11.73 Comp/ TC 0.73	N 18465 Mean 67.65 SD 10.83 Comp/ TC 0.93

Appendix B.
Trial 2 Treated Routes Free Flow Speed Summaries

Myers Road DoT ID 1 (T)	Stanleys Road DoT ID 3 (T)
	
N 21294 Mean 81.89 SD 9.22 Compliance 0.85 Target Compliance 0.40	N 16659 Mean 88.76 SD 10.70 Compliance 0.56 Target Compliance 0.16
	
N 12317 Mean 77.28 SD 8.16 Comp 0.68	N 8837 Mean 83.93 SD 11.61 Comp 0.33
	
N 28428 Mean 78.05 SD 8.13 Comp 0.64	N 19766 Mean 83.07 SD 10.11 Comp 0.38
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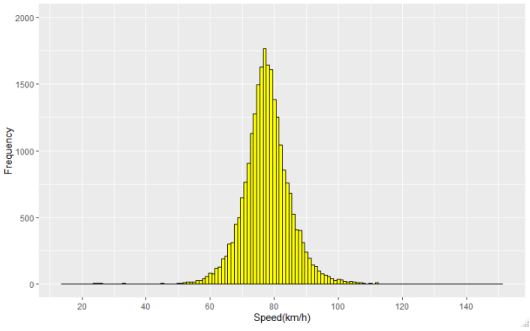
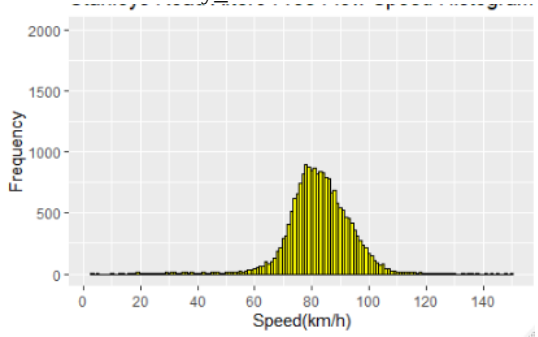
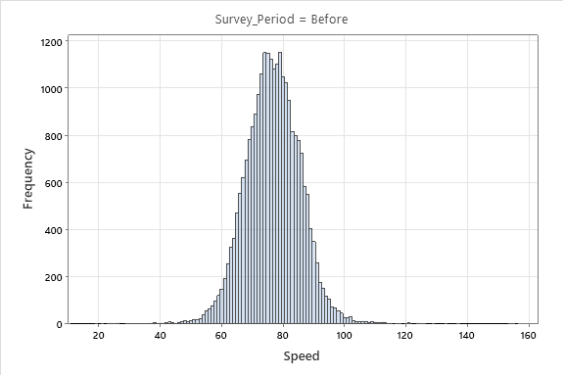
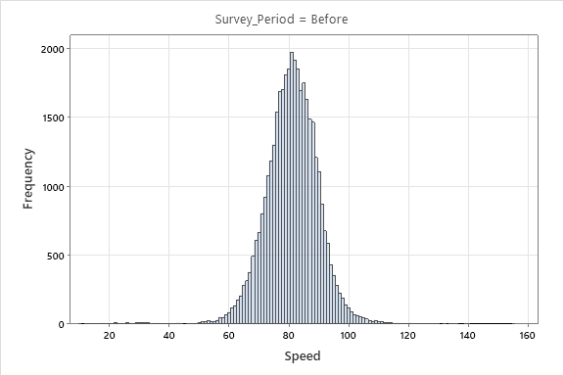
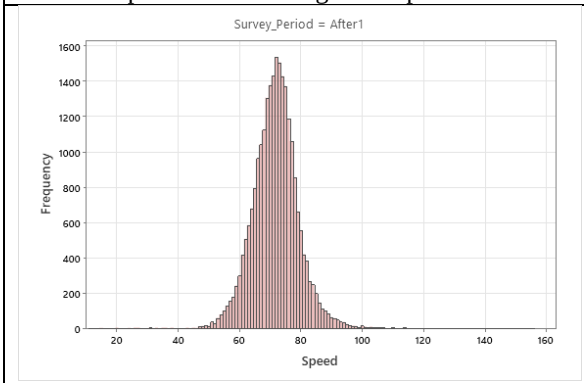
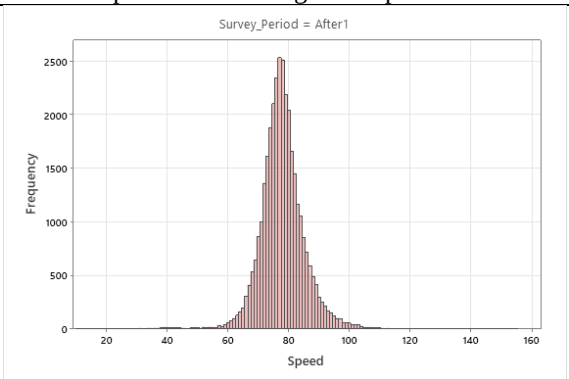
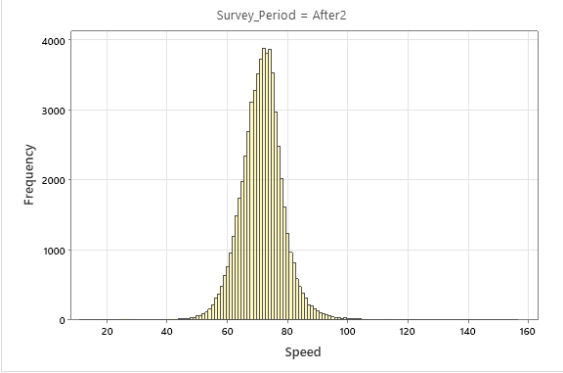
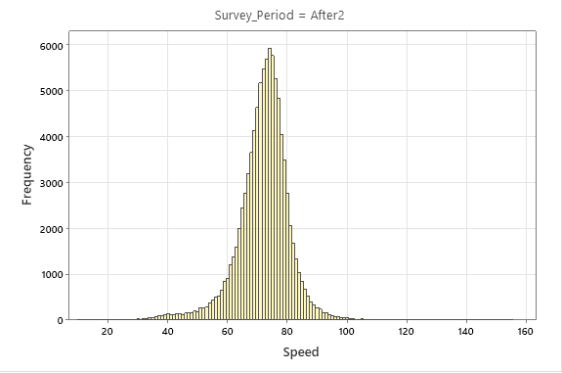
	
N 24480 Mean 77.65 SD 8.01 Comp/ TC 0.66	N 20081 Mean 82.50 SD 11.33 Comp/ TC 0.40

Hawkins Road DoT ID 4 (T)	Browns Road (Fingal) DoT ID 5 (T)
	
N 24942 Mean 76.69 SD 9.13 Compliance 0.94 Target Compliance 0.65	N 38358 Mean 80.95 SD 9.17 Compliance 0.87 Target Compliance 0.44
	
N 24329 Mean 71.66 SD 7.97 Comp 0.89	N 33780 Mean 77.86 SD 7.71 Comp 0.67
	
N 60188 Mean 71.41 SD 7.61 Comp 0.91	N 93565 Mean 71.93 SD 8.88 Comp 0.87
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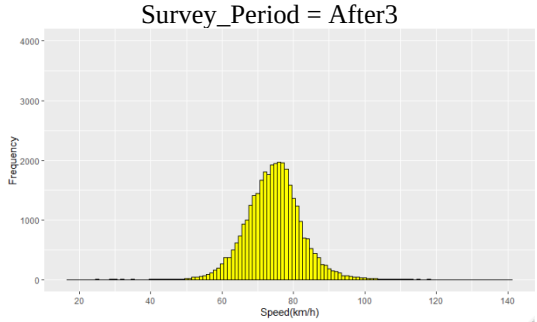
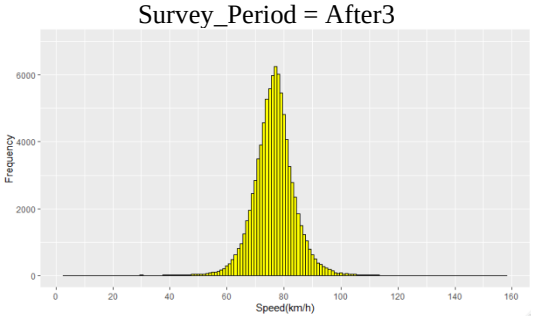
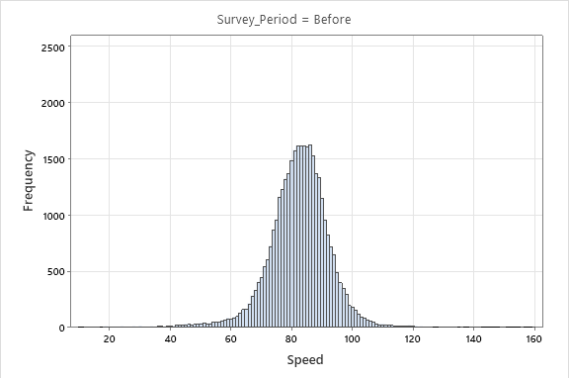
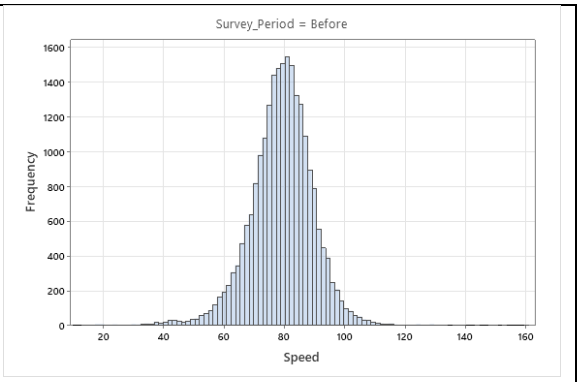
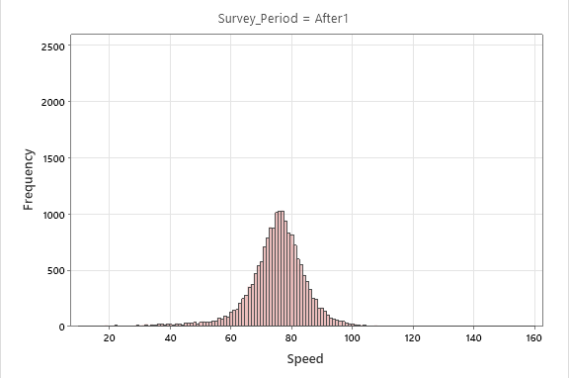
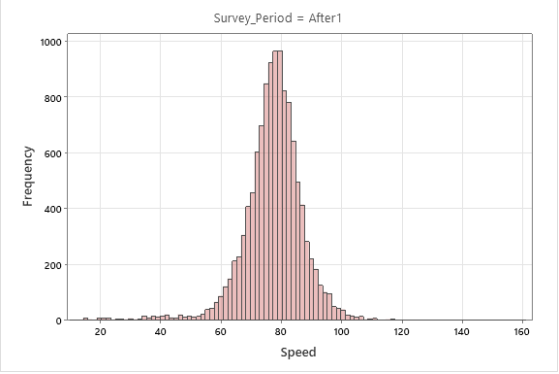
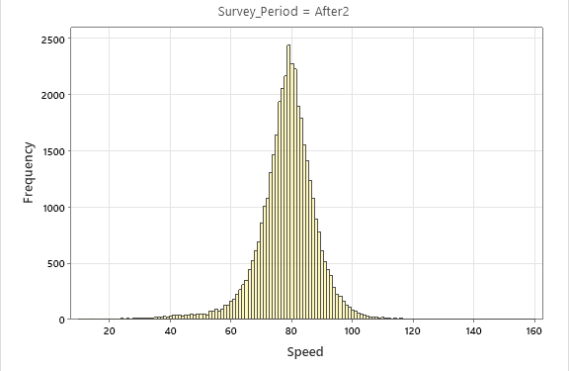
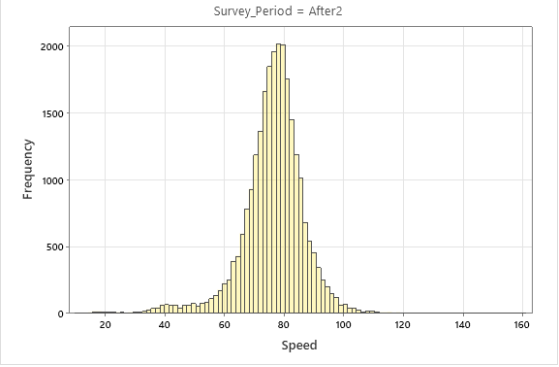
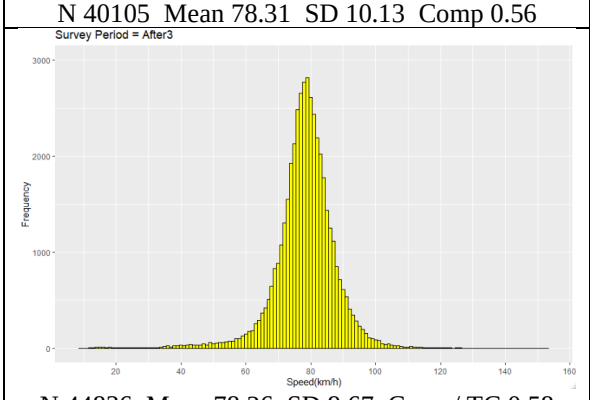
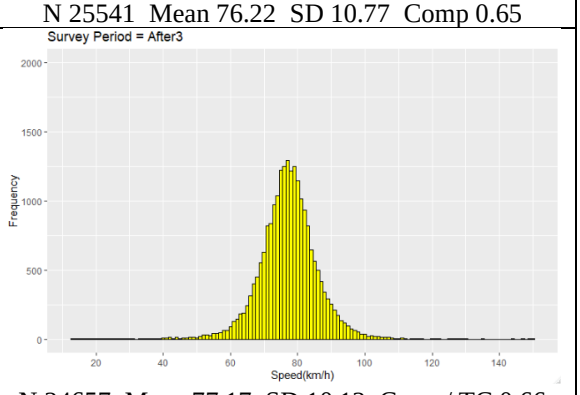
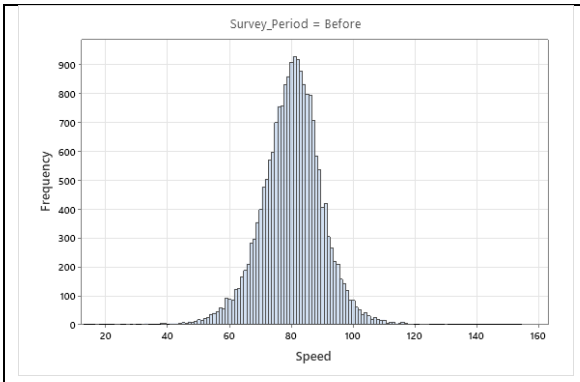
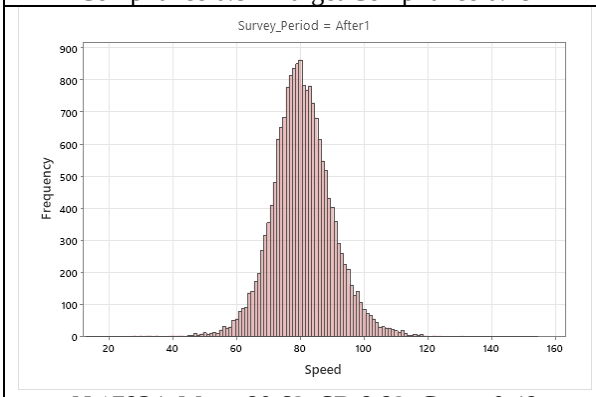
	
N 34271 Mean 77.65 SD 8.01 Comp/ TC 0.79	N 88732 Mean 76.53 SD 7.62 Comp/ TC 0.72

Browns Road (Main Ridge) DoT ID 8 (T)	Jetty Road DoT ID 9 (T)
	
N 34493 Mean 82.31 SD 10.33 Compliance 0.81 Target Compliance 0.37	N 23018 Mean 79.12 SD 10.66 Compliance 0.88 Target Compliance 0.52
	
N 17985 Mean 74.94 SD 10.26 Comp 0.72	N 11817 Mean 77.33 SD 10.35 Comp 0.61
	
N 40105 Mean 78.31 SD 10.13 Comp 0.56	N 25541 Mean 76.22 SD 10.77 Comp 0.65
	
N 44836 Mean 78.26 SD 9.67 Comp/ TC 0.58	N 24657 Mean 77.17 SD 10.12 Comp/ TC 0.66

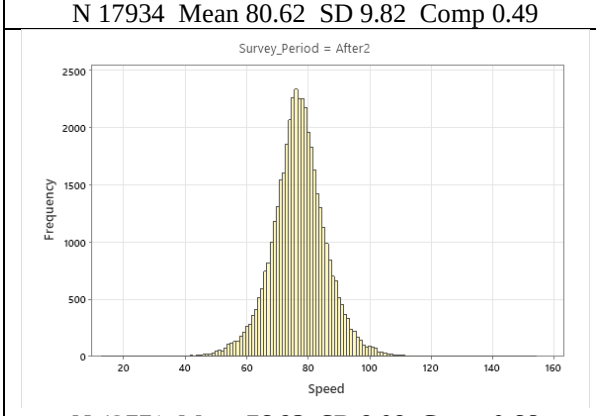
Limestone Road DoT ID 10 (T)



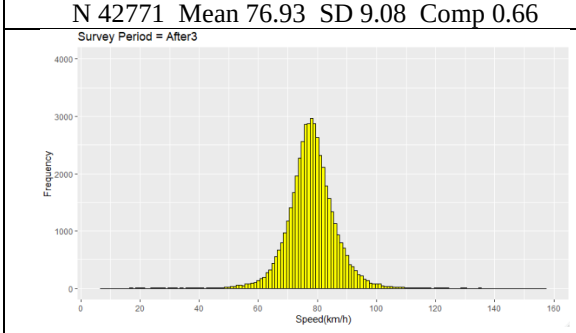
N 19529 Mean 80.13 SD 9.71
Compliance 0.87 Target Compliance 0.48



N 17934 Mean 80.62 SD 9.82 Comp 0.49

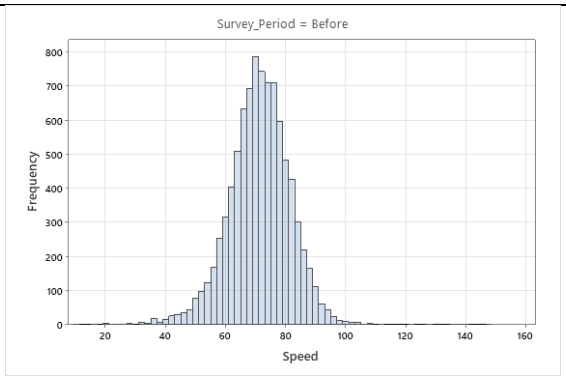


N 42771 Mean 76.93 SD 9.08 Comp 0.66

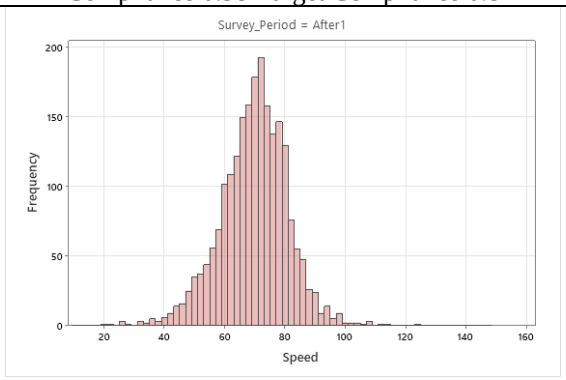


N 46200 Mean 78.03 SD 8.12 Comp/ TC 0.63

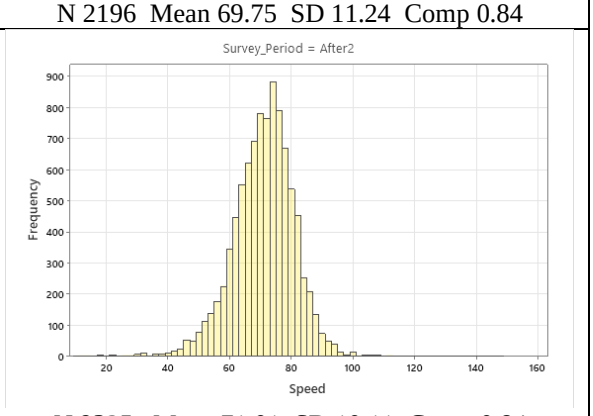
Harrisons Road DoT ID 12 (T)



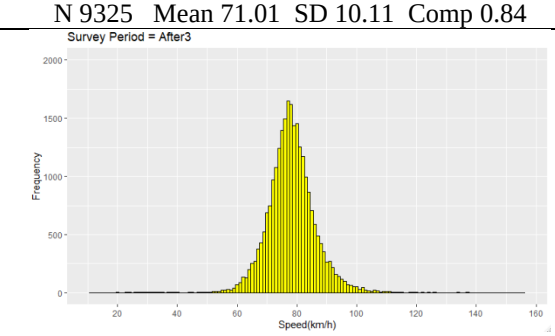
N 8937 Mean 71.24 SD 10.33
Compliance 0.98 Target Compliance 0.82



N 2196 Mean 69.75 SD 11.24 Comp 0.84

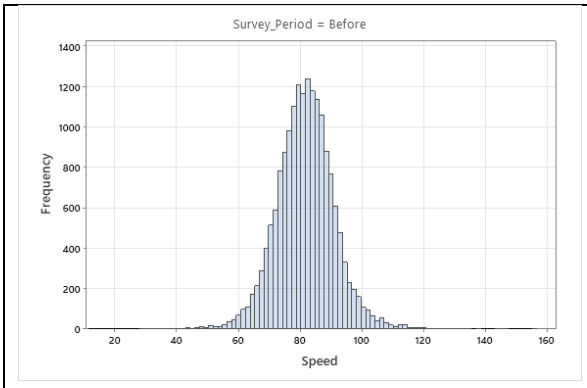


N 9325 Mean 71.01 SD 10.11 Comp 0.84

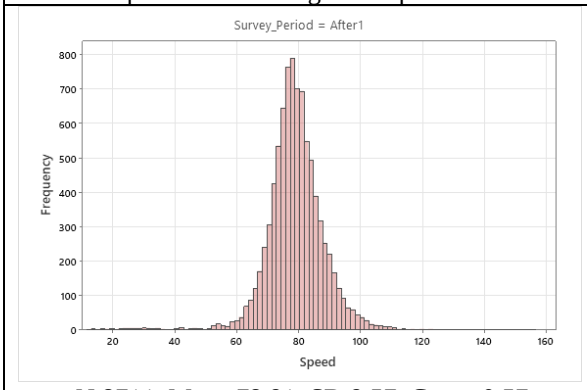


N 10104 Mean 67.93 SD 9.84 Comp/ TC 0.92

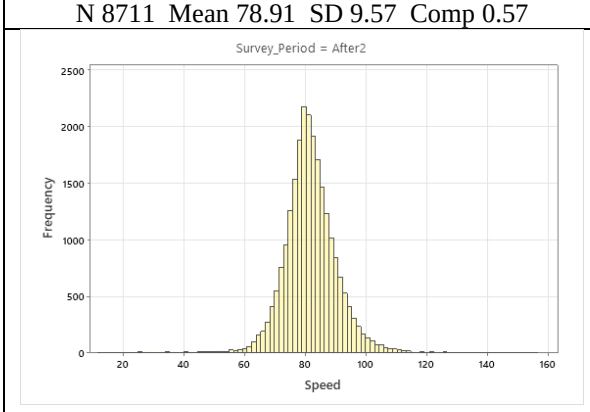
Truemans Road DoT ID 14 (T)



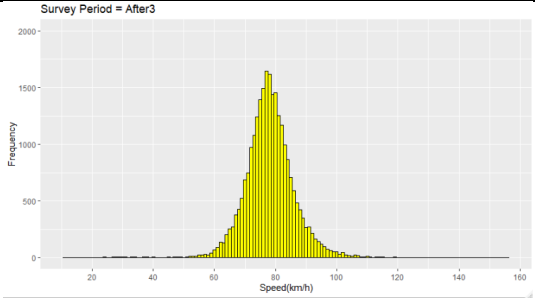
N 17642 Mean 81.72 SD 9.61
Compliance 0.84 Target Compliance 0.42



N 8711 Mean 78.91 SD 9.57 Comp 0.57

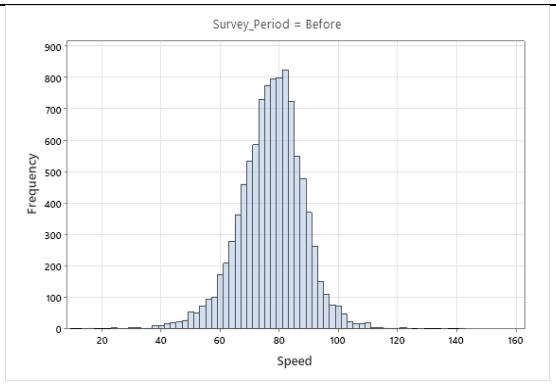


N 23974 Mean 81.56 SD 9.37 Comp 0.43

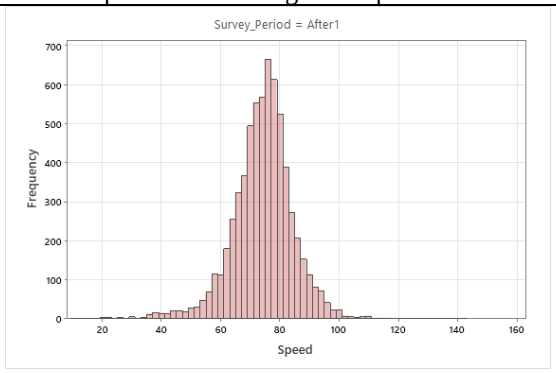


N 25164 Mean 78.16 SD 8.46 Comp/ TC 0.63

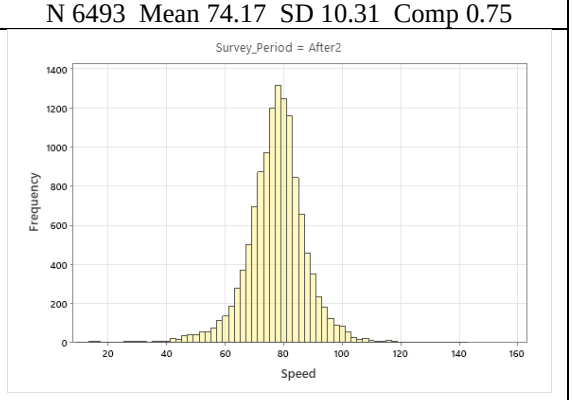
Baldrys Road DoT ID 16 (T)



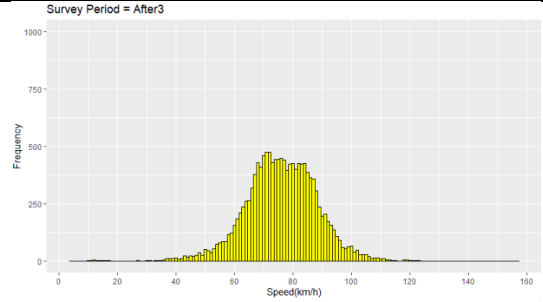
N 9993 Mean 77.36 SD 11.10
Compliance 0.90 Target Compliance 0.58



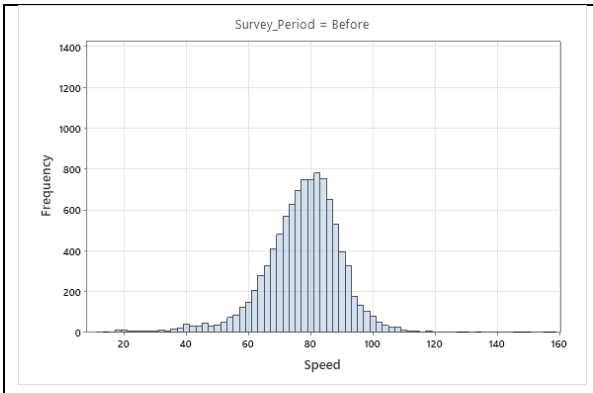
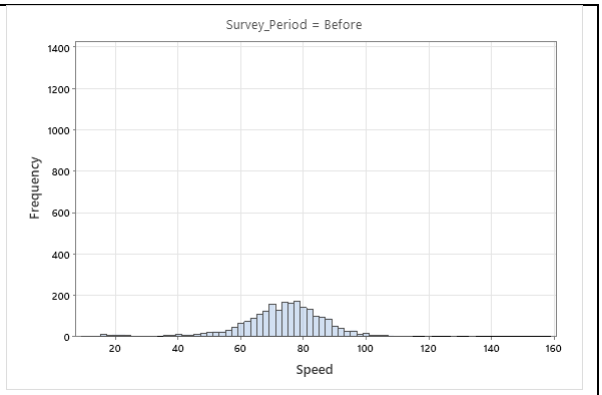
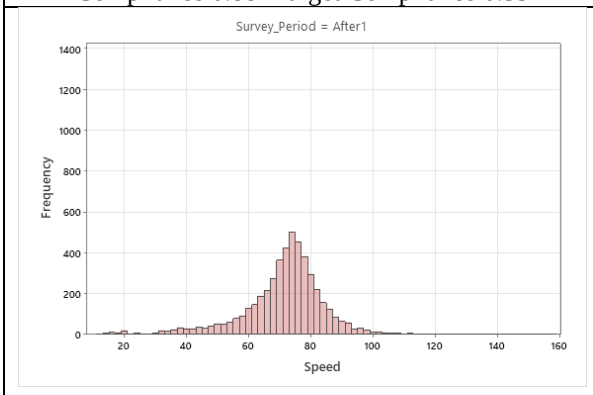
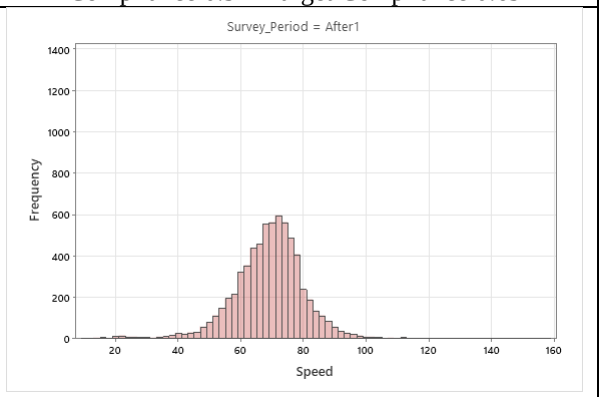
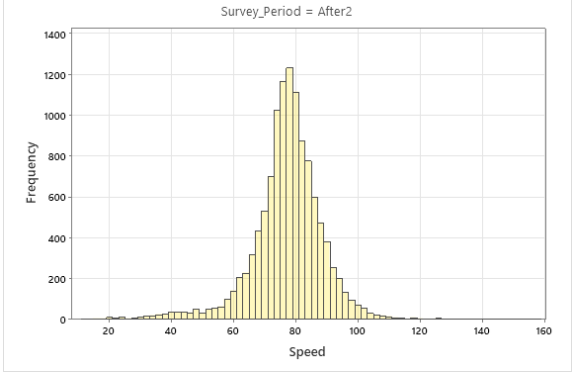
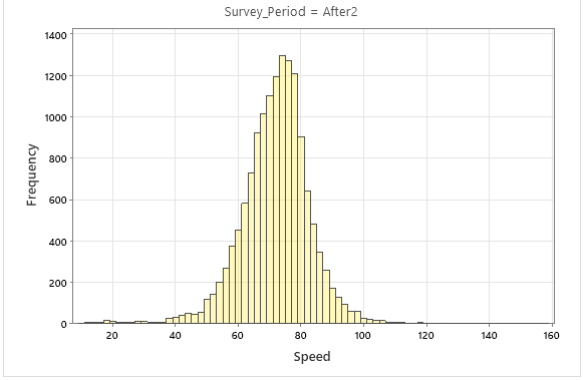
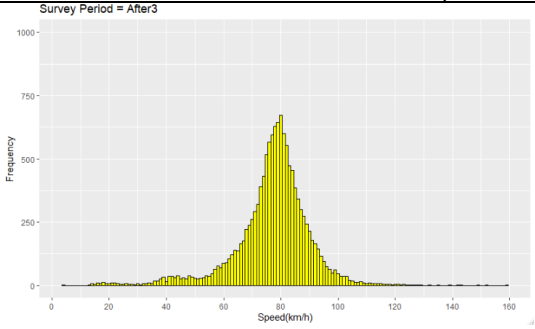
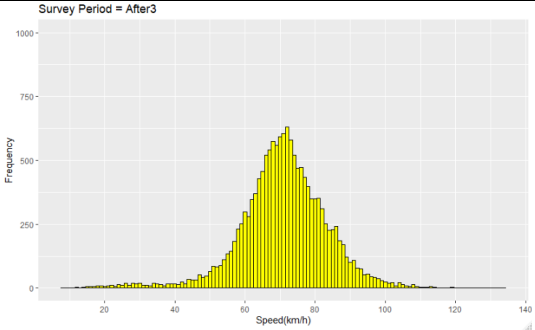
N 6493 Mean 74.17 SD 10.31 Comp 0.75

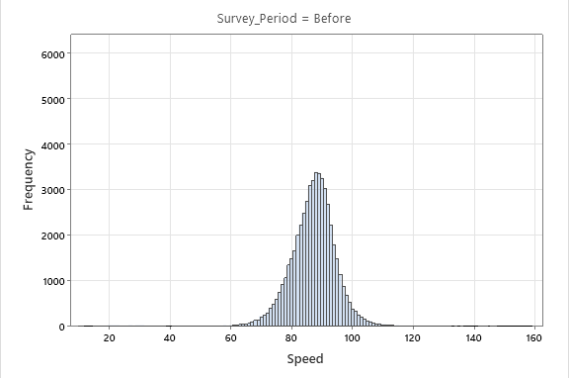
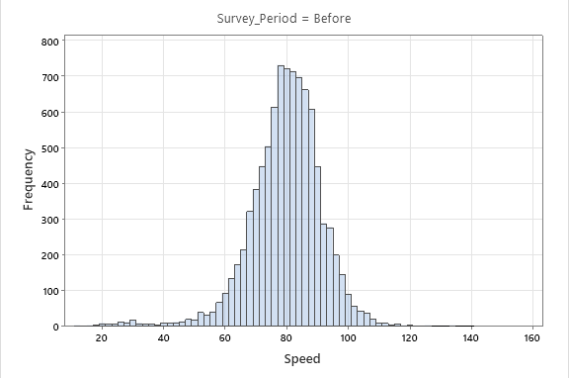
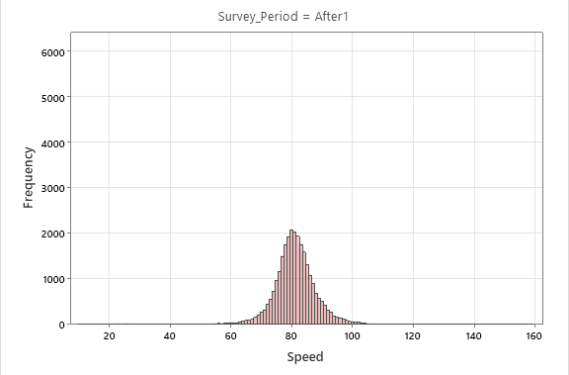
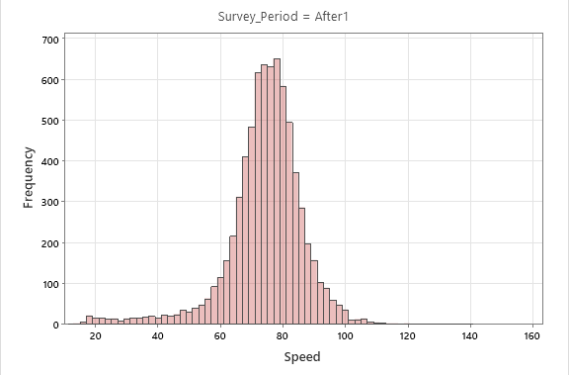
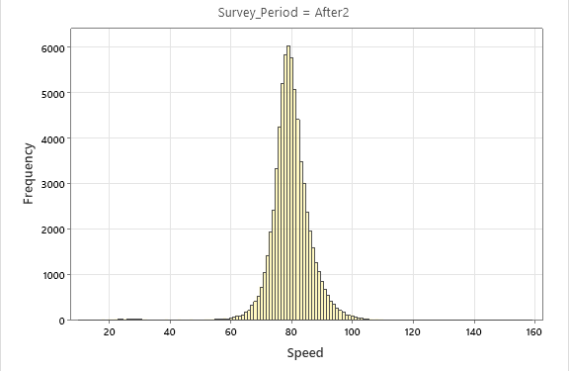
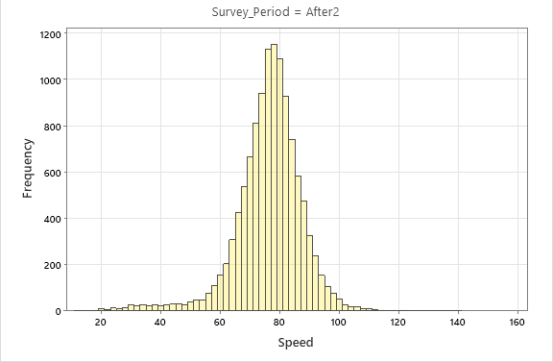
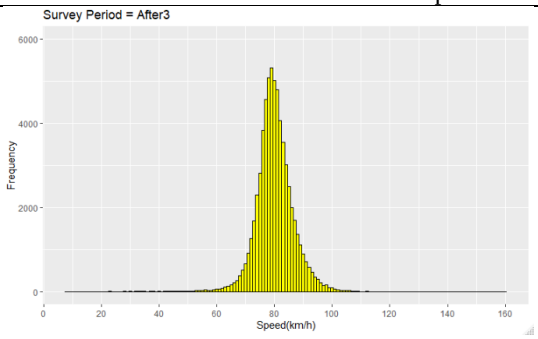
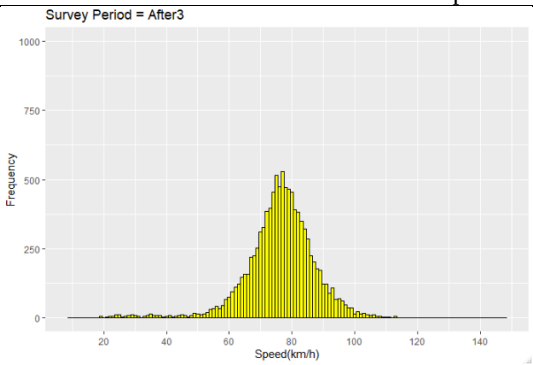


N 12686 Mean 77.37 SD 10.57 Comp 0.61

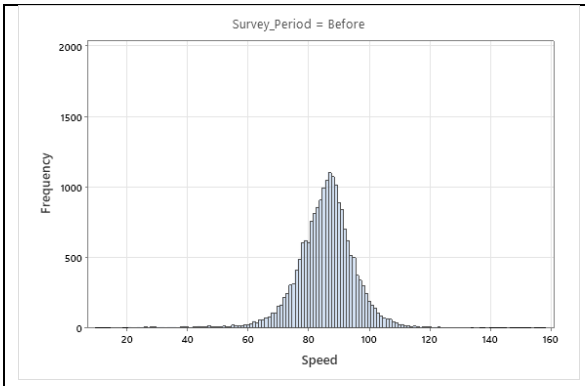


N 13775 Mean 75.93 SD 12.80 Comp/ TC 0.62

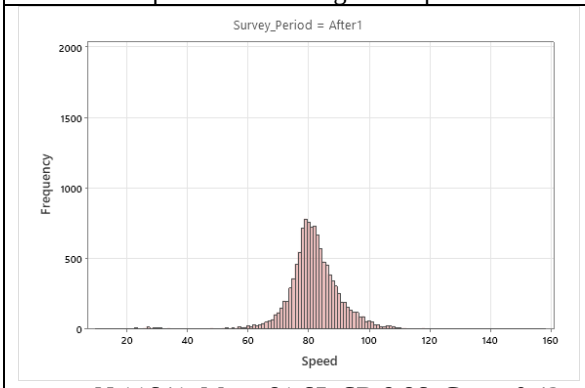
Purves Road DoT ID 17 (T)	Merricks Beach Road DoT ID 19 (T)
	
N 10086 Mean 77.44 SD 12.83 Compliance 0.88 Target Compliance 0.55	N 2281 Mean 73.09 SD 14.61 Compliance 0.92 Target Compliance 0.69
	
N 4881 Mean 71.18 SD 13.43 Comp 0.80	N 6717 Mean 69.01 SD 11.61 Comp 0.88
	
N 11817 Mean 77.25 SD 11.81 Comp 0.61	N 14552 Mean 71.91 SD 11.27 Comp 0.81
	
N 12871 Mean 77.17 SD 13.04 Comp/ TC 0.58	N 14658 Mean 70.97 SD 12.65 Comp/ TC 0.79

Eramosa Road West DoT ID 24 (T)	Point Leo Road DoT ID 27 (T)
	
N 52977 Mean 86.89 SD 8.55 Compliance 0.66 Target Compliance 0.15	N 9022 Mean 79.69 SD 11.92 Compliance 0.84 Target Compliance 0.48
	
N 27673 Mean 80.67 SD 8.56 Comp 0.44	N 7283 Mean 74.27 SD 12.53 Comp 0.70
	
N 69693 Mean 79.58 SD 7.45 Comp 0.55	N 11900 Mean 76.23 SD 11.48 Comp 0.64
	
N 64557 Mean 80.07 SD 6.97 Comp/ TC 0.52	N N 10232 Mean 76.37 SD 10.98 Comp/ TC 0.65

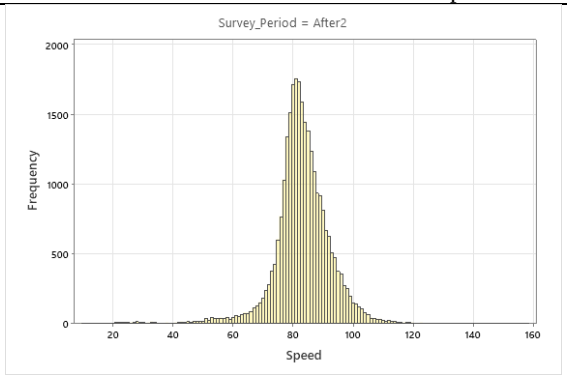
South Beach Road DoT ID 29 (T)



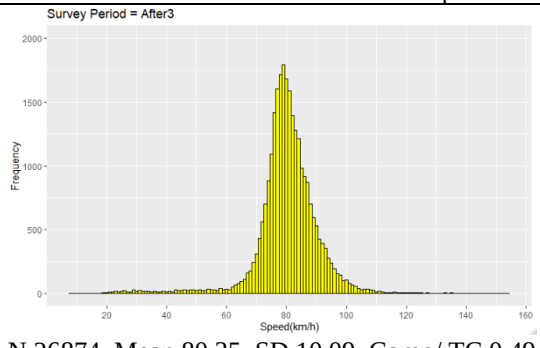
N 20254 Mean 85.40 SD 10.49
Compliance 0.70 Target Compliance 0.24



N 11641 Mean 81.65 SD 9.86 Comp 0.42



N 27661 Mean 82.96 SD 9.97 Comp 0.33



N 26874 Mean 80.35 SD 10.09 Comp/ TC 0.49

Appendix C.
Technical Solutions

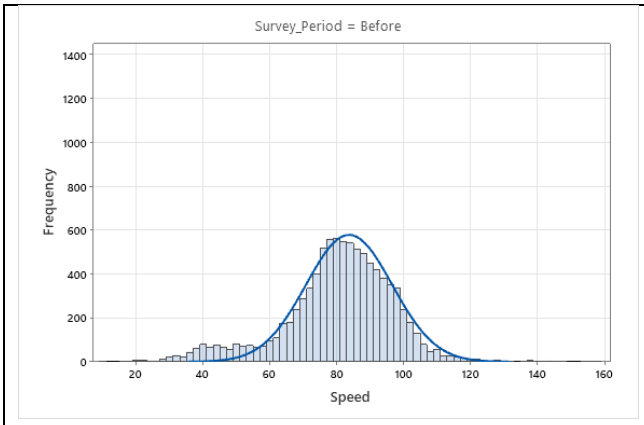
Additional compliance graphics
1. Correcting for slow traffic

Lower Somerville Road DoT ID 32 (T)

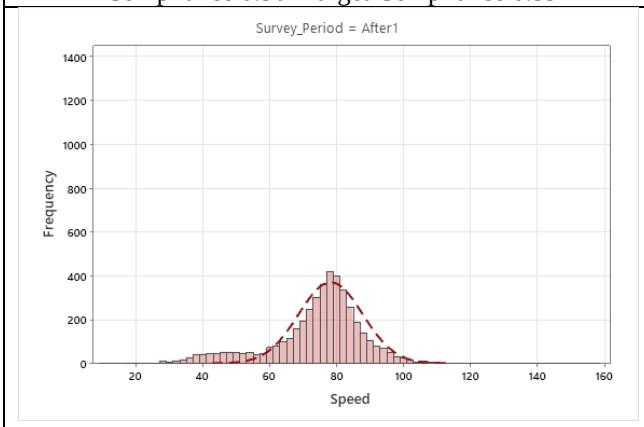
The speed histograms of three sites were bimodal - Site 32 (Lower Somerville Road), Site 50 (St Huberts Road) and Site 57 (White Hill Road). At Site 32 Drovers Lane is close to the tube location, so has turning vehicles lowering the mean speed. Site 50 is close to a number of vineyard entrances; increase in turning traffic was lowering After2 speeds. At Site 57 the tube location was 70m from an intersection so has many turning vehicles again with low speed.

The speed histograms for Before (blue), After1 (red) and After2 (yellow) collection periods at Lower Somerville Road are shown on the right. The two populations of traffic are evident, one with mean around 50kph and the other around 80kph.

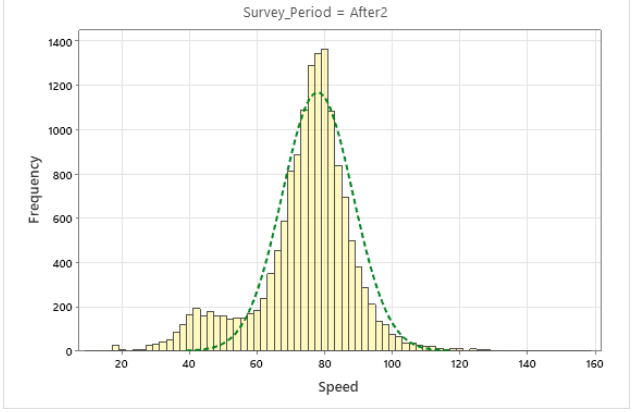
The "mixtools" package in R offers the funtion "normalmixEM2comp" which efficiently fits a mixture of two normal distributions to data. This was used to separate the slow and standard populations. Minitab was then used to overlay the distribution of the standard population on the histogram of all speeds, as shown on the right for each of the three periods. This enabled correction of mean speed and compliance proportion. The corrected Mean, SD and Comp figures are shown.



N 9344 Mean 83.70 SD 12.89
Compliance 0.90 Target Compliance 0.39



N 4446 Mean 78.35 SD 9.58 Comp 0.57



N 15360 Mean 78.03 SD 10.48 Comp 0.58

2. Analyzing proportion data

Means tend to be normally distributed, so testing hypotheses about them and finding confidence intervals for them is very standard. Proportions ("compliances" in this report) are not generally normally distributed, so the usual theory cannot be applied. This is sorted out by transforming proportions into "log odds" which tend to be much more normally distributed. Working in this transformed world allows us to correct using controls, to test hypotheses about whether compliances change as we go from Before to After1 etc. and to find confidence intervals for these changes, exactly as we do for means.

If we do this, the analogue of a statement like "a 5kph drop" we see for means from Before to After1 is a "a 0.09 odds ratio" for compliances. This will probably seem strange, but it allows us to move from compliance Before to compliance After1, the change we want to know, as shown in Figure 10. It also allows us to test the significance of the change and find a confidence interval for the After1 compliance.

Here, using a numerical example, are the three steps to move from compliance Before (say 0.9) to compliance After1 (which turns out to be 0.47) if we know the odds ratio is 0.09 (using numbers similar to those in Trial 1).

Step 1: A Before compliance proportion of 0.9 is equivalent to a compliance odds of 9:1 (meaning a vehicle is 9 times more likely to comply with the speed limit as to not comply). We simplify this by saying "the odds of compliance are 9 to 1, or just 9).

Step 2: The After1 compliance odds are found by multiplying the Before compliance odds by the odds ratio, or 9 x 0.1 = 0.9.

Step 3: The After1 compliance C is found by converting the After1 compliance odds to a proportion. The formula which allows this is "After1 compliance odds = 0.9" or C/(1-C)=0.9 or C=0.47. This is illustrated in Figure 10.

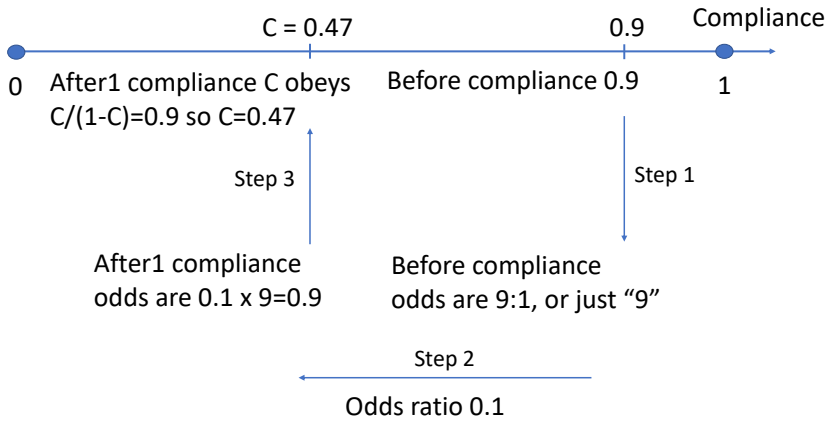


Figure 10. Showing the three steps involved in moving from a Before compliance to an After1 compliance, using an estimated odds ratio.

In the report, when summarizing compliance changes, we quote odds ratios and their significance. This is entirely analogous to quoting speed drops and their significance. If the odds ratios are small (say 0.1), expect a big drop in compliance; if they are large (say 3) then the compliance drop will not be large. An odds ratio of 1 means there is no change in compliance.

Geometric means are used in preference to arithmetic means for understanding samples of proportions. For simplicity the compliance graphics in this report still use arithmetic means, but in the more detailed numerical examples provided geometric means are used.

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