THE EFFECT OF CYCLE LANES ON CYCLE NUMBERS AND SAFETY

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ABSTRACT

Marked on-road cycle lanes are a relatively inexpensive means of providing for cycling; however, their use in New Zealand has been questioned both in terms of their safety and their effectiveness in attracting more people to take up cycling. While both questions have been previously researched locally, the findings have been rather inconclusive.

A recent Engineering Masters research project investigated the relative effects on cycle count and crash numbers of installing a series of cycle lanes. Twelve routes installed in Christchurch during the mid-2000s were analysed, together with some control sites. Cycle count data from a series of route locations and dates were used to establish cycling trends before and after installation. These were also compared against cycle crash numbers along these routes during the same periods.

The results generally show no consistent "step" increase in cycling numbers immediately following installation of cycle lanes, with some increasing and decreasing. Changes on cycling growth rates were more positive, although it is clear that other wider trends such as motor traffic growth are having an effect. Taking into account the relative changes in volumes and controls, the study also found notable reductions in cycle crashes following installation, typically with a 23% average reduction in crash rates.

1 INTRODUCTION

On-road cycling, especially on major traffic routes, is perceived by many commuters and policy makers as being a hazardous form of commuting, with numerous incidents between motor vehicles and cyclists gaining media, government and judicial attention in the past few years. With this nationwide attention there has been a general consensus developing in the community that there is a need for better provision for cycling on major traffic routes.

Both local and central governments over the past five to ten years have been working to encourage and improve the safety of cycling in urban centres. As part of this move, local government, especially in the three larger urban areas, have installed dedicated on-road cycle facilities ("cycle lanes") on their local and arterial roading networks. These treatments have been undertaken with the aim to improve the perceived and actual safety of cycling in the urban environment, and to encourage the use of cycling as a safe mode for commuting and leisure trips, improving environmental outcomes and the general health and wellbeing of riders.

As this movement towards increasing the on-road facilities available for cycling has continued, there has been limited research conducted in New Zealand as to whether these treatments have induced or increased cycle trips to these routes and whether safety has improved for cyclists on these routes. Few post-treatment studies have been conducted on the impacts of crash and cycle numbers, with studies to date focusing on predictive modelling of the treatment impacts. NZTA research reports and the Economic Evaluation Manual have assumed a positive "step change" in the predicted post-treatment cycle counts. To date, this assumption has not been tested on a large scale.

To address this gap in the research, a recent Engineering Masters research project (Parsons 2012) investigated the relative effects of installing a series of cycle lanes. Fifteen arterial routes around Christchurch with cycle lanes installed have been analysed to determine whether the cycle lane treatments have impacted on cycle numbers and crash rates, as well as testing the assumption of a step change in the cycle count. Twelve of the sites were treated with cycle lanes in the 2003-2006 period, with three routes that were treated well before this period acting as a control comparison. Figure 1 shows a typical layout investigated, featuring cycle lanes adjacent to parking (top) and kerbing (bottom).

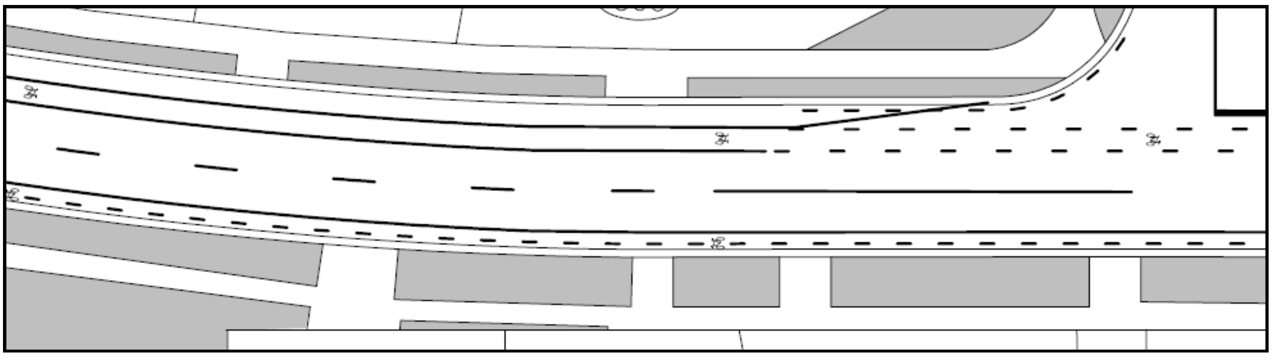

Figure 1: New Brighton Road -Typical Mid-Block Cycle Lane layout investigated

2 RESEARCH CONTEXT

2.1 Cycle Lanes and the Impact on Cycle Numbers

Cycling plays a role in the makeup of commuting trips in numerous New Zealand cities and towns. In Christchurch ~6% of total home/work trips are made by bicycle (~9000 trips/day), with a similar share of cycling amongst the student population travelling to schools and tertiary institutions (Milne *et al.* 2011). As a result of this modal share, facilitating for cycling especially along major commuter and arterial routes and the mitigation of conflicts between cyclists and motor vehicles is a key safety outcome that has been targeted by the Christchurch City Council in their strategy for cycling (CCC 2004).

One of the biggest deficiencies identified in the New Zealand literature and media is the lack of, or poor provision for, cycling in general roading situations. This is shown in numerous locations throughout the existing road network; for example, key arterials such as Riccarton Road in Christchurch, where there are numerous trip generators and destinations (schools, retail outlets and businesses) and have high traffic volumes with either no dedicated facilities or poor provision for cycle traffic.

In these cases cyclists are forced to compete for lane space with motor vehicles, increasing the exposure for conflicts between motor vehicles and cyclists. This lack of on-road facilities tends to discourage all but the most experienced cyclists from travelling along the arterial route. To address this issue, authorities have retrofitted numerous arterial routes with cycle facilities to encourage cyclists of a wider ability to use these routes and to encourage motorists to shift to cycling.

LTSA (2004) and RTA (2003) cite five key requirements for an attractive cycle network that facilities must attempt to address in order to be effective cycle routes. These are

- ***Cohesion*** – Provision of a complete route that matches the need for travel
- ***Directness*** – Directness in terms of distance and travel time (and minimal stopping)
- ***Safety*** – a treatment that aims to avoid conflicts; in terms of crossing vehicles, speeds and separated from vehicle types, in a manner that is uniform.
- ***Comfort*** – Prevent nuisance to all users, reducing the need to stop, provide smooth surfaces, minimise obstruction by other vehicles
- ***Attractiveness*** – Personal security, perception of safety, attractiveness of environment

In terms of Christchurch, the most popular treatment that has been implemented on arterial routes to date is the installation of marked cycle lanes outside of parking. Another common variation, particularly where space is limited, is the installation of kerbside lanes; this is commonly found on short sections near intersections and on arterial routes where parking has been removed. Figure 2 illustrates a typical arterial street in Christchurch that has both forms of cycle lanes.

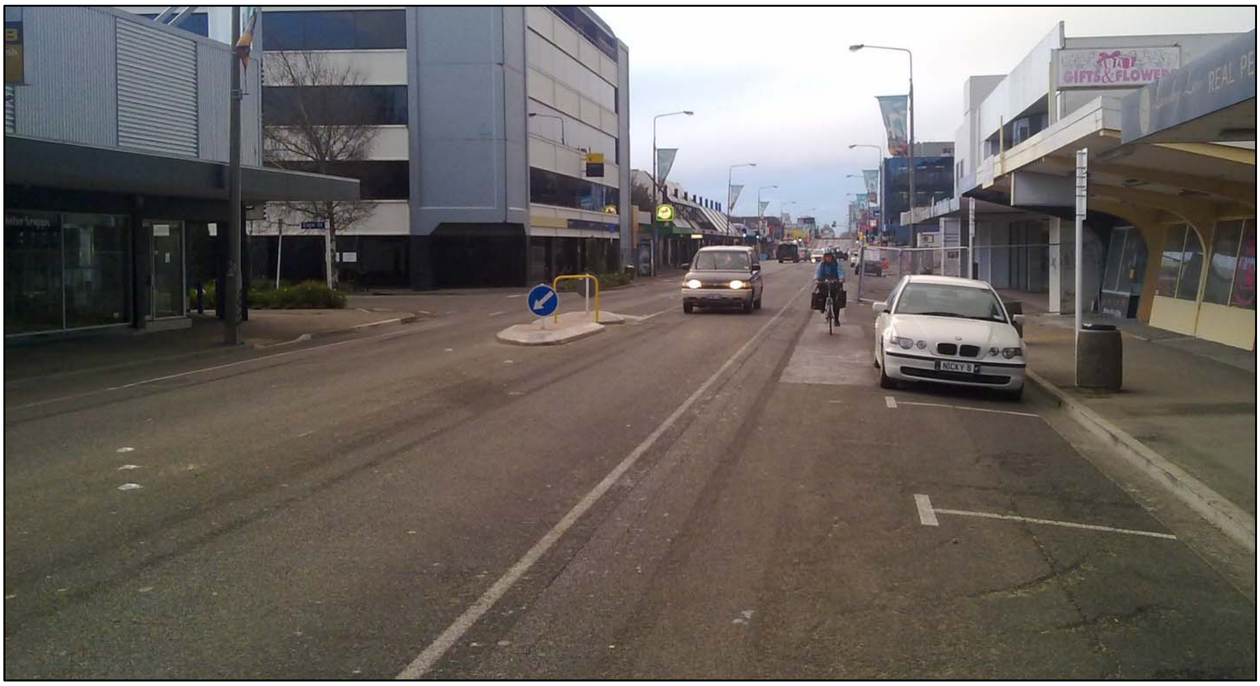

Figure 2: Mid-Block Cycle Lanes next to kerbside (left) and parking (right)

Although the implementation of cycle lanes has been preferred in New Zealand there is an absence of comprehensive studies conducted into the impact of cycle lanes. Studies to date have focused on estimating the demand for facilities (such as McDonald *et al.* 2007) based on scaling up findings on a small number or sites with assumed volume changes, and largely ignoring the impact of motorised traffic growth on cycle counts. This lack of verifiable information in the local context for on-road facilities may be due to the focus by authorities and academia on the impact of lanes on cycle safety rather than cycle volumes.

McDonald *et al.* (2007) focused on estimating the demand for new cycling facilities in New Zealand. With just five on-road sites for validation, this study assumed that a jump in cycling numbers would occur following the installation of a cycle facility due to dormant demand and greater awareness of a new facility. Figure 3 illustrates this assumed relationship, with a jump in cycle numbers at implementation (Year Y_0).

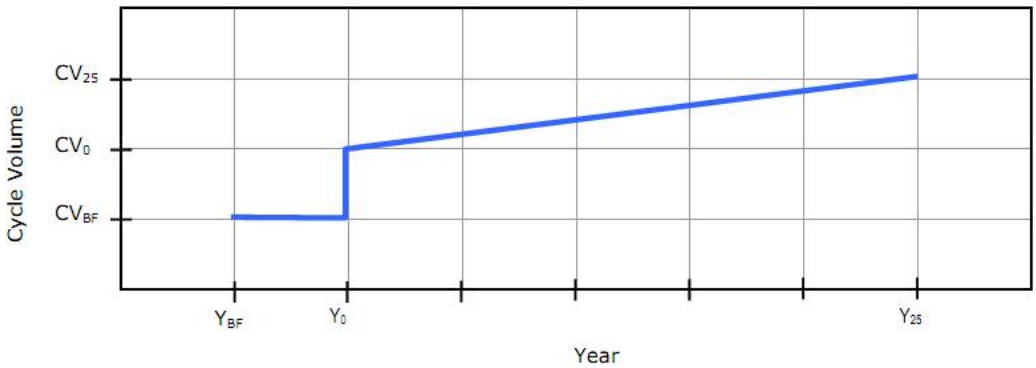

Figure 3: Assumed "Step Change" post cycle lane treatment (McDonald *et al.* 2007)

This "step change" assumption is used in the economic evaluation of cycle projects (NZTA 2010), although no subsequent validation as to its occurrence has been carried out on a large scale.

A before and after study on cycle lanes in Copenhagen (Jensen 2008) suggests that the construction of cycle lane treatments has a minor impact on both cycle and motor vehicle traffic volumes post-implementation.

Jensen noted in his report that the marking of cycling lanes along routes in Copenhagen resulted in a 5% increase in cycle traffic mileage and a 1% decrease in motor vehicle traffic mileage along the treated routes (Jensen 2008). Although this result is noted as not being statistically significant in this case (with the 95% confidence intervals suggesting a possible impact of -4% to +14% impact on mileage) the impact of *separated* cycle lanes (or cycle tracks) noted a 20% increase in cycle mileage and a 10% decrease in vehicle mileage.

The higher volume change under the separated cycle lane scenario suggests that, when presented with a new linkage comprehensive cycle network that exists in Copenhagen, the impact on traffic volumes can be noticeable. In the New Zealand context, generally cities and towns largely lack comprehensive cycle facilities and networks that are found overseas, with New Zealand networks largely consisting of on-road linkages and poor facilitation for the needs of cyclists at route endings. These network and infrastructure factors make it hard to assess whether cycle lane treatments in New Zealand would have a similar impact on volumes (it may have a bigger effect due to tapping assumed latent demand for facilities).

This difference in the level of infrastructure combined with unknown demand might indicate why little research has been conducted into the volume effects of cycle lanes.

2.2 Cycle Lanes and the Impact on Cycle Safety

Like motor vehicle crashes, statistics of crashes involving cyclists suffer from under-reporting or non-reporting, especially non-injury and minor injury crashes.

In New Zealand, road crashes involving cyclists have been required to be reported to police since 1998, although data for incidents that do not involve operated motor vehicles and non-hospitalised injuries tend to fall through the cracks (Turner *et al.* 2006). Evidence presented in Turner *et al.* (2006) suggested that the reporting rate for cycling crashes may be as low as 21%, with overseas rates (such as the Netherlands at 20%) similarly low.

As a result of the non-collection of data in these cases there is the potential for bias towards certain types and injuries that may not necessarily make up a large proportion of actual crash types (Hurst 1982). With these constraints on data collection, the statistics obtained from national databases such as the Crash Analysis System (CAS) are fairly limited in providing information about crashes between cyclists and pedestrians, other cyclists and parked vehicles (Wilke & Buckley, 2000). As a result of these blind spots in the data, studies conducted nationally and overseas historically have tended to focus on severe and fatal crashes rather than all crashes.

Studies conducted in Christchurch by Turner *et al.* (2006) of on-road cyclist crash casualties (who had made ACC claims for their injuries) suggested that 73% of those hospitalised had been involved in an crash involving a motor vehicle compared to 24% whom were involved in cyclist only incidents. These figures are in contrast to other studies such as Munster *et al.* (2001), which suggested that on-road injury crashes involving cyclists only were at least two times as frequent as cycle crashes involving a motor vehicle, also based on hospital and ACC data.

The absence in standardised data and variance in reporting rates is an issue that afflicts not only New Zealand data but overseas studies as well, leading to a wide variance in study results and a tendency to focus on certain crash types and injuries at the expense of complete data sets.

The Munster *et al.* study of on-road cycling crashes found that the majority of the total crashes involving cyclists occurred in locations not specifically designed for cycle movements, with 48% of crashes occurring in the traffic lane, 32% on the shoulder, and only 7% in a cycle lane. These results suggest that dedicated facilities could have a positive impact on cyclist safety.

Evidence from Wilke & Buckley’s (2000) study of cycle lane performance in Christchurch found that there was a notable reduction in cycle crashes post route treatment. They focused on five arterial routes in Christchurch to determine the cycle and pedestrian safety impacts. Post-treatment analysis of data obtained from the CAS database, showed that a 9% reduction in cycle crashes was found across the routes. These findings led the authors to contend that cyclist crash rates are reduced in the period following cycle lane treatment.

Other studies in New Zealand by Turner *et al.* (2009) and Allatt *et al.* (2012) suggest that the installation of cycle lanes at midblock locations resulted in a 10% reduction in cycle crashes, although it was noted that other treatments such as flush medians and the removal of kerbside parking appeared to have even greater crash reductions. Turner *et al.* were surprised that the crash reduction was not greater and speculated that it may be due to increases in cycle numbers (attracted to the new facility) minimising the absolute safety benefits obtained.

When the cycle lanes were coloured in Turner’s studies the overall awareness of cyclists was improved and led to better driver behaviour and awareness, leading to a 39% reduction in crashes at midblock and intersections.

Duthie *et al.* (2010) studied the impact that cycle lanes in the US have on cyclist positioning and the safety benefits to cyclists and motor vehicles. Cycle lanes were found to increase the lateral position of the cyclist in lane (further from the doors of parked cars and the kerb) implying greater comfort and confidence in being able to defend the lane space. The positioning of motor vehicles on the road was affected by the provision of cycle lanes, finding that motor vehicles do not deviate as much in their lateral position on the roadway, with motor vehicles tending not to move out of lane to pass cyclists (which is potentially hazardous, especially on arterial routes) as sometimes found in wide traffic lanes.

The main factor that dictates the effectiveness of cycle lanes on user safety is the relationship between lane positioning and the relationship with vehicle parking. Evidence from Turner *et al.* (2009) indicates that the absence of adjacent parking can impact on the rate of midblock cycle crashes by up to 75%. In addition, Turner *et al*. found that sites that had infrequent or spasmodic parking loadings (marked but mostly unused) had between 30 to 120% higher crash rates than routes with average or high parking loadings. Duthie *et al.* (2010) backs up this contention, finding that lateral positioning of cyclists increased in response to continuous or high parking loadings relative to discrete or intermittent parking loadings. This indicates that cyclists were more willing to take a gamble on passing by the door of a single car, or feel more confident in being able to predict a door opening in this case than if there was a row of cars, thus maintaining a smaller gap than otherwise. It could also reflect the propensity for some cyclists to swing in and out between infrequent parking, as opposed to maintaining a consistent line next to frequent parking.

A common issue with most of the studies listed above is the lack of control of cycle numbers when examining cycle crash rates. Given the likely influence of cycle facilities themselves on attracting cycling numbers, this is a key input when considering whether crash rates have improved or not.

3 INITIAL DATA COLLECTION

This study focused on determining the impact of cycle lane treatments on cycle and crash rates, whilst examining whether there was a noticeable (positive or negative) step change in the cycle numbers during the treatment period.

Fifteen routes from around Christchurch were chosen for analysis; twelve of these routes were treated with cycle lanes in the years 2003-2006, with three other routes treated before this period being selected to control for any underlying trend in cycle and crash numbers. Table 1 summarises the sites investigated. Note that all sites featured at least one side with cycle lanes on the outside of kerbside parking.

Table 1: Selected Cycle Lane routes and Characteristics

Corridor	Length	Area of City	Implementation Timeframe	AADT (000's)	Road Class
Blighs Road	800m	W	2006-2007	10-12	Minor Arterial
Centaurus Road	2750m	SE	2003-2004	5-8	Minor Arterial
Creyke-Kilmarnock Route	*3150m*	*W*	*Pre-2000 (Control)*	*12-14*	*Minor Arterial*
Greers Road	850m	NW	Early 2004	16-18	Major Arterial
Hoon Hay Road	2900m	SW	Early 2004	Med	Minor Arterial
Lincoln Road	850m	SW	Mid 2004	21-26	Major Arterial
Lyttelton Street	1800m	SW	2004-2006	7-8	Collector
Marshland Road	*2000m*	*N*	*Pre-2000 (Control)*	*20-25*	*Minor Arterial*
Milton Street	*1100m*	*SW*	*Pre-2000 (Control)*	*14-16*	*Minor Arterial*
Moorhouse Avenue	2250m	City	2004-2006	32-39	Major Arterial
New Brighton Road	3100m	NE	2004-2005	6-7	Minor Arterial
Pages Road	3800m	E	2004-2006	24-25	Major Arterial
Strickland Street	1300m	S	Mid 2004	6-8	Minor Arterial
Wainoni Road	2400m	E	Mid/Late 2004	20-22	Minor Arterial
Wairakei Road	2100m	NW	Early 2003	15-17	Minor Arterial

The *Cycle Network and Route Planning Guide* (LTSA 2004) provides a cycling count scaling method based on research using Christchurch City Council data. This method uses scale factors based on the time of day, day of the week, and time of year (e.g. school term or not) to scale up short-term cycle counts into an Annual Average Daily Traffic (AADT) estimate.

This method is based on the assumption that cycle numbers follow a common cycling profile, which is determined by whether the route is considered to be a commuter (and thus more cyclical with morning and evening peaks) or non-commuter site, with the respective scaling factors changing based on this cycle profile. Given the use of local data this method of data analysis has been used for this study. Figure 4 illustrates the AADT scaling equation used.

Calculation equation

The following equation yields the best estimate of a cycling AADT:

$$AADT_{Cyc} = Count * \frac{1}{\sum H} * \frac{1}{D} * \frac{W}{7}$$

where *Count* = result of count period

H = scale factor for time of day

D = scale factor for day of week

W = scale factor for week of year

If cycle count data for more than one day is available, then the calculation should be carried out for each day, and the results averaged.

Figure 4: Cycle count scaling equation (LTSA 2004)

Cycle count data has been obtained from the Christchurch City Council for the intersections of these routes (as cyclists are not generally recorded at midblock locations by CCC) with the corridor being broken up into section lengths based on the distance between sample sites. Count data from 1999 onwards was used to enable at least five years either side of treatment.

Two types of counts exist in the council database, historic (pre-2004) manually collected cycle only counts, typically counted in the 7:30-9am and 4:15-5:45pm time periods, and the post-2004 shared counts (counts conducted at the same time as motorised traffic, either manually or electronically) typically counted between 7-9am and 4-6pm. Both have been treated equally in this study. Each of these cycle counts have been scaled up into AADT estimates using the scaling calculation.

AADT estimates have been sorted into pre-treatment, treatment impacted and post-treatment periods for each site and for the overall corridor and then graphed. AADTs for each site and for the corridor as a whole have also been graphed to display an overall cycle trend. These graphs have then been linearly regressed to determine the average growth rate before, during and after treatment as well as overall.

The million vehicle-kilometres travelled (MVKT) for each period, site and corridor has been determined by integrating the graphs, and then multiplying by the section length.

Cycle crash data for all 15 routes has been obtained from the CAS database for the years between 1999 and 2009 (typically five years pre-treatment, five years post-treatment and one treatment affected year). The crash data has been grouped to the nearest count site and is then used to calculate the crash rate per MVKT for each site and for the route overall, in the pre- and post-treatment periods and for the overall study period, with the before and after treatment rates analysed to determine the impact of the treatment on crash rates.

The cycle growth rates per year have been determined using the graphed trends in the pre-treatment, treatment impacted and post-treatment periods to determine the impact on cycle numbers, with the existence of any step change during the treatment period analysed.

4 STUDY FINDINGS

The Hoon Hay Road route provides an example of a typical result found in this study; the corridor has three sample sites across a 2900m length that was treated with cycle lanes (parking retained on one side, and a flush median also installed). Figure 5 shows a timeline plot of all cycle counts recorded along this route, before treatment (blue data), during treatment (yellow data), and after implementation (pink data).

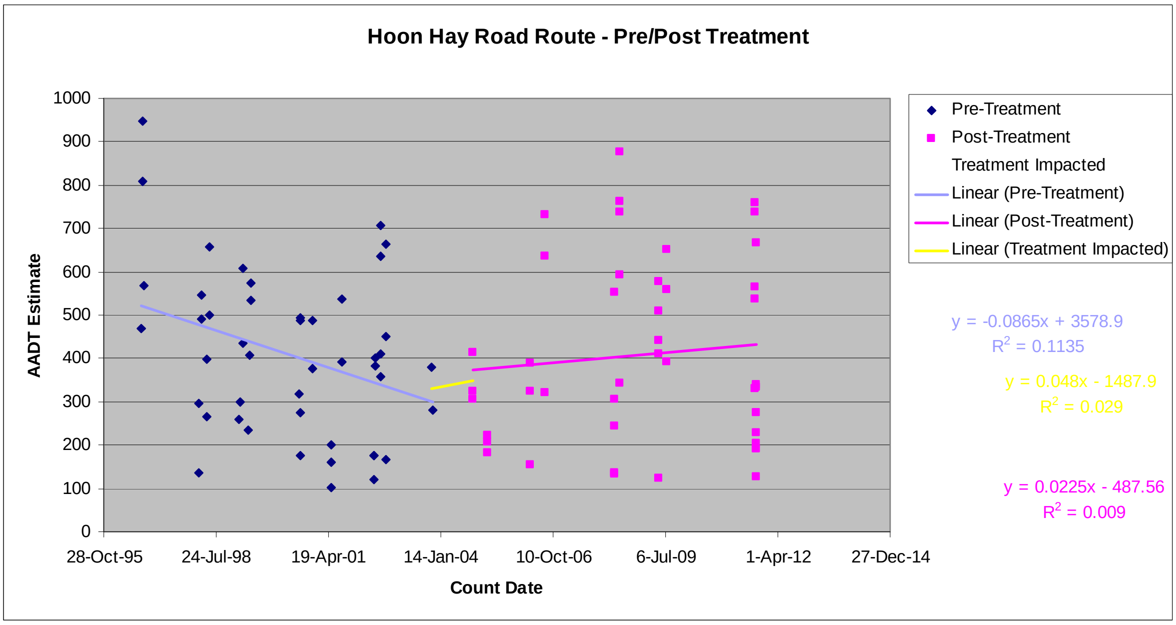

Figure 5: Hoon Hay Road corridor – Cycle Counts pre-, during and post-treatment

The Hoon Hay Road corridor demonstrates a positive impact on cycle numbers from the cycle treatment. Pre-treatment Hoon Hay Road had a declining cycle count, which was arrested by a slight increase in cycle numbers during the treatment influenced years, implying that there is an impact on cycle numbers on this route corresponding to the cycle lane treatment.

Overall cycle numbers on the Hoon Hay Road corridor have slightly decreased over the study period, with a trend of -2 cyclists per annum (cp/a). However the count data is highly scattered leading to a noticeable difference between the overall and treatment cycle counts.

The slight decline in cycle numbers has flowed through to a stagnant average counts for the corridor (from 408 to 409, post-treatment). The step change (treatment impacted) for the overall route is positive, with all sites showing a positive step change impact on cycle numbers (18 c/pa increase). The pre-implementation rate is strongly negative (-32 c/pa), which has reverted to a positive cycle count (8 c/pa) in the post-implementation period.

Table 2 summarises the key statistics for this corridor, alongside million vehicle (cycle) kilometres travelled for each site and route. Note that the MVKT values for the overall corridor do not equal the sum of the three sub-section MVKTs because of overlaps in the section lengths used.

Table 2: Hoon Hay Road Corridor – Cycle counts & crashes pre, during and post-treatment

Hoon Hay Road Corridor **(Early 2004 Implementation)**
Length = 2900m MVKT = Million Vehicle Kilometres Travelled

Corridor Site	Halswell Road		Sparks Road		Cashmere Road		Overall Corridor	
	MVKT	Trend	MVKT	Trend	MVKT	Trend	MVKT	Trend
Pre-Treatment	1.96	-0.170	1.20	-0.100	0.39	-0.056	3.08	-0.087
Treatment Impacted	0.55	0.084	0.38	0.007	0.43	0.142	0.35	0.048
Post-Treatment	2.35	0.067	1.12	0.060	0.76	-0.049	3.81	0.023
Treatment Total	4.86	-	2.69	-	1.58	-	7.24	-
Site Total	4.90	0.011	2.81	-0.008	1.58	0.015	6.50	-0.005

Crash Data	Total	Mid-Block	Junction	Halswell	Sparks	Cashmere
1999 - Implementation	3	2	1	2	1	0
Implementation - 2009	0	0	0	0	0	0
CAS - 1999-2009	3	2	1	2	1	0

The reported crash data for the Hoon Hay Road corridor has been collected for the period 1999-2009 (11 years, 5 years either side of treatment) with this data being grouped to the nearest count site to determine the crash rate per million vehicle kilometres for each site and the corridor overall. The findings are detailed Table 3, with this site recording a 100% reduction in reported crash numbers post-implementation, albeit from very small prior crash numbers (three).

Table 3: Hoon Hay Road Corridor – Site crash rate & count changes

Crashes Per MVKT	Halswell	Sparks	Cashmere	Corridor
Pre: 1999 - 2003	1.02	0.83	0	0.98
Post: 2005 - 2009	0	0	0	0
%Change	-100%	-100%	-	-100%
Overall: 1999-2009	0.41	0.36	0	0.46
Rate Per Km	0.24	0.21	0	0.16

	Pre	Step	Post	Step-change	Change
Vehicle AADT (000s)	6.0-7.0	7.0-7.5	6.9-7.8	STAGNANT	STAGNANT
Cycle AADT trend (cp/a)	-32	18	8	156%	125%

Obviously crash numbers like these for a single site are too small to draw any conclusions from. Likewise, the count data trends are not necessarily conclusive on an individual site basis. Therefore, more attention was paid to the overall trends across all of the sites investigated, as discussed later.

4.1 Study Wide Cycle counts

The cycle counts for all routes and dates city-wide have been plotted to determine whether there is an underlying trend across the city. Cycle numbers city-wide have slightly increased over the study period, with a trend of 2 cp/a. Figure 6 shows the overall citywide trends for cycle numbers at all recorded sites. Although the data is highly scattered the overall trend falls in line with the three untreated routes in the city (stagnant or slight increase in the cycle growth rate).

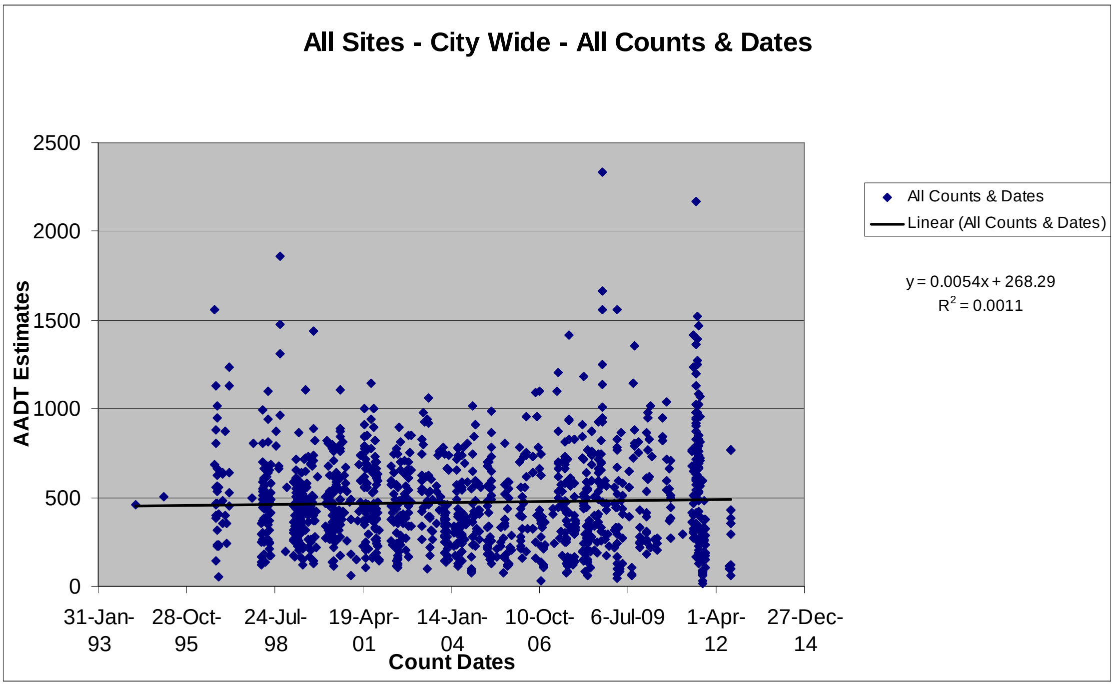

Figure 6: Citywide Cycle Counts – All Sites

Table 4 summarises the results for all of the studied sites. Slightly over half of all routes demonstrated a negative step-change during the treatment impacted stage, questioning the validity of the assumption of a positive jump in the cycle count, at least in the short term. The overall step-change trend for all sites collectively was also overwhelmingly negative. Interestingly, the individual count sites within each route were fairly evenly split, in terms of positive and negative step-changes.

However, some of the most extreme negative step-changes were predominantly due to background trends such as route shifting or long periods of road works on these routes. Allowing for this, the average-step change shifts to a slightly positive impact overall, but it is still arguably inconclusive.

By contrast, the longer-term changes in cycle counts post-treatment have been strongly positive, with an average increase in cycle count trends of over 200% across all routes.

On a count site by site basis the change in trend has been positive, with sites having negative cycle counts post-implementation only recording relatively small negative trends. These results indicate that the cycle lane treatments have had a measurable positive impact on the cycle count trends post-implementation.

Table 4: All Sites - Cycle Counts – Impacts and Trends

	Growth Rate - Cycles p/a			Step	Pre/Post
Corridor	**Pre**	**Step**	**Post**	**Change**	**Change**
Blighs Road	–55	–24	+3	+31 (+56%)	+58 (+105%)
Centaurus Road	+4	+33	+15	+29 (+725%)	+11 (+275%)
Greers Road	–26	+49	+2	+75 (+288%)	+28 (+106%)
Hoon Hay Road	–32	+18	+8	+50 (+156%)	+40 (+125%)
Lincoln Road	–7	+36	+31	+43 (+614%)	+38 (+542%)
Lyttelton Street	+41	–187	+40	–228 (–556%)	–1 (–2%)
Moorhouse Avenue	–25	+201	+53	+226 (+904%)	+78 (+312%)
New Brighton Road	+6	–98	–18	–104 (–1733%)	–24 (–400%)
Pages Road	0	–26	–13	–26 (–)	–13 (–)
Strickland Street	+35	–42	+23	–77 (–220%)	–12 (–34%)
Wainoni Road	–13	–191	–6	–178 (–1369%)	+7 (+54%)
Wairakei Road	–16	–60	–18	–44 (–275%)	–2 (–13%)
Overall	**–88**	**–291**	**+120**	**–203 (–231%)**	**+208 (+236%)**
Creyke-Kilmarnock Route	*+6*				
Marshland Road	*–22*				
Milton Street	*+3*				

One possible reason for the decline in the cycle counts during the implementation period is the shifting to adjacent or parallel routes during the construction and early post-implementation stage (e.g. as seen with in the Lyttelton and Strickland Street corridors). Many cyclists would avoid long-term roadworks if possible, with those cyclists returning to the route or new cyclists shifting to the route in the years post-implementation.

One exception to this is the Moorhouse Avenue site, which recorded large positive step changes at seven of the nine count sites. Sites in the south and south west of the city have recorded positive step changes (with the exception of Lyttelton Street) with sites in the east all recording strongly negative step changes.

The control routes (that were treated pre-2000) have recorded slightly positive growth rates over the period (although barely above the slight city-wide growth), with the exception of the Marshland Road route of which the QEII Drive site has recorded a large decline, amplifying the overall decline.

On a count site by site basis the change in trend has been positive, with sites with negative cycle counts post-implementation recording a reduction in the magnitude of the negative trend. These results indicate that the cycle lane treatments have had a measurable positive impact on the cycle count post-implementation.

4.2 Study Wide Cycle Crash Rates

Table 5 summarises the changes in reported crash rates for each route. The majority of corridors studied have experienced a decrease in crash rates post cycle lane treatment, with nine out of the twelve routes recording a lower reported crash rate. Overall the average reduction in the crash rate is 43% with seven of 12 treated routes experiencing a reduction in crash rates of 40% or greater.

The control routes (that were treated pre-2000) also experienced an overall reduction in reported crash rate of 25%. Therefore it is likely that some of the crash reduction experienced at the study sites would have occurred anyway, regardless of cycle lane treatment. Nevertheless, eight out of the 12 sites experienced reported crash reductions greater than the control sites, in many cases considerably more.

Table 5: All Sites – Reported Crash Rates – Impacts and Trends

Corridor	Cycle MVKT		Crashes		Crash Rate / MVKT		Pre/Post
	Pre	Post	Pre	Post	Pre	Post	Change
Blighs Road	1.45	0.62	2	1	1.38	1.61	+16%
Centaurus Road	1.79	3.11	3	6	1.67	1.93	+15%
Greers Road	1.00	0.69	3	0	3.00	0	–100%
Hoon Hay Road	3.08	3.81	3	0	0.98	0	–100%
Lincoln Road	1.08	1.32	4	1	3.70	0.76	–79%
Lyttelton Street	2.07	2.90	4	4	1.94	1.38	–28%
Moorhouse Avenue	3.41	3.64	15	7	4.40	1.93	–56%
New Brighton Road	1.93	2.14	9	6	4.66	2.81	–40%
Pages Road	2.92	2.32	17	7	5.82	3.02	–48%
Strickland Street	1.71	2.89	3	2	1.75	0.69	–61%
Wainoni Road	3.00	1.38	5	2	1.67	1.45	–13%
Wairakei Road	2.90	1.36	4	5	1.38	3.68	+167%
Overall	**26.34**	**26.18**	**72**	**41**	**2.73**	**1.57**	**-43%**
Creyke-Kilmarnock Route	*3.74*	*3.95*	*14*	*10*	*3.74*	*2.53*	*–32%*
Marshland Road	*1.53*	*1.04*	*1*	*2*	*0.65*	*1.92*	*+196%*
Milton Street	*5.81*	*6.12*	*1*	*0*	*0.17*	*0*	*–100%*
Overall	***11.08***	***11.11***	***16***	***12***	***1.44***	***1.08***	***-25%***

The overall decline in reported crash rates post-implementation indicates that the cycle lane treatment has had a notable positive impact on cycle crash rates. Adjusting for the expected control site crash reduction, the expected overall crash reduction after installing cycle lanes is **23%**.

5 DISCUSSION

5.1 Christchurch Earthquake and the Impact on Cycle Numbers

The 2011 Christchurch Earthquake caused extensive damage to the city's road infrastructure, especially in the eastern suburbs. Counts undertaken post 22/02/11 are noticeably lower, in some cases 20% lower than counts undertaken under 12-24 months beforehand. This decrease in counts has influenced overall trend data, leading to post-implementation and overall site counts to either present a more negative than trend cycle count (drags down the trend) or the flattening out or reversal of positive cycle growth rates. To minimise post-earthquake impacts on the study crash rates, sampling of CAS data was ceased at 2009. Further study into the long term impact of the earthquake on cycling rates will be required in order to determine whether these counts are reflective of new travel patterns or are just a short term impact on cycle numbers.

5.2 Route Influencing Factors

One of the largest route influencing factors found in this study was competition from other cycle facilities. The Railway Cycleway, a dedicated off-road cycle path, intersects three of the study routes. These routes have a noticeable decline in cycle counts, which correspond to the completion of new stages of this more direct and preferred off-road route. Competition between cycle lane treated routes also occurred between two of the study corridors at the Lyttelton Street and Hoon Hay Roads routes, which are parallel.

A decline in the cycle numbers on the Lyttelton Street corridor corresponded with an increase at the Hoon Hay Road corridor, indicating the potential for some shift between the two routes. On the Strickland Street corridor, the Colombo Street count site saw a decline in overall cycle numbers following the treatment of the adjacent Colombo Street route being treated with cycle lanes. The Colombo Street route provides a more direct route through to the CBD, with the post-treatment cycle count weighted down by this shift away from the corridor (still positive but a less steep positive trend).

Changes to the traffic conditions and types of traffic may have influenced some of the sample sites in the study. Sites that saw an increase in motor vehicle traffic, especially heavy vehicle traffic corresponded to falling cycle counts. The ANZAC Drive and QEII Drive count sites in the northeast of the city, with a growing trend of heavy vehicles along the State Highway 74 corridor, declined at a greater rate than other sites in the corridor. This factor may have also influenced the cycle counts at the Blighs and Wairakei Road corridor sites, which declined substantially over the study period (even away from the sites influenced by the Railway Cycleway). These sites saw stagnant overall motorised traffic growth but an increasing share of heavy vehicles using the route, especially on Blighs Road, suggesting some influence of cycle attractiveness of this route. These changing conditions may have contributed to a greater shift rate to the railway cycleway over the period than what may otherwise been observed, as the on-road route changed.

5.3 Data Integrity and Sampling Methods

Mid way through the study period, the data collection method and times changed with historical (pre-2004) manually-collected cycle only counts, typically counted in the 7:30-9am and 4:15-5:45pm time periods, and the post-2004 shared counts (counts conducted at the same time as motorised traffic, either manually or electronically via tube counter) typically counted between 7-9am and 4-6pm. The change in the count method also corresponded with a change in sampling methodology with intersection counts only being done on Tuesdays, Wednesdays, or Thursdays, from random sampling, to reflect motorised traffic trends.

The new methodology sees same-day sampling, with morning, afternoon and evening counts undertaken. This change has increased the scatter of data points in the study. To combat this, these multiple daily counts have been averaged into one count for the particular day (this has not been done at sample sites where there is a low number of data points). Counts undertaken using this method tend to be lower than the cycle-only counts, especially on high traffic routes (such as ANZAC and QEII Drive sites). This lower count rate may have contributed to some of the decline in cycle counts in the post-treatment period. Counts undertaken in higher traffic locations may under-estimate the cycle counts at these sites (either through manual counts of motor traffic overlooking cyclists or motor vehicles “masking” electronic cycle detections), leading to lower recorded cycle numbers at these locations in the eastern suburbs.

6 CONCLUSIONS AND RECOMMENDATIONS

Overall the study has demonstrated that cycle lane treatments are effective at meeting the policy and road safety aims postulated in the in the literature.

The bulk of step changes in this study have been found to be negative; this is reflected in the negative average step change of over 200%.

Of the individual sample sites just over half of all sites demonstrated a negative step change during the treatment impacted stage, questioning the validity of the assumed positive jump in the cycle count, at least in the short term. However, ignoring sites affected by external factors, the average-step change shifts to a slightly positive impact overall, but it is still arguably inconclusive.

Overall the change in cycle counts post-treatment have been strongly positive, with an average increase in annual cycle count numbers of more than 200% overall. On a count site by site basis the change in trend has been positive, with sites with negative cycle counts post-implementation recording a reduction in the magnitude of the negative trend. These results indicate that the cycle lane treatments have had a measurable positive impact on the cycle count post-implementation.

The majority of corridors have experienced a decrease in crash rates post cycle lane treatment, with nine out of the twelve routes recording a lower crash rate. Overall the average reduction the crash rate is 43% with seven of 12 treated routes experiencing a reduction in crash rates of 40% or greater. The strong decline in crash rates post-implementation indicates that the cycle lane treatment has had a very positive impact on cycle crash rate. Allowing for crash reductions experienced by the control sites, an average 23% reduction in crash rates was observed following cycle lane implementation.

The study draws into question the suitability of the assumption in pre-existing levels and growth in cycle numbers used in NZTA Report 340, with the study contradicting the core assumption of the large jump in cycle numbers hold all other factors equal.

This study raised areas to be researched further. Key areas to be studied further are to:

- Conduct further analysis of pre/post-treatment count numbers and rates at a variety of sites across New Zealand to assess whether the assumption of a step change is valid on a national scale.
- Undertake further long term research as to the impact of the Christchurch Earthquake on cycle growth rates.
- Conduct research into the influence of traffic conditions and types of traffic on counts.

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