

Post Implementation Review

Caversham Highway Improvements

Otago Highways & Network Operations



October 2017

The purpose of NZ Transport Agency Post Implementation Reviews are to:

- assess how well a project (or package) has delivered its expected benefits
- explain any variation between actual results and expected benefits and costs
- identify any lessons learned that can be used to improve future projects

Executive summary

The Caversham Highway Improvements project upgraded this busy 3km section of State Highway 1 into Dunedin City. The project was completed in two distinct stages. Stage 1 widened a remaining two lane stretch of highway to four lanes. Stage 2 focused on safety improvements. Safety improvements included replacing two at-grade intersections with an overbridge, shoulder widening, and installation of a kerbed central median. As part of Stage 2, a service lane also replaced previously direct access onto the highway for adjacent houses, and walking and cycling facilities were improved.

Highway upgrade has not produced travel time savings...

The widening of the remaining two lane section of highway to four lanes was expected to improve travel times by increasing capacity and eliminating traffic slowing at merge points. These travel time savings have not eventuated. This post implementation review found average travel times on the Caversham Highway have actually modestly increased across different times of the day. These increases are only very minor, however, ranging from a few seconds to less than half a minute.

The most likely explanation for the lack of expected travel time benefits is strong traffic volume growth over the past couple of years. There was 10.5% growth in daily traffic on the highway between 2010 and 2016; this equates to nearly 30,000 vehicles now using the highway each day, compared with around 25,000 when the project's first stage started. It is likely that congestion would therefore have been significantly worse (and travel times longer) if the four-laning had not occurred.

...but safety has been improved

Caversham Highway is a safe road for the high volume of vehicles using it each day. Over the past decade there have tended to be only around half a dozen crashes recorded on the highway each year. This is a low crash rate for a highway carrying between 25,000 to nearly 30,000 vehicles per day.

Safety has been further improved as a result of the upgrade improvements. There has been a statistically significant reduction in crashes on the section of the highway upgraded by Stage 1 of the project. Several more years' crash data are required to conclude more confidently on the safety outcomes of Stage 2's interventions. Indicative results are positive, however, with only five crashes recorded on Stage 2's section of highway between project completion in late 2015 and the end of 2016. The replacement of two at-grade intersections with an overbridge has removed a significant safety risk for both local traffic accessing the highway and pedestrians crossing it.

Geotechnical issues delayed project completion and pushed up costs

The Caversham Highway Improvement project (both stages) was constructed for an overall cost of nearly \$46 million, 13.5% (\$5.45 million) higher than budgeted. This was driven mainly by higher Stage 2 costs associated with geotechnical issues requiring re-design work to build the overbridge and its embankments. Completion of the project (in late 2015) was delayed by around eight months as a result.

Good practice initiatives used with upgrade design features

Noise reduction fences were able to be designed to suppress highway traffic noise for nearby residents while being at a height which did not obstruct their views.

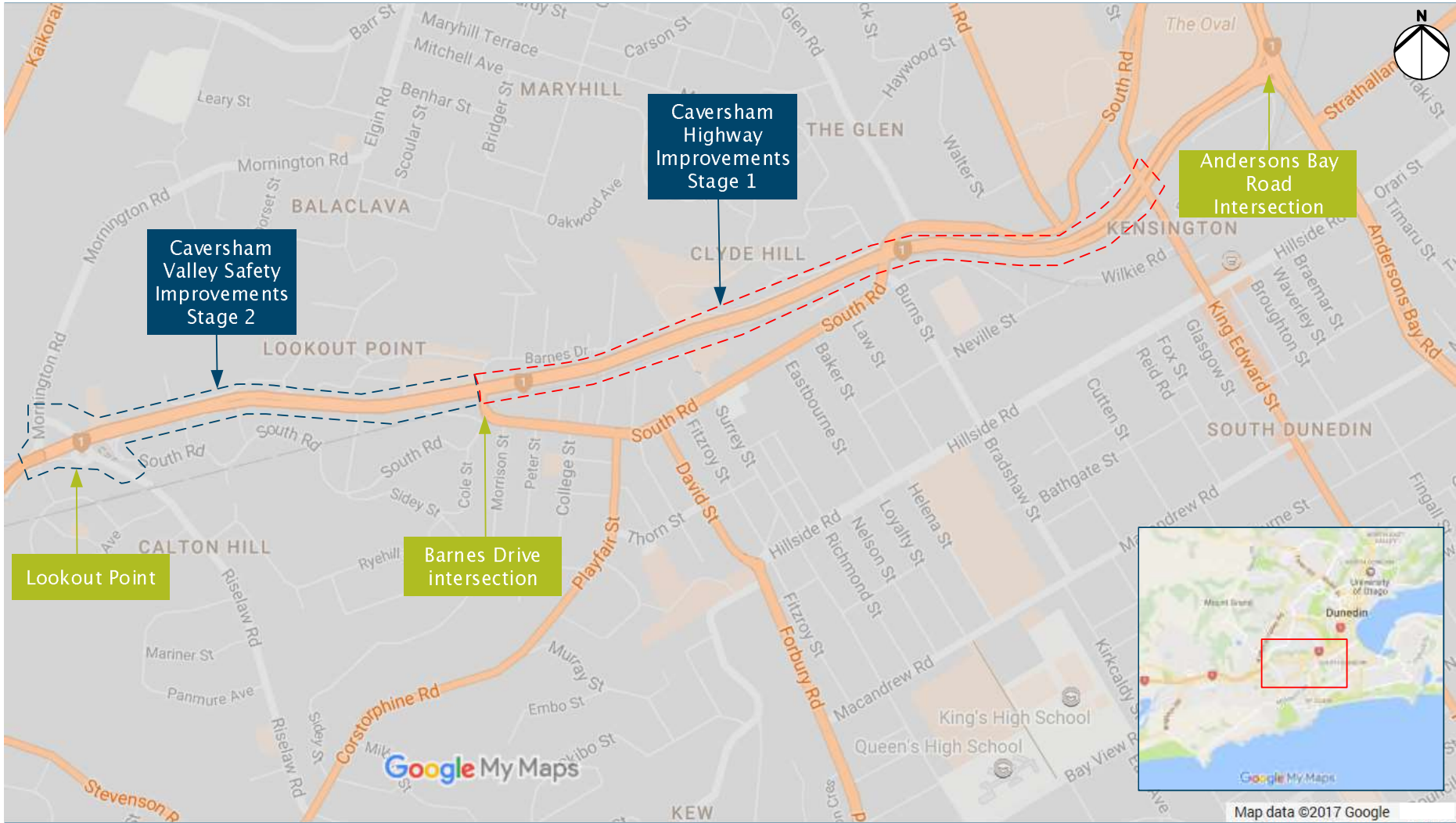
Bridge handrail and barrier designs prevent objects being placed in positions where they might dangerously fall onto highway traffic.

Recommendation

This post implementation review makes one recommendation relating to incorrect monetised benefits for the project in the NZ Transport Agency's Transport Investment Online (TIO) system.

That the Transport Agency reviews its procedures for checking accuracy of information put into TIO and introduce, if needed, appropriate quality assurance controls.

Figure 1: Caversham Highway Improvements location map



1. Project benefits

Project description

The Caversham highway is a key part of the SH1 southern arterial route into Dunedin City. The highway is one of the busiest roads in Otago, with nearly 30,000 vehicles a day using it on average in 2016. It forms part of a main freight route via SH88 to Port Chalmers.

The Caversham Highway Improvements project upgraded the 3km section of SH1 from Lookout Point to just west of the intersection with Andersons Bay Road. Figure 1 on page 4 shows the project location.

The highway upgrade was done in two distinct project stages:

- **Stage 1** – widened the 1.7km section of highway between the King Edward Street over bridge and the signalised intersection with Barnes Drive from two to four lanes. Other features of Stage 1 included intersection improvements at Barnes Drive, an upgrade of a footbridge over the highway, two overbridge widenings, and an extension of a walk and cycleway adjacent to the highway. Stage 1 was constructed between December 2010 and October 2012.
- **Stage 2** – known as the ‘Caversham Valley Safety Improvements’ – concentrated on making safety improvements to the section of highway from the Barnes Drive intersection to Lookout Point. Main features of this stage included widening and improving the alignment of the existing road with wider shoulders and a kerbed central median. Two at-grade intersections at Lookout Point were replaced with a bridge over the highway to link Mornington Road and Riselaw Road. Provision was also made to provide service lanes to residential properties next to the highway. Access to these houses was previously directly off the highway. Figure 2 illustrates the before and after situation. Stage 2 was completed between late 2012 and October 2015.

Expected project benefits were to reduce travel times and improve safety

The overall project objectives were to:

- Reduce peak hour traffic congestion and increase capacity on the Caversham highway,
- Improve travel times and deliver more predictable journey times¹ between Andersons Bay Road and Lookout Point, and
- Increase safety on the busiest highway corridor south of Christchurch.

In broad terms, Stage 1 of the project was more focused on producing the travel time and reliability benefits, while Stage 2 was concentrated more on delivering safety improvement benefits.

Quantifying the predicted benefits for Stage 1 was not possible from the project’s information in the NZ Transport Agency’s Transport Investment Online (TIO) database. This was due to confusing and seemingly erroneous information about the project’s staged breakdown of predicted monetised benefits. This is apparent from figure 3, which summarises expected benefits for both project stages.

¹ Journey time reliability is about variability in travel times road users can expect based on the traffic conditions they face. High journey time reliability is preferable because it means road users can better predict their travel times while facing reduced probability of being delayed.

Figure 2: Main features of Stage 2 improvements

Before: four lane highway with no median, direct access to highway from adjacent houses, kerbside parking.



After: kerbed central median separating highway traffic, replacement of kerbside parking and direct highway access from houses with service lane (behind timber panelled noise reduction fence), wider shoulders. The overbridge which replaced two at-grade intersections at the brow of hill is also shown.



Figure 3: Comparison of predicted project benefits for Stages 1 and 2

Predicted benefits	Stage 1		Stage 2	
	\$m	%	\$m	%
Travel time cost savings	228.8	-100%	21.0	33%
Vehicle operating cost savings	-457.8	200%	9.4	15%
Crash cost savings	0.4	-0.2%	32.5	52%
TOTAL benefits	-228.6	100%	62.9	100%

Source: NZ Transport Agency, *Transport Investment Online (TIO)*

Referring to figure 3, the benefits breakdown information for Stage 1 is incorrect. Significant travel time savings benefits of more than \$200 million cannot be greatly negated by nearly \$500 million in vehicle operating cost disbenefits. Travel time savings *reduce* vehicle operating costs. Furthermore, a project with total benefits actually being estimated as disbenefits totalling more than \$200 million would not be feasible nor funded.

It is unclear how this mistake occurred, but it highlights a need for improved quality assurance controls by the Transport Agency to ensure information in the TIO database is accurate. Correct information about Stage 1 benefits was not available for this review.

RECOMMENDATION

It is recommended that the NZ Transport Agency reviews its procedures for checking accuracy of information put into TIO and introduce, if needed, appropriate quality assurance controls.

TIO is the Transport Agency's principal investment funding and monitoring system. It is therefore important that the accuracy of its information is verified.

The predicted benefits breakdown for Stage 2 of the project (figure 2) is more straightforward. This shows that the expected benefits used in the economic evaluation supporting this project stage's funding predicted just over half (52%) of benefits to come from improved safety. Travel time savings contributed a further 33% of the predicted benefits and vehicle operating cost savings the remaining 15%.

Focus of this post implementation review

This post implementation review concentrated on evaluating how well the travel-time related benefits of the Caversham highway improvements project were achieved. Safety outcomes to date are covered but these are only indicative. This is because evaluating safety outcomes from a project's intervention requires at least three years and preferably five years of crash data. Stage 2 of the project was only completed in late 2015 and therefore there is insufficient crash history to conclude with confidence that the observed crash trend will be enduring or can be attributed to the project's safety improvements.

Capacity increased but travel time savings have not eventuated...

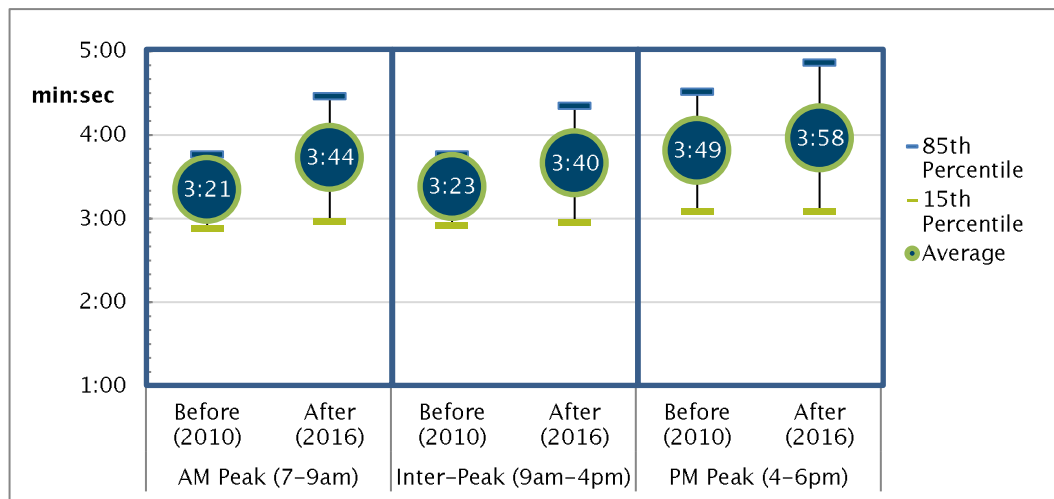
The Caversham Highway's capacity has been increased, but average travel times and reliability have not improved.

The widening of the Caversham highway to four lanes has successfully increased its capacity to cope with future traffic volume growth. However, the improvements made by both Stages 1 and 2 on the highway have not resulted in any significant improvements in travel times or journey time reliability.

This is apparent from figures 4 and 5, which compare average travel times in both directions along the whole section of highway covered by the project. This covers the 3.1km length of highway between Lookout Point (to the west) and the Andersons Bay Road intersection (to the east). Average times over two years are compared: 2010, the year before construction of Stage 1 started², and 2016 – the first full year after all project construction was completed. Three time periods are covered:

- AM Peak period between 7am and 9am
- Inter-Peak period between 9am and 4pm, and
- PM Peak period 4pm–6pm.

Figure 4: Caversham highway average eastbound travel times and variability before and after highway improvements



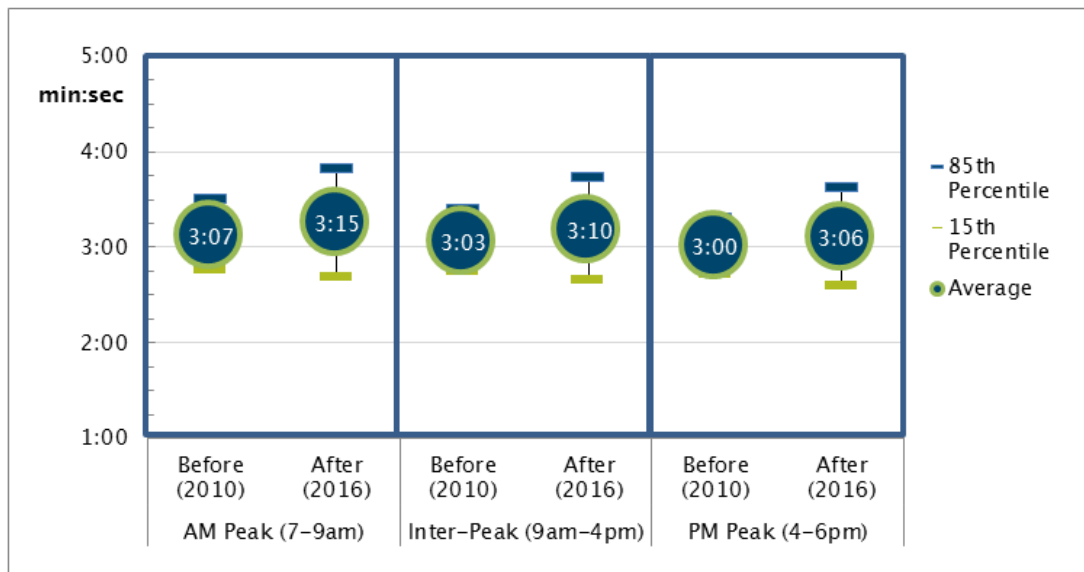
Source: TomTom, Traffic Stats

Figures 4 and 5 show that average travel times on the Caversham Highway have actually increased rather than reduced. However it should be noted that these travel time increases are only minor, ranging from around six to 23 seconds depending on time of day.

There have also been modest increases in travel time variability. This is shown in figures 4 and 5 by the 'hi-low bars' showing the 15th and 85th percentiles of recorded travel times. The difference between these percentiles is a commonly used indicator of travel time variability.

² December 2010 was excluded because construction of Stage 1 started in this month and may have affected typical travel conditions.

Figure 5: Caversham highway average westbound travel times and variability before and after highway improvements



Source: TomTom, Traffic Stats

...possibly due to stronger-than-forecast traffic volume growth

It is unclear why the predicted travel time benefits have not eventuated, as key aspects of the highway project should have facilitated travel time savings:

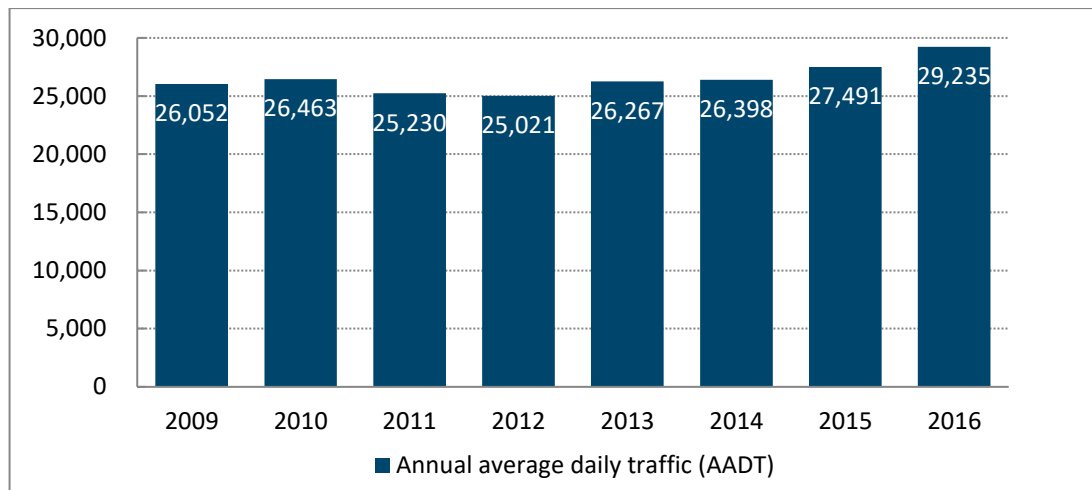
- The 4-laning of the entire highway between Andersons Bay Road intersection and the Barnes Drive intersection has removed merge points which would have previously slowed traffic during congested peak periods.
- The posted speed limit on that section of highway has stayed the same at 80km/h, while the section upgraded by Stage 2 has been increased from 50km/h to 60km/h, resulting in an overall higher speed environment on the highway.

A possible explanation for the small increases in average travel times and reduced journey reliability might be higher-than-expected traffic volume growth. Traffic volumes on Caversham Highway stayed relatively stable between 2009 and 2014 (as figure 6 shows) but grew strongly in 2015 and 2016. Overall, traffic volumes on the highway were 10.5% higher in 2016 than 2010. This is equivalent to around 2,700 more vehicles a day using the highway. This is a big enough increase in traffic volumes to reduce average travel speeds and increase travel time.

There have also been similar small reductions in average travel times on the Dunedin Southern Motorway west of Caversham. The section of motorway analysed³ has a 100km/hr posted speed limit and no at-grade intersections or other design features introduced likely to have reduced average travel times. This reinforces the likelihood that strong traffic volume growth has marginally reduced average speeds to slightly increase travel times.

³ The section was between the Old Brighton Road interchange and the western start of the Caversham Highway at Lookout Point.

Figure 6: Traffic volume growth on Caversham highway, 2009–2016



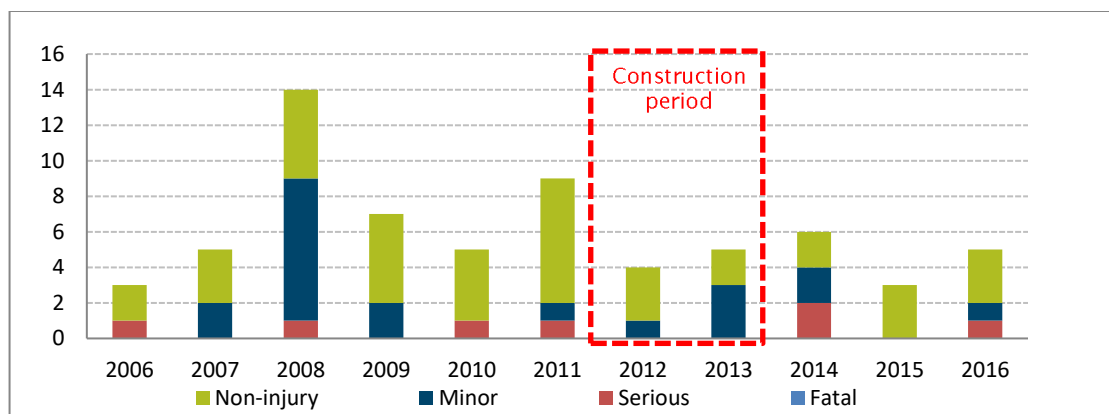
Source: NZ Transport Agency, State Highway AADT Data Booklets (various years).

Improved safety has been achieved from Stage 1 improvements...

Safety has improved on the Caversham Highway between Andersons Bay Road and Barnes Drive as a result of Stage 1's interventions. However, this section of highway only tended to have a low incidence of crashes in recent years (figure 7). Except for a peak of crashes in 2008, for most years over the past decade there has tended to be less than six crashes recorded each year. This is a comparatively low number of crashes for a busy highway carrying more than 25,000 vehicles each day.

The Stage 1 improvements have further boosted this strong safety record. There has been statistically significant reduction in recorded crashes on this stretch of the highway since Stage 1's improvements were completed in late 2012.⁴ The crash rate fell from 6.94 crashes per year recorded over the five years before construction started, to 4.87 crashes per year for the period since Stage 1 completion and the end of 2016.

Figure 7: Crashes on Caversham Highway between Andersons Bay Road and Barnes Drive intersection, 2006–2016



Source: NZ Transport Agency, Crash Analysis System (CAS)

⁴ Testing for statistical significance means it can be confidently concluded that the observed crash reduction has been helped by the project's road improvements and not just reflective of random fluctuations which tend to occur with crashes.

...and indicative results suggest the Stage 2 changes have also improved safety

There have been five crashes recorded on the Caversham Highway between the Barnes Drive intersection and Lookout Point since Stage 2 was completed.⁵ Four of these were non-injury crashes and the other one a minor injury crash. Three out of five of them were rear-ending crashes. This compares with 38 crashes recorded over the five years before Stage 2 construction started (in late 2012).

The low crash incidence post-completion of Stage 2 indicates this section of the highway has an improved level of safety. However, it is too soon after project completion (in late 2015) to conclude with sufficient confidence that the observed crash rate can be attributed to the project's interventions. This is because three to five years of crash data is required to help remove random fluctuations which occur with road crashes and be able to attribute observed trends to a project's interventions.⁶

A focus of the Stage 2 improvements was to address a high safety risk caused by having two at-grade intersections at Lookout Point feeding local road traffic directly on and off the highway (first photo in figure 8). Right turning traffic from both Mornington Road and Riselaw Road had to cross the state highway. The project replaced these intersections with an overbridge, successfully removing the safety risk of local traffic crossing the state highway at Lookout Point. The previous intersection of Mornington Road with the state highway, in particular, had clear safety risks, as shown in figure 9. Drivers turning from the state highway right into Mornington Road had poor visibility of oncoming highway traffic approaching the brow of the hill at Lookout Point.

Indications of vehicles travelling too fast through Lookout Point

Several scrape marks were observed on the inner concrete barrier on the bend at the western end of highway immediately west of Lookout Point (see photo below). This suggests there has been an issue with vehicles being driven too fast as they accelerate up to the 100km/h speed limit at this location. These loss-of-control incidents have not shown up in the recorded crash statistics but the issue is worth monitoring in case corrective action is required.



⁵ The period covered here is 2016 and the first half of 2017.

⁶ A multitude of factors can result in a crash occurring, many of which may have nothing to do with the condition and/or design of the actual road.

Figure 8: Replacement of at-grade intersections at Lookout Point with overbridge

Before: Traffic from Mornington and Riselaw Roads could turn right across SH1



After: Mornington Road traffic heading west towards airport and Riselaw Road traffic heading east towards



Source: Aerial photography imagery © Google Earth 2017.

Figure 9: Dangerous right turn across highway at brow of hill removed

Before: Poor visibility for right turning vehicles of oncoming SH1 traffic over brow of hill



After: safety risk removed with intersection removal and installation of median barrier



2. Project cost and timeframe

Geotechnical issues pushed up overall construction costs...

The total construction cost for the Caversham Highway Improvements was just under \$46 million. This was \$5.45 million (+13.5%) higher than their combined budgeted cost of \$40.45 million.

Both Stage 1 and Stage 2 had higher-than-budgeted construction costs.

Stage 1's construction cost of \$20.71 million was modestly (+6.2%) higher than budgeted. This was due to escalation of costs in the first year of construction and the need for additional noise fencing and a retrofit of existing bridge barriers.

Stage 2's actual construction costs ended up being substantially higher than budgeted. The actual construction cost of \$25.24 million was 20.2% above budget. This cost escalation was driven by unforeseen major geotechnical issues and ground conditions, especially at Lookout Point. These issues, which included a hidden non-active fault line, and a large hole found

within the bedrock, required a completely new design plan and approach for constructing the Lookout Point Bridge.

...delaying completion of Stage 2 by nearly a year

The geotechnical and ground condition problems at the bridge site resulted a much longer lead-in time for design and preparation before bridge and embankment construction could start. This resulted in the completion of Stage 2 being pushed out from late 2014 to October 2015. The earlier Stage 1 was completed in October 2012 as planned within a 20–24 month timeframe.

Figure 10 summarises budgeted and actual construction costs for the Caversham Highway Improvements project. Figure 11 summarises construction timeframes.

Figure 10: Budgeted and actual construction costs comparisons*

Project stage	Budgeted/estimated at start of project stage	Actual result	Variance
Stage 1:	\$19.50m	\$20.71m	+\$1.21m (+6.2%)
Stage 2	\$21.00m	\$25.24m	+\$4.24m (+20.2%)
TOTAL	\$40.45m	\$45.95m	+\$5.45m (+13.5%)

* Excluded from the costs in this table are investigation and design costs of nearly \$3.5 million, and property purchase costs associated with the project totalling nearly \$6.3 million.

Figure 11: Planned and actual construction timeframes

Project stage	Start	Planned completion	Actual completion	Variance
Stage 1:	December 2010	20-24 months (Sept-Dec 2012)	October 2012	On time
Stage 2	November 2012	Late 2014	October 2015	Around 10 months behind schedule due to late start

3. Good practice identified

Project has improved safety and provided for safer walking and cycling journeys

The provision of an off-road shared cycling/pedestrian path alongside the Caversham Highway has significantly improved walking and cycling facilities.

Lookout Point Bridge's replacement of the at-grade intersections has also successfully addressed a significant safety risk for pedestrians. Previously, pedestrians (including local school children) wanting to cross the busy highway at Lookout Point had only a central thin

median strip with edge marker posts at which to stop midway across the highway. This provided unsatisfactory and inadequate protection to pedestrians from the highway traffic. Pedestrians travelling between the residential areas around Mornington and Riselaw Roads can now cross safely using the overbridge.

Functional noise barrier fences accommodating of local residents

Noise barrier fences erected along the Caversham Highway were able to be designed at a height which didn't impede adjacent houses' outlooks while still helping suppress noise from highway traffic. This is a good example of customer focus with project design.



Bridge fencing design incorporating littering deterrent

Bridge fencing used on the project has been designed so that objects cannot be left on top of the railing or against any gaps in the fence mesh. This has successfully removed a safety risk found with other motorway/highway overbridges of potentially dangerous items such as discarded glass bottles falling off barriers onto traffic below.

