

# Post Implementation Review

## Kamo Bypass Stage 2

### Northland Highway & Network Operations



January 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 Kamo Bypass Stage 2 project completed a State Highway 1 bypass of the Kamo township immediately north of Whangarei. The project extended an existing partial bypass of Kamo (Stage 1 opened in 2005) to create a more direct northern route between Whangarei and the Far North. The bypass aimed to shift state highway through-traffic away from Kamo.

### Summary assessment of project outcomes

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The Kamo Bypass Stage 2 appears to have achieved expected benefits of safety through crash cost savings and the reduction of heavy vehicle volumes through the Kamo township. Stages 1 and 2 of the Kamo Bypass together provide a shorter, more efficient access route between Whangarei and the Far North.

Although travel time savings dominated the predicted benefits, these savings have not yet eventuated. Average speeds along the entire bypass route since completion of Stage 2 of the bypass have actually declined.

Whilst it is difficult to attribute this to a single cause, a combination of the following factors has had some effect on travel times:

- Average speeds have reduced on the original Stage 1 section of the bypass since Stage 2 was completed even though there has been only a small increase in traffic volumes.
- Traffic volumes at a new signalised intersection joining Kamo Road, Western Hills Drive and Stage 2 of the bypass have grown by 36% in four years.
- The project's predicted travel time benefits were based on a non-signalised seagull intersection where Stage 2 of the Bypass intersects with Puna Rere Drive. Traffic signals were later added to the project and this had a direct effect on travel times.
- A 'temporary' speed limit of 50km/h has been put in place along 900m of the bypass since 2011. A speed review of the Stage 2 of the Bypass was undertaken in 2012 and a recommended speed limit of 60 km/h was recommended in this area. This recommended change had not been implemented at the time of this review in mid-late 2016 and needs to be addressed.

Crash analysis of the project area and surrounds has shown that safety has improved on Kamo Road, and Stage 2 of the Bypass is a safe highway. The substantial traffic growth at the new intersection of Western Hills Drive /Kamo Road and the Stage 2 of the bypass has, however, led to a significant increase in non-injury crashes (predominately nose-to-tail crashes).

### Project delivery and cost

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Although the Stage 2 Bypass opened three months ahead of schedule, in September 2011, cost savings have not eventuated. This is because remedial works have subsequently been needed to replace a damaged at-grade railway crossing on the bypass and address vegetation control issues. Further remedial work is also required, and planned to take place over summer 2016/17, to fix poor condition of the bypass' pavement. An independent review concluded failure of pavement was at the lower end of the predicted life expectancy of the surface type used.

Final project costs were not available at the time of this review due to these ongoing remedial works. But as of November 2016, the total project cost (construction and property) was \$18.137 million, 7% higher than originally budgeted.

## Recommendations:

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That Northland Highways & Network Operations investigates:

- a) removing the 50km/h temporary speed limit on Kamo Bypass Stage 2 and replaces it with a permanent 60km/h limit as recommended in the 2012 speed review, and
- b) the cause of the premature failure to the Kamo Bypass Stage 2 pavement surface.

**Figure 1: Kamo Bypass Stages 1 and 2 and previous SH1 route**

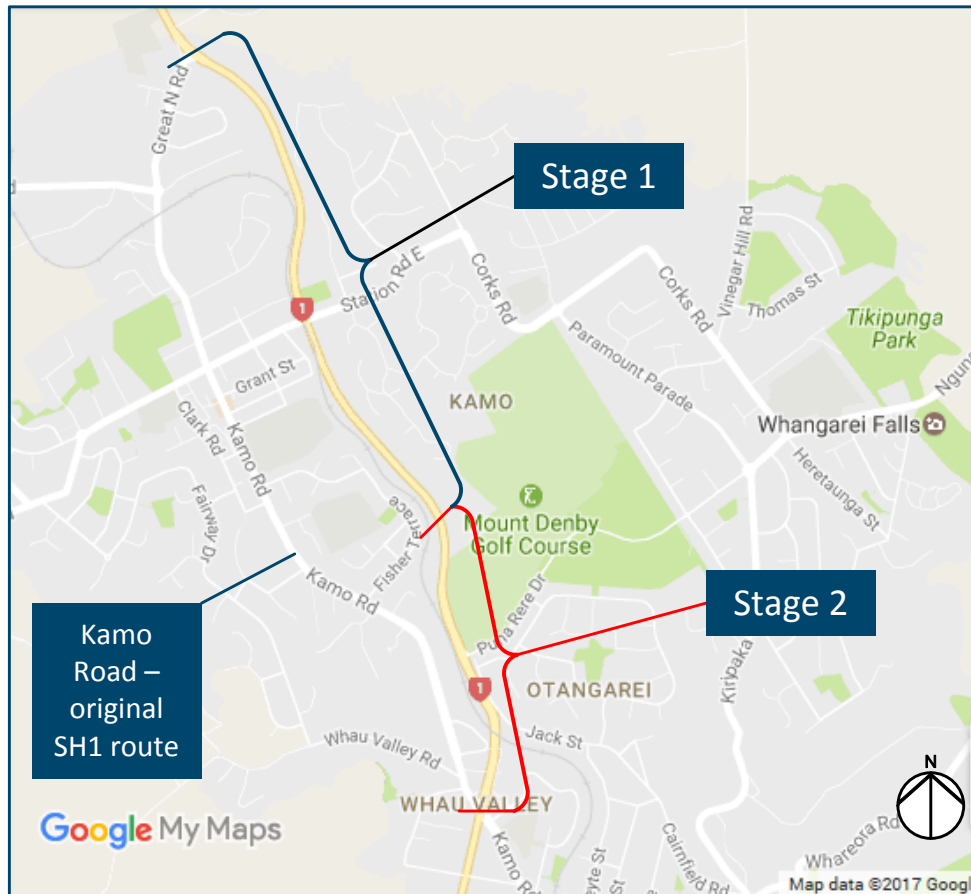
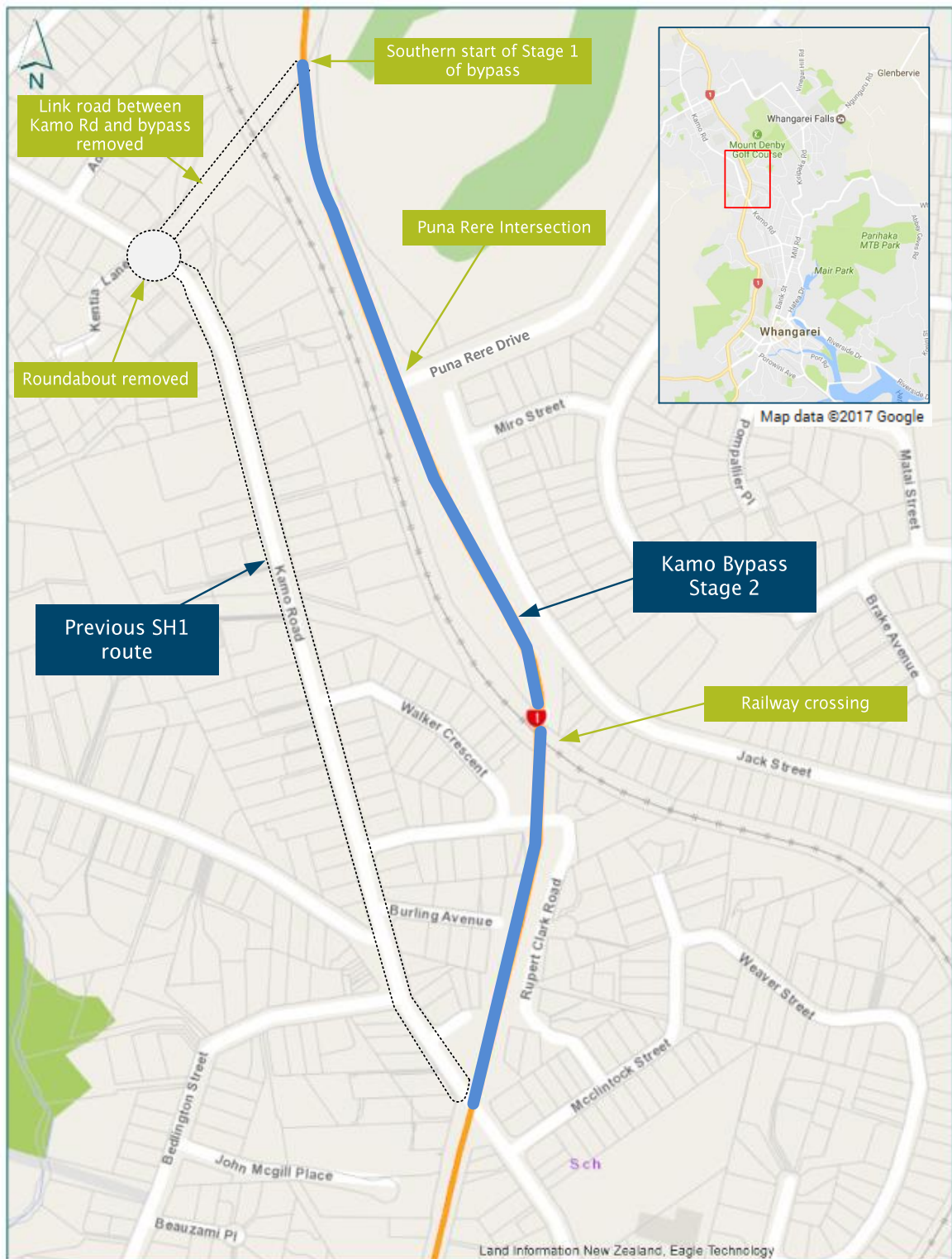


Figure 2: Kamo Bypass Stage 2 key features



# 1. Project benefits

## Project description and objectives

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This project constructed a new 1.3 km section of State Highway 1 in Kamo, a northern suburb of Whangarei. The new road connects with the previous Stage 1 Kamo Bypass. Stage 2 extends south from Stage 1 (SH1) of the project on the western side of Otangarei to the connection of Kamo Road and Western Hills Drive (SH1). The project also included two signalised intersections and a railway crossing. Figures 1 and 2 show the location of the bypass.

The expected benefits of providing this Bypass were to help:

- Relieve congestion, and improve journey time and reliability
- Improve safety along Kamo Road
- Enable economic growth in Northland
- Develop Whangarei's eastern area

The project has been part of a package of initiatives between Whangarei District Council and the NZ Transport Agency to improve travel time and safety in the District's roading network.

The Scheme Assessment Report promoting this project's funding was produced in December 2008. A number of options were suggested. The bypass included a railway crossing which added to the challenges facing the design. A grade separated option was considered, but given the cost, it was decided that an "at grade" solution would be recommended.

The "at grade" option recommended for the Stage 2 Kamo Bypass had an expected benefit cost ratio (BCR) of 1.25.

## Monetised benefits

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Benefits	Present Value (\$)	%
Travel time cost savings (\$)	29,411,907	89.6
Vehicle operating cost savings (\$)	1,703,402	5.2
Crash cost savings (\$)	1,641,234	5
Vehicle emission reduction benefits (\$)	68,136	0.2
<b>Total Benefits Present Value (\$)</b>	<b>32,824,679</b>	

## Travel time saving outcomes

Travel time savings benefits dominated the predicted monetised benefits of this project given in the benefit cost ratio (BCR) originally supporting its funding. They accounted for 89.6% of the expected benefits.

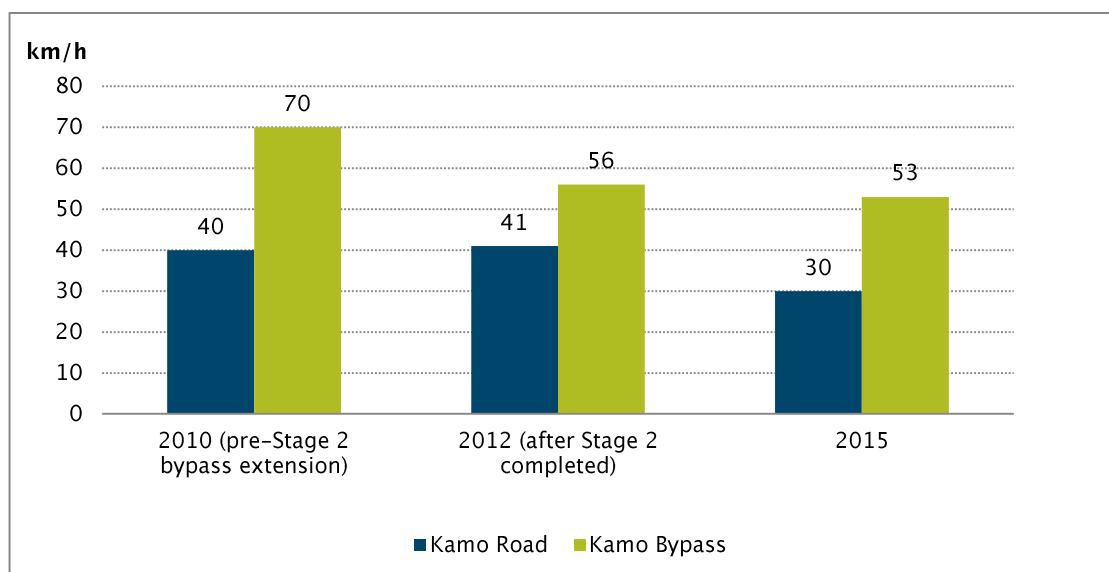
To evaluate the effect of the project on travel times, this review compared average speed and travel times:

- On the entire length of Kamo Bypass against those on Kamo Road, and
- Along the bypass route before and after completion of the Stage 2 extension.

### Kamo Bypass and Kamo Road speeds and travel times

The Kamo Bypass is a faster and more efficient northern route out of Whangarei than Kamo Road. However, since completion of Stage 2 of the bypass there has actually been a deterioration in average speeds along the bypass. This is apparent from Figure 3, which shows that in 2010, before Stage 2 was completed, there were average speeds of 70kmh along the bypass and its previous linked section of Kamo Road (which Stage 2 replaced). This compared with average speeds of 40kmh on Kamo Road. Since Stage 2 opened, average speeds have fallen significantly, from around 70kmh to an average speed of 56kmh in 2012, with some further deterioration apparent more recently in 2015, when there was an average speed of 53kmh.

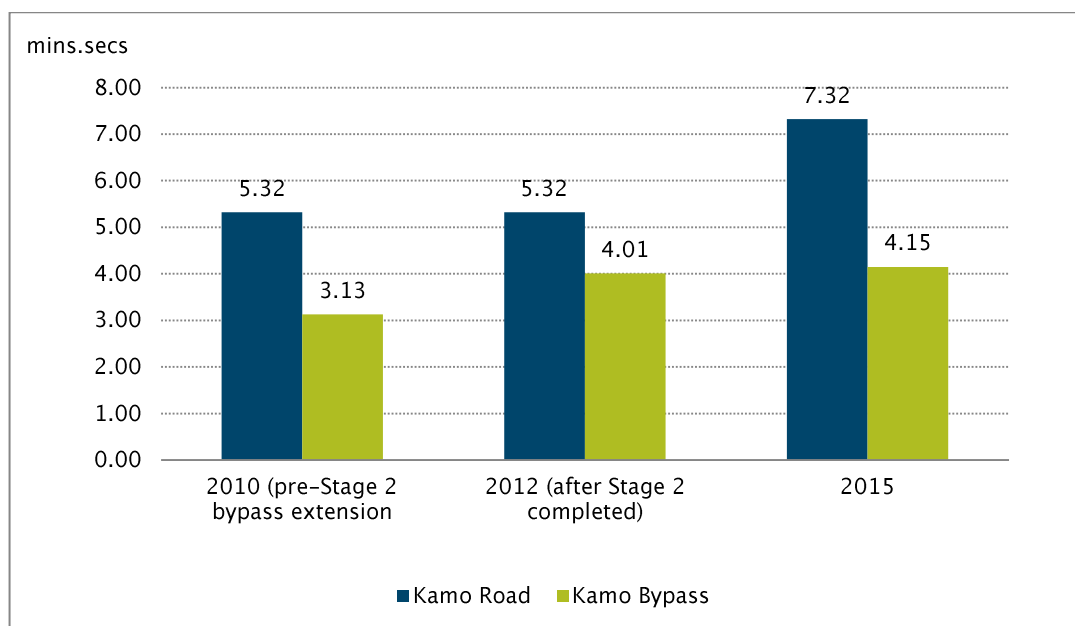
**Figure 3: Average speed comparisons – Kamo Bypass and Kamo Road before and after opening of Stage 2 of the bypass**



Source: TomTom Traffic Stats

The effect of these observed average speeds on travel times is summarised in Figure 4. Before completion of Stage 2 of the bypass, it took on average five and a half minutes to drive Kamo Road from just south of where the Stage 2 section of the bypass now begins to its intersection with the northern end of the bypass (Stage 1). These average travel times along Kamo Road were initially (in 2012) unaffected by the opening of the Stage 2 extension, but more recently (on average over 2015) have slowed by two minutes. It is unclear why this has occurred.

**Figure 4: Travel time comparisons – Kamo Bypass and Kamo Road before and after opening of Stage 2 of the bypass**



Source: TomTom Traffic Stats

#### Travel time outcomes from completion of Stage 2 of Kamo Bypass

Journey times were predicted to improve as a result of completion of Kamo Bypass Stage 2. This predicted benefit has not been achieved on the actual bypass route. Average travel times along the full bypass are significantly slower than the previous route along part of Kamo road and Stage 1 of the bypass (Figure 3). This has resulted in the deterioration in average travel times since Stage 2 opened.

There are several factors which appear to have influenced the failure of the Stage 2 project to achieve its expected travel time benefits.

First, average travel times along the original Stage 1 section of the bypass have declined modestly since Stage 2 opened (Figure 5). On average speeds have fallen by around 5 km/h, resulting in a small average travel time of nearly 10 seconds along this section of state highway. It is unclear why this small reduction in average travel times has occurred. Its design elements and designated speed limits have not changed. There has been a small increase in recorded traffic volumes – up from 9,019 annual average daily traffic (AADT) in 2010 to 10,492 AADT in 2015. But this traffic volume increase is unlikely to have caused a slowing of average speeds.

**Figure 5: Average speed and travel time comparisons on Kamo Bypass Stage 1 section – before and after opening of Stage 2**

	2010 (pre Stage 2)	2012 (post Stage 2)	Difference
Average speed	78 km/h	73 km/h	-5 km/h
Average travel time (mins:secs)	2:17	2:25	+0:08 secs

Source: TomTom Traffic Stats

A second factor which has contributed to reduced travel times on the bypass is the influence of congestion and delays at its southern signalised intersection with Kamo Road and Western Hills Drive. For example, average speeds along the bypass including the intersection were 4 minutes and 15 seconds in 2015. Excluding the intersection reduced the average travel time by just over half a minute to 3 minutes and 32 seconds. Site observations and discussions with Whangarei District Council as part of this review identified some specific features slowing travel of bypass traffic through the intersection:

- The phasing of the traffic signals originally favoured State Highway 1 traffic using the bypass. But this has been changed to favour Kamo Road traffic since around 2/3rds of total intersection capacity is through to Kamo Road compared with 1/3<sup>rd</sup> on State Highway 1 and the bypass.
- A school crossing on Kamo Road immediately south of the intersection often causes congestion and traffic queuing back onto the bypass in peak before and after school period.

A third factor contributing to the average reduction in travel times along the Kamo Bypass since its second stage opened is the impact of traffic signals at the intersection with Puna Rere Drive. In contrast, the original southern link to the bypass (Stage 1) off Kamo Road was through a roundabout.

The intersection with Puna Rere Drive is a signalised T–intersection, meaning bypass traffic is regularly stopped by the signals to enable movement of traffic in and out of Puna Rere Road. The Kamo Bypass Stage Scheme Assessment Addendum Report on which the project's predicted benefits were formulated recommended a non–signalised seagull intersection.<sup>1</sup> This type of intersection would have allowed northbound bypass traffic to travel unimpeded through the intersection. If the final decision to signalise the intersection had been accompanied with a signalised seagull design, predicted travel time savings would have been more likely to have been achieved because northbound bypass traffic would not be impeded by the traffic signals.

A final factor reducing average travel times along the Stage 2 section of the bypass is a 50km/h 'temporary' speed limit. This speed limit extends for 900m of the bypass, from its southern start to 200m north of the Puna Rere Drive intersection. Although officially designated as a temporary speed limit – requiring it to be reviewed every six months – this 50km/h restriction has been in place since Stage 2 opened in September 2011. It is lower than the 60km/h design speed used in the project's Scheme Assessment Report to support its predicted benefits. A speed review of the Stage 2 Bypass was undertaken in 2012. This review concluded the temporary 50km/h limit was too low and recommended that it be replaced with a permanent 60km/h limit. This has not happened and needs to be addressed by Northland Highway & Network Operations.

### **Recommendation:**

That Northland Highways & Network Operations investigates removing the 50km/h temporary speed limit on Kamo Bypass Stage 2 and replaces it with a permanent 60km/h limit as recommended in the 2012 speed review.

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<sup>1</sup> Maunsell Aecom (2008), *Kamo Bypass Stage 2 SAR Addendum Report – At Grade/Rail Option*, 19 December.



## Safety Outcomes

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Improving safety along Kamo Road was a stated objective of the Kamo Bypass Stage 2 project, although crash cost savings made up only a residual 5% of the monetised benefit cost savings used in the BCR supporting the project's application for funding.

Overall, the influence of the Kamo Bypass Stage 2 project on safety in the local area has been mixed:

- Safety has improved on Kamo Road. There has been a statistically significant reduction in recorded crashes on Kamo Road on its section which previously linked the intersection of Western Hills Drive (SH1) and Kamo Road with Stage 1 of the bypass. The crash rate on this part of Kamo Road has fallen from 14.4 crashes per year over the five years to September 2008 to 9.8 crashes per year recorded in four years after Stage 2 of the bypass opened. The big influence on this improved safety has been the removal of the roundabout which was previously on the route. However, when adjusting for wider downward trends across Whangarei District with crash incidence, the specific impact of the bypass on improving safety on Kamo Road is less clear.
- The Stage 2 section of the Kamo Bypass is a safe highway. Crashes on it are relatively rare, with only 10 minor injury or non-injury crashes recorded between opening in September 2011 and December 2015. The majority of crashes have been at the bypass' intersection with Puna Rere Drive, and have tended to involve nose-to-trail crashes.
- The intersection of Western Hills Drive (SH1) and Kamo Road was reconfigured to add the southern entrance to the Stage 2 Bypass. This has resulted in a considerably higher capacity and busier intersection than previously – daily traffic volumes on its southern approach (from Western Hills Drive) have grown by 36% between 2011 and 2015. In addition, daily traffic volumes of more than 15,000 vehicles per day feed in and out of the intersection through the Stage 2 Bypass (and volumes are increasing as the residential areas which Puna Rere Drive links to grow). It is likely that this substantial growth in traffic using the Western Hills Drive/Kamo Road/Kamo Bypass intersection has contributed to a significant increase in non-injury crashes since the project was completed. Most of these crashes (68%) have been nose-to-tail crashes, while nearly a quarter were crossing/turning crashes.

More detailed commentary on the crash analysis review is given below. This analysis tested for statistical significant changes in crashes and assessed actual safety outcomes against predicted reductions using past crash history.

## 2. Project delivery and cost

### The bypass opened ahead of schedule in September 2011...

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Construction of the Kamo Bypass Stage 2 started in April 2010 and it opened in September 2011, three months ahead of schedule. This early opening date helped meet a Transport Agency request to complete the bypass in time for the Rugby World Cup in September, when there was expected to be a surge in tourists travelling on the Northland state highway network.

### ...but significant remedial work has increased the project's cost

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The original estimated total cost of the project was \$25.5 million. This was comprised of \$9.192 million for required property purchases and \$16.308 million for construction costs. Whangarei District Council contributed \$408,000 to the construction costs.

The early completion of the project meant it was tracking under budget upon opening in 2011. However, significant remedial work has subsequently been required after problems emerged with the design of the railway crossing. This has pushed up the project's cost and delayed the project's closure as a capital project.<sup>2</sup> Misalignment of the highway and rails at the rail crossing had caused trucks to hit the rails, damaging the structure. A decision was made in 2015 to replace the original flexible rail crossing with a sturdier concrete design. The rail crossing replacement along with the need for spending on vegetation control adjacent to the new section of highway resulted in a \$1.92 million increase in the project's cost.

At the time of this review the project was still "open" as a capital project, meaning a final cost cannot yet be established for the project. As at November 2016, construction costs totalled \$18.137 million, 11% above budget. Total project costs, including property, was \$27.329 million (as at November 2016), 7% above budget. Figure 6 below summarises the variances in costs.

**Figure 6: Kamo Bypass Stage 2 project cost and timeframe comparisons\***

	Approved/estimated at start of project	Actual result (as at November 2016)	Variance
Project completion (opening)	December 2011	September 2011	-3 months
Construction costs	\$16.308 million	\$18.137 million	+\$1.829 million (+11%)
Property acquisition costs	\$9.192 million	\$9.192 million	\$0
Total project costs	\$25.500 million	\$27.329 million	+1.829 million (+7%)

\* Costs exclude administration costs.

### Additional remedial work on the highway pavement may increase costs further

Our field visit in August 2016 found the condition of the highway pavement on the bypass to be poor (see Figure 7). The Transport Agency first noted the road was showing signs of premature failure in early 2016. It commissioned an independent review in March 2016 to determine the liability with respect to the failures. The independent review concluded that the road had been constructed to Transport Agency specifications, and that even though the Open Grade Porous Asphalt (OGPA) had been in place for just over four years, it would expect the contractor would vigorously defend any action to recover funds.

It also found that based on the road curvature measured on this project, the OGPA life of between four and five years is within the predicted life expectations of this surfacing. Further enquiries as part of this post implementation review revealed that the pavement has deteriorated to a point where a full resurface of the bypass is now required. This will cost approximately \$1 million and is planned to be done over summer 2016/17.

<sup>2</sup> In general there is a process whereby state highway capital projects are closed off after completion and their infrastructure transferred to a maintenance section of the Transport Agency's Highway & Network Operations for ongoing maintenance.

**Figure 7: Kamo Bypass pavement deterioration**



### **3. Good Practice Identified**

The Whangarei North Transport Strategy study identified a number of options which required NZ Transport Agency (HNO) and Council to work collaboratively together to achieve the desired outcomes. We noted good relationships had formed with HNO over the time the projects were implemented. To date Council has built a new road connecting properties on the east and west of the bypass. Council has also extended Spedding Road (Puna Rere Drive), providing North/South access to the bypass by from suburbs in eastern Whangarei e.g. Tikipunga.

In addition to the roads, the project included an off road cycle path and footpath and a signalised pedestrian crossing, extensive landscaping, noise walls near residential properties, and artworks by local artists in the underpass at the end of Walker Crescent.

### **4. Lessons Learnt**

Lessons with relevance for other future projects were identified as follows:

- There is an opportunity for Highways and Network Operations to learn from the causes of the premature deterioration of the Kamo Bypass pavement surface. This could to help prevent similar problems with future projects.
- It was apparent from this project that there was, at least initially, insufficient consideration given to whole of life costs, and roles and responsibilities for vegetation control. This has resulted in significant additional project costs. A lesson learned from this observation is that vegetation control needs to be explicitly considered as part of both capital and ongoing maintenance costs. There also should be clearly defined roles and responsibilities for vegetation control.
- The absence of clear before-data made it difficult to measure the effect the bypass had on traffic volumes across the nearby local roading network. Accurate baseline data is key to evaluating the predicted benefits of funded projects.
- HNO should actively consider whether there are lessons to be learned for future projects from the failure of the original rail crossing design on the Kamo Bypass.

## Whangarei District Council view of project outcomes

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We interviewed Whangarei District Council's Roading Manager specifically to gauge how the project had affected the local roading network. Overall the project has realised positive outcomes for Council, particularly the effects on Kamo Road and the significant reduction in heavy vehicles through the Kamo township. There were also positive comments relating to the collaborative effort between Council and the New Zealand Transport Agency on implementing a suite of projects to improve travel time and safety in the Whangarei roading network.

## 5. Northland Highway & Network Operation's Response

### Northland Highway & Network Operation's Response is as follows:

#### Traffic Modelling:

In the report it is stated that average speeds have actually decreased since the opening of stage 2 of the bypass. Considering the effects of the introduction of the additional intersection it is possible that the movements of heavy vehicles restricts flow (and speeds) below that which would be optimal. There is evidence also that most vehicles slow down for the rail crossing. The traffic modelling that derived the benefits as outlined in the Scheme Assessment report was based on the wider Strategic Model for WDC which is very high level and generally used to determine the effects of population and employment on travel for various future years and scenarios. We therefore agree that a more detailed modelling exercise is appropriate at the planning stage of a project – in this case it would have ensured that the interaction of the various traffic controls and rail crossings were assessed.

The SAR appears to be more strategic in nature and it is unclear as to how the capacity through the study area was derived. For instance, improvements on SH1 through Whangarei would likely increase the rate at which traffic can reach Whangarei north, thus potentially increase demand in peak periods. This may explain some of the issues experienced.

Accurate and auditable pre project traffic counts sufficient to fully assess project benefits are needed at project outset. This work needs to be given sufficient importance at project inception and a lesson learned should be entered into the portal currently under development and shared with the PMF and planning and delivery teams nationwide. The effects on local roads being equally important to our state highways.

#### Speed Limit:

We have discussed the speed limit matter with the Safety and Network Performance team who have been working towards solutions for a number of alterations across Northland. March / April 2017 should see the conclusion of this work and a new speed limit will then be gazetted.

#### Quality:

HNO have worked with the National pavements specialists to try to identify the causes of the failure of the OGPA surfacing. Any liability under contracts has been very difficult to ascertain and pavement remediation has become a priority and is currently underway. An independent review has suggested that the service life of the OGPA surfacing may be shorter than anticipated. This will be given due consideration by the team at National office and will inform future pavement designs. The "Quality Right" initiative addresses the concerns that

the business has over this and other instances of pavement failure across the country. The HNO team are aligned with the initiative and keen to adopt as many of the recommendations as possible. The general message is being communicated openly with contractors in our region and a national approach to this is anticipated in the near future (roadshow?). Changes to conditions of contract and standard specifications will follow. We have taken a pro-active approach on more recent projects (Muriwai and Southern Corridor) to ensure additional MSQA effort is procured and focused on quality of outcome.

#### Vegetation and Planting:

New specifications for the management of newly vegetated areas within contract limits have been developed and are now being included in our contracts. These deal with both quality of product and maintenance boundaries and timings to ensure smooth transition to the NOC or AMA. We now include a detailed Safety in Design and Maintenance in Design process that highlights and records the maintenance obligations for NZTA as a result of the project. Longer periods of maintenance are now specified in construction contracts to ensure new vegetation gets well established and is weed free and healthy prior to final handover to the Agency.

#### Rail Crossing:

HNO to record a formal lesson learned in respect of the performance of the types of rail crossing approved by Kiwirail. It appears that the crossing type selected for service at Kamo did not perform to expectations and required replacement within a few years of construction. The concrete type now installed is a more robust design and should be the default design choice unless specific geotechnical advice warrants another alternative. A standard rail crossing detail should be prepared by the National Office specialist team (approved by Kiwirail) and made available for future projects.

## Appendix: detailed crash analysis

This section discusses in more detail the crash analysis and its findings summarised in Section 1 which was used to assess how well the Kamo Bypass Stage 2 project achieved its predicted safety benefits.

### Crash analysis coverage

It is preferable with analysis of crashes before and after a project to focus on high severity (fatal and serious) crashes. However, there were too few of these at Kamo to enable significant conclusions to be made. Therefore, all crashes were analysed.<sup>3</sup>

Three periods were used for the crash analysis:

- A pre-project '*before*' period between September 2004 and September 2008 which the crash data used in the project's Scheme Assessment Report was based on;
- A '*between*' period October 2008 to March 2010 covering the months between the end of the before period and the start of project construction (in April 2010); and
- A post project '*after*' period from October 2011 to December 2015.<sup>4</sup>

Crashes from the construction period April 2010 to September 2011 were excluded from the crash analysis as construction activity can disrupt crash factors and types.

Three crash datasets were used:

- Crashes within an area extending from immediately south of the Kamo Road/Western Hills/Stage 2 Bypass intersection up Kamo Road to where it originally connected through a roundabout to the southern start of the Stage 1 bypass. (Figure A1 shows this crash area as presented in the project's SAR – before the Stage 2 bypass was constructed.)
- Crashes in Whangarei District were used as a control group to assess the potential effect of wider regional crash or reporting trends on the observed number of crashes on the studied section of Kamo Road.
- A post-project crash area along the Kamo Stage 2 bypass, starting from immediately south of the Kamo Road/Western Hills/Stage 2 Bypass intersection north along the bypass to approximately 200m north of its intersection with Puna Rere Drive.

### Crashes on Kamo Road along the original route replaced by the Stage 2 Bypass

Figure A2 summarises the analysis of *all crashes* on the section of Kamo Road covered by the crash analysis. The crash rate at the site fell from 14.4 crashes per year over the five years covered by the Scheme Assessment crash analysis to 9.8 crashes per year after the Stage 2 bypass opened in October 2011 up till December 2015.

On the basis of the crash history in the six and a half years before project construction started, it was estimated that 62 crashes could have been expected in the post construction period between October 2011 and December 2015. The actual result of 41 crashes is therefore a substantial reduction on the expected number, which is statistically significant at 90% confidence using the Poisson distribution.<sup>5</sup>

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<sup>3</sup> All crashes include recorded fatal, serious, minor injury, and non-injury crashes.

<sup>4</sup> Originally it was planned to extend the 'after' period to June 2016, but an issue was identified with non-injury crashes recorded for the Whangarei District in 2016 – only one is recorded, which must be erroneous given typically 200+ of these crashes are recorded each year.

<sup>5</sup> Due to the chance nature of their occurrence, crashes tend to vary randomly over time in a way which is best represented by the Poisson Distribution. This distribution applies when a relatively small number of uncommon independent events occur over a set time period.



To test whether the observed reduction in crashes at the site area have been affected by wider trends in crash rates, the results were also trend adjusted using a control group of all reported crashes in Whangarei District. On this basis, it would have been expected that 47 crashes would have occurred in the 4.2 years October 2011 to December 2015 after Stage 2 opened. The actual result of 41 crashes is less than predicted by the crash reduction on Kamo Road when adjusted for wider trends and is not statistically significant at 90% confidence.

This means that the observed crash reduction on Kamo Road may at least partly be attributable to a more general downward trend in crash incidence evident across the Whangarei District.

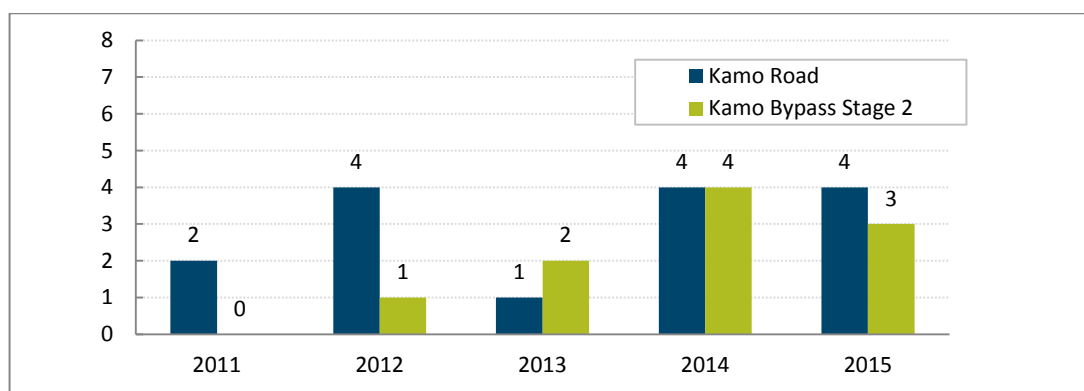
### Kamo Bypass Stage 2 crashes

Figure A3 below compares crash numbers on Kamo Bypass Stage 2 after it opened (in September 2011) with the section of Kamo Road it replaced.<sup>6</sup> Crashes at the intersection of Western Hills Drive, Kamo Road and the start of the Stage 2 Bypass were deliberately excluded. This was to avoid double counting of crashes at this intersection being attributed to both routes. (Crashes at the intersection are discussed separately below.)

Overall, there were 10 crashes on the Stage 2 Bypass between when it opened and December 2015, compared with 15 crashes over the same period on the section of Kamo Road the bypass extension replaced. The overall incidence of crashes on both routes is low, with no serious or fatal crashes since project opening. Most (seven) of ten recorded crashes on Stage 2 of the bypass were at the signalised intersection with Puna Rere Drive. These have tended to mainly involve nose-to-tail crashes at the traffic signals.

### Figure A3: Crashes on Kamo Stage 2 Bypass and original Kamo Road route

(2011 data covers October-December only)



### Crashes at the southern intersection of the bypass

The intersection of Western Hills Drive (SH1) and Kamo Road was reconstructed as part of the project to add the southern entrance of the Stage 2 bypass. There has been a significant increase in recorded crashes at the intersection since the intersection was reconfigured – see Figure A4. Predominantly these have been non-injury crashes, with no high severity (fatal or serious injury) crashes, and only a handful of minor injury crashes recorded. The majority of crash types (68%) have been rear end/obstructions, while nearly a quarter (24%) were attributed to crossing/turning crashes.

It is unclear whether the observed increase in crashes indicates any specific safety issues with the intersection's design, or whether it is simply reflective of the intersection now being higher capacity and substantially busier than previously:

<sup>6</sup> This original route post-2011 excludes the roundabout and short link from the roundabout to the start of the Stage 1 bypass which was removed as part of the Stage 2 project.



- Traffic volumes of 15,679 AADT were measured on the bypass south of the Puna Rere Drive, with much of this traffic now using the reconfigured intersection, and
- Traffic volumes on Western Hills Drive (SH1) which feeds into the intersection from its immediate south have grown by 36% between 2011 and 2015 (from 15,297 AADT to 20,876 AADT).

**Figure A4: Crashes at the Western Hills Drive/Kamo Road/Kamo Bypass intersection (southern start of bypass), October 2011 to December 2015**

