Part Time single metered signal at Ngongotaha Roundabout - Rotorua

Technical Note

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ABSTRACT

The Ngongotaha Roundabout is located at the intersection of SH5 and SH36 at the northern end of Rotorua. The roundabout controls traffic flow from SH5, from Hamilton or Titau, and SH36, from Ngongotaha Township. The roundabout exhibits unbalanced flow patterns especially during morning peaks. This causes undesirable queues, extending all the way into Ngongotaha township, and undue delays on SH36.

A key focus of this study is to reduce travel time, delays and queues for traffic on SH36 travelling south to Rotorua. The use of part time roundabout metering signals (2 phase, red and blank only) could be used to create gaps in the circulating stream in order to ease the problem of excessive queues and delays affected by highly directional flows.

A trial was conducted over three days, morning peaks only, using a single metered traffic signal on SH5 (western approach). The queues and delays on SH36 were monitored during this trial. During the trial the delays and queues on SH36 were reduced considerably.

The trial has shown that the use of the part time metered single traffic signal during morning peak has reduced travel time, created gaps and reduced queues, thus increasing the capacity of the roundabout.

Introduction

The intersection of SH5 and SH36, northern entrance to Rotorua, is a 25m radius single lane roundabout commonly known as the Ngongotaha Roundabout. The roundabout controls traffic flow from SH5 and SH36. State Highway 36 is the main route for travellers originating in Ngongotaha and districts further east, while SH 5 provides a key east west connection joining Rotorua to Hamilton (via SH1).

The capacity of the roundabout is generally acceptable, except during the morning peaks when there are high southbound traffic volumes on both State Highway 36 and State Highway 5. This peak demand generates queues of approximately 1km on State Highway 36, extending back into and in some cases beyond Ngongotaha township.

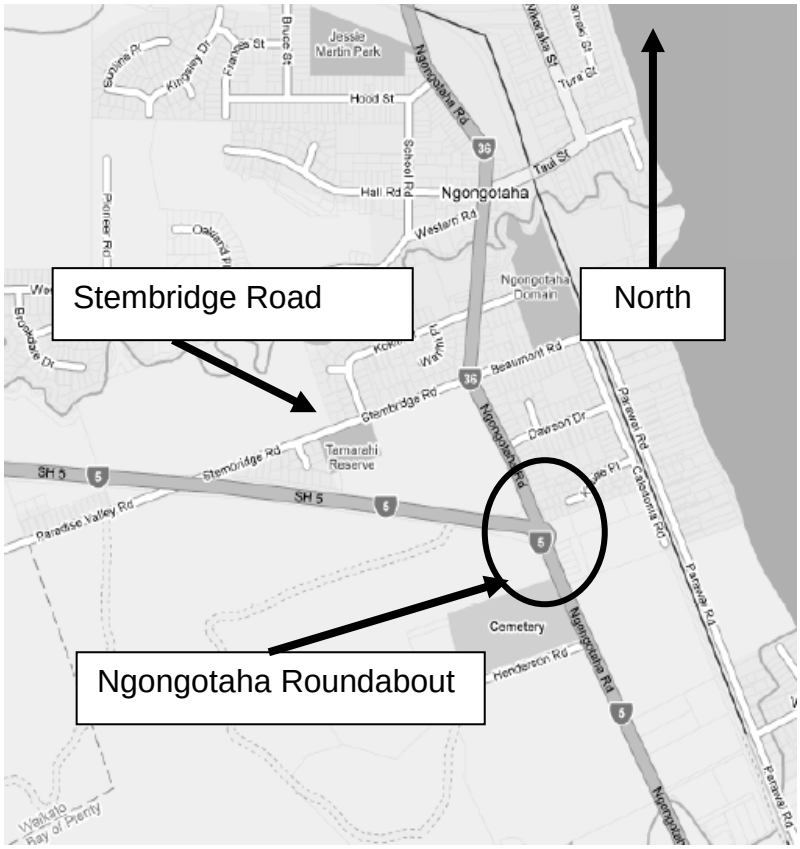

Figure 1 - Location of Ngongotaha Roundabout

Although Rotorua District Council is investigating longer term solutions, such as four laning, an interim "part-time", low cost solution is sought to provide relief to morning congestion.

Problem

The single lane, three legged roundabout with a 25m diameter turning circle (see **Error! Reference source not found.**) is located in the urban rural fringe in generally flat terrain. The speed limit on the northern leg is 50km/h, the southern leg is 80km/h while the western leg has a speed limit of 100km/h.

The northbound SH 5 leg includes a continuous left turn slip lane that splits off approximately 80m before the roundabout and bypasses the roundabout.

Figure 2 - Roundabout layout

The average weekday traffic volumes on each roundabout are shown in Table 1, together with volume recorded in the morning period between 06:00 and 10:00. Key features of Table

1 are the generally modest weekday flows and that roughly a third of the State Highway 36 southbound flow occurrs over the morning peak and shoulder periods.

Table 1 - Traffic volume data

Loop Location	SH36 Southbound	SH5 Southbound	SH5 North/West bound (Unsplit)
	70m North of Roundabout	70m West of Roundabout	130m South of Roundabout
Weekday ADT	6295	3144	9103
Morning (6am - 10am)	2018	693	1454

The 15 minute traffic flows on each approach are shown in Figure 3**Error! Reference source not found.**. Looking at the period from approximately 07:45 to 08:15, it appears that a relatively small increase in the State Highway 5 southbound traffic (probably in the order of 20 vehicles per 15 minutes) is enough to reduce the entry capacity for the peak flow on SH36 southbound.

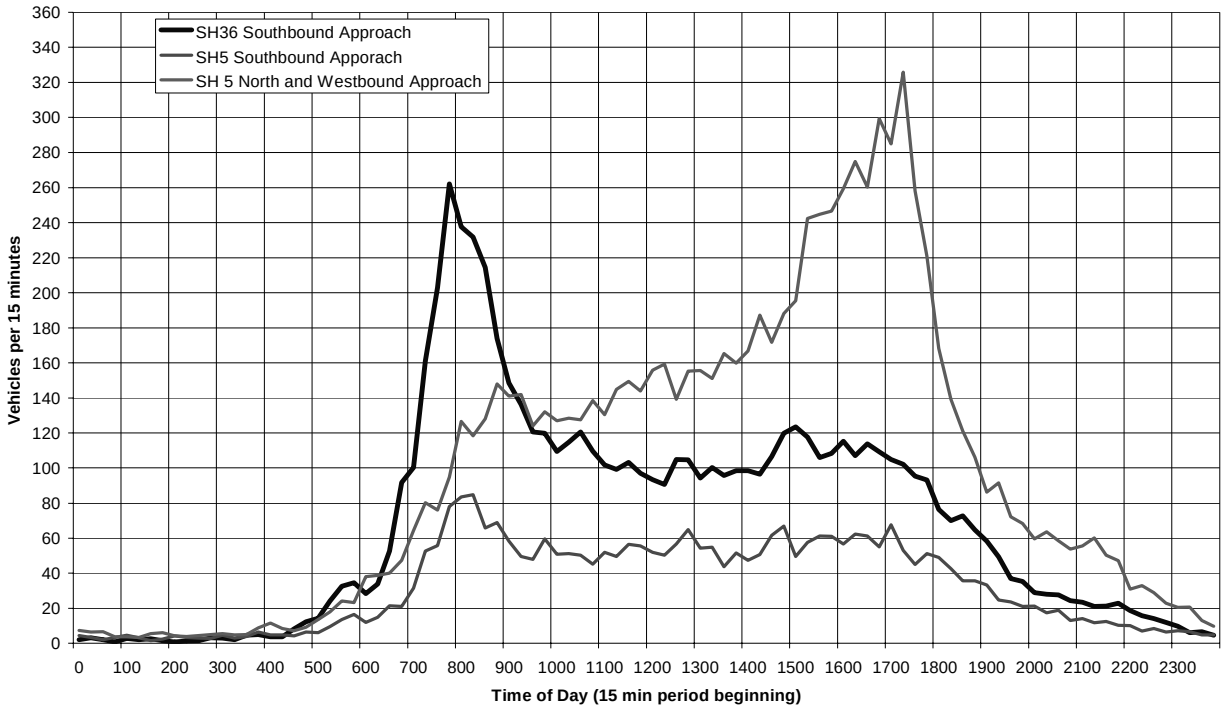

Figure 3 Average weekday 15 minute traffic volumes recorded on each approach to the roundabout

With no traffic facilities upstream of the roundabout (on SH5 southbound) to platoon the traffic, and only minimal northbound traffic travelling from SH 5 to SH36, the SH 5 southbound traffic streams into the roundabout providing few gaps large enough to be accepted by the southbound SH 36 traffic.

As a consequence of the delays and queues on SH36, some local motorist use local streets such as Stembridge Road (see Figure 1 **Error! Reference source not found.**) to gain access to SH5 upstream of the roundabout, in order to gain priority. This further increases the traffic on this leg, increasing the delay for traffic southbound on SH36.

A previous survey by undertaken Opus International Consultants (OPUS PFR, Sept 2006), recorded a maximum stationary queue of 74 vehicles on SH36, and the delays and queues are expected to increase as the Rotorua Western Basin continues to develop and the number of vehicles using SH36 grows.

Although the first response to this problem might be to add an additional circulating lane or signalise the intersection, both "solutions" are likely to be costly and may not be worthwhile given the problem occurs for a relatively short time each weekday.

Adding an additional lane would theoretically increase the yield line capacity, however, the extent to which actual capacity might be increased is debatable as the main problem of streaming arrivals eastbound on SH5 would not be addressed.

While signalisation would address the root cause, signalisation would result in unnecessary delays to traffic outside the morning peak period and involve significant cost, with much of the investment being lost should the route be four laned in the future.

One solution would be the use of part-time roundabout metering signals to create gaps in the circulating stream in order to ease the problem of excessive queues and delays generated by the highly directional flows in the morning peak. Roundabout metering signals are often installed on selected roundabout approaches and used on a part time basis when heavy demand conditions occur during peak periods (Akcelik 2006).

Signal Trial

The aim of the trial was to determine if a single traffic signal located on the southbound SH 5 approach could be used to "meter" the approaching traffic, and provide sufficient acceptable gaps for the SH36 southbound traffic to enter the roundabout and thereby reducing the queues on SH 36 and the total travel time.

A traffic signal trial was conducted over three days (Friday the 27 June, Monday 30 June and Tuesday 1 July 2008). This was a low cost preliminary trail, to first test to see whether signal metering could potentially address the problem, whether such as system could be viable and worthy of more detailed investigation, and if so to gain an initial appreciation of the metering parameters.

Methodology

This low cost trial involved the use of temporary traffic management on SH5, which included installation of a single manually operated temporary traffic signal on SH5 southbound to "meter" the SH5 traffic flow into the roundabout, upstream of SH36.

The signal operated manually from 7:30am to 9:00am over the three day period. During this period traffic queues were monitored together with the number of vehicles that entered the roundabout from SH36 using the gaps created by metering the SH5 approach.

Layout

Temporary traffic management with a 30km/h speed restriction was instigated on SH 5 southbound into Rotorua and SH 5 to Hamilton, while SH36 was left uncontrolled; to ensure that as close to normal performance was maintained.

The temporary traffic signal was installed on the SH5 southbound approach 96m from the hold lines of the roundabout. The signal operated two aspects amber/orange (prepare to stop) and red (stop). This configuration is recommended in Austroads Part 7 Traffic Signals.

This arrangement, location back from the roundabout hold lines, and the lack of a green aspect, sought to ensure that approaching traffic were not under the impression that the signals were to control the roundabout i.e. the circulating traffic is not controlled and therefore normal roundabout priority rules apply. Vehicles that arrived at the signal during the red phase were stopped and could then proceed on to the roundabout during the blank uncontrolled phase.

The traffic signal was operated to give a 40 second blank phase during which vehicles could proceed to the roundabout, a 5 second amber/orange phase before the red phase. The red phase timings were varied between 20 and 60 seconds.

Measurements

A queue survey was conducted using three stationary observers. Two observers were positioned at the signal; one to operate the signal and one to measure the maximum stationary queue on the SH5 approach. A further observer was stationed on SH36 to measure the queue lengths during the blank phase; when the SH5 traffic was flowing and SH36 traffic had to find acceptable gaps to enter the roundabout; and the number of SH36 vehicles that entered the roundabout when the red phase on the SH5 southbound approach operated.

Results

The red phase was set at 20seconds initially. However, there was a minimal change in the queue length on SH 36. The red phase for SH5 southbound was increased to 25 seconds and 30 seconds, but still to no avail, there being only a negligible impact on SH36 queue length. Finally a red phase of 40 seconds was set as the lower bound for the study.

The maximum stationary queue measured at the SH5 traffic signals was 14 vehicles and on one occasion an overflow queue, of 2 cars occurred. An overflow queue occurs when not all the vehicles queued on the approach could pass through the traffic signal during the period when the signals were not displaying red. This indicates that the average delay to SH5 southbound traffic is in the order of 20 seconds per vehicle with a maximum of approximately 48 seconds.

The impact that “metering” the SH5 traffic, had on the SH36 queues is shown in Table 2, which shows the maximum SH36 queue, during the blank phase on SH5 is only 28 vehicles. This is a substantial reduction on the 74 vehicles previously recorded, and an essentially rolling flow occurred on the SH36 approach.

Table 2 – Maximum Queues and entry volumes on SH36

BLANK Phase (secs)	Max Queue on BLANK Phase (No.)	RED phase (secs)	Max Vehicles through on RED Phase (No.)
40	24	60	32
40	24	50	30
40	28	40	32

Discussion and Conclusion

This relatively simple, low cost, trial suggests that metering one approach to the Ngongotaha Roundabout is likely to have a significant impact on queuing on SH36. The trail produced reduction in maximum queuing on SH36 of between 30% and 40% with little additional delay accruing to the metered traffic stream southbound on SH5.

There are however, some concerns. This trial was based around a temporary “worksite” and associated traffic management. With staff on site a small number of violations of the red phase occurred but whether this would remain the case for a more permanent solution is unknown and given the lack of surrounding development there is also a concern that a more permanent installation could suffer vandalism.

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Acknowledgments

We would like to thank Rotorua District Council for the opportunity to complete this trial.