OBT

SCATS RAMP SIGNALLING - SAFETY & OPERATIONAL OUTCOMES IN AUCKLAND NZ

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Why Ramp signalling?

It works!

Summary of Presentation & Paper

Paper describes the safety and operational outcomes of the Auckland Travel Demand Management (TDM) project.

In particular those outcomes that could be directly associated with the use of the Roads & Marine Services (R&MS) NSW's SCATS Ramp Metering System (SCATS RMS) for the Auckland TDM project undertaken between 2005 and 2010.

Summary of Presentation & Paper

The paper covers:

- safety outcomes involving all severities of crashes;
- assessment of periods when ramp signalling generally operated;
- Operational improvements (speeds, throughputs) in sections of motorway where capacity upgrade works did not influence performance.

Background to Adaptive Ramp Metering

- Peter Lowrie (RTA) presents at ITE AM in Minneapolis the outcomes for Minneapolis SMART corridor trial incorporating ramp metering
- Peter invited to present at ITE ANZ Conference in 1998
- Research into motorway flow breakdown (Monash & Eastern)
- Scanning trip and research into 'best practice' in motorway management (2000)
- Outcome – ramp metering/signalling ONLY means of avoiding/recovering flow breakdown
- VicRoads (reluctantly) agreed to ramp metering trial at Bulleen Road on Eastern Freeway
- Trial a great success – 2-4 hours flow breakdown to near zero
- Monash Freeway @ Warrigal Road and Huntingdale Road

Background to Adaptive Ramp Metering

- VicRoads takes back in-house (2003-4) and starts to develop its own system
- System rolled out on most of M1 upgrade – but not on the other Melbourne motorways over last 10 years
- Around 2003-4, NZTA visits Bulleen Road/Warrigal Road and decides to trial ramp signalling at Rimu Road
- Trial a success → whole of Auckland motorway system
- Ramp signalling implemented over most of the Auckland motorway system in 3-4 years

Motorway Network

Figure 1 Map of Auckland Motorway Network (Source: NZTA)

Summary of Outcomes

Safety and operational outcomes of the Auckland covering:

- safety outcomes involving all severities of crashes;
- assessment of periods when ramp signalling generally operated;
- operational improvements (speeds, throughputs) in sections of motorway where capacity upgrade works did not influence performance.

Safety Outcomes

Most ramp signal works on the Southern Motorway installed during 2008, hence the before and after periods were 2005-2007 (3 years) and 2009-2010 (2 years) respectively (suitable data not available for 2011).

The safety outcomes involving all severities of crashes:

- Crash reductions (all congested sites):
  - 32-34% outbound
  - 17% inbound;
- These are overall crash reductions where the only likely cause has been the introduction of ramp signalling

Safety Outcomes

SH1 Mt Wellington to Market (northbound)

- still suffers significant congestion in both peaks
- not expect a substantial reduction in crashes, although 11% reduction was achieved.

A 50% overall reduction in northbound RE crashes in the weaving area between Gillies Avenue and Khyber Pass Road in the after period:

- 31% occurred at weekends compared to just 12% (of a much larger number) on weekends in the before-period
- This suggests that the ramp signalling has been very successful in addressing safety in the weaving area, and that ramp signalling should be operated on weekends as well as on weekdays

Delay Outcomes

Basis for delay/productivity outcomes

Table 1: Before & After Delay Calculator Example

Measures for Recovery & Queue Delay	Period	
	AM	PM
Before average speed (km/h)	36	63
Before period of flow breakdown (h)	2.5	2.0
Recovery distance (m)	800	800
Average before flow rate (vph)	4107	6800
Estimated upstream Q length (m)	1000	1000
After average speed (km/h)	77	67
Recovery delay/veh (s)	13.6	1.3
Q delay/veh (s)	53.2	3.4
Total delay/veh (s)	66.8	4.7
Daily delay reduction (hr)	194.4	17.9
Annual delay reduction (hr)	48610	4470

Delay Outcomes

Curran Street before and after

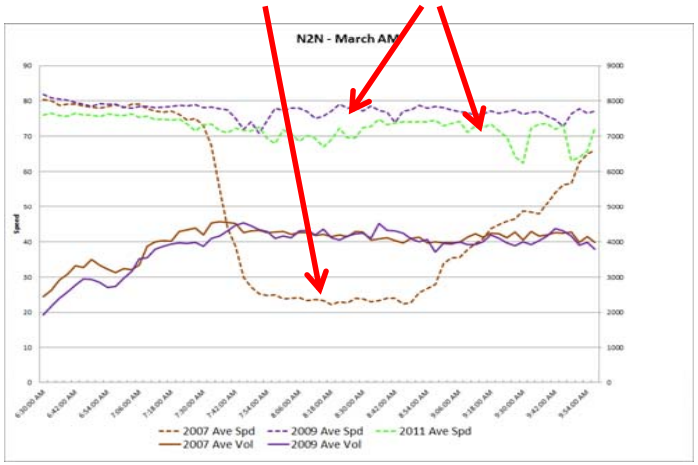

Figure 3: Monthly Before and After Speed and Flow Data at Curran Street

Delay & Throughput Outcomes

Northwestern Motorway before and after

Site	Peak Period	Duration (h)		Ave Speed		Ave flow		Delay savings	
		Before	After	Before	After	Before	After	/vehicle (s)	/yr (h)
Eastbound									
Te Atatu	AM	3.0	2.75	51	58	3660	4250	21	**15330**
Great North	AM	2.75	2.0	47	69	3620	4040	58.7	**40790**
St Lukes	AM	3.25	2.5	43	55	4170	4610	44.5	**35580**
Average (Total)		3	2.4	**47**	**60.7**	(11450)	(12900)	(124.2)	**(91700)**
Westbound									
St Lukes	PM	2.5	2.25	57	57	3780	4190	0	**0**
Great North	PM	2.5	2.25	53	65	**2840**	**3550**	18.8	**11500**
Te Atatu	PM	3.5	3.25	66	68	2830	3100	3	**1270**
Average (Total)	**PM**	**2.8**	**2.6**	**58.7**	**63.3**	**(9450)**	**(10840)**	**(21.8)**	**(12770)**

Table 3 Northwestern Motorway – Operating Conditions – Before & After

Delay & Throughput Outcomes

Southern Motorway and the Curran Street ramp:

- southbound the average speeds increased by about 14 km/h across both peaks
- southbound – also significantly increased flow rates
- Northbound - 8 km/h average speed increase.
- Mt Wellington northbound - significant speed reduction, but compensating significant increase in flow rate (10.5%).
- Annual delay savings of 150,000 hours have been achieved at the two southbound sites, with 100,000 hours at the four northbound sites.
- The group of sites studied have generated annual travel time savings of around $5 m.

Delay & Throughput Outcomes

Northwestern Motorway.

- Eastbound average speeds increased by 14 km/h (AM peak), combined with significant increases in flow rates of about 12.7%.
- Westbound the effects are less - 5 km/h average speed increase, but with even greater increases in flow rates of about 14.7%.
- Annual delay savings of around 100,000 hours have been achieved at the three sites
- annual travel time savings of around $2 m.

Ramp Metering Intensive Weaves

Khyber Pass Road to Gillies Avenue:

- weaving flow breakdown occurred often up to 10 hours per weekday
- a critical bottleneck with flow breakdown occurring due to the extremely high weaving flows
- about 1900 vph entering, and 1300 vph exiting downstream (northbound PM peak)
- opposite in the southbound AM peak
- with a weaving distance of about 380 m

Ramp Metering Intensive Weaves

Khyber Pass Road to Gillies Avenue:

- The 'after' northbound flow breakdown that did occur in the PM peak associated with a centre lane queue from downstream flow
- Metering offers just enough regularly spaced physical gaps for exiting vehicles to lane change
- Treatment – metering at the SLOWEST rate possible!

SCATS RMS - Ramp Metering System

Basics:

- Uses 30s flow rates and occupancy
- Operates over user-chosen groups of ramps
- Integrates with SCATS for intersections for queue control
- Maximises throughputs at critical bottlenecks
- Allows the motorway to operate at maximum capacity – if flow breakdown starts, metering rates adjust to recover flow
- It seems to have all the functionality of the new VicRoads suite of metering algorithms

Ramp Signalling System

Operational 'failures':

- If it is so good, why do we still have flow breakdown?
- It is an operational strategy to balance the 'pain' between arterials and the motorway
- Switching off system during heavy congestion – operational strategy which I consider wrong as it redistributes the equity established when operating

Conclusions

Very positive operational and safety performance:

Productivity (increased throughput):

- Southern Motorway/Curran - increased throughput 7.3%/8.7% in the AM/PM peak periods southbound, and 1.0%/6.0% northbound.
- Northwestern Motorway - increased 12.7% (AM) eastbound, and 14.7% (PM) peak westbound.

Average speeds increases:

- Southern Motorway southbound - 14 km/h across both peaks combined with significant increases in flow rates.

Conclusions (cont.)

- Southern Motorway/Curran - northbound - 8 km/h average increase.
- Northwestern Motorway - 14 km/h inbound in the AM peak, with significant increases in flow rates of about 12.7%.
- Northwestern Motorway - 5 km/h average speed increase outbound, with even greater increases in flow rates of about 14.7%.

Annual delay savings:

- Southern Motorway/Curran Street - The group of sites studied generated annual travel time savings of around $5 m.

Conclusions (cont.)

- Northwestern Motorway - the 3 sites generated annual travel time savings of around $2 m

Crash reductions:

- Southern Motorway – 34% outbound and 17% inbound
- Northwestern Motorway – 32% outbound and 17% inbound

Most significant operational and safety outcome was eliminating flow breakdown in a short but intensive weaving area

Where to from here?

Christchurch & Wellington could save $m's/year

Get to it!!

Todays (painful) change results in tomorrow's normality