Auckland Motorways – Network Performance Monitoring

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ABSTRACT

The Auckland Motorways (AMA) was set up in October 2008 with an aim to provide customers with a better experience on the motorway network. The AMA is empowered to foster innovation in maintenance and operational practices to reduce the negative impacts of its activities on customers.

One of the Key Result Area for the AMA is to increase the efficiency of the network. The efficiency of the network has to be measured consistently to enable a methodical approach of managing network performance. This paper provides an overview of:

- how network performance is currently measured by the AMA, using the following key performance indicators (KPI's):
    - definition of congestion
    - performance baseline establishment
    - performance target establishment
- how the network performed in the last 2 years (2008 – 2010)
- how we monitor impact of:
    - capital project construction activities
    - how we work together with capital projects e.g. Newmarket viaduct
    - other activities/unplanned closures/diversions
- how to increase granularity in the performance monitoring
- what difference has the AMA made
- the future.

INTRODUCTION

The Auckland Motorway network is unique in terms of the volume of goods and commuters that it carries and the additional economic cost of congestion that the nation incurs for transporting these goods and people.

Attempts have been made to determine the level of congestion on the network, including but not limited to, travel time surveys, quarterly average speed reporting. While most of these attempts have been very successful in demonstrating the general trend of how the network is performing, these attempts are considered insufficient to provide a baseline measure of the level of congestion on the network.

The performance of the Auckland motorway network has been measured consistently to enable assessment of the benefits attained by implementing minor improvements or adjustments on the network. If one cannot measure network performance, it cannot be managed effectively.

The measurement of performance involves the use of data collected on the network. The current method of data collection with in-road sensors significantly increases the complexity of the resulting information. When data is collected off an in-road sensor, it represents the performance of the roadway at one point only. The data has to be converted to a measurement that represents a length of roadway and the estimated impact of such measurement on the road users.

Once the current performance of the network is established, initiatives to positively influence network performance are investigated and implemented progressively. These matters are further discussed in this paper.

WHAT IS CONGESTION

There are many definitions for congestion, and academically most of them based on reduction in free flow speed, which is defined as the speed of traffic flow that is unaffected by upstream or downstream conditions. It is considered that speed drop is the most accurate indicator of the severity of congestion on a section of roadway at a given time. It also aligns with the individual motorist's perception of congestion.

Hence, a section of motorway is defined as congested when the 15 minute average operating speed has dropped below half of the free flow speed based on measurement from the vehicle detection site within the section of motorway.

The concept of free flow speed was adopted, rather the posted speed limit, in defining congestion because free flow speed is considered to be a more robust representation of roadway characteristics as it is the speed at which motorists (customers) intend to travel at on a particular section of motorway. The adoption of free flow speed also takes into account the effects of geometry, lane widths and roadside features, which could change as a result of capital project(s) or temporary traffic management measures.

Customer expectations

The AMA conducted a telephone survey in March/ April 2009 to canvas issues related to the operation and maintenance of the Auckland motorway network. The survey provided the AMA with some understanding of the expectations of its customers. It is noted in the customer survey that:

- nearly 60% of the respondents considered the way congestion is managed needs to be improved

- en-route traveller information, including messages on variable message signs, was ranked as the third most important by the customers
- reliable travel time was ranked as the sixth most important by the customers
- pre-trip traveller information was ranked as the seventh most important by the customers

The need to manage congestion better and provision of improved traveller information are recognised by the AMA and actions are being taken to address these gradually.

BASELINE ESTABLISHMENT AND KPI'S TARGETS

The establishment of the performance baseline commenced in October 2008, the exercise began with selecting the appropriate traffic descriptors to measure the current performance on the network.

It was concluded that speed and volume are the two most important and readily available descriptors to describe existing traffic flow on the network, because:

- Both speed and volume are recorded in most of the available datasets
- Both speed and volume can be easily visualised
- Density, headway and spacing are also important descriptors, but these descriptors can be very misleading when used to establish baselines, i.e. these descriptors are dependent on speed and volume
- Productivity measurement (based on Austroads' definition) is derived from these two traffic basic descriptors. Productivity is the product of speed and flow. A high productivity is achieved if both speed and flow are maintained at the optimum flow rate and speed.
- The traffic descriptors not directly measured by detectors, e.g. density, can be derived from empirically generalised relationships.

The performance baseline establishment exercise was therefore focused on speed with consideration given to volume to determine traffic conditions such as flow breakdowns and peak demands.

The decision made was to use ATMS I data to establish baselines because it is most reliable and continuously, and is comparable with historic Data. The geographic coverage of the State Highway count system is shown in Figure 1.

Figure 1. ATMS I count sites on the Auckland Motorway network

Baseline establishment

The baseline performance at each count site was established and presented as report cards in the report of Baseline Establishment and Key Performance Indicators – Interim Report (Cheung and Lin, 2008). At individual site level, the baseline information is very useful. However, nothing made sense when the information was aggregated to the network level. Therefore, another dimension was introduced to enable aggregation of the number of vehicles (motorists) affected by congestion.

Since each count site represents a predefined section of the motorway, the number of vehicles (motorists) affected by congestion multiplied by the length represented by the count site would give us the vehicle kilometres travelled (VKT) affected by congestion per count site. VKT affected by congestion quantifies the impact of congestion based on volume and

distance, using speed as a threshold. The advantages of using VKT as a measurement include:

- it is consistent with how network utilisation is reported by most road controlling authorities
- it allows new count sites to be added to the measurement to improve accuracy of the measurement
- it enables aggregation of measurements to occur and a single number can be reported at the network level.

KPI's and their targets

However, there was one significant disadvantage with VKT – it cannot be a public facing Key Performance Indicator (KPI), because most customers do not understand what VKT is. Two presentation layers were developed to wrap around VKT based KPI's:

- **Bread Run** – also known as Delay due to Roadworks – Percentage of movements between 20:00 to 5:00 on weekdays affected by roadworks
- **Courier Run** – also known as Congested Travel – Percentage of movements between 5:00 to 20:00 on weekdays affected by congestion

Further to the above measures, another baseline measurement for travel time reliability was established and is known as **On Time**, to reflect our customers' desires to get to work, meetings, or appointments on time, without having to set out on their journey too early. This KPI is defined by identifying and quantifying the worst 5% of the trips on the network in 2007/08 (i.e. the baseline). The aim for the AMA is to reduce the number of these very bad trips on the motorway network, and therefore decrease the percentage of customers experiencing travel speed (time) that is worse than the baseline.

The targets for the above three KPI's were developed using information from the last 10 years and are shown in Table 1.

Table 1: Targets for KPI's

	Courier Run	Bread Run	On Time
Unsatisfactory	11%	0.50%	8.10%
Below Average	10%	0.30%	6.00%
Business As Usual (BAU)	9%	0.20%	5.20%
Above Average	8%	0.14%	3.70%
Breakthrough	7%	0.10%	2.50%

PERFORMANCE MONITORING

All three KPI's are measured on a quarterly basis and Figure 2 below shows the overall network performance from 2008 to 2010. These measurements can be further drilled down to different motorways such as Northern Motorway, Southern Motorway and Northwestern Motorway in Figure 3, Figure 4, and Figure 5 to successfully demonstrate that the measurements are robust enough to measure the current performance on the network, such as:

- Capital project construction activities
- AMA activities/unplanned closures/diversions

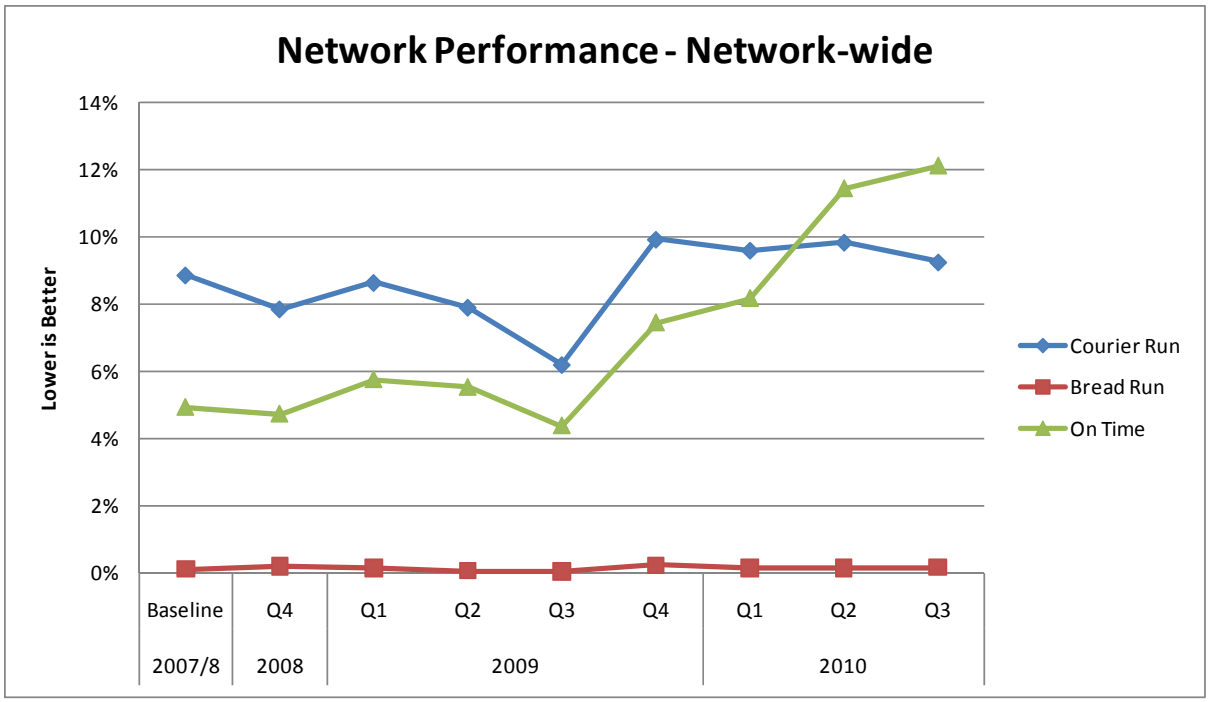

Figure 2. Network Performance Trend

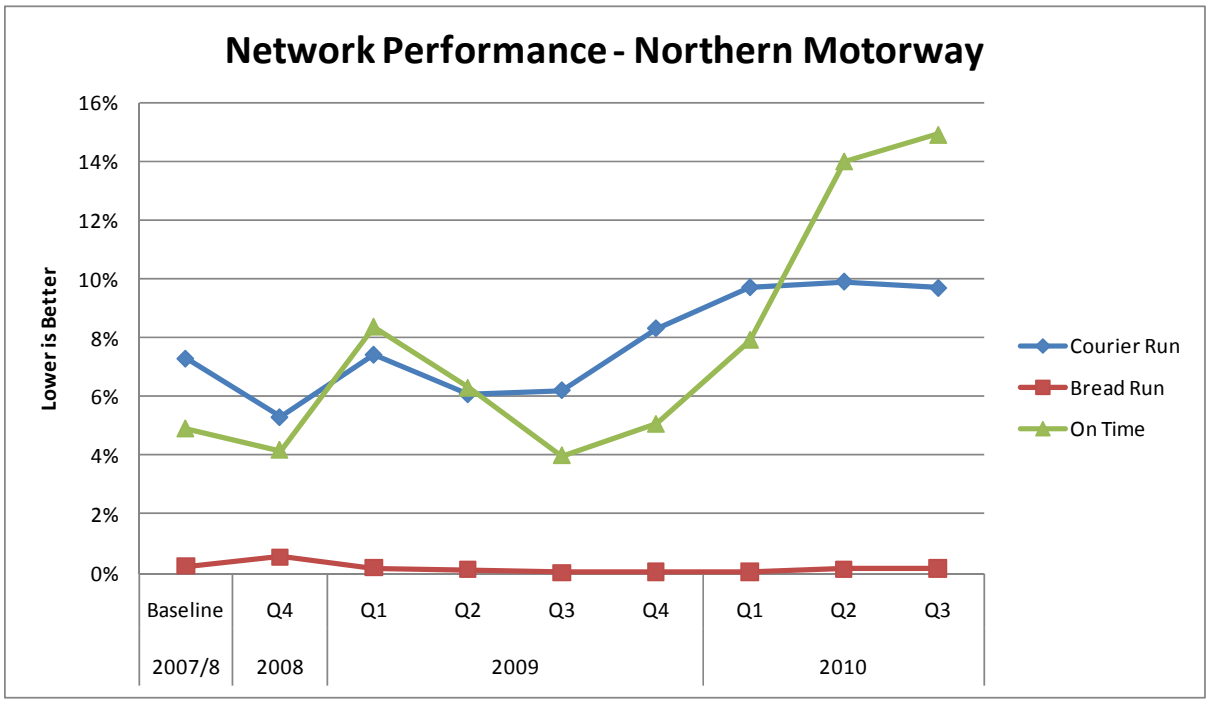

Figure 3. Network Performance – Northern Motorway

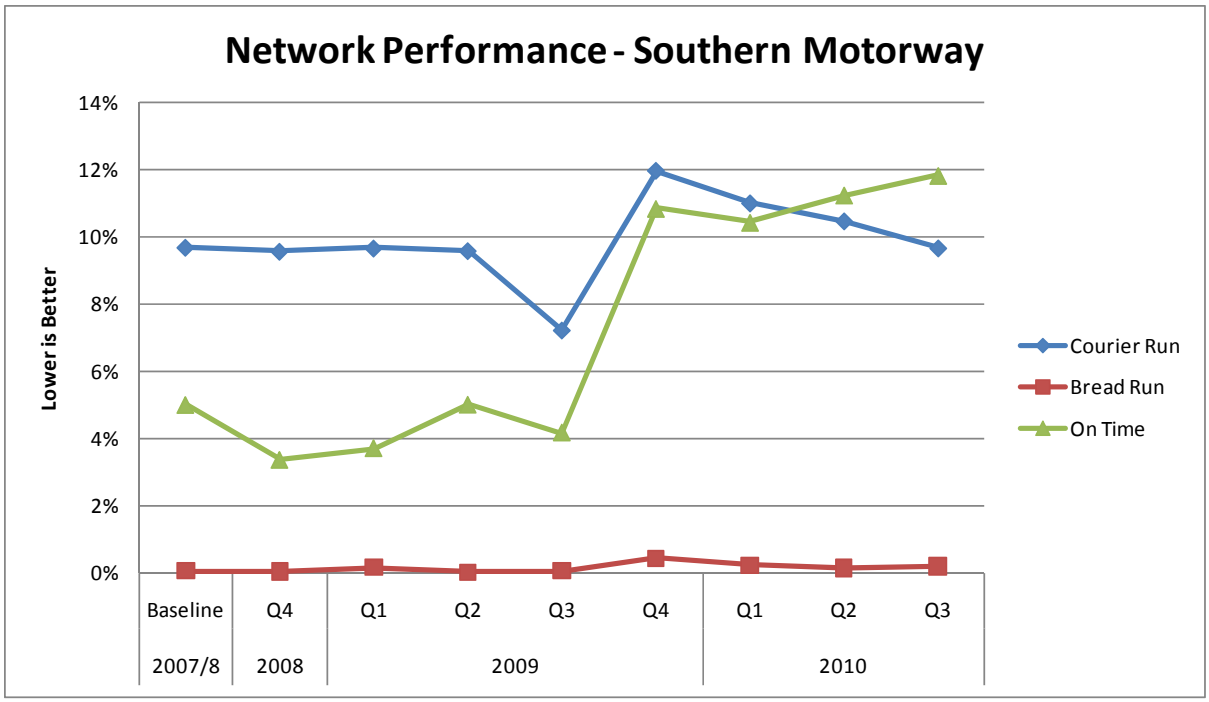

Figure 4. Network Performance – Southern Motorway

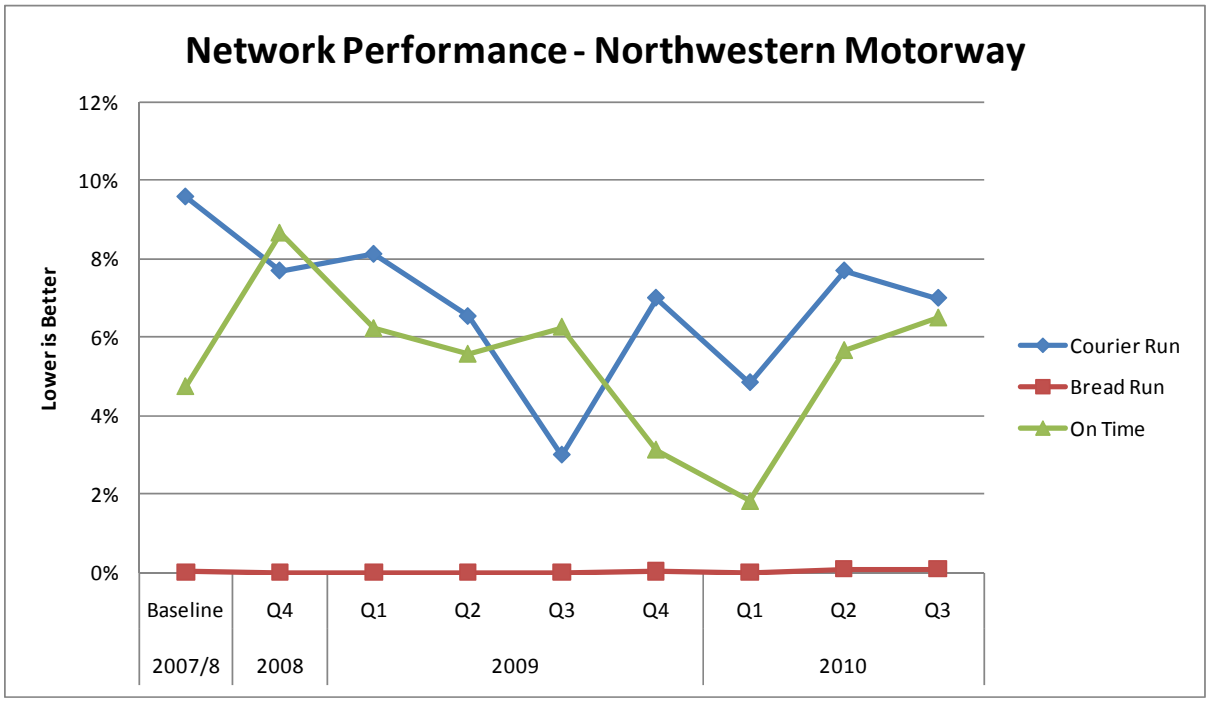

Figure 5. Network Performance – Northwestern Motorway

Working with capital projects

The KPI's have been affected significantly by capital works, including but not limited to the following:

- SH1 Newmarket Viaduct (Viaduct Project NB & SB)
- SH1 Market Road to Green Lane East Four Laning SB
- SH1 Victoria Park Tunnel (VPT) NB.

Travel time reliability has been severely affected by the commencement of major construction works on the motorways, in particular the Newmarket and Victoria Park Tunnel projects as is shown below in Figure 6. Although both these projects will deliver long term economic benefits to the people of Auckland, the "pain" during construction has to be managed. The AMA is working closely with each of these projects to ensure that a better balance between short-term pain and long-term gain is attained.

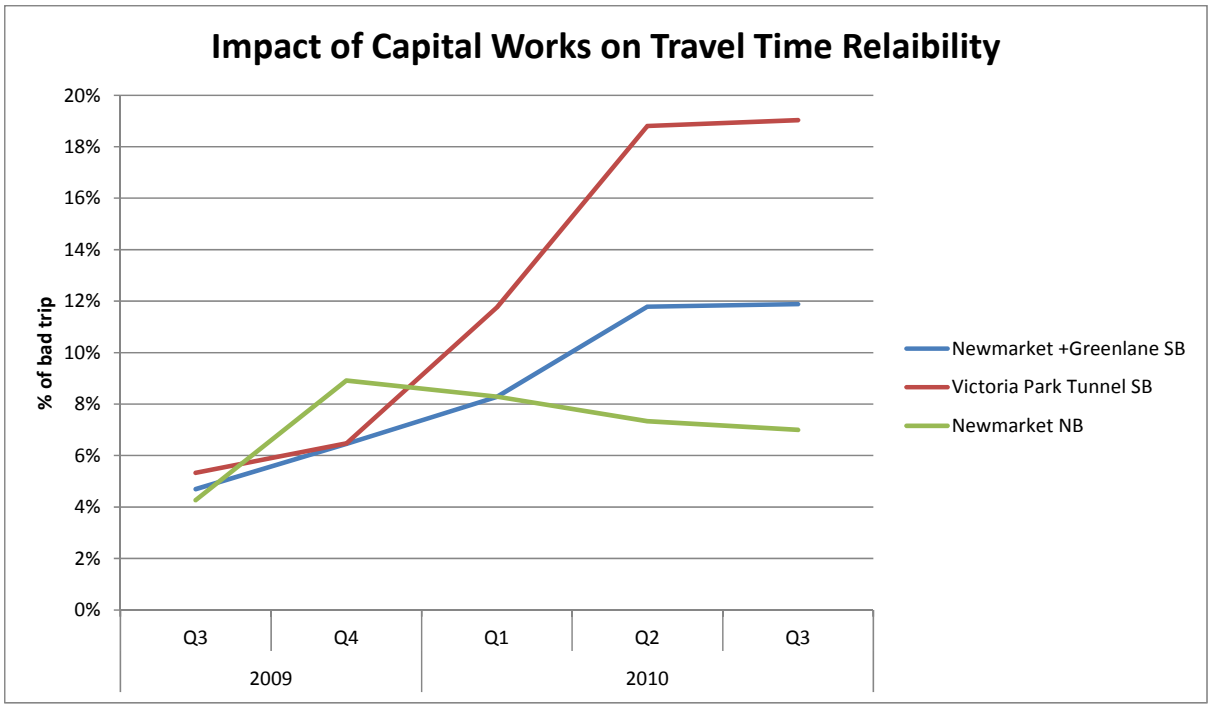

Figure 6. Impact on Travel Time Reliability by projects

A summary of how capital project actions and AMA initiatives influenced the performance of the network is outlined below:

2009 Q3

- Newmarket lane narrowing Stage 1 was put in place
- Ramp signals were commissioned on the Northwestern Motorway city-bound on-ramps.

2009 Q4

- Newmarket to Green Lane East 4 laning project installed temporary barriers and introduced lane narrowing over the entire project length
- Victoria Park Alliance narrowed lanes in St. Mary's Bay and altered alignment.

2010 Q1

- St Marks Road ramp signals were adjusted to reduce in-flow onto the motorway mainline
- Victoria Park Alliance realigned SH1 and introduced "dog legs" on both north and southbound carriageways north of Victoria Park Viaduct, reducing through capacity.

2010 Q2

- Northern Motorway was subject to unplanned works by Victoria Park Alliance, reducing travel time reliability
- Newmarket to Green Lane 4 laning project relocated temporary barriers and removed site screens where possible responding to AMA's request
- Ramp signals at St. Marks Road on-ramp were adjusted again to further reduce in flow onto the motorway mainline.

2010 Q3

- Victoria Park Alliance has been unable to reduce the amount of temporary barriers and site screens installed, capacity reduction and lack of shoulder have significantly increased the duration of incidents, greatly reducing travel time reliability
- Northern Gateway Alliance Newmarket Viaduct has removed temporary barriers and site screens on SH1 northbound where possible, reducing impact of roadworks on our customers, which also provided shoulder widths for incident response.

The AMA, NZTA ramp signalling team and the Newmarket Viaduct, Market Road to Green Lane 4 laning project teams have been working together closely. The Newmarket Viaduct project has developed its own set of congestion and traffic safety KPI's in conjunction with the AMA.

One of the initiatives was the adjustments of ramp signal settings at St. Marks Road southbound on-ramp, reducing the on-ramp flow from more than 900 vehicles an hour to just over 600 vehicles an hour, easing the demand on a section of network where the capacity has been reduced by the narrowed lanes.

The Newmarket Viaduct project team has also removed temporary barriers and site screens on SH1 northbound where possible to reduce the impact of roadworks on our customers and provided shoulder widths for incident response where possible. The effects of these improvements have been noticeable in Newmarket Viaduct's congestion KPI.

More frequent reporting

The AMA has been trialling the use of data sources with increased time and space granularity to derive performance measurements, with an aim to increase the accuracy and frequency of the performance reporting since February 2010.

The trials were undertaken using NZTA's Performance Metrics database to retrieve data collected by the ramp signalling loops on a weekly basis. The weekly monitoring assists the AMA to identify effects of changes made on the network within a week. The spike that was detected on week starting 22 November 2010 (Figure 7) was due to special events, e.g. U2 concerts on 25 and 26 November 2010 at Mt. Smart Stadium. The trial has also highlighted a few data issues that is being addressed in due course.

The weekly monitoring has been useful for the AMA to develop an understanding of the correlation factors and profiles required for working with various data sources and form a better understanding of network performance at a more granular level.

In the long term, the AMA will pursue the use of data from ramp signalling and various other data sources for contractual performance reporting.

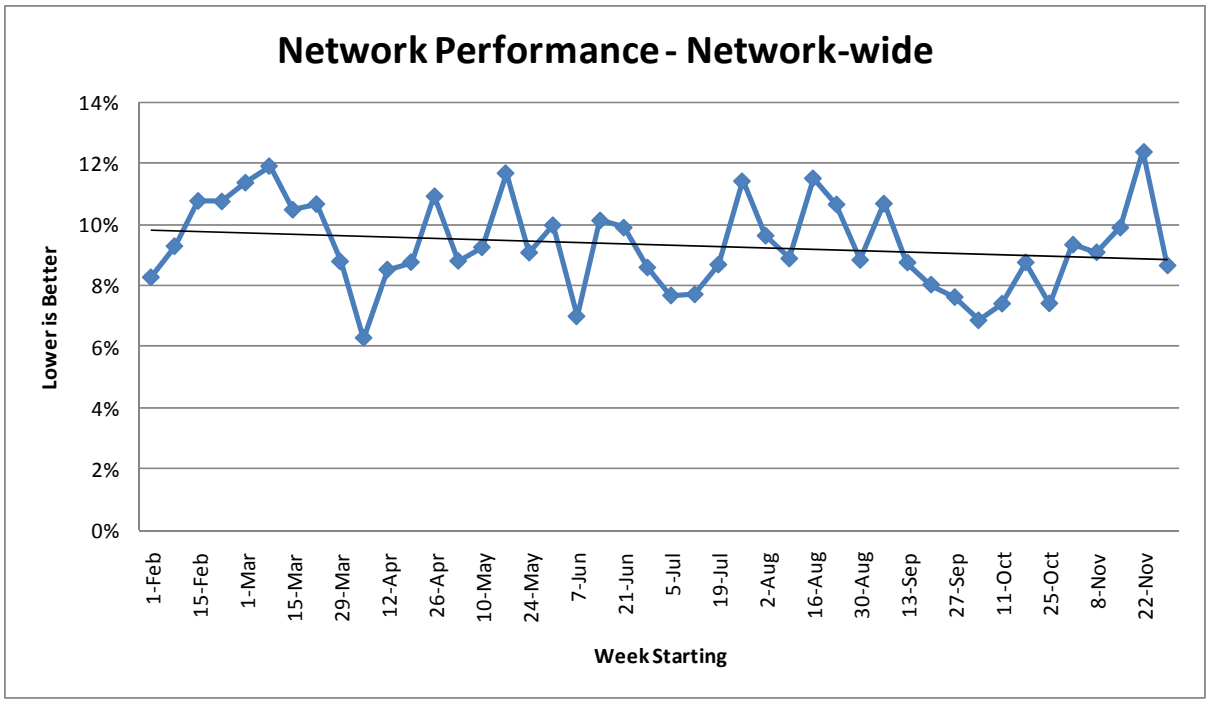

Figure 7. Weekly performance monitoring trial

INITIATIVES TO IMPROVE NETWORK PERFORMANCE

The following initiatives are also being investigated by the AMA:

- Operational Plans for the network
- Incident Response Strategy
- Moveable Lane Barrier Operational Strategy
- Bottleneck Removal Action Plans
- Incident Detection Improvement
- Traffic Data Collection Improvement Plan
- Traveller Information Strategy
- Off-ramp Traffic Signals Operational Review
- High Value Vehicles Performance Baseline Establishment.

Although not all of the above would be in place by Rugby World Cup, the progress made on these initiatives should lead to better customer experience on the network in the future.

CONCLUSIONS

The AMA has successfully:

- established the first ever baseline for the network
- established the network based KPI's – Courier Run, Bread Run and On Time
- established the KPI targets
- monitoring the network performance
- proved that the methodology is robust and consistent
- liaising with different capital projects to minimise the impact on the road users
- increasing the granularity in performance reporting

Since the baseline performance was established, many initiatives have been investigated and implemented progressively to increase the efficiency of the network.

REFERENCES

CHEUNG, H. and LIN, A. (2008). *Baseline Establishment and Key Performance Indicators Interim Report*, Auckland Motorways, Auckland.

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