

## 3.5 Conclusions

- Review and implement integrated and coordinated communication processes, messages and contacts between MR, TransLink in order to maximise coverage of all key portfolio and service messages
- This could include coordinating pre-scripted and pre-approved key message quotes by the Minister at the commencement of incidents/campaign, to be used in subsequent and ongoing releases. These coordinated quotes should be adopted across the portfolio so that agencies are reinforcing each other's key messages and not “competing” for coverage
- The need also exists for integrated and coordinated communication processes to be established between local governments and TransLink and MR in particular, in communicating public transport service information and traffic operation information
- All incident management media communication should target radio as the primary source of communicating information and key messages quickly and effectively to the public. Radio interviews by key agency spokespersons should be utilised as a means of increasing volume of coverage and delivering a factual/balanced tone to incident coverage
- Real time message communication channels should be investigated and could involve:
  - Establishing relationships with radio outlets to communicate government information during major incidents and emergencies
  - SMS messaging to registered public transport users or interested individuals or groups to provide instant information and avoid congestion of call centres and websites
  - Email alert system to registered public and all government road and transport stakeholders
  - Networked control of existing real-time message boards including bus stop real-time timetables, Busway real-time timetables, Busway public announcement messaging and VMS boards
  - Two way radios for all Busway operators to enable direct communication with Busway drivers, particularly after hours when offices are closed
- Coordinated media releases, media briefings, media interviews and service announcements should refer public enquiry to the website and warn of possible call centre delays
- All government agencies should review standardising public transport and passenger information to avoid duplicating messages and resources. For example, one coordinated notice placed at each bus stop and one standard brief with coordinated messages from both agencies sent to call centres.

## 4.0 Network impact analysis

### 4.1 Introduction

This section analyses a range of traffic and public transport data to determine how the transport system responded to the closure.

The section provides:

- analysis of traffic volumes on the road network before and during the closure
- public transport service and patronage analysis for each provider
- overall patronage assessment during and after the closure
- network impact conclusions
- recommendations for managing future closures.

## 4.2 Purpose and objectives

The purpose of conducting a Network Impacts Analysis was to:

- record the impact of the closure on the road network
- record the management strategies applied by key public transport operators
- capture, interpret and compare patronage figures across modes and over time
- provide information that may be beneficial in the event that other high capacity links in the network are closed in the future.

## 4.3 Road analysis

### 4.3.1 Objectives

The key objective of the study was to analyse the changes in traffic volumes as a result of the closure.

### 4.3.2 Methodology

The analysis was primarily based on traffic data from counters maintained by MR and BCC.

A broad cross section of the major corridors in greater Brisbane was included in the analysis and

provides an accurate but not complete picture of traffic volumes during the closure (see Tables 1 and 2 for traffic count locations).

Analysis of MR's traffic data was based on a comparison of data collected on 18 October 2006 with the average traffic for the other Wednesdays in October 2006. It is important to note that MR is responsible for the state controlled road network. With the exception of the Pacific Motorway, the road network generally moves from state control to BCC control closer to Brisbane's CBD. Consequently MR traffic counters are located further from the CBD, while BCC traffic counters are generally closer to the CBD.

Analysis of BCC traffic data was based on a comparison of data collected during the week of the closure with data collected in the same week in 2004 and 2005. Unfortunately some BCC data, particularly in and around the CBD, was incomplete.

### 4.3.3 Findings

Table 1 shows very little change in traffic volumes at MR counter locations north of the Brisbane River.

**Table 1 – Traffic comparison analysis for traffic north of the Brisbane River**

Location of traffic count	Percentage Change (+/-) during REX Closure
Abbotsford Road @ Burrows Street, Bowen Hills (BCC)	-7.00
Anzac Avenue @ Petrie Street, Petrie (MR)	+2.07
Breakfast Creek Road @ Kingsford Smith Drive, Newstead (BCC)	-2.50
Bruce Highway @ Dohles Rocks Road, Murrumba Downs/Griffin (MR)	-2.13
Bruce Highway @ Gateway Merge, Bald Hills (MR)	-0.05
Gympie Road near Darwin @ Aspley (MR)	-2.63
Gympie Road near Todds Road, Lawnton (MR)	+1.78
Moggill Road near Cedarleigh, Chapel Hill (MR)	+0.36
Old Northern Road near Keong , Albany Creek (MR)	+1.02
Samford Road near Dawson Parade, Keperra (MR)	-0.21
Sandgate Road near Pritchard Street, Virginia (MR)	+1.37
Wardell Street @ Fraser Street, Ashgrove (MR)	+0.73

Table 2 shows the traffic comparison analysis for traffic south of the Brisbane River.

**Table 2 – Traffic comparison analysis for traffic south of the Brisbane River**

Location of traffic count	Percentage Change (+/-) during REX Closure
Beaudesert Road near Boundary Road, Acacia Ridge (MR)	+2.73
Gateway Motorway @ Mt Gravatt Capalaba Road, Mackenzie (MR)	+5.20
Gateway Motorway @ Bridge toll booths (QML)	+11.0
Honour Av near Hurlton, Graceville (BCC)	+9.00
Ipswich Motorway near Francis @ Redbank (MR)	+1.37
Ipswich Motorway @ Goodna (MR)	+1.28
Logan Road @ Juliette Street, Stones Corner (BCC)	+7.00
Logan Road near Marshall Road , Holland Park West (MR)	+2.55
Pacific Motorway @ Gaza Road On ramp, Mt Gravatt (MR)	-23.93
Pacific Motorway @ Stanley Street On ramp (MR)	-69.70
Wynnum Road at Junction Road, Morningside (BCC)	+8.20

From **Table 2**, it can be concluded that a majority of commuters travelling to and from the west on the Ipswich Motorway experienced little change. However, there was a significant increase (nine per cent) in the traffic volume using the Walter Taylor Bridge between Chelmer and Indooroopilly. There were also significant increases in traffic volumes on the Gateway Motorway and Wynnum Road and as expected there was also a significant change in traffic in the north-south corridor along the Pacific Motorway.

During the closure, on 18 October 2006, there were approximately 34 000 fewer vehicles on the Pacific Motorway at Gaza Road (8 kilometres from the CBD) than on 11 October. If it is assumed that on average 1.2 people travelled in each vehicle, a total of 41 000 commuters made alternative transport arrangements such as different route, mode, deferment or cancellation of trip.

**Table 3** indicates a significant increase in traffic volumes in and around the CBD with an average increase of over 20 per cent on the arterials approaching the CBD.

**Table 3 – Traffic comparison analysis of the CBD**

Location of traffic count	Percentage Change (+/-) during REX Closure
Bowen Bridge Road @ Gregory Terrace, Fortitude Valley (BCC)	+32.50
Coronation Drive @ Graham Street, Milton (BCC)	+45.00
Elizabeth Street On Ramp @ William Street, CBD (BCC)	Incomplete data
Grey Street Bridge @ Saul Street, North Quay (BCC)	Incomplete data
Kemp Place (North bound), (BCC)	+21.60
Margaret Street On ramp @ George Street, CBD (BCC)	Incomplete data
Milton Road @ Castlemaine Street, CBD (BCC)	+8.00
Normanby Fiveways @ Spring Hill (BCC)	+21.00
River Terrace @ Main Street, Kangaroo Point (BCC)	+19.00

Daily traffic volume data sets for the three week period from Monday 9 October to Sunday 29 October 2006 were also analysed for six key sites across the Main Roads network. The sites were:

- Pacific Motorway at Gaza Road (Figure 7)
- Pacific Motorway at Park Road (Figure 8)
- Gympie Road at Darwin Street, Aspley (Figure 9)
- Samford Road at Dawson Parade, Keperra (Figure 10)
- Western Arterial at Wardell Street (Figure 11)
- Gateway South at Capalaba Road, Mount Gravatt (Figure 12)

When compared with traffic volumes for weeks either side of the closure and generally with traffic from similar periods in the previous two years (2004 and 2005) this analysis provides an appreciation for the magnitude of the impact of the REX closure on traffic volumes on these roads.

Figure 7 – Weekly traffic volumes Pacific Hwy North of Gaza Rd

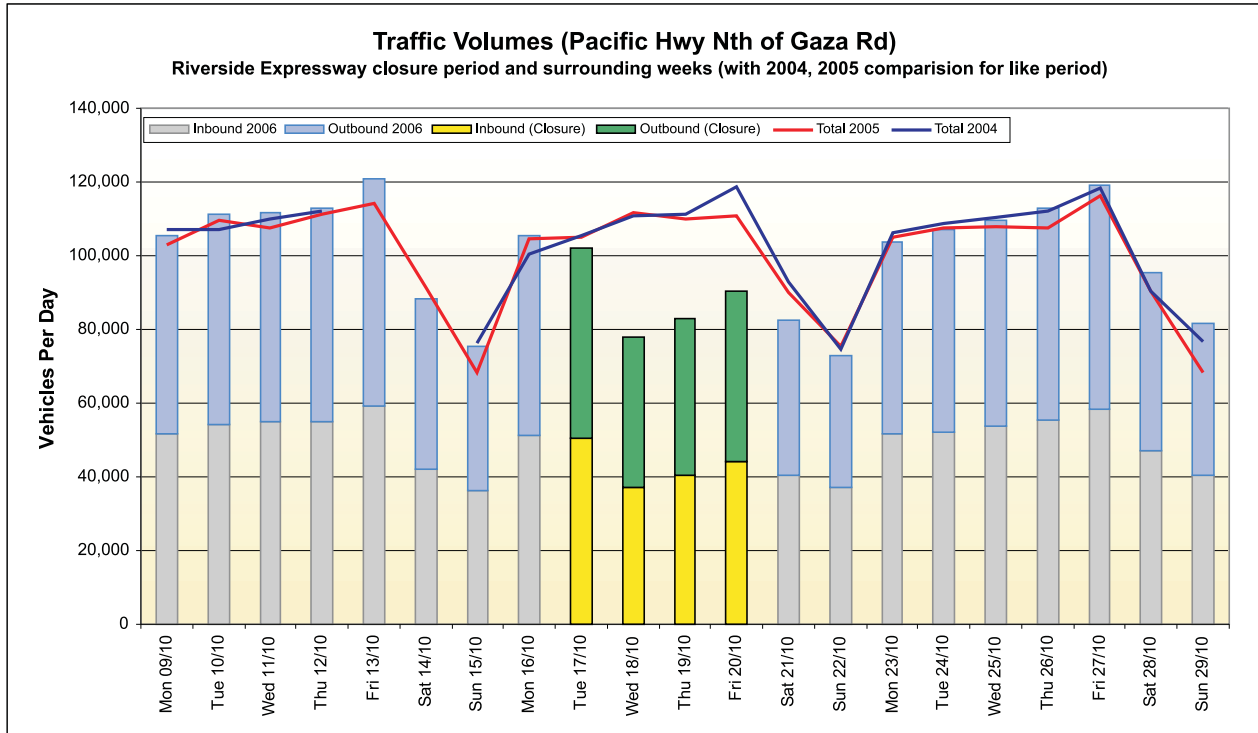


Figure 8 – Weekly traffic volumes Pacific Hwy at Park Rd

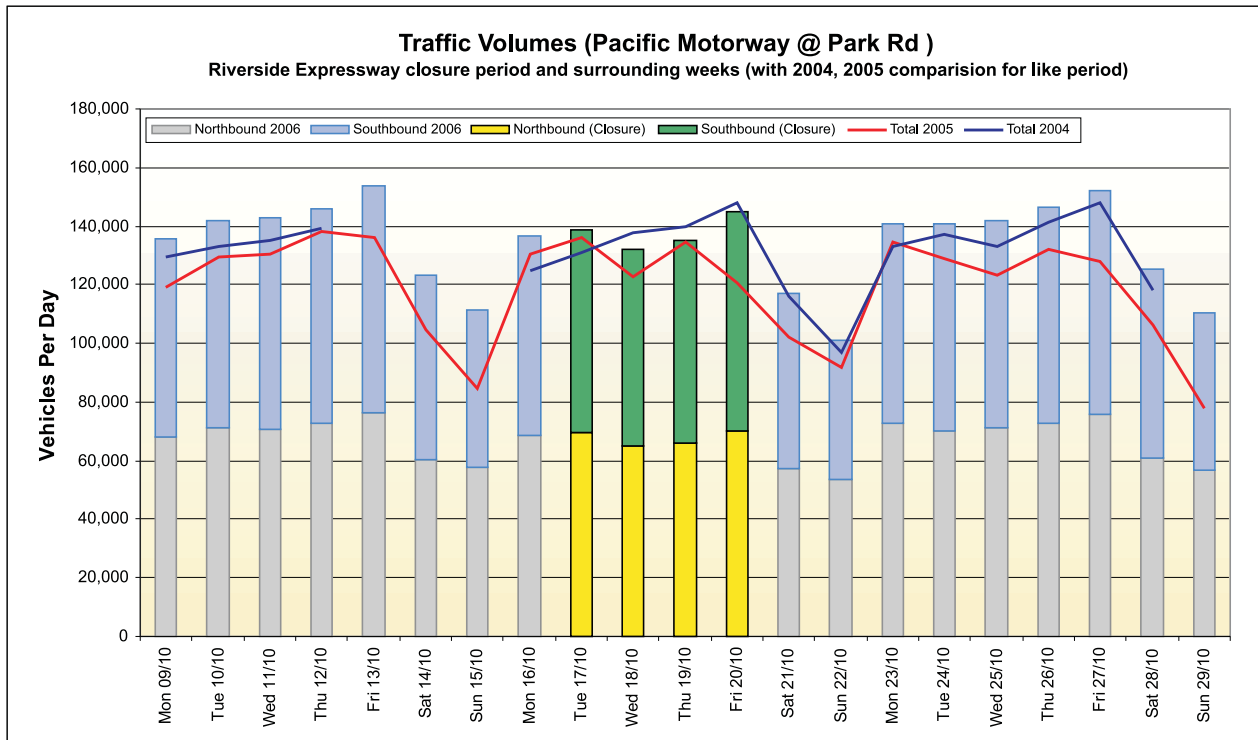


Figure 9 – Weekly traffic volumes Gympie Rd at Darwin St, Aspley

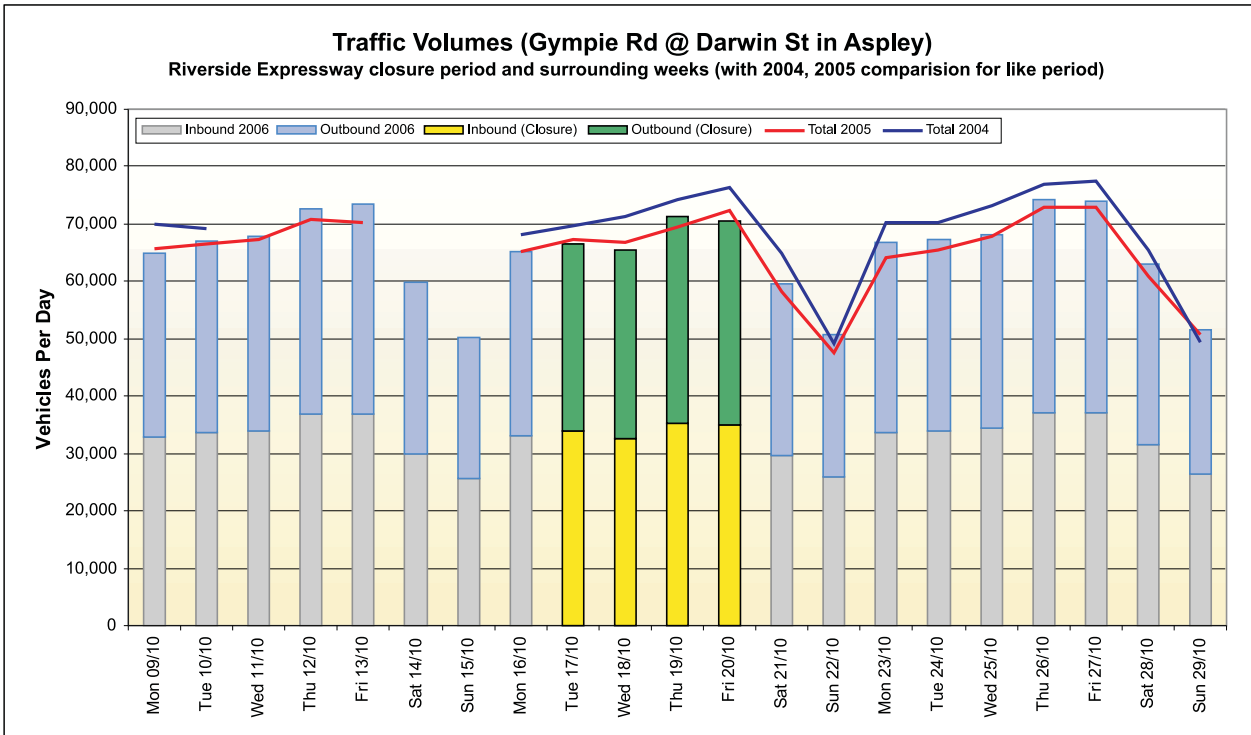


Figure 10 – Weekly traffic volumes at Samford Rd, Dawson Pde, Keperra

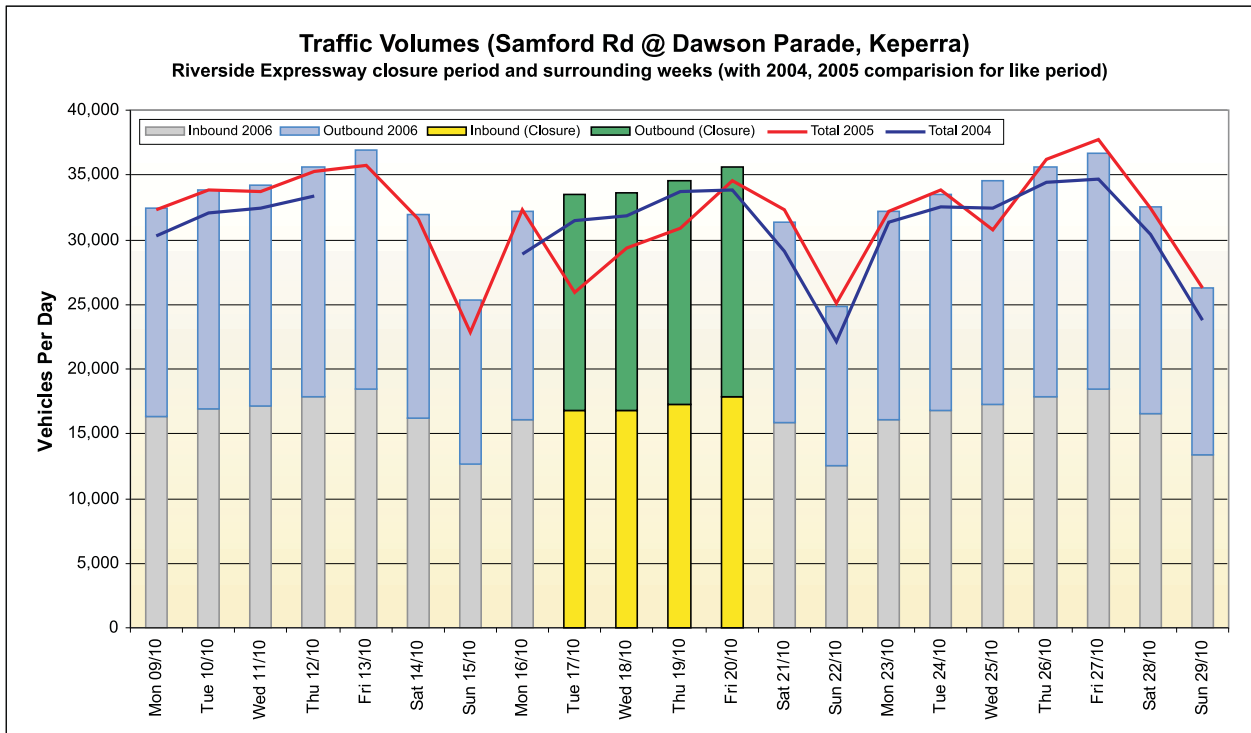


Figure 11 – Weekly traffic volumes for Western Arterial at Wardell St

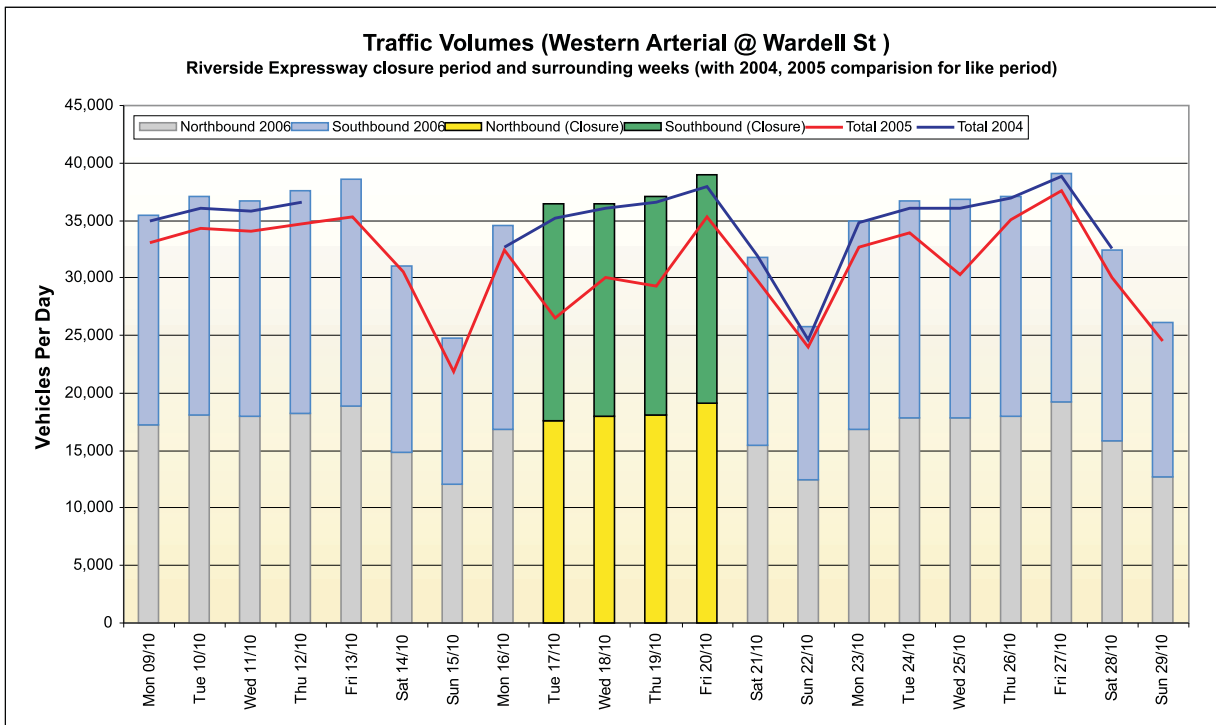
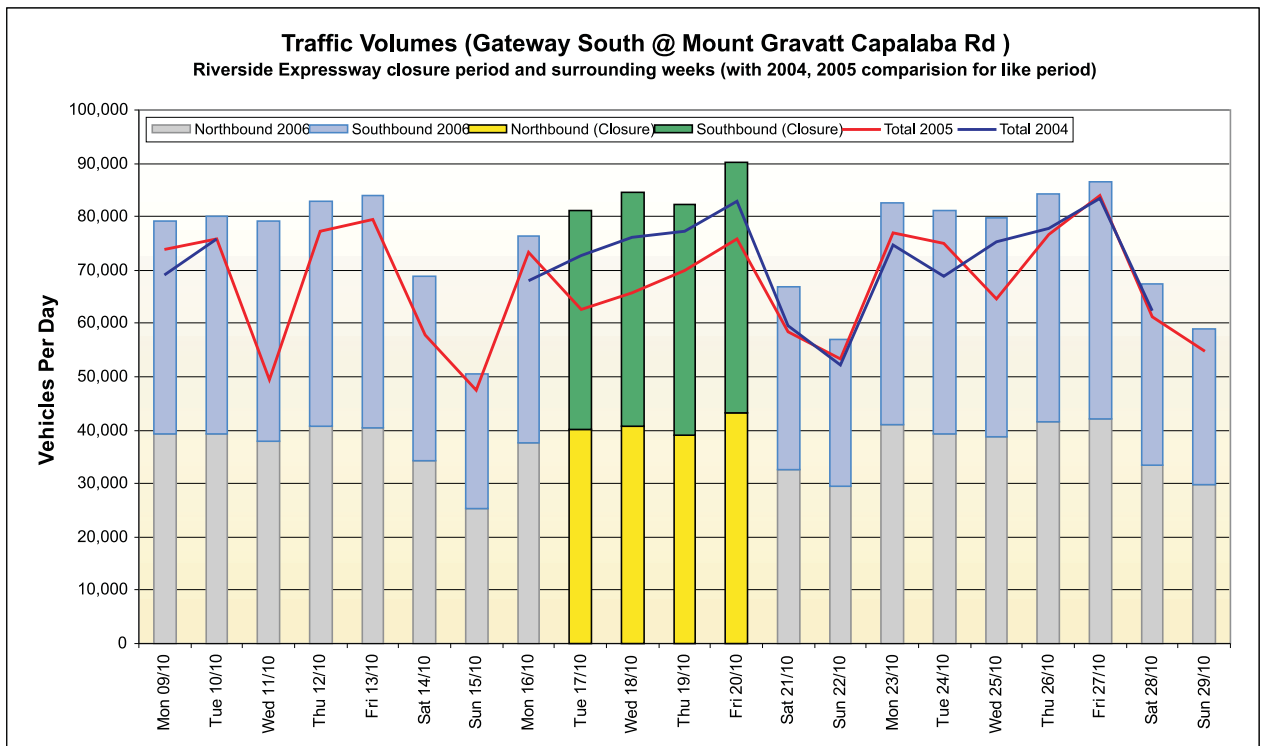


Figure 12 – Weekly traffic volumes, Gateway South at Mount Gravatt, Capalaba Rd



## 4.4 Public transport

### 4.4.1 Objectives

To understand how key public transport providers and commuters responded to the closure and what impact their response had on the overall network.

### 4.4.2 Methodology

The following information was collated and assessed:

- QR service changes and patronage figures
- bus and ferry service changes and patronage figures
- anecdotal information from QR and BT staff.

Unfortunately there was no pedestrian and cycle data collected during the closure for analysis.

### 4.4.3 QR

#### Service Changes

Additional train capacity was introduced to the QR Citytrain network on 18 October 2006. These additional services ceased on 25 October 2006. This additional capacity generally consisted of the following services in both the morning and afternoon peak:

- Ferny Grove Line

One service to Mitchelton upgraded from three to six carriages

Three services altered to continue from Mitchelton to Ferny Grove

One additional six carriage service from Roma Street to Ferny Grove

- Ipswich Line

One additional six carriage service from City to Corinda

One service altered to continue from Darra to Goodna

- Cleveland Line

Three services upgraded from three to six carriages and altered to stop at all stations to Cleveland

One service altered to continue all stations Manly to Cleveland

- Gold Coast/Beenleigh Line

Two Gold Coast and two Beenleigh services upgraded from three to six carriages

One service altered to continue all stations Kuraby to Beenleigh

- Airport Line

Two services upgraded from three to six carriages

- Caboolture, Shorncliffe and Doomben services

No Alterations.

Over and above these service changes, passenger numbers at stations were monitored by staff and additional services introduced when required. For example:

- more frequent stops for express services
- additional express services to the city when carriages were full.

In real terms this resulted in a potential increase of train patronage per day as shown in **Table 4**.

**Table 4 – Rail capacity added during closure**

QR Service	Additional Capacity AM peak	Additional Capacity PM peak
Ferny Grove Line	9 carriages	9 carriages
Ipswich Line	6 carriages	6 carriages
Cleveland Line	9 carriages	9 carriages
Gold Coast / Beenleigh Line	12 carriages	12 carriages
Airport Line	6 carriages	6 carriages
Caboolture, Shorncliffe and Doomben services	Nil	Nil

QR ticketing records show there was a 14 per cent increase in ticket sales during the week of the closure. During the closure, typical six carriage configurations were required to accommodate between 850 and 900 passengers. This level of service is more commonly referred to as “crush” levels. By way of comparison non-crush services are typically six carriage configurations that comfortably accommodate approximately 600 to 750 passengers.

**Patronage: measurement constraints**

While additional capacity was introduced by QR, precise patronage calculations during the closure were unable to be made for the following reasons:

- there are no systems in place for recording the numbers of rail passengers by line or station
- any valid TransLink ticket was accepted for rail travel during the closure. Consequently, increases in rail ticket sales did not represent the entire increase in rail patronage
- the majority of regular rail passengers used seasonal tickets and most of these would have been purchased prior to the closure and be valid during the closure.

**Patronage: anecdotal information**

Experienced QR staff reported the following observations:

- the average daily patronage of 160 000 people increased by 20 to 25 per cent during the closure, adding between 32 000 and 40 000 passengers per day, an observation supported by the TransLink data in Table 4
- substantial increase in passenger numbers was observed specifically along the Ipswich line at Ipswich and Indooroopilly, the Ferny Grove line and Caboolture line at Carseldine
- normal peaks between 6.00 am and 9.00 am and 4.30 pm to 7.00 pm were lengthened. There were many people leaving as early as 2.30 pm in the afternoon peak, with the morning peak extending to 10.30 am.

**Service sustainability**

QR believes the strategies implemented to increase services were not sustainable beyond the closure period for the following reasons:

- drivers and guards were at their maximum hours for the month
- every item of available rolling stock was in service. If service levels remained as high for longer periods, failures could be expected due to the reduced opportunities for maintenance
- QR surveys indicated passengers were tolerant of the “crush” conditions early in the week but to the week’s end were becoming less tolerant.

#### 4.4.4 Brisbane Transport (BT) buses

##### Service strategies

Open road based bus operations were severely affected by the closure as they are greatly hindered by traffic congestion, particularly in the CBD. With these constraints in mind, BT responded to the closure by applying the following key principles:

- maintain service integrity
- update real-time service information to adapt to changing conditions
- maximise bus availability through more services to busy routes to minimise the number of stops/trips missed
- ensure adequate rest stops and shift lengths for drivers to manage driver fatigue.

##### Service changes and impacts

- BT 'Rocket' services were re-routed via the Victoria Bridge due to the closure of the Captain Cook Bridge
- north/west services were diverted over the William Jolly/Grey Street Bridge
- bus volumes doubled on the Victoria Bridge and severe bus congestion resulted
- BT diverted empty (dead running) outbound buses during the morning peak (counter peak buses) along Victoria Bridge and the SEB.

As a result the volume of dead running buses created higher flows in the counter peak making traffic management at key intersections such as North Quay, Victoria Bridge, and Melbourne and Grey Street, difficult.

- signal timing was modified and QPS was employed to direct traffic to prevent traffic bottlenecks
- BT directed the Rockets back onto the Captain Cook Bridge on 19 October 2006
- buses were diverted from Milton Road to Coronation Drive when it became apparent Coronation Drive was underutilised by motorists.

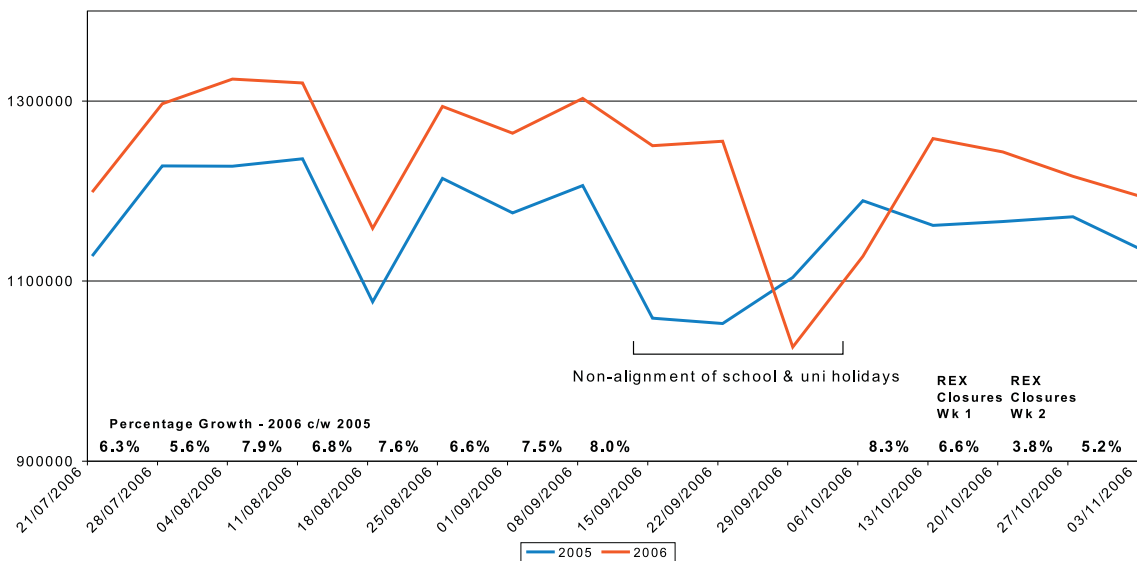
Key impact areas:

- western services experienced the most severe disruption
- the critical blockage point was consistently the eastern end of Milton Road at the intersection of Upper Roma Street.

##### Patronage

In an attempt to gain an understanding of bus patronage impacts, BT's patron profile from 17 July 2006 to 3 November 2006 was compared with the corresponding period in 2005 as shown in Figure 13.

**Figure 13 – 2005-2006 Comparison of bus weekly patronage: week ending – 2006**



Determining the cause of impacts on bus patronage during the closure is complicated by a number of factors:

- the non-alignment of school and university holidays affecting the four weeks around the closures
- the typical impacts of university exams during October and ensuing pre- and post-Christmas holidays
- the significance of single day events such as pupil free days.

Due to the variance of major event times each year and the impacts of single day events on patronage, weekly or daily analysis and annual comparisons should be treated with caution.

As shown, BT's annual patronage growth for 2006 prior to the closures was in the range of six to eight per cent. During week one of the closures this growth slowed (compared with the preceding week), and slowed further in week two. This was possibly due to the pupil free day on 23 October 2006.

The analysis of the available data does not show any consistent increase or decrease in bus patronage related to the REX closure.

#### **Patronage: regional assessment**

- Southside routes stretching from Forest Lake to Mansfield using the SEB (known as the 100 series) have consistently performed above the network average in terms of patronage growth, compared with 2005, and show slightly better performance in the weeks of the closures.
- More detailed assessment of the 100 series showed a patronage increase in Route 130, however this corresponds with the addition of nine extra peak trips in each direction on 23 October 2006 and is therefore unlikely to be directly related to the closures.
- Eastern suburb routes (known as the 200 series) performed at or slightly above the average for annual patronage growth.
- Northside routes (known as the 300 series) performed at or slightly below the average for annual patronage growth.
- Western routes (known as the 400 series) performed consistently and significantly below the average, particularly in week one of the closures. However a spike in week two was recorded and appears to be the result of the introduction of the Route 444 Moggill BUZ on 23 October 2006, which has experienced a growth in patronage of 40 to 50 per cent.
- Cityxpress corridors displayed the standard downward trend evident at this time of year.

#### **4.4.5 South East Busway (SEB)**

It is evident that the SEB proved invaluable to the overall functioning of the bus network system during the closure. It is estimated that Victoria Bridge carried more than 350 inbound buses (double the usual number of 177 buses) per hour during the closures as a result of BT diversions. As a result of the increased volume the inner part of the SEB did not cope efficiently and bus queues occasionally extended back to Mater Hill Busway Station, which is about two kilometres from the city end of the SEB.

Unrelated to the closure, services operating on the outer SEB beyond Buranda Station were delayed between five and 15 minutes due to ongoing resurfacing works between Greenslopes and Griffith University. Service delays increased total trip times while the variability of the delay is thought to have adversely affected commuter trust in the SEB's reliability, particularly routes 111 and 160.

#### **4.4.6 Ferries**

Additional ferry services were introduced by BCC and analysis indicates that ferry patronage increased by approximately 30 per cent during the time of the REX closure when compared with the same days in the week prior to the closure. Although this growth is significant the increase is from a relatively low base and the overall impact on the transport task was relatively small compared to bus and rail.

## 4.5 Overall patronage assessment

### 4.5.1 Constraints

- collection of patronage data during the closure was secondary to coordinating the overall transport task
- the use of bus tickets and seasonal tickets for train travel render it virtually impossible to obtain accurate patronage figures for the closure period
- BT data is highly variable as it is significantly impacted by wet weather, school and university holidays, exam timetables and daily events, thus making it difficult to isolate the effects of specific occurrences.

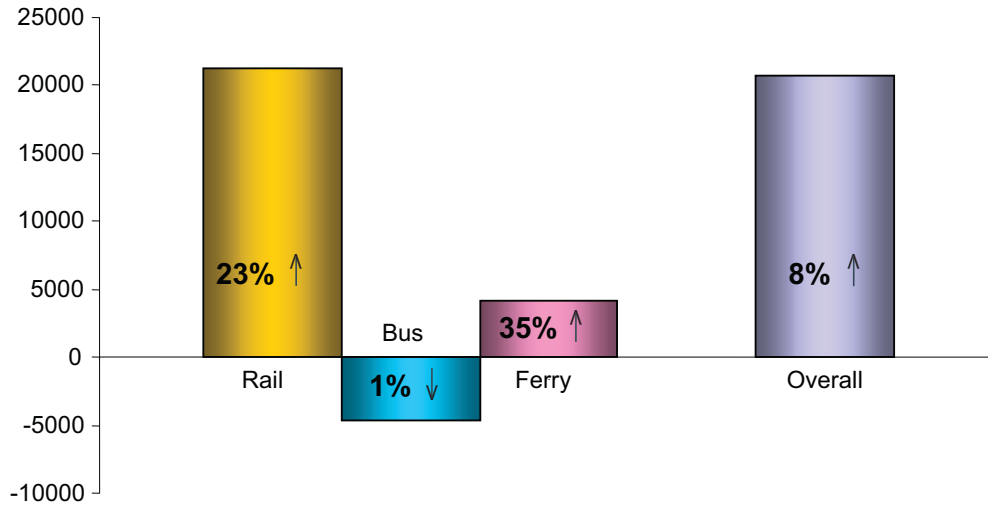
### 4.5.2 Patronage analysis

- TransLink's data has been analysed in Table 5 to estimate public transport patronage changes according to mode.

Table 5 – Estimated changes to PT patronage during closure

	Tuesday 17/10/2006		Wednesday 18/10/2006		Thursday 19/10/2006		Friday 20/10/2006	
	Change	Percent Change	Change	Percent Change	Change	Percent Change	Change	Percent Change
Rail	3,802	3.0%	30,890	26%	28,811	24.0%	21,371	20.0%
Bus (BT Only)*	-13,100	-6.0%	-4,243	-2%	-187	0.0%	-837	0.0%
Ferry	59	0.0%	6047	38%	5991	40.0%	4464	25.0%
Combined	-9239	2.4%	32,694	8.3%	34,615	8.7%	24,998	6.5%

**Figure 14 – Public transport mode shift during closure**



The data indicates that public transport patronage (not including services other than BT and QR) increased by approximately eight per cent during the closure.

#### 4.5.3 Patronage retention

Table 6 compares patronage figures for the week prior to the closure (week commencing 8 October 2006) with patronage figures three weeks after the closure (week commencing 5 November 2006), to see if commuters retained their use of public transport when the REX was reopened.

**Table 6 – Retention in changes to PT patronage**

	Wednesday 8/11/2006		Thursday 9/11/2006		Thursday 9/11/2006		Friday 10/11/2006	
	Change	Percent Change	Change	Percent Change	Change	Percent Change	Change	Percent Change
Rail	-2378	-1.63%	4835	4%	-34	-0.03%	5275	4.93%
Bus (BT Only)*	-8980	-4.06%	-15700	-7.04%	-11182	-4.93%	-6766	-3.0%
Ferry	-42	-0.24%	-1334	-8.28%	-603	-3.98%	10	0.06%
Combined	-11400	-2.96%	-12199	-3.39%	-11819	-3.26%	-1481	-0.42%

\* The analysis of change undertaken to date has not considered the effect of patronage for other bus operators

Table 6 indicates that there does not appear to be any retention of the increased public transport patronage following the reopening of the REX, except for a slight increase in rail usage. However the reductions in patronage are consistent with the typical decline at this time of year and are not related to the closure.

## 4.6 Conclusions

### 4.6.1 Traffic

The closure of the REX had a major effect on the city road network with traffic increases of between 10 and 20 per cent on the major arterials within one kilometre of the CBD.

The Gateway Motorway and some eastern arterial roads were also affected while most roads outside the CBD's one kilometre radius generally experienced little impact.

The removal of the Gateway Bridge toll during the closure is responsible (at least in part) to the increase in traffic on the Gateway. The cost to Government in lost revenue which resulted from removal of the tolls for the peak periods for the five days during the closure was in the order of \$525 000 excluding GST.

Better collection of traffic data and passenger transport patronage figures in the future will improve understanding of modal shifts. The planned Smart card ticketing system is expected to collect more reliable passenger data on public transport services.

The current road network in and around the CBD is at capacity during peaks and consequently severe congestion results if there is disruption to major transport links, particularly those providing a river crossing into the CBD.

### 4.6.2 Public transport

Line haul passenger transport services such as Citytrain and the SEB were most effective in getting people in and out of the city. This was reflected in the substantial increase in rail patronage figures.

The increased traffic volumes in and around the CBD had a major effect on bus operations, particularly from the western and northern suburbs and on the Victoria Bridge. Bus figures, although down from the average, were only slightly lower.

When complete, the Inner Northern Busway and the new King George Square Busway Station should improve the bus network. Improved bus access into the city from the western suburbs would also improve reliability.

Although a mode shift from private motor vehicles to public transport during the closure was recorded, the extra rail and bus services introduced to make the shift possible cannot be sustained over time without additional rolling stock and personnel.

Rail contributed more additional capacity to the system during the closure than any other mode. This is because bus and road transport were affected by the increased congestion on the road network.

#### QR

Without a system to record rail passenger numbers it is not possible to accurately quantify patronage increases during the closure. However, based on ticket sales and staff observations it is apparent that rail played a critical role in compensating for the loss of road network capacity.

QR has limited capacity to sustain an increase in services to the degree achieved during the closure. Existing rolling stock and human resources are already at or nearing capacity and consequently there are insufficient reserves to maintain the higher capacities for prolonged periods.

#### Bus

There is an observable difference across the four geographic regions. Patronage of the southern and eastern route groups reduced to less than the average. Conversely, the western route group increased to more than the average. However, a comparison of the 2006 closure weeks with 2005 shows a similar above average decline in the western route group, which may be attributed to the impact of the University of Queensland's pre-exam study period. The decrease in patronage may also be attributed to western region bus services being most affected by traffic delays during the closure.

## 5.0 Case study learnings

### 5.1 Introduction

This section reviews the management of six transport network disruptions across Canada, USA, UK, Japan and Australia. This research was conducted to compare the impacts, agency responses and travel behaviour changes with Queensland's management and experience of the REX closures.

### 5.2 Purpose and objectives

The purpose of this research was to examine international transport management trends and traffic impact patterns for consideration in future incident management in Queensland.

The review examined international case studies to:

- understand the responses of government agencies to the event itself and longer term opportunities
- identify before, during and after incident travel behaviour impacts and trends
- compare agency responses, traffic impacts and trends to the REX closure.

### 5.3 Methodology

International incidents were considered a suitable case study, if they:

- resulted in the removal of an important transport link
- were caused by disaster, catastrophic failure, major repair or maintenance work or through proactive policies to reduce road space
- had sufficient published research to review.

Each case study was analysed to answer the following questions:

- what were government agency responses to the incident?
- what happened to traffic patterns and public transport patronage?
- how effective were measures to promote the use of alternative transport modes and reduce congestion in the long term?
- what travel behaviour changes occurred over the short, medium and long term?
- what happened to traffic patterns when network capacity was restored?
- are there any implications for future disruptions in Queensland?

The following incidents are reported in reverse chronological order:

- 2006 Laval Overpass collapse (Montreal)
- 2001 9/11 attacks (New York)
- 1997 Hammersmith Bridge closure (London)
- 1995 Hanshin Awaji earthquake (Kobe)
- 1994 Northridge earthquake (Los Angeles)
- 1975 Tasman Bridge collapse (Hobart)

### 5.4 Case studies

Event descriptions, agency responses and travel behaviour impacts are detailed below for each incident.

#### 5.4.1 2006 Laval overpass collapse (Montreal)

On 30 September 2006, a 65 foot section of a three lane overpass collapsed in Laval on Concorde Boulevard, crossing over Autoroute 19 in Canada. The collapse crushed two vehicles, killing five people and seriously injuring six others who went over the edge. This closed Autoroute 19 for almost four weeks, disabling an important north-south link between Montreal and its northern suburbs. Normal traffic flows along Autoroute 19 amount to 57 000 vehicles per day in both directions (Marotte and Magder, 2006).

### **Agency responses**

Several blocks of concrete had fallen from the overpass prior to its collapse. This concrete debris was cleared but no decision was made to close the overpass or the road beneath it.

In response to the partial collapse of the overpass, the Quebec government instigated several strategies to speed the recovery effort and to minimise inconvenience to commuters.

- Emergency procedures focused on rescuing survivors then clearing the scene
- Detour routes were put in place and commuters were urged to use public transport and to carpool
- Shuttle bus services were provided to ferry commuters between new park and ride sites and subway stations, which had restricted access due to the road closures
- Canadian Automobile Association-Quebec (CAA-Quebec), a non-profit organisation, promoted use of their free carpool ride-sharing program which enables the forming of car pooling networks
- Transit authorities in Laval and Montreal increased services on some routes and extended the reserved bus lanes.

### **Travel behaviour impacts**

The major expressways into Montreal from Laval were gridlocked during the morning peak following the collapse. The peak period started much earlier than usual and was extended in duration. Motorists responded by changing routes (mainly official detour routes), the time they left for work (earlier or later), or the mode they used (bus, subway, etc.).

### **5.4.2 2001 9/11 attacks (New York)**

On 11 September 2001, the World Trade Centre in New York was destroyed, crippling the public transport infrastructure of Lower Manhattan's major inter-modal transport hub. Highway exits in the immediate area were closed by emergency services and security agencies resulting in traffic chaos. Some streets remained closed for the duration of the clean-up.

New York's subway network transports over 4.2 million people every work day (US Department of Transportation, 2002). The principal point of access to two subway stations was destroyed in the attacks. Part of a subway tunnel was also destroyed, necessitating re-routing and the cancellation of some services. The Lower Manhattan rail station was seriously damaged. New York buses transport over 2.5 million people every work day, making it the second most popular transit mode in the city. Bus infrastructure was largely unaffected by the attacks.

### **Agency responses**

Agency responses assisted the recovery effort in reducing congestion across the network. Many bridges, tunnels and highways into Manhattan were closed, later being restricted to high occupancy vehicles (HOV) and emergency vehicles during peak periods.

The Department of Transport:

- urged people to use bikes, buses, ferries and subway
- increased ferry routes and services
- re-routed trains
- commissioned a new ferry terminal to cater for the expected influx of patrons from the closed subway and rail stations
- established new bus routes and services.

### **Travel behaviour impacts**

The banning of single occupancy vehicles (SOV) on bridges into Manhattan resulted in peak spreading and an estimated 30 per cent reduction in traffic across the road network leading toward Manhattan. There was an estimated 20 per cent decrease in traffic in the Lower Manhattan area itself (US Department of Transportation, 2002).

Ferry patronage increased by 164 per cent as it catered for many subway users. Overall patronage on the bus system did not change substantially, with losses on some services balancing new patrons on others.

Some subway patrons changed their destination to subway stations that remained open and others used the ferries. The subway also experienced an influx of passengers from the at-grade rail network as the subway still had open stations within walking distance of Lower Manhattan. When the subway tunnel was reopened in September 2002 patronage returned to pre-attack levels.

Many of the streets in Lower Manhattan had chronic pedestrian congestion prior to 11 September 2001. After the attack, pedestrian congestion was reduced due to lower levels of overall activity in the area. Improvements were incorporated into new pedestrian infrastructure to spread the high volumes across broader paths.

### **5.4.3 1997 Hammersmith Bridge closure (London, UK)**

The Hammersmith Bridge in London was closed to private motor vehicles and heavy industrial vehicles in 1997 for repairs, as it was too weak to handle typical traffic levels of 30 000 vehicles a day. The bridge remained open to cyclists, pedestrians, motor bikes, emergency vehicles and buses while the repairs were undertaken (Rees and Williams, 1998).

In addition to the structural repairs, several complementary travel behaviour objectives were associated with closing the bridge to personal vehicle traffic. These were to:

- reduce growth in the length of motorised journeys
- reduce the reliance on the private motor vehicle
- encourage alternative means of travel which have less environmental impact.

### **Agency responses**

In addition to the closure, government agencies provided extra bus services and modified bus routes. The bridge became significantly more attractive to pedestrians and cyclists as private vehicle traffic was removed.

The bridge was reopened in 1999 to all traffic. In an attempt to maintain increased public transport patronage the local government planned to install new traffic signals and introduce bus priority measures to allow buses to bypass traffic queues. The Hammersmith Bridge was then bombed and closed once again in 2000. It was reopened four months later with a weight restriction of 7.5 tonnes in place.

### **Travel behaviour impacts**

Surveys were conducted before, immediately after and eight months after the bridge closure to identify changes in travel behaviour.

**Figure 15 – Changes in work and non-work trips and mode used as a result of bridge closure**

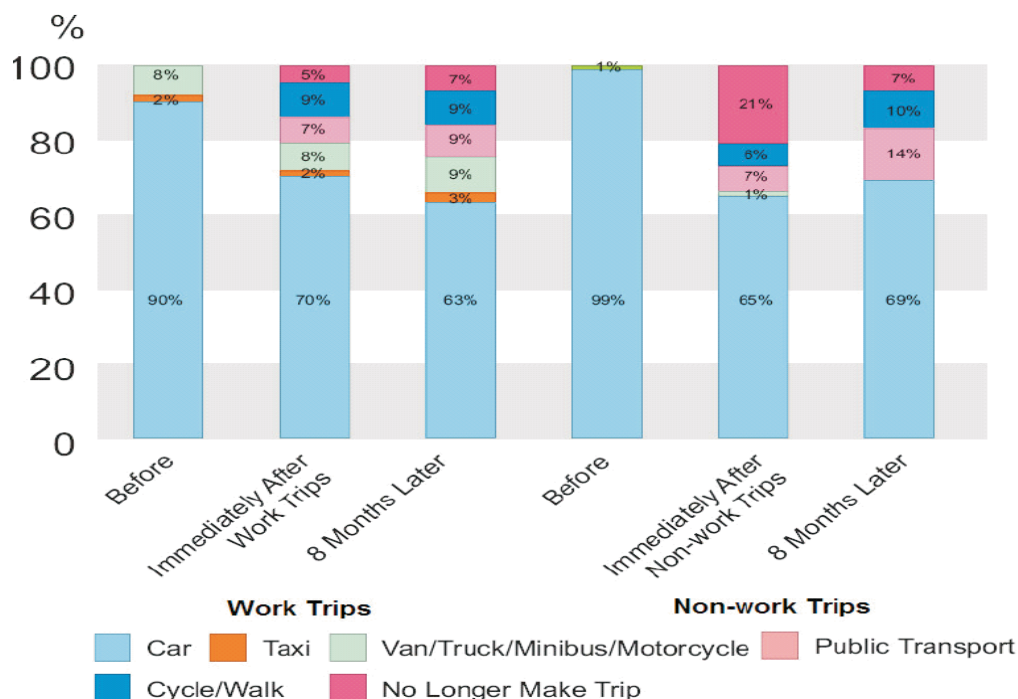


Figure 15 shows the proportion of all motor vehicle trips (work and non-work trips) that went to other modes at these times.

Of work-related trips:

- nine per cent transferred to public transport
- nine per cent transferred to walking and cycling
- others left work earlier or later, worked from home or rearranged appointments.

Overall, there was a 28 per cent drop in work-related motor vehicle use by respondents.

Travel behaviour change for non-work related trips was larger than for work related trips. Non-work related trips are generally more flexible, with greater opportunities to change the time or destination or to combine the trip with other activities or not make the trip at all.

Of the non-work related trips made:

- immediately after the restrictions, 21 per cent were not made at all
- within eight months of the closure, 14 per cent had transferred to public transport
- ten per cent transferred to walking and cycling.

Many respondents reported that they changed their shopping locations when the bridge was closed.

There is evidence that some local streets were suffering from increased congestion but the total volume of traffic over the broader network had reduced. Traffic reductions in the local area of up to 30 per cent or 10 000 vehicle trips/day were recorded, against a three to four per cent traffic growth in London over the same period.

Buses benefited with a 37 per cent decrease in wait times and a patronage increase of 23 per cent (1.2 million passengers per year). These benefits were achieved despite the weight restriction allowing only one bus at a time over the bridge in each direction. Patronage increases resulted in more occurrences of overcrowding and an increase of complaints.

Conditions were also significantly improved for pedestrians and cyclists. Each day 1158 cyclists used the bridge up from 815 pre-closure. Before and after pedestrians counts were not undertaken but it was observed that numbers had increased substantially.

#### **5.4.4 1995 Hanshin Awaji earthquake (Kobe)**

The Kobe Earthquake occurred in 1995, killing 5,300 people and devastating the densely populated region in Japan. Most of the transport network including all major highways and rail links between Kobe and Osaka were destroyed, causing a dramatic decline in vehicle traffic (Bureau of Transportation Statistics, 1996). The major rail and highway network in the area was fully restored in six months and traffic resumed pre-quake patterns within another month. Prior to the earthquake about 80 per cent of commuting trips were by public transport (Chang and Nojima, 1999).

##### **Agency responses**

The rapid replacement of highway and rail infrastructure was the priority management response.

During reconstruction, agencies:

- restricted many highways to emergency vehicles
- established exclusive bus lanes
- substituted shuttle buses for rail services along damaged rail lines.

The strategies helped to maintain patronage but resulted in significant increases in travel time and reductions in service levels. Priority infrastructure replacement did however allow the recovery to progress quickly, reducing the duration of disruption to travel, trade and daily life.

##### **Travel behaviour impacts**

Within the impacted area, activities became more localised and some trips were cancelled. Post incident analysis revealed that non-work travel could be reduced by about 65 per cent for extended periods during transport disruptions, this is accompanied by a shift away from motorised modes to walking and cycling.

People in non-impacted and minor impacted areas showed no significant change in trip frequency but did shorten their trip length.

Only 52 per cent (235,400 out of 449,800) of the average daily vehicle counts were present shortly after the earthquake on all major expressways and alternative routes in and outside the affected area (Chang and Nojima, 1999). This large amount of 'disappearing traffic' is attributed to the substantial decrease in roadway capacity (Cairns et al, 2001).

As capacity to highways was replaced, traffic began to return to pre-quake travel patterns and modal share.

#### **5.4.5 1994 Northridge earthquake (Los Angeles)**

The Northridge earthquake in Los Angeles in 1994 caused significant damage to four critical freeways (Bureau of Transportation Statistics, 1998). The earthquake occurred on a national holiday, with little traffic on the roads at the time. In the first week of the disaster, many businesses and schools were closed, reducing the demand on the freeway network. Many people also stayed at home to repair their own earthquake damage. Following this, traffic volumes increased steadily as more people returned to work.

The damaged highways had combined average daily trips in 1993 of 645 000 vehicles. In Los Angeles County, approximately 85 per cent of workers commute by private motor vehicles and only 6.5 per cent rely on public transport (US Department of Transportation, 2002, p.4-5).

## Agency responses

The Californian Department of Transport (CALTRANS) implemented emergency measures as a priority, followed by transportation recovery plans which included the:

- deployment of traffic management teams to inspect and implement closures and detours, remove debris and demolish highways
- establishment of the CALTRANS traffic management centre (TMC) as the regional communication hub, providing up-to-date information on closures, detours and reconstruction activities distributed through the TMC to public officials, media and other agencies
- decision to immediately replace damaged highway infrastructure.
- The TMC sent out messages to persuade commuters to:
  - stagger working hours
  - avoid the Northridge area completely (long-range travellers not destined for Los Angeles)
  - not drive cars at all if possible.

Intelligent transport systems were used to maximise capacity by adjusting signal timing on detour routes and using VMS and highway advisory radio to communicate traffic information. A number of detours were designated for HOVs to encourage carpooling. These were supported with rideshare matching programs and carpooling networks.

Public transport improvements were implemented to reduce the number of vehicles travelling. These included:

- additional rail services along freight rail lines
- extra rail carriages and buses
- additional bus routes and services
- extra park and ride sites
- ticket price reductions
- some free shuttle services provided by businesses for their employees.

## Travel behaviour impacts

A range of behaviour changes were recorded on the different highways during reconstruction, the nature of which depended upon the local context.

Along one highway there were limited alternative routes or public transport services available, resulting in significantly increased delays. Delays stabilised after two months as people experimented and gradually found the most viable alternatives. The most common behaviour change was the changing of departure times to before 6.00 am and after 8.00 am and eliminating unnecessary trips (Bureau of Transportation Statistics, 1998).

Another highway had limited alternative routes but was adjacent to a rail line. Rail experienced a significant increase in patronage from 850 passengers to 22 000 a day. The majority of new riders reported intentions to continue using the train to avoid congestion, reduce stress and take advantage of employer incentives. Despite these intentions, patronage decreased steadily as the reconstruction progressed.

Two other highways had many alternative routes available allowing people to continue to drive without excessive inconvenience. This limited the extent of patronage increases for bus services. All detours were relatively well used except for HOV transfers, which were not as high as expected.

Once capacity was restored, traffic patterns reverted to pre-incident levels, with minor residual increases for the alternative modes. The reasons for this pattern include:

- the network was reconstructed quickly, preventing establishment of long-term behaviour changes.
- delays during reconstruction were not generally substantial enough to precipitate a major change in travel mode
- Los Angeles has decentralised activity centres, requiring diverse travel patterns unsuited to high levels of public transport and HOV use.

### 5.4.6 1975 Tasman Bridge collapse (Hobart)

On 5 January 1975, the ship 'Lake Illawarra' hit the Tasman Bridge and demolished two bridge piers, resulting in the collapse of three spans of the bridge. Seven ship crew members and five motorists were killed.

In 1975 a majority of the population of metropolitan Hobart were concentrated on the western shore of the Derwent River, together with the major commercial and industrial areas. The remaining population lived on the eastern shore. Over 80 per cent of employed eastern shore residents worked on the western shore, using the Tasman Bridge as the primary commute route. In addition to this, the Tasman Bridge carried trunk water and telecommunication infrastructure (Australian Road Research Board, 1998).

#### Agency responses

Response to the incident was rapid with notification through police, radio, and telephone. Identified internal organisational issues were addressed well but mass coordinated responses were constrained by communication difficulties.

Additional ferries were located and began services the following day. Additional passenger rail and connecting bus services were scheduled. The rapid establishment of alternative transport arrangements significantly reduced the potential short term impact on the community.

A Bailey bridge was constructed after the collapse about six kilometres up the Derwent River. It was hoped that the new bridge would create a more direct link to the CBD, compared with the Bridgewater Bridge which required a 50 kilometres detour. Unfortunately the new location, constrained capacity of the bridge, and poor connecting roads meant it could not fulfil many of the functions of the Tasman Bridge.

#### Travel behaviour impacts

Total daily person movements across the Derwent River decreased by 30 per cent (10 000 person movements) post collapse. Peak period travel was also reduced and major changes in mode and route of travel occurred. The majority of travellers made multimodal journeys utilising ferries and some travelled via Bridgewater. Hourly ferry capacity increased from 400 to 13,500 through the construction of additional terminals and provision of extra ferries (Australian Road Research Board, 1998). An adjacent sports ground was converted to a car park.

The incident resulted in major increases in traffic flows on roads not designated for such volumes. A number of capacity upgrades were undertaken in response.

Other affects included:

- premature retirements
- transferred employment from one shore to the other
- relocation within multi locational organisations
- flexible working arrangements implemented by a number of organisations.

The collapse accelerated the decentralisation of Hobart and the development of a high degree of self-sufficiency on the eastern shore. Over 65 per cent of retail purchases by eastern shore residents pre-collapse were made in the Hobart CBD (Australian Road Research Board, 1998, p.26). Following, there was a substantial decline in the usage of Hobart CBD outlets with a corresponding increase in the patronage of eastern shore shops.

*2A Bailey bridge is a portable pre-fabricated truss bridge, designed for use by military engineering units to bridge up to 60 metre gaps.*

When the bridge reopened in October 1977, peak bus patronage rose to 3,375, above the pre-collapse and predicted levels. However, overcrowding was reported and with no supply response, the bus patronage quickly tapered to the capacity of 2,900. Six months after reopening, total peak period cross river trips were still eight per cent less than they had been prior and the number of private motor vehicle trips was 14 per cent lower than previously.

A number of studies into the collapse and response, designed to improve responses to future disruptions, have made recommendations on the:

- restriction of private vehicle use
- alteration of traffic signal phasing
- encouragement of flexible working hours to reduce peak traffic volumes
- alteration of bus schedules, with the provision of park and ride facilities, express services and coordination with ferry schedules
- provision of ferries
- upgrading of access to alternate routes
- establishment of transit lanes for buses and other high occupancy vehicles
- preparation of a development plan for the region to better plan location of facilities and residential growth.

#### **5.4.7 List of articles cited in case studies**

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## **5.5 Conclusions**

The following observations highlight the most important findings of the international case study research across the areas of how agencies respond and how people modify their travel behaviours to adjust to transport network disruptions.

### 5.5.1 Agency responses

#### Safety is the most critical management concern

In times of crisis, all agencies undertake an emergency response first and consider transport network impacts second. Acting to save lives by closing infrastructure as a precaution is the expectation of communities. More serious consequences occur if a vulnerable piece of infrastructure remains in use and fails later, with potential loss of life. The Laval Overpass collapse for example, demonstrated these serious consequences.

#### Restrict SOV and extend HOV to increase capacity

In all case studies, government agencies instigated some form of discouragement or restriction to single occupant vehicles (SOVs). This often included the introduction or extension of HOV transit and bus lanes and bus priority measures. Public transport services were increased or extended and additional park and ride sites were made available. These responses were aimed at decreasing the number of vehicles and associated congestion across the network. The success of these measures was mixed, dependent on the extent of time savings afforded to the buses and HOVs, the extent of concentrated versus dispersed trip destinations and the availability of additional public transport vehicles and staff.

#### Real time traffic incident management systems are vital

Intelligent transport systems have been used to reduce congestion during disruptions in the following three ways:

- Travel time information: inform motorists before and during trips of which routes to use and what to expect
- Dynamic traffic signal coordination and emergency vehicle access and bus priority (traffic flow priorities). Where adaptive control is available, they have been used to adjust traffic signal timing and priorities to optimise the re-routed traffic flow, minimise delays and reduce the need for police to control intersections
- Improved incident response and management: rapidly locate and respond appropriately to secondary incidents that would otherwise cause additional delays.

#### Non-transport organisations help

The media and many other organisations support the efforts of transport agencies to inform travellers of transport options and encourage use of alternative modes. All organisations can adjust their own activities to reduce, relocate or spread demand on the network. Workplaces often provide flexible work arrangements and those with existing travel plans utilise the opportunity to support alternative modes so staff are better able to avoid traffic congestion.

### 5.5.2 Travel behaviours

#### People can respond quickly

Behaviour change varied widely because of differences in the extent and nature of disruption and opportunity to utilise alternatives. The most common changes were route changes, retiming of trips (usually earlier) and mode substitutions. People tend to make rational choices based on the perceived opportunities available to them and are able to maintain the new travel behaviour until the capacity is reinstated and a more convenient/shorter trip becomes possible again.

#### Activities will become more local

The inability to reach some destinations and the inconvenience of travel delays result in more people choosing local destinations. The substitution of local destinations is higher amongst the more discretionary non-work trips and is accompanied by increases in walking and cycling. Convenient and safe local walking and cycling paths and end-of-trip facilities therefore lead to better outcomes when disruptions occur. Improved local walking and cycling paths also improve access to public transport.