APPENDIX C

Traffic Study and Economic Analysis

Traffic Study and Economic Analysis for Route Selection Study Second Bridge Crossing of the Clarence River, Grafton.

Prepared for
RTA Project Services
Northern Region

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19 December 2003

Contents

1 EXECUTIVE SUMMARY

This traffic study provides sufficient information and analysis in order to distinguish between various crossing localities under consideration.

The traffic study shows that the main traffic flows across Grafton Bridge are to and from Grafton. Refer to Figure 1 and Table 1. Of the 27,000 vehicles that used the bridge on the survey day 1000 (3.7%) also travelled through Junction Hill. Of these 1000 trips approximately 100 were to/from the north on the Pacific Highway and 220 to/from the south on the Highway. Only 9 to/from the north and 14 to/from the south on the Highway were heavy vehicles. The rest either originated in South Grafton or came from the west along the Gwydir Highway.

Approximately half of these 1000 trips were 'through traffic' that did not stop or were (local trips) vehicles that showed up more than once in the survey period.

Only 30 of the 400 trucks using the bridge on the survey day were 'through traffic'. It is estimated that 10% of 'through traffic' are heavy vehicles after allowing for some additional through trucks at night.

Traffic volumes on the Grafton Bridge vary across the week. Figure 1 shows daily traffic flows together with vehicle composition for the week ending Sunday 21 September 2003. Buses are included in the light commercial category.

Figure 1

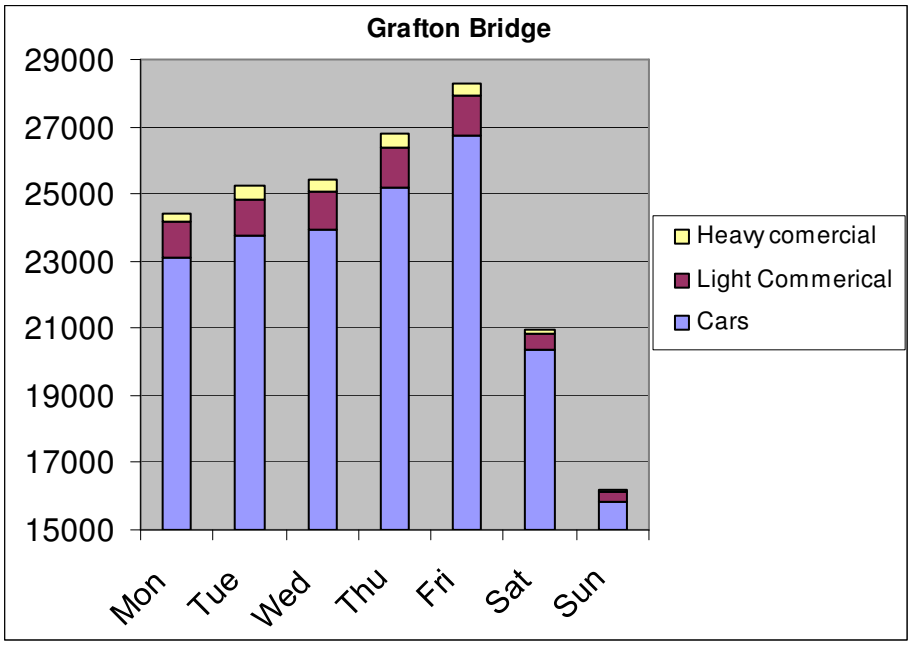


Table 1 - Origin and Destination Survey Results

24 hour Trips	Vehicle Type	Northbound	Southbound	Comment
All vehicles at Junction Hill on survey day	Car Bus Light Commercial Heavy Commercial Total	1380 14 95 110 1599	1369 14 143 98 1624	Obtained from Classification counters
Vehicles using Grafton Bridge and passing through Junction Hill on survey day	Car Bus Light Commercial Heavy Commercial Total	395 9 46 50 500	395 9 46 50 500	Includes vehicles doing repeat trips and no limit on trips time.
THROUGH TRAFFIC Vehicles using Grafton Bridge and Junction Hill on survey day	Car Bus Light Commercial Heavy Commercial Total	156 2 34 14 206	155 2 33 15 206	Excludes vehicles doing repeat trips. Travel time < 25mins from bridge & 45mins from Pacific Hwy.

The figure of 26,000 vehicles per day on the bridge has been used for analysis purposes because it reflects typical weekday traffic flows. Daily volumes during the survey week progressively increased from 24,000 on Monday to 28,000 on Friday. Weekend volumes were considerably lower.

This data has been used to predict future volumes on various crossing localities being considered.

Locality 1 will attract a reasonable volume of traffic (10,000 vpd leaving 16,000 on the existing bridge). Refer to Table 2. Traffic will disperse at Fitzroy Street but there will be increased volumes in Prince Street that would otherwise use Villiers Street. Comparison of traffic flows at the Villiers Street roundabout shows that approximately twice as much traffic comes to / from the Prince Street precinct from the Bridge than to/from the Villiers Street area.

The crossing would not attract much Pacific Highway traffic due to distance, possible delays associated with parking in the CBD and viaduct height restrictions. However, it will attract some South Grafton traffic and almost all of the Gwydir Highway traffic.

A second crossing at this locality would encourage traffic onto the main street (Prince Street) and this raises safety and amenity issues. It is likely that traffic management measures would be necessary to ensure that the Prince Street shopping environment remains compatible with business activities.

Measures such as diverting trucks via Duke Street may need to be considered. This would possibly result in trucks continuing to use the existing bridge.

Locality 2 will attract considerable traffic (11,000 vpd) off the existing bridge, due to its proximity to the existing bridge and the Pacific Highway. Much of the South Grafton traffic and almost all of the Gwydir Highway traffic would be attracted.

For the purposes of the analysis it is assumed that the road connection in this locality is via Villiers Street.

Some traffic would use Victoria Street to disperse prior to entering the Villiers Street / Fitzroy Street roundabout. This would have some benefits for the intersection but the additional traffic in Victoria Street will have impacts on parking and safety.

Traffic volumes in Villiers Street to the north of Fitzroy Street would not necessarily increase to any significant degree.

Locality 2 will need the Villiers Street approach widened to 2 entry lanes into the roundabout at Fitzroy St to achieve a LOS 'C' in 30 years. The left turn lane from Clarence Street onto the bridge will need to be retained or queuing will develop in Villiers Street in the afternoon.

There will be less traffic entering the Fitzroy St roundabout compared to Locality 3 because some traffic will use Victoria Street. This will mean slightly less congestion at the roundabout in the long term.

A second bridge located adjacent to the existing bridge (Locality 3) provides the highest traffic benefits of the crossings considered due to two travel lanes being available in both directions. Other localities have a single lane flow in each direction on two bridges. The differences are shown in the level of service calculations where a 4 lane facility provides better travel conditions – freedom to manoeuvre, ability to pass slower vehicles, extra capacity. However, the impact on existing intersections is greater because Locality 3 centralises traffic flows. Other localities distribute traffic more widely.

Modelling shows that the Villiers Street / Fitzroy Street intersection will operate up to a LOS 'C' under its current configuration within the 30 year period. Additional lanes or a change to traffic signals may ultimately be necessary depending upon traffic growth and operational issues at the intersection.

Retention of the Clarence Street access onto the bridge would be necessary to help relieve traffic congestion in the long term at the Villiers Street / Fitzroy Street intersection. With two lanes in each direction on the bridge, the impact of traffic 'pushing in' to travel south in the afternoon will be minor. The left turn lane from Clarence Street onto the bridge needs to be retained or the LOS at the Villiers Street roundabout will drop to 'F' in the afternoon with queuing in Villiers Street.

Intersections on the southern approach, Bent Street at Through Street and at Ryan Street, are shown to function satisfactorily but may also require traffic management within 30 years. Again the replacement of the roundabouts with traffic signals is a long term option.

Downstream crossings (Localities 4 to 7) have some traffic management appeal as they provide a direct connection to the north of Grafton and the Summerland Way from the Pacific Highway. Localities 4 and 5 provide a direct connection to the future development area of Clarenza where three schools are located. These crossing locations would attract many school buses off the existing bridge. Currently 270 buses use the bridge each day.

The attractiveness for traffic of downstream localities diminishes as the distance for a second crossing increases from the existing bridge. The volumes that would be taken off the existing Bridge ranges from 6,000vpd at locality 4 reducing to 3,000vpd at locality 7, Elizabeth Island. Table 2 shows that the downstream localities will attract traffic at a higher rate over time due to development at Clarenza and to the north.

These four localities will generate additional travel on the Pacific Highway even though there will be some reduction in travel distance for traffic to and from the north. The safety implications of additional local travel on the Highway and an

additional intersection on the Highway are important. It would be desirable to minimise the mix of local and through traffic movements on the Highway.

Traffic volumes will increase on local road connections for the downstream localities giving rise to road safety and amenity impacts. These localities will increase traffic flow past residences and sensitive developments such as nursing homes and Grafton Hospital. For the purposes of the analysis existing traffic volumes have been estimated up to 3000 vehicles per day on potentially affected local roads where counts are unavailable. As a guide Oliver Street west of Prince Street carries almost 2000 vehicles per day.

Table 2 showing changes in traffic flow

Criteria	Do Nothing	Locality 1	Locality 2	Locality 3	Locality 4	Locality 5	Locality 6	Locality 7
1. Transport and Traffic								
Volumes on crossings **2003**								
New bridge	-	10000	11000	13000	6000	5000	4500	3000
Existing bridge	26000	16000	15000	13000	20000	21000	21500	23000
Volumes on crossings **2033**								
New bridge	-	12000	13000	17000	10000	9000	8000	6000
Existing bridge	34000	22000	21000	17000	24000 **	25000 **	26000 **	28000 **
** Traffic on the existing bridge may not exceed 24,000 because it may transfer to other routes to avoid peak hour delays.								
Level of Service year **2033** peak								
New Bridge	-	D	D	C	C	C	C	B
Existing Bridge	F	E	E	C	E	E	E	E/F
Based on Florida DOT model for Urban Conditions with 8.4% peak hour flows and 63% tidal flow. Los A= Very Good, Los F= Very Poor, Los C is the project objective.								
Average weekday traffic in streets forming possible connection to localities.		Sth of Fitzroy	Sth of Fitzroy		East of Villiers	East of Villiers	East of Villiers	East of Villiers
Existing traffic volumes **(2003)**	-	5000	3000	26000	3000	3000	3000	3000
Volumes with Do nothing **(2033)**	-	6500	3000	34000	3000	3000	3000	3000
Volumes with new bridge **(2033)**	-	18500	16000	34000	13000	12000	11000	9000
Total Large Trucks **2033**								
New bridge	-	130	270	250	260	260	240	190
Existing bridge	500	370	150	250	240	240	260	310
Light trucks and buses excluded								

All crossings will be designed in a way to maximise safety. However, it is difficult to accurately predict accident savings due to the high number of variables. As an indication of the safety performance of each option an estimation of future traffic flows on existing and possible future major roads has been made across the network within the Grafton area. Existing accident rates have been calculated and applied to the change in traffic flow over the main routes. Estimated accident savings for a 5 year period are shown in the Table 3. For example, an accident saving of –5.0 means that 1 accident per year would be saved.

Those options that involve an increase in accidents results from additional traffic being allocated to sections of road with higher accident numbers, ie Pacific Highway between the Gwydir Highway and Duncans Lane and parts of the Gwydir Highway.

The accidents included in the analysis are the more serious accidents that involve injury or tow away. Minor collisions are not shown in the RTA database. Table 3 relates to the safety performance of each locality.

Table 3 Difference in Safety Performance across all major routes

Criteria	Do Nothing	Locality 1	Locality 2	Locality 3	Locality 4	Locality 5	Locality 6	Locality 7
5 Year Accident Savings **								
2003		-6	-8	-12	+2	+4	+1	-3
2013		-7	-9	-13	+3	+5	+1	-4
2023		-7	-9	-14	+3	+5	+1	-5
2033		-8	-10	-15	+4	+6	+2	-6

** The change in accident savings is shown every 10 years and relates to a 5 year period.

An economic analysis was carried out on the outputs from the traffic model. Table 4 contains a summary of the results.

Table 4 Economic Analysis Summary

Economics	**Do Nothing**	**Locality 1**	**Locality 2**	**Locality 3**	**Locality 4**	**Locality 5**	**Locality 6**	**Locality 7**
Return on investment								
Project Cost (Strategic Est)		$45m	$45m	$40m	$45m	$40m	$50m	$55m
Benefit cost ratio @7%		1.49	1.44	2.02	1.06	0.94	0.57	0.14
First year rate of return 7%		9.7%	9.2%	12.9%	5.6%	5.1%	2.4%	0.0%

The benefits are derived from improvement in travel time, reduction in travel distance, savings in terms of fuel, wear and tear etc and from reduced accidents. Both construction costs and accrued benefits were discounted to current day dollars to provide a benefit cost ratio. The first year rate of return shows the percentage return on investment (cost of the project) in the first year of operation after completion.

2 Introduction

Roadnet Pty Ltd has been engaged by RTA Northern Region to carry out a traffic study for a possible second crossing of the Clarence River at Grafton. This traffic study will form part of the Route Selection Study being prepared by RTA Northern Region and aims to provide sufficient information and analysis in order to distinguish between various crossing localities under consideration.

The traffic study provides an assessment of potential bridge crossing sites of the Clarence River to improve the quality of access to Grafton and in particular reduce congestion problems on the existing Grafton Bridge.

The evaluation has been carried out with consideration of area wide traffic flows for existing and future conditions.

The traffic study examines the distribution of traffic associated with providing a new bridge at the following localities.

Locality 1	Prince St Locality
Locality 2	Villiers St Locality
Locality 3	At the existing bridge
Locality 4	Bacon St Locality
Locality 5	Dobie St Locality
Locality 6	Arthur St Locality
Locality 7	North St Locality

The assessment of these localities has been carried out by distributing traffic across the different road networks created by the new links. A spreadsheet traffic model of the study area was developed to assist in the calculations. The model takes account of factors such as safety performance, travel times, road user costs and maintenance costs. The difference in cost per trip between the existing traffic conditions and the new arrangement for each locality was calculated. The performance of the road network, including intersections, is assessed for 30 years.

The outputs from the model provide data that are used in benefit cost analysis. The analysis contained in this study essentially provides a ratio of benefits over costs. Traffic growth was calculated over a 35 year analysis period to generate a benefit stream for 30 years after opening.

The analysis process and summary of results are discussed in detail in this report. Outputs from the model and analyses are contained in the Appendices.

INSET LOCALITIES MAP Figure 2

2.1 Scope

The following tasks formed the main part of the traffic investigations.

- Consideration of urban growth in the Grafton locality and in nearby centres.
- Consideration of traffic issues raised by the community during the consultation process.
- Consideration of future traffic growth and needs up to 30 years.
- A review of existing data and collection of additional traffic data.
- Formulation of a traffic model.
- Use of the model to analyse various localities.
- A benefit cost analysis on the basis of the modelling outputs and cost estimates contained in this report.

The study contains more detailed analysis than the Feasibility Study but is still at a network level for this route selection stage. The data contained in the study needs to be sufficient for decision making, ie to distinguish the differences between options.

2.2 Methodology

This traffic study is based on a combination of existing traffic data collected over many years and documented in the Feasibility Study plus additional traffic survey data recently acquired. Additional traffic counts, travel time and origin and destination surveys have been conducted to update the data used in the Feasibility Study.

A traffic model has been formulated using the Microsoft Excel spreadsheet program. It is a strategic assessment that quantifies the differences in traffic performance between the existing bridge and new bridge crossing options. The model is essentially constructed in the following way.

Daily traffic counts based on 15 minute intervals were used to determine traffic periods for a typical day. Four periods were established Peak, Business, Offpeak and Night. Travel times were measured and a speed / flow algorithm calculated for the existing bridge and approaches. The speed / flow algorithm was applied to the various bridge options considered. In addition, it provided a basis for assessing peak flow capacity, which means that peak traffic periods will become longer to provide for future increases in traffic. Growth in traffic has been calculated on the conservative basis of 1% linear. This growth rate has been reviewed using census data, long term traffic counting data and consideration of future growth including road freight movement trends.

Travel patterns have been established from an origin and destination survey which tracked sample vehicles from the Pacific Highway, across the Grafton Bridge, at Dobie Street and at Junction Hill. Total traffic was counted on the Bridge. Intersection traffic counts at Ryan and Bent Streets and Spring and Bent Streets were used to apportion the remaining traffic from South Grafton and west along the Gwydir Highway.

The Grafton area was divided into zones and a centroid identified in each. It was assumed that all traffic travelling between zones passed through these centroids. The attractiveness of the zones within Grafton was estimated from the 2001 Census population and employment data.

Population growth in various areas was estimated in consultation with Grafton City Council. The changes in the origin of future trips over time were incorporated into the traffic model.

Changes in traffic conditions were calculated for each 5 year period up to 35 years to obtain benefits for 30 years after opening. Costs (from RTA Economic Analysis Manual, year 2002 costs) were applied to these traffic conditions and aggregated over a 30 year time period. The costs include travel time and road user costs (fuel, wear and tear etc). Accident costs were added separately.

An economic analysis was carried out on the outputs from the traffic model. Both construction costs and accrued benefits were discounted back to current day dollars to provide a benefit cost ratio. These factors were examined using various discount rates for sensitivity purposes.

Accidents for the period 1997 to Sept 2003 inclusive were plotted onto a map of the locality and analysed to determine trends. Accident savings were predicted for each bridge locality examined. These savings were included in the benefit cost analysis.

Traffic impacts on the road approaches and on the general locality of each crossing option was assessed. This was done by adding predicted traffic to the new road network and modelling the level of service of road capacity and intersection capacity. Intersection treatments associated with each option have been estimated for the purposes of the traffic analysis to ensure that the road system will function adequately. These treatments may change with further investigation after a preferred locality has been selected.

Traffic issues identified during the planning process have been addressed in this report to a level of detail sufficient to distinguish the differences between localities.

2.3 Traffic Issues

Traffic issues have been identified from the following sources:

- Feasibility Study
- Community Focus Group
- Community Workshops
- Community and Business Owner Interviews
- Liaison with Grafton City Council and Government Agencies
- Submissions and letters from the Community
- Site inspections.

The main traffic and safety issues are shown in the following:

- Delays on the existing Grafton Bridge during peak hours.
- Height restrictions - viaducts
- Safety on the Bridge and connecting roads
- Emergency vehicles – access across the bridge – lack of alternative access
- Heavy vehicles – existing and future volumes – impact on delays
- Heavy vehicles – remove from the town and residential streets
- Impact of Bridge kinks on traffic flow –heavy vehicles and buses
- Capacity of road approaches – intersections –connecting roads
- Impact of Clarence Street traffic on bridge approach traffic flow
- Linking Summerland Way to remove through traffic
- Impact of future development on traffic flows – residential areas and possible commercial development at South Grafton
- Is there a need for a new bridge at this time
- What will be the effect of changed traffic patterns resulting from a bridge in a new location
- Access for pedestrians and cyclists
- Will delays be transferred from the bridge to nearby intersections following the construction of a second crossing.

2.4 Road Hierarchy

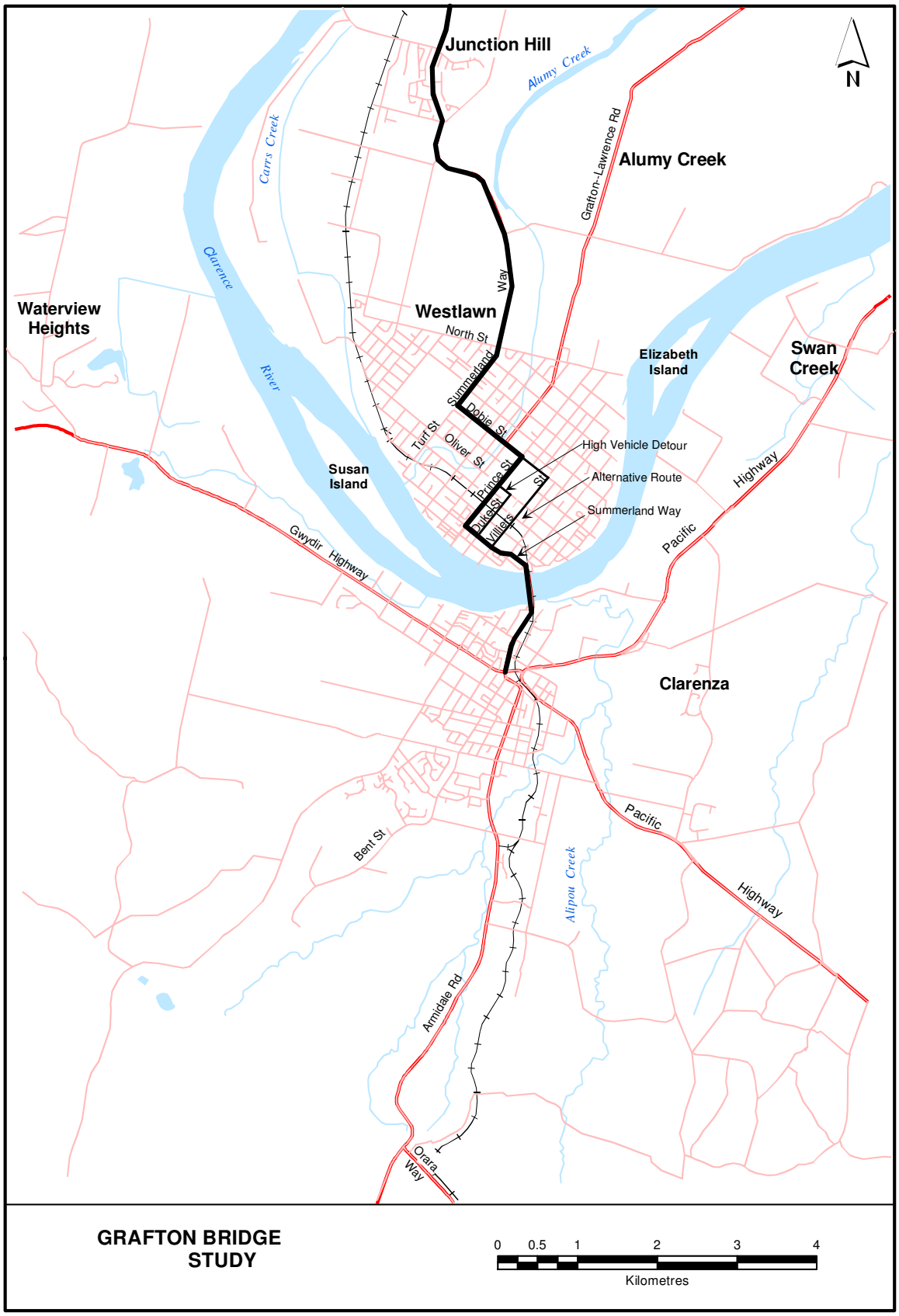
All crossing localities under consideration must fit into the existing road hierarchy for Grafton City. Refer to Figure 3 – Locality Plan. Each will attract different volumes of traffic and will have different impacts on the crossing localities and adjacent streets. A description of the road hierarchy for primary routes is contained in the following to set the context of the project.

The Pacific Highway is the main north south route passing through the area. The Gwydir Highway is an east west State Route linking the Pacific Highway with the New England and Newell Highways. It joins the Pacific Highway at South Grafton.

The Summerland Way (Main Road No 83) runs in a northerly direction from the Gwydir Highway via Bent Street, Grafton Bridge, Craig Street, Fitzroy Street, Prince Street, Dobie Street and Turf Street and then through Junction Hill to Casino, Kyogle and beyond into Queensland.

Villiers Street is a signposted bypass of Grafton's 'Main Street' - Prince Street section of the Summerland Way. Duke Street is another signposted alternative for High Vehicles due to height restrictions at the railway viaduct.

Figure 3 – Locality Plan



2.5 Cyclists

Grafton City Council has a bike plan for the city that is being progressively implemented and improved. The City has a number of off road cycleways eg Gwydir Highway, Rushforth Road, Grafton Bridge and Summerland Way. These will be mostly unaffected by the project.

On Road cycle routes that potentially could be affected by the project are shown in Table 5.

Table 5 On-road Cycleways

Cycleway	From	To
North Street	Turf Street	Cranworth Street
Kirchner Street	River	Villiers Street
Clarence Street	Oliver Street	Hoof Street
Kent Street	Pound Street	Oliver Street
Oliver Street	Kent Street	Turf Street
Hoof Street	Clarence Street	Turf Street

2.6 Pedestrians

Pedestrians are well catered for on the existing bridge with a footpath on both sides. No additional pedestrian facilities would be provided on a new bridge located adjacent.

A footpath would typically be located on one side of crossings located on all other bridge localities.

Pedestrian safety on the approach roads for localities other than duplication of the existing would need to be considered in detail at the concept development stage of the project. Issues such as travel speeds and the ability to safely cross the new routes in view of increased traffic flows would be important considerations.

3 Traffic Analysis

3.1 General

Applicable traffic survey data used for the Feasibility Study have been retained in this study. Additional traffic surveys were carried out in Grafton over the week ending Sunday 21 Sept 2003 to check and update the previous data.

3.2 Vehicle Occupancy

A vehicle occupancy survey was carried out on the bridge for the morning and afternoon peak periods in July 2002. This survey counted all vehicles and identified occupancy as well as estimating occupancy of buses. Table 6 shows the average car occupancy.

Table 6

Period / Direction	Average occupancy per vehicle	Percent of cars with 1 occupant (Driver only)
AM Peak Northbound	1.46	67%
AM Peak Southbound	1.34	74%
PM Peak Northbound	1.61	60%
PM Peak Southbound	1.56	61%
Combined	1.53	63%

This is generally consistent with the figure of 1.6 persons per vehicle used in the RTA Economic Analysis Manual for assessment of rural travel in NSW.

3.3 Travel Times

Table 7 shows travel times recorded for various traffic periods of the day for the section of Bent Street between Gwydir Highway and Villiers Street.

In high traffic periods one direction of travel is delayed considerably more than the other.

For the trip between Gwydir Highway and Villiers Street, a distance of 1.9km, the average travel time for both directions of travel ranges between:

2.3 minutes at 50kph in low traffic conditions (unimpeded flow) to

5.7 minutes at 20kph in maximum flow conditions eg 8:30 to 9:00 am and 4:00 to 5:00pm.

These times include normal delays incurred at the roundabouts on both ends. The travel time can fluctuate significantly from day to day depending upon volumes and incidents that affect flows. Refer to Figure 6 on page 21 that shows the variation in daily traffic volumes. The figure shows that volumes progressively increase from Monday through to Friday and have a variation of 4000 vehicles per day over the weekdays.

Table 7

Period	NORTHBOUND	SOUTHBOUND
am peak	7 min 30 secs (Average)	3 min 00 secs
am peak 8:30 to 9:00	Variable up to (9 min 50 secs max)	3 min 00 secs
pm peak	2 min 55 secs	5 min 00 secs
Business	2 min 50 secs	2 min 50 secs
Offpeak	2 min 30 secs	2 min 30 secs
Night	2 min 15 secs	2 min 15 secs

3.4 Delays

When a road is operating at or near its maximum capacity it eventually reaches a state of unstable equilibrium where high volumes can pass along the road but any small disturbance can sometimes cause a collapse of equilibrium. Queuing and delays result. Refer to Figure 4.

Once unstable flow conditions occur, a loss of effective capacity can result that tends to remain until traffic clears and the road returns to normal stable flow conditions. This is the current situation on Grafton Bridge.

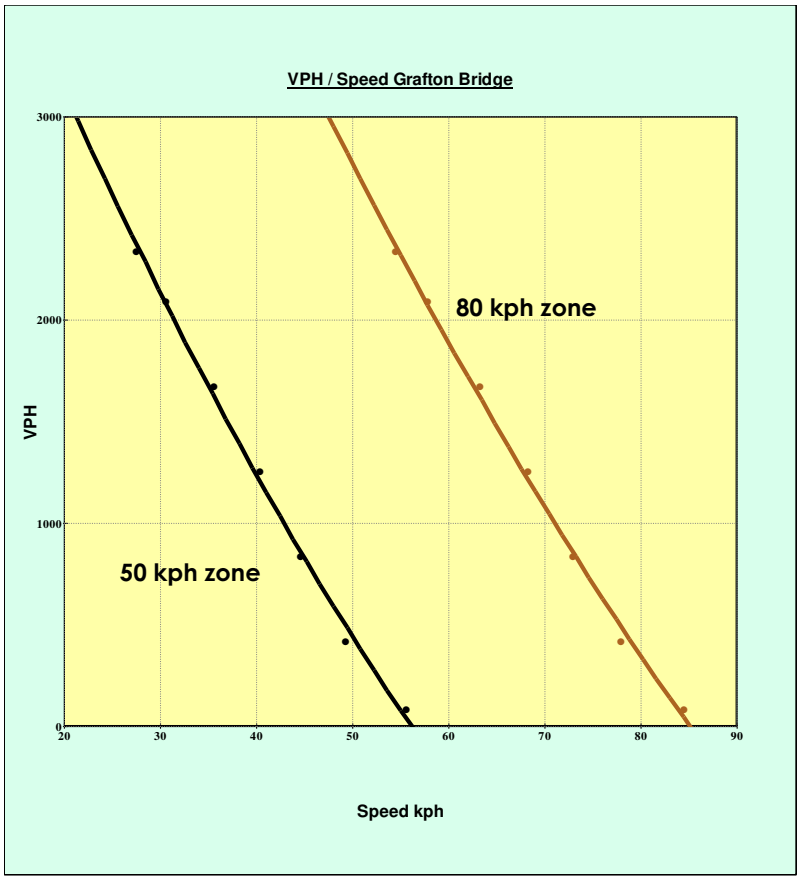
Abnormal events, where long delays occur will become more frequent and extend over longer periods as traffic volumes increase.

Accidents on the bridge (including minor crashes) can also be the source of significant delays while the roadway is being cleared because there is no alternative route. This is a major issue for emergency vehicles.

Existing congestion during peak hours has a number of social and business impacts. Local heavy vehicle operators have indicated that they avoid using the bridge during peak hours whenever possible. Some older drivers and less confident motorists have indicated that they avoid using the bridge because of the kinks and large vehicles. Tourists using the Pacific Highway would be dissuaded from entering Grafton due to the nature of the access across the River.

Indications are that there is a latent demand for the bridge during peak hours and in general due to these factors. It is difficult to quantify the latent demand however it is a reasonable proposition that a significant improvement in travel conditions to Grafton would generate additional travel on the bridge. This would provide increased opportunities for social and economic activity.

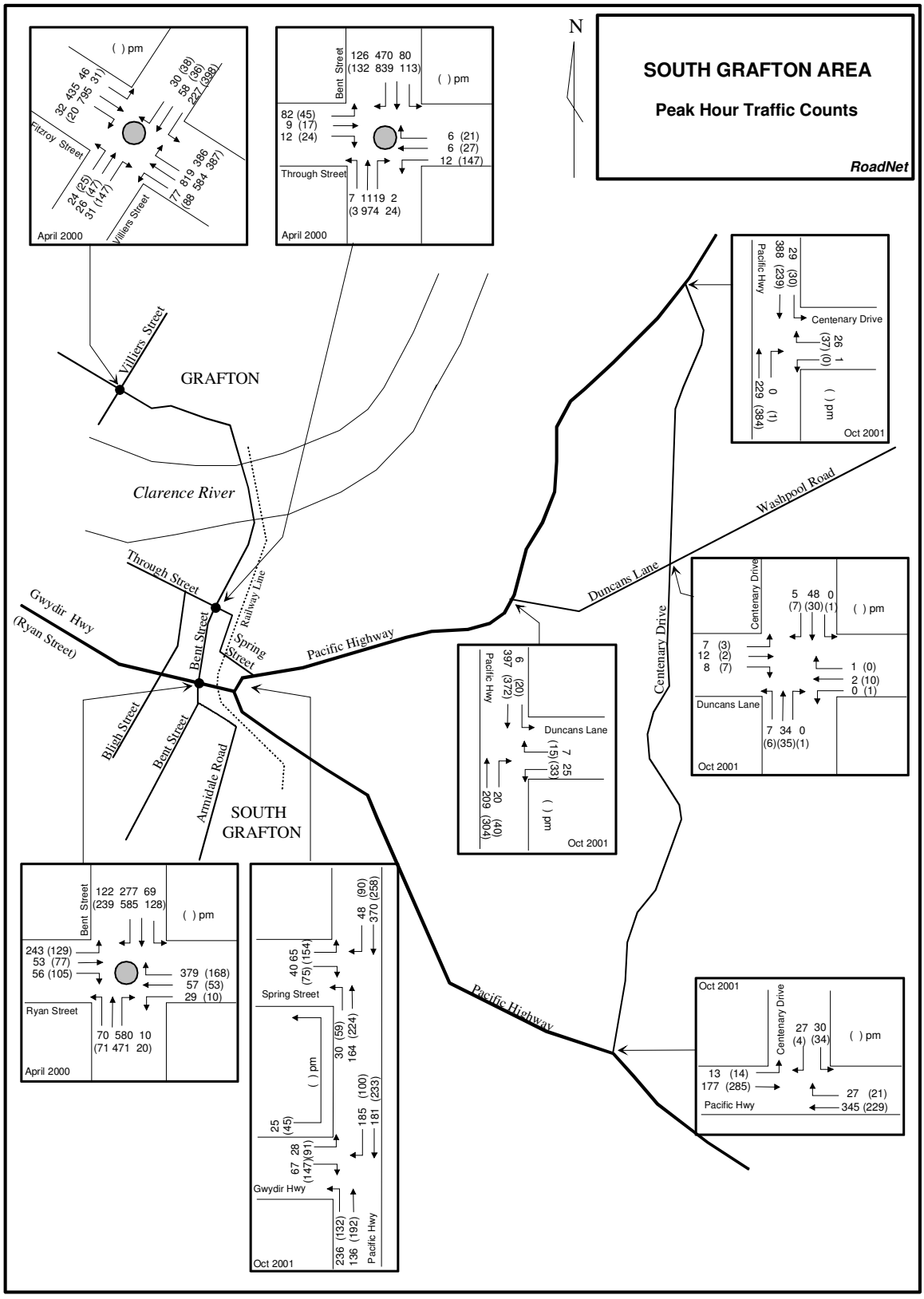
Figure 4



3.5 Peak hour traffic

Peak hour traffic counts were taken at a number of sites in the locality. A summary of these counts is shown below in Figure 5.

Figure 5



3.6 Origin and Destination Survey Sept 2003

Vehicle classification counters were installed for the survey week counting all vehicles in both directions. The survey locations are shown in Table 8. On Thursday 18 Sept 2003 a number plate survey was carried out to track heavy vehicles and a proportion of cars that turned off the Pacific Highway and travelled north through Grafton to the Summerland Way. The survey was carried out over a 12 hour period between 7am and 7pm. The assumption was made that southbound traffic would be the reverse of the survey traffic.

Table 8 - Survey Locations

Site	T All Trucks & Buses	C Red Cars	Number plate survey	Vehicle Classification Counts
Pacific Highway at Gwydir Hwy	T	C	Northbound in Pacific Highway turning into Gwydir Highway	No. Reliance on previous intersection traffic counts
Pacific Highway at Gwydir Hwy	T	C	Southbound in Pacific Highway turning into Gwydir Highway and Spring Street	No. Reliance on previous intersection traffic counts
Grafton Bridge	T	C	Northbound	Yes - 2 way
Villiers Street north of viaduct between Bacon and Oliver Streets	-	-	-	Yes - 2 way
Dobie Street West of Prince Street	T	-	1. Westbound In Dobie 2. Northbound in Prince and left into Dobie St	Yes - 2 way
Summerland Way Junction Hill north of Carrs Peninsula Rd	T	C	Northbound	Yes - 2 way
Dobie Street, West of Queen Street	-	-	-	Yes - 2 way
Oliver Street, East of Alice Street	-	-	-	Yes - 2 way

3.7 Number Plate Survey

Number plates were noted of all heavy vehicles (Austroads class 3 and above) and of all "red" cars. Red cars (Austroads class 1 and 2) make up approximately 12% of all vehicles. Accurate percentages have been obtained by comparing the total number of red vehicles recorded with the classification count on Grafton Bridge taken at the same time.

Each survey station had a minimum of two people at all times. Number plates were recorded by entering the plate numbers directly into an excel spreadsheet using laptop computers. One person entered the data on advice from one/two 'spotters' that would identify the number plate and tell the computer operator. The spotters would then check that the computer operator had entered all the numbers correctly.

Examination of the final data from all stations revealed very few anomalies.

3.8 Planning the Survey

Prior to the number plate survey Grafton City Council and all utility providers were contacted to request that works that may disrupt traffic flow or change normal travel patterns be deferred. All agencies cooperated and traffic patterns were 'normal' on the survey day.

Grafton City Council was carrying out sewerage repair work in Dobie Street during the week leading up to the survey day. The construction site was controlled by traffic signals and one lane was operating at all times. Council was contacted regarding the proposed survey. Council arranged for the reseal of the road to be done after Thursday and had the road open completely by Wednesday afternoon. Traffic volumes on Dobie Street may have been slightly down from Sunday to Wednesday but were back to normal by Thursday.

3.9 Traffic delays on the survey day

During the am peak at about 8:40, northbound traffic was queued form the bridge back onto Ryan Street to the railway viaduct. There did not appear to be any reason for this such as an accident or breakdown. A review of the data shows that the survey day was a high traffic day with almost 27,000 vehicles crossing the River.

A minor rear end crash occurred on the middle of the bridge at 13:05 creating queuing back to BI-LO for northbound and Prince Street and Pound Street for southbound. One lane of the bridge was blocked for approximately 15 minutes and it took about another 20 minutes for the traffic to become free flowing again.

3.10 Vehicle classification Counts

Vehicle classification counts were conducted for the week ending Sunday 21 Sept 2003. Vehicle types were obtained from tube counters installed on the road. These consist of two tubes that send pulses to a roadside computer that can determine the type of vehicle from its axle configuration. The counters also count total vehicles.

The counters were checked the day before the number plate survey and were found to be working properly except for the Oliver Street counter which was only collecting total volumes, not vehicle classification. The tubes were reinstalled and data collected for an additional 3 days to obtain classification data during the following week.

The daily volumes along with type of vehicles for Grafton Bridge and Summerland Way, Junction Hill are shown in Figure 6 and Figure 7. Additional counting information is contained in the appendices.

Figure 6

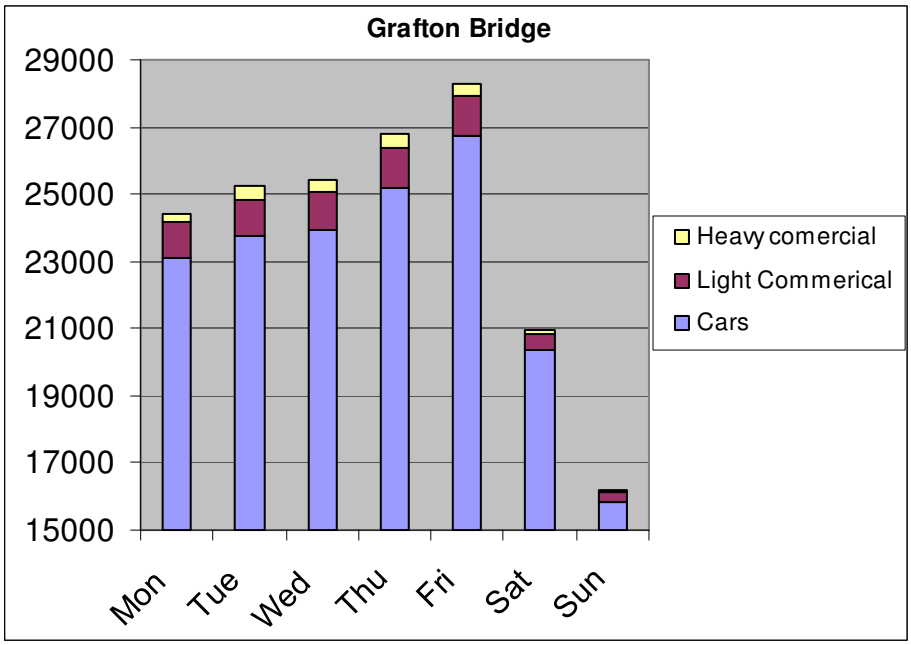
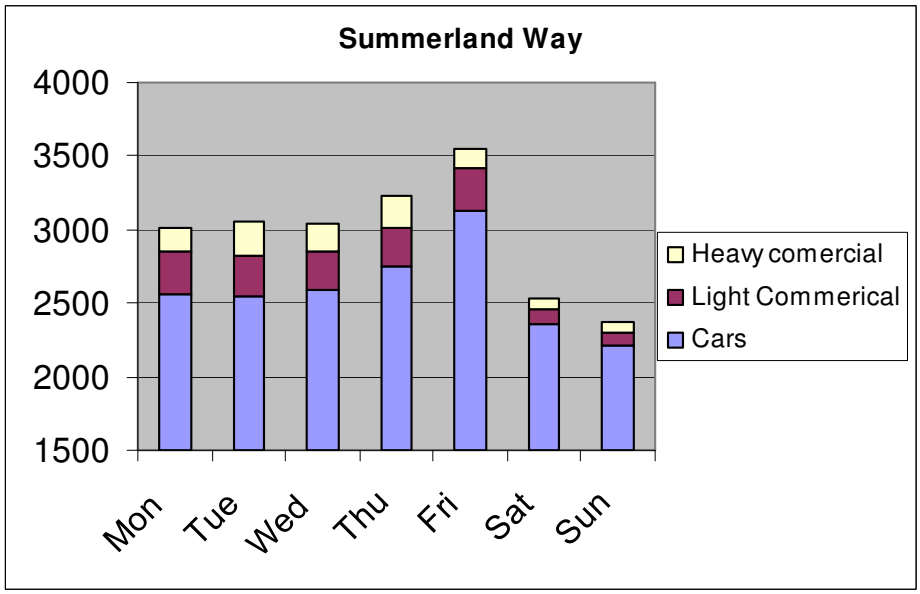


Figure 7



The charts show that the weekly traffic profile is consistent with historical data contained in the RTA's Traffic Counting Publication 2001.

Traffic volumes in the RTA publication, 'Traffic Volume Data for Northern Region 2001' shows an AADT of 22,721 and average weekday traffic volumes (AAWT) are:

Northbound	12,531	Southbound	12,471	Total	25,002

The highest recorded daily volumes were on Thursday 20/12/01:

Northbound	14,895	Southbound	14,871	Total	29,766

The origin and destination survey (tracking trips by numberplate) was carried out on Thursday 18/9/03. The daily volumes recorded on that day were:

Northbound	13,440	Southbound	13,335	Total	26,775

For the survey week in September 2003 the following percentages of vehicle types were recorded crossing the bridge.

- Cars and cars with Trailers 95%
- Buses and Light Commercial 3.8 %
- Heavy Commercial 1.2%

3.11 Numberplate Survey Results

An origin and destination survey conducted by the RTA in 1974 showed that 5% of traffic on the bridge also used the Summerland Way north of Junction Hill. It was assumed that this percentage was through traffic.

The recent survey (refer to Table 9) shows that 1000 vehicles on the bridge also used the Summerland Way north of Junction Hill. On the survey day this accounted for 3.7% of total traffic on the bridge. Approximately 50% of these trips were repeat trips or trips that took longer than 25 minutes which indicates that they had business in Grafton and were not through traffic.

Of these 1000 trips approximately 90 came from North on the Pacific Highway and 200 from the south on the Highway. Only 7 to/from the north and 11 to/from the south on the Highway were heavy vehicles. The rest either originated in South Grafton or came from the west along the Gwydir Highway.

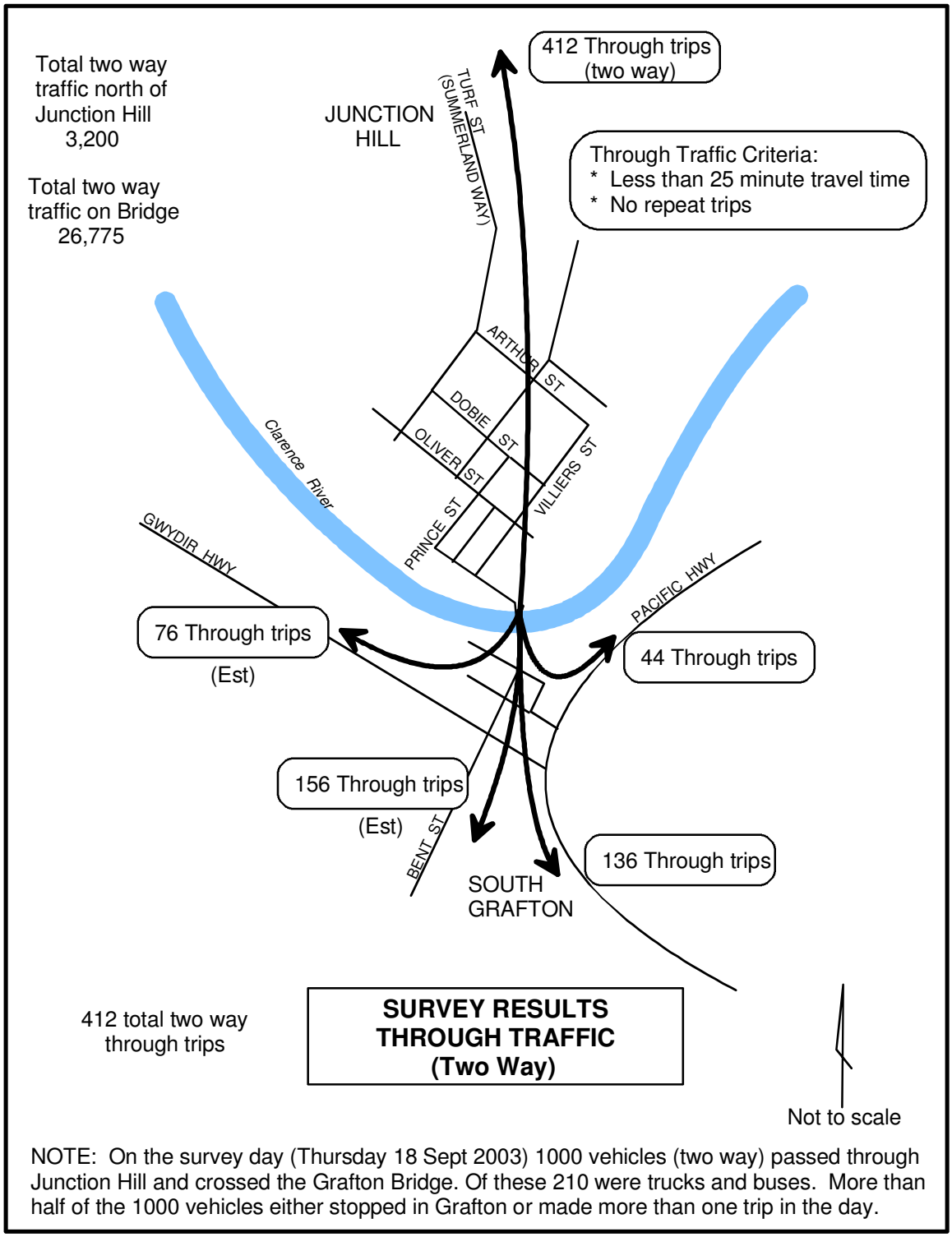
Table 9 - Origin and Destination Survey Results

24 hour Trips	Vehicle Type	Northbound	Southbound	Comment
All vehicles at Junction Hill on survey day	Car Bus Light Commercial Heavy Commercial Total	1380 14 95 110 1599	1369 14 143 98 1624	Obtained from Classification counters
Vehicles using Grafton Bridge and Junction Hill on survey day	Car Bus Light Commercial Heavy Commercial Total	395 9 46 50 500	395 9 46 50 500	Includes vehicles doing repeat trips and no limit on trips time.
THROUGH TRAFFIC Vehicles using Grafton Bridge and Junction Hill on survey day	Car Bus Light Commercial Heavy Commercial Total	156 2 34 14 206	155 2 33 15 206	Excludes vehicles doing repeat trips. Travel time < 25 mins from bridge & 45mins from Pacific Hwy.

The origin and destination survey was carried out over a 12 hour period 7am to 7pm and total volumes for the day were factored up in line with the 24 hour classification counts taken on the bridge. These are shown in Figure 8 and figure 9.

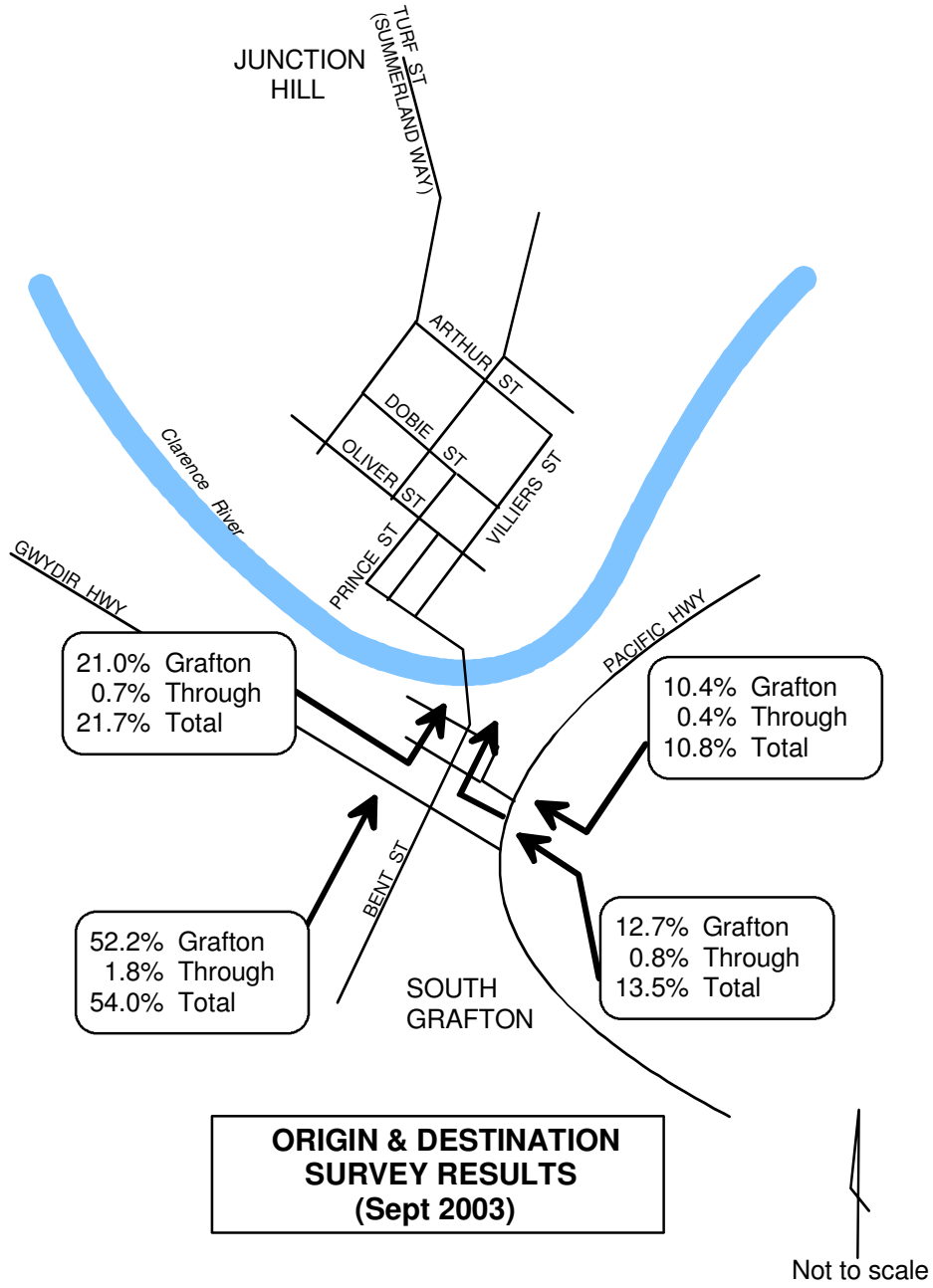
The number of Through Traffic heavy commercial vehicles at night may exceed the factored volumes shown in Table 9. Refer to Section 3.11.1 for further explanation.

Figure 8



NOTE: On the survey day (Thursday 18 Sept 2003) 1000 vehicles (two way) passed through Junction Hill and crossed the Grafton Bridge. Of these 210 were trucks and buses. More than half of the 1000 vehicles either stopped in Grafton or made more than one trip in the day.

Figure 9



Through traffic shown includes repeat trips during the day and does not take account of trip times. Genuine through trips without stopping are less than 50% of the percentages shown.

3.11.1 Heavy Vehicles

The number of heavy vehicles on a road has an impact on lane capacity. This is particularly important on the Grafton Bridge in peak hours because of the sharp bends where opposing drivers hesitate to allow heavy vehicles to negotiate the bends. This behaviour causes a shock wave to occur in the traffic stream and reduces road capacity.

Previous surveys show that commercial vehicles accounted for between 4% and 6% on the bridge depending upon time of day. A survey in 2001 showed trucks and buses accounted for 6% of total traffic during peak hour. The 2003 survey showed 5%.

Morning Peak Period (8:00 to 9:00am) (1 Hour)

2001 northbound 41 trucks and 32 buses (Total of 78 in Sept 03 counts)
2001 southbound 48 trucks and 32 buses (Total of 89 in Sept 03 counts)

Afternoon Peak Period (3:00 to 5:00pm) (2 Hours)

2001 northbound 88 trucks and 28 buses (Total of 143 in Sept 03 counts)
2001 southbound 76 trucks and 43 buses (Total of 122 in Sept 03 counts)

Table 10 shows Heavy Commercial vehicles at various sites for day time and night time periods on the survey day Thursday 18 September 2003.

Table 10

	Day time 7am to 7pm		Night time 7pm to 7am	
Direction	Northbound	Southbound	Northbound	Southbound
Junction Hill	75	65	35	33
Dobie Street west of Prince	81	81	24	16
Villiers Street	90	73	22	9
Grafton Bridge	162	141	53	47

These are total truck volumes at specific locations and do not specifically reflect travel paths. However, it may be concluded from the data that up to 40 large trucks (20 each way) may use the Grafton Bridge / Summerland Way during night time hours.

3.11.2 Heavy Vehicle Routes

Prince Street is Main Road No 83. It passes through Grafton's commercial precinct. A number of alternative route have been signposted to remove unnecessary traffic from the 'main street'.

Villiers Street is a signposted alternative route to Prince Street to destinations north. Trucks commonly use Villiers Street to travel in a north/south direction except for high loads which use Duke Street. Duke Street runs parallel to Villiers Street and Prince Street and is used (signposted) as a high vehicle detour.

3.11.3 Vertical Clearance

The railway viaduct creates a barrier to high vehicles.

4.3m is the maximum legal vehicle height. This can be increased to 4.6m with a permit.

4.0m vertical clearance is currently available in Villiers and Prince Streets.

Duke Street has a 5.0m clearance and as such has been signposted as a High Vehicle Detour.

It is understood that Grafton City Council has investigated ways to increase the vertical clearance at the viaduct in Villiers Street to obtain a vertical clearance of 4.6m.

Viaduct crossings to the west of Prince Street have signposted height restrictions except for Mary Street which has no restriction.

3.11.4 Constraints to heavy vehicle usage

The suitability of each crossing locality for large vehicles (including B-Doubles) is influenced by:

- Vertical clearance.
- Kinks on existing bridge, tight turns at roundabouts and congestion in town.
- The Duke Street High Vehicle Detour passes a major shopping centre and has additional turning movements for trucks.
- The Villiers Street town centre bypass is along a residential street.
- Some localities would put additional truck traffic in residential streets and past sensitive developments eg schools.
- Through truck traffic is very low and consideration of this alone would not justify the provision of a second crossing.
- Congestion on the existing bridge creates an impediment to business activities. Truck movements involving local business deliveries are deferred if possible until after peak hours.
- The CBD and town centre is destination in itself for truck deliveries and access is required for large vehicles.

3.12 Road Capacity

The capacity of the road is determined by factors including the volume of opposing flow, the number of large vehicles, lane width, adjacent development, vertical and horizontal alignment.

The road / bridge is at capacity when two way volumes reach 2400 vehicles per hour, or for shorter periods, say 15 minutes when volumes reach 600 vehicles for that period. Refer to Figure 10.

Under existing traffic arrangements a one directional flow of up to 1,400 vph can be achieved which is the typical am peak hour volume.

Traffic counts indicate that the pm peak hour is busier, however am arrivals are more concentrated with the intensity peaking around 8:20 am and continuing to 9:15am. Similar volumes occur on the bridge between 4:30 and 5:30 in the afternoon but the arrival rate is less intense and queuing is not as extensive as the morning period. Nevertheless, more traffic arrives in the afternoon period than can be accommodated by the bridge and approaches and queuing results.

An examination of traffic volumes over 15minute periods of the day provides an insight into traffic distribution. The distribution shows that in year 2001 the peak period is 2.5 hours per day, typically comprising 45 minutes in the morning (8:15 – 9:00) and 1 hour 45 minutes in the afternoon (3:30 – 5:15). These periods have 15 minute two way volumes of between 500 and 600. The capacity of the bridge is 600 per 15 minutes under ideal conditions which is equivalent to 2,400 vph.

Further analysis of traffic growth shows that traffic periods change throughout the day as traffic increases. The peak periods become longer as maximum flow conditions are extended to accommodate the increased flow.

The peak period will extend to 3 hours by year 2011 and the delays currently experienced in the morning peak leading up to 9:00am will be common for the whole period, morning and afternoon. By 2011 traffic flows for the whole period (3 hours) will approach that of the current 15 minutes peaks. This will mean a higher probability of collapse of flow equilibrium with the resultant long delays.

By year 2021 the peak period will extend to 4 hours 30 minutes and to 9 hours by year 2031. These peak periods are calculated on the basis of maximum flow conditions (600vp15 minutes)

In reality, there will be operational problems well before these extended peaks occur because of start times for school, work and business activities. There is more flexibility in travel decisions in the afternoon period but that too will incur longer delays. It has been necessary to extend the peak period in this way in the analysis to allow the modelling of daily flows.

With the type of delays that currently occur on the bridge there is likely to be a latent demand that would readily take up any minor improvements to traffic capacity on the bridge. The result would be the same level of peak hour delays would continue to occur.

Table 11 shows existing and future volumes on various roads and possible crossing localities.

The analysis shows that Locality 3 would have the best level of service in 2033 with a new bridge simply because it has 2 lanes of traffic in each direction and the volumes would be equally distributed on each bridge. Two travel lanes in one direction has a far larger capacity than one travel lane due to freedom of traffic to choose their own speeds, pass slower vehicles and have less 'side friction'. The volume at which the LOS changes from C to D is 10,000 vehicles per day, however the LOS in these cases is largely driven by the high peak hour flows.

Table 11

Criteria	**Do Nothing**	**Locality 1**	**Locality 2**	**Locality 3**	**Locality 4**	**Locality 5**	**Locality 6**	**Locality 7**
1. Transport and Traffic								
Volumes on crossings **2003**								
New bridge	-	10000	11000	13000	6000	5000	4500	3000
Existing bridge	26000	16000	15000	13000	20000	21000	21500	23000
Volumes on crossings **2033**								
New bridge	-	12000	13000	17000	10000	9000	8000	6000
Existing bridge	34000	22000	21000	17000	24000 **	25000 **	26000 **	28000 **
** Traffic on the existing bridge may not exceed 24,000 because it may transfer to other routes to avoid peak hour delays.								
Level of Service year **2033** peak								
New Bridge	-	D	D	C	C	C	C	B
Existing Bridge	F	E	E	C	E	E	E	E/F
Based on Florida DOT model for Urban Conditions with 8.4% peak hour flows and 63% tidal flow. Los A= Very Good, Los F= Very Poor, Los C is the project objective.								
Average weekday traffic in streets forming possible connection to localities.		Sth of Fitzroy	Sth of Fitzroy		East of Villiers	East of Villiers	East of Villiers	East of Villiers
Existing traffic volumes **(2003)**	-	5000	3000	26000	3000	3000	3000	3000
Volumes with Do nothing **(2033)**	-	6500	3000	34000	3000	3000	3000	3000
Volumes with new bridge **(2033)**	-	18500	16000	34000	13000	12000	11000	9000

Figure 10

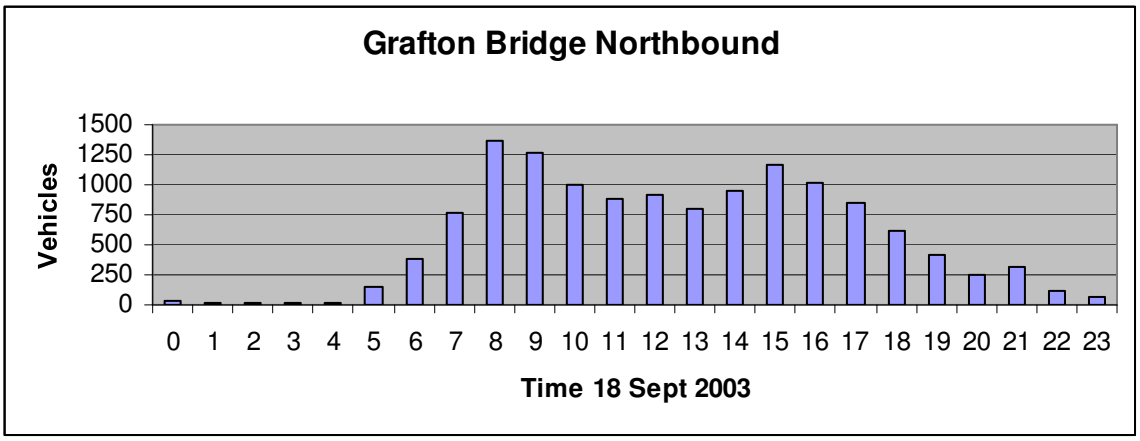


Figure 11

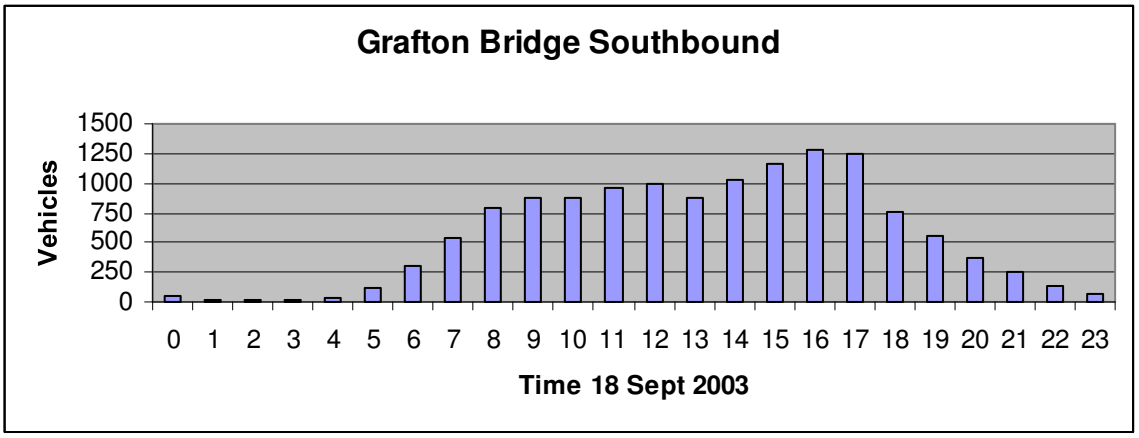
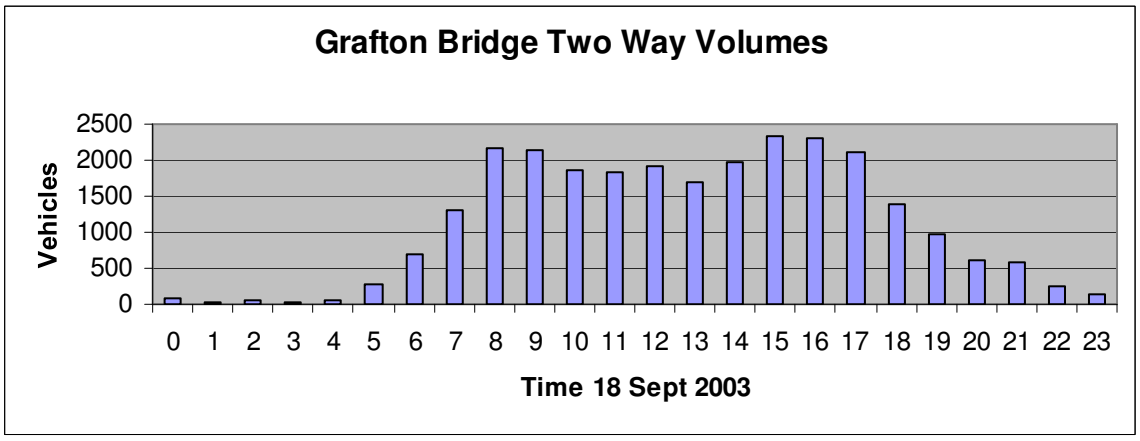


Figure 12



3.13 Intersection Capacity

This traffic study assumes that existing intersections have adequate spare capacity to accommodate reassigned traffic associated with each option. This assumption is based on previous analysis and the assessment that there is scope to enhance these sites as part of any bridge option to obtain an acceptable level of service.

Key intersections were modelled (SKM Study 1999) in regard to the option of duplication of the existing bridge. Practical capacity would occur at these two lane circulating roundabouts at a Degree of Saturation of about 0.85 at which point queuing would occur. The SKM Report concluded that these sites would continue to operate satisfactorily if the existing bridge were to be duplicated.

The sites shown in Table 12 are the critical intersections in Grafton. They have been modelled for the highest traffic volumes that would occur from any option. The modelling indicates that the intersections will be able to accommodate an increase in traffic of 30%, which is the predicted growth for the next 30 years.

The Villiers and Fitzroy Street roundabout will reach practical capacity in about 30 years for Locality 3. The two roundabouts in Bent Street on the southern side of the River will function satisfactorily for the period but may require traffic management for other reasons eg pedestrians, turning paths for trucks, unexpected increased turning volumes for certain movements.

Table 12 – Modelling Results

SIDRA Analysis		Level of Service	Degree of Saturation	Average Delay for worst movement (sec)	Queue (m)
2 Lane Roundabout 2003	am	A	0.38	17	18
Bent St / Through St	pm	A	0.36	17	17
2 Lane Roundabout 2033	am	B	0.51	18	28
Bent St / Through St	pm	B	0.50	19	27
2 Lane Roundabout 2003	am	B	0.34	18	18
Bent St / Ryan St	pm	B	0.35	15	17
2 Lane Roundabout 2033	am	C	0.55	33	22
Bent St / Ryan St	pm	B	0.49	18	27
2 Lane Roundabout 2003	am	B	0.43	15	22
Villiers St / Fitzroy St	pm	B	0.57	20	31
2 Lane Roundabout 2033	am	B	0.58	19	37
Villiers St / Fitzroy St	pm	C	0.88	29	83 **

Existing traffic volumes increased by 30% to reflect 2033 volumes.

** The am peak could have similar performance to the pm if the bridge is duplicated because more traffic may arrive at the site in a shorter time than under the currently constrained situation caused by the limited capacity of the bridge.

The modelling indicates that the intersections will be able to cope in 30 years time however some may need improvements. Table 13 indicates which key intersections may need upgrading within that period.

Table 13

	Do Nothing	**Locality 1**	**Locality 2**	**Locality 3**	**Locality 4**	**Locality 5**	**Locality 6**	**Locality 7**
Impact on intersections in approaches to existing bridge								
- Villiers/Fitzroy	U	N	U	U	N	N	U	U
- Bent/Through	U	N	N	U	N	N	U	U
- Bent/Ryan	U	N	N	U	N	N	N	U
N-No significant works needed, by **2033**								
U- Upgrade by **2033**								

Possible intersection treatments on typical streets for the various localities are shown in Table 14. These are indicative and are included for analysis purposes only.

Table 14

POSSIBLE INTERSECTION TREATMENTS

Locality	South End	Existing Intersection	Proposed Intersection	North End	Existing Intersection	Proposed Intersection
1	Connnection to Gwydir Hwy	Nil	Roundabout	Direct onto Prince Street and meeting Fitzroy St	Roundabout	Same - No upgrade
2	Connnection to Gwydir Hwy	4 way intersection	Roundabout 4 way	Direct onto Villiers Street and meeting Fitzroy street	Roundabout	provide 2 lane approach in Villiers St south
3	Merge with existing route on Bent Street	Nil. No access for Riverside Dr	Nil	Connection to Villiers St	Roundabout	No upgrade
4	Connection to Pacific Hwy	Nil	T juction Seagull intersection	Connection to Prince St	4 way with priority	Possible roundabout at Prince St and at Villiers St
5	Connection to Pacific Hwy	Nil	T juction Seagull intersection	Connection to Prince St	Roundabout	No upgrade
6	Connection to Pacific Hwy	Nil	T juction Seagull intersection	Connection to Turf St	T-junction Turf St priority	No upgrade
7	Connection to Pacific Hwy possibly at Centenary Dr	T-junction at with painted medians	4 way intersection possibly a roundabout	Connection to Turf St	4 way intersection Turf St priority	No upgrade

Note: 1. Main Road #83 = Summerland Way - incorporates Bent, Craig, Fitzroy, Prince, Dobie and Turf Streets then Richmond Road
2. Heavy Vehicle CBD Bypass for Summerland Way is via Villiers and Dobie streets
3. High vehicles via Duke Street
4. Connecting roads from crossings to Summerland Way, Gwydir Highway or Pacific Highway would have priority over side streets.

4 Population and traffic growth

4.1 Population Growth

Population figures for the Clarence Valley provided by Planning NSW show an increase in population from 46,555 in 1996 to 60,290 in 2016. This equates to a linear growth rate of 1.5%.

The growth rate over the past five years between the 1996 census and 2001 census is 1.03%.

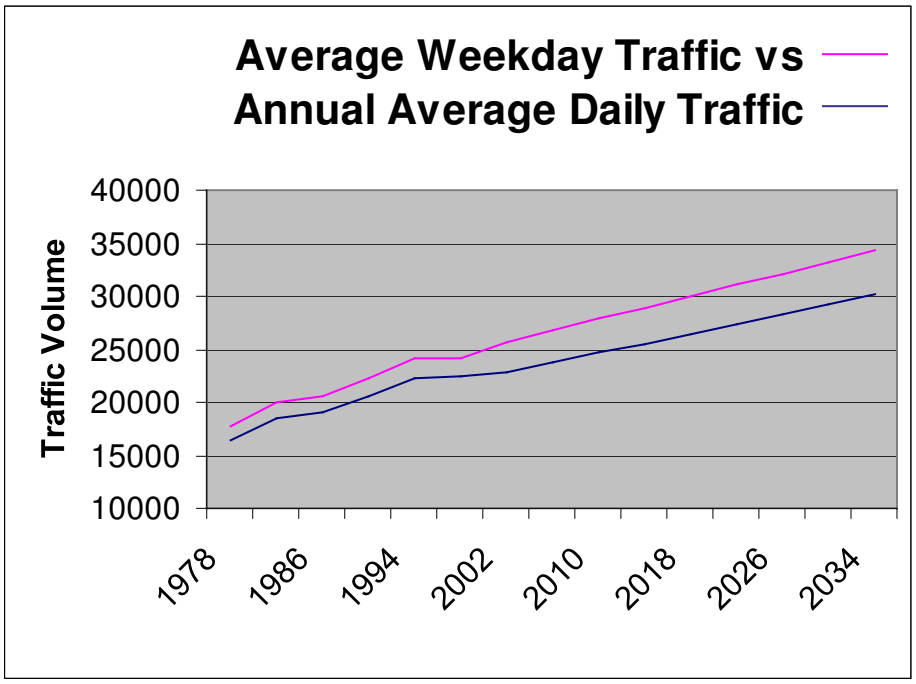
Discussions with Grafton City Planners revealed that the more conservative rate of 1% linear growth is the more applicable figure.

Should the higher figure be realised over time the traffic impacts identified in this study would occur earlier.

4.2 Traffic Growth

Traffic growth is closely aligned with population growth. Proposed development within the Grafton locality has been taken into account in arriving at the traffic projections. Figure 13 shows historical traffic volumes on the Grafton Bridge as well as a projection for the next 30 years based on a growth rate of 1.03%.

Figure 13



The Clarenza area has been identified in the Clarence Valley Urban Development Strategy as a prime area for urban growth for Grafton. New residential subdivision and three new schools are currently being developed in the Clarenza area.

Urban development at Clarenza is likely to increase traffic flow on the Grafton Bridge.

The daily additional traffic is estimated as 1500 with the main impact being between 8:00-9:00am and 3:00-4:00pm because of school traffic. Peak hour increases are estimated as:

am peak	100vph southbound 130vph northbound	pm peak	130vph southbound 100vph northbound

The actual number of bus movements on the Grafton Bridge should not significantly change due to the current mix of students from both sides of the River attending private schools.

Other residential development in Grafton North, Junction Hill, South Grafton and Waterview Heights has also been considered.

Recent traffic counts show that the new shopping centre at South Grafton has not significantly changed traffic volumes on the Grafton Bridge.

Table 15 the assumptions made for growth in traffic for the next 35 years from various sources. A 35 year period is used to allow benefits to be calculated for 30 years after construction. The table shows how many lots might be developed by that time to achieve a 1% growth rate with a reasonable distribution. It is generally in line with the Clarence Valley Urban Growth Strategy although more lots could be available at Clarenza (250), North Grafton (200), and Waterview Heights (50).

Table 15

Future Traffic Growth	%	Volume	
Clarenza	0.29	2700	500 lots over next 35 years = 4500 trips. Assume 60% to Grafton
Pacific H/way North	0.15	1420	2700 trips @1.5% growth
Pacific H/way South	0.19	1780	3382 trips @1.5% growth
South Grafton	0.17	1620	300 lots over next 35 years = 2700 trips. Assume 60% to Grafton
Gwydir H/way West	0.09	810	150 lots over next 35 years = 1350 trips. Assume 60% to Grafton
North Grafton*	0.09	810	300 lots over next 35 years = 2700 trips. Assume 30% from Grafton
Grafton*	0.03	270	100 lots over next 35 years = 900 trips. Assume 30% from Grafton
35 years	1.00	9410	Growth Rate = 36% or just over 1%pa

* Counterflow to external sources above from development in North Grafton and Grafton

5 Traffic Model

5.1 Assumptions

Traffic growth is based on a 1% linear rate on year 2003 base volumes.

This growth rate takes account of trip generation from the new and proposed development at South Grafton, Clarenza, South Grafton, Junction Hill and areas to the north and south that are serviced by Grafton. Trips have been assigned in the model to reflect this predicted development.

An accelerated growth rate would simply bring forward in time the volumes shown in the model. A 2% growth rate would halve the time to reach the volumes shown.

2,400 vehicles per hour is the maximum two way flow rate on the bridge. This is the counted maximum flow during peak conditions.

Motorists will generally take the most direct or shortest path. Some allowance has been made for slightly longer trips in order to avoid congestion and minimise travel times.

Intersections would be designed and upgraded to operate safely and efficiently.

From the origin and destination survey the Summerland Way / Pacific Highway route comprises only a small percentage (3.7%) of total traffic using the bridge.

Existing behaviour will continue, ie car occupancy, level of public transport, peak traffic demand etc.

Downstream options may encourage an increased use of Centenary Drive. No additional traffic has been assigned to Centenary Drive for these options. It is assumed that traffic will stay on the existing highway.

5.2 Origin and Destination

To carry out traffic flow modelling it is necessary to aggregate traffic into manageable groups.

In practice, traffic origin and destinations are grouped to reflect the distribution of residential areas and the main attractors – school, work, shopping, business and recreation. The areas are identified and a point in each area selected to represent the typical start and finish point for a trip to and from that area. These Nodes are then used in the modelling for the calculation of trip lengths and destinations.

The origin and destination of trips has been derived from numberplate surveys in September 2003 and partially interpolated from peak hour intersection counts at key intersections. The results are shown in Table 16. These percentages are shown to change slightly over time consistent with changes to the pattern of urban development.

Table 16

ORIGIN AND DESTINATION

EXTERNAL SOUTH & WEST Variation of source with time

Percentages		**2003**	**2008**	**2013**	**2018**	**2023**	**2028**	**2033**	**2038**
Pacific H/way North	Grafton	96.8%	96.8%	96.8%	96.8%	96.8%	96.8%	96.8%	96.8%
	Through (All)	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%
	Total	**10.8%**	**12.6%**	**14.2%**	**15.6%**	**16.9%**	**18.2%**	**19.3%**	**20.3%**
Pacific H/way South	Grafton	93.8%	93.8%	93.8%	93.8%	93.8%	93.8%	93.8%	93.8%
	Through (All)	6.2%	6.2%	6.2%	6.2%	6.2%	6.2%	6.2%	6.2%
	Total	**13.5%**	**13.9%**	**14.3%**	**14.6%**	**14.9%**	**15.2%**	**15.5%**	**15.7%**
South Grafton	Grafton	96.6%	96.6%	96.6%	96.6%	96.6%	96.6%	96.6%	96.6%
	Through (All)	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%
	Total	**54.0%**	**52.3%**	**50.8%**	**49.4%**	**48.2%**	**47.0%**	**45.9%**	**45.0%**
Gwydir H/way West	Grafton	96.6%	96.6%	96.6%	96.6%	96.6%	96.6%	96.6%	96.6%
	Through (All)	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%
	Total	**21.7%**	**21.2%**	**20.7%**	**20.3%**	**20.0%**	**19.6%**	**19.3%**	**19.0%**
	Check	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

ORIGIN		**2003**	**2008**	**2013**	**2018**	**2023**	**2028**	**2033**	**2038**
Pacific H/way North	Grafton	2716	3323	3930	4536	5143	5750	6357	6964
	Through (All)	91	111	132	152	172	193	213	233
	Total	2807	3434	4061	4688	5316	5943	6570	7197
Pacific H/way South	Grafton	3299	3574	3848	4123	4398	4673	4947	5222
	Through (All)	218	236	254	272	291	309	327	345
	Total	3517	3810	4103	4396	4688	4981	5274	5567
South Grafton	Grafton	13560	13821	14082	14343	14604	14864	15125	15386
	Through (All)	473	482	491	500	509	519	528	537
	Total	14033	14303	14573	14843	15113	15383	15653	15923
Gwydir H/way West	Grafton	5453	5602	5751	5900	6049	6198	6348	6497
	Through (All)	190	195	200	206	211	216	221	226
	Total	5643	5797	5952	6106	6260	6414	6569	6723
Bridge AADT		26000	27344	28689	30033	31377	32721	34066	35410

DESTINATION	**2003**	**2008**	**2013**	**2018**	**2023**	**2028**	**2033**	**2038**
CBD	75.0%	75.0%	75.0%	75.0%	75.0%	75.0%	75.0%	75.0%
Grafton East	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%
Grafton West	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%
Grafton North & Through Junction Hill	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

5.3 Traffic Assignment

Table 17 shows traffic volumes derived from the model on the existing and new bridge for each option up to year 2033.

Table 17

TRAFFIC ASSIGNMENT FOR ALTERNATIVE CROSSING LOCALITIES

Vehicle Class	Locality 1 Prince St	Locality 2 Villiers St	Locality 3 Existing	Locality 4 Bacon St	Locality 5 Dobie St	Locality 6 Arthur St	Locality 7 North St
Year 2003	Daily Traffic volume that would use alternative crossing sites						
Cars	9720	10432	24531	5380	4738	3938	2793
Buses	111	149	269	83	77	67	56
Light Commercial	330	358	831	247	246	250	163
Heavy Commercial	102	220	368	161	160	138	117
Total	10264	11159	26000	5871	5221	4393	3129
Percentage	39.5%	42.9%	100.0%	22.6%	20.1%	16.9%	12.0%
Year 2013							
Cars	10246	11055	27039	6672	5950	5001	3608
Buses	117	168	306	110	102	90	73
Light Commercial	352	383	932	311	309	307	207
Heavy Commercial	110	237	412	194	193	170	140
Total	10826	11843	28688	7287	6554	5568	4028
Percentage	37.7%	41.3%	100.0%	25.4%	22.8%	19.4%	14.0%
Year 2023							
Cars	10771	11678	29546	7964	7162	6065	4423
Buses	123	188	343	138	128	112	91
Light Commercial	374	407	1032	375	371	364	251
Heavy Commercial	119	255	457	227	226	202	163
Total	11387	12527	31377	8704	7887	6742	4927
Percentage	36.3%	39.9%	100.0%	27.7%	25.1%	21.5%	15.7%
Year 2033							
Cars	11297	12300	32053	9256	8374	7128	5237
Buses	129	207	379	166	153	135	108
Light Commercial	396	432	1132	439	433	421	295
Heavy Commercial	127	272	501	260	259	234	186
Total	11948	13211	34065	10121	9220	7917	5825
Percentage	35.1%	38.8%	100.0%	29.7%	27.1%	23.2%	17.1%

Assumes 1% annual growth rate.

Year 2003 Average Weekday Traffic 26000. Survey day volumes adjusted accordingly.

6 Economic Analysis

For a new bridge to be competitive with other worthwhile projects throughout NSW it must be shown that benefits exceed the cost of investment. This is normally demonstrated by estimating future costs and future benefits and translating them into current day dollars to give a benefit cost ratio (BCR). RTA policy is that a BCR of least 2:1 is usually needed before investing public funds.

For road projects, benefits are calculated by estimating the savings in accidents, travel time and road user costs. As a general rule most benefits are derived from reducing delays, reducing travel (shortening the route or reducing traffic volumes), improving the riding quality of the road and improving alignment, especially grades for trucks. Dollar costs are given to these factors and applied to the number of vehicles involved.

For the current planning exercise several important factors should be highlighted.

A new bridge located next to the existing bridge would create a 4 lane road, two lanes in each direction.

A 4 lane road has a considerably higher capacity and performance than 2 two lane roads.

A new bridge located away from the existing bridge would be a two lane two way, road.

In economic terms the way in which benefits are accrued from road projects means that a duplication of the existing bridge has an inherent advantage over other potential bridge sites.

This is not to say that other crossings nearby would not attract enough traffic off the existing bridge for both bridges to operate satisfactorily into the foreseeable future without any significant delays. It simply means that the level of traffic attracted may not be sufficient to justify that site in isolation. Other issues may need to be considered in conjunction.

On the basis of current and future development patterns it is a reasonable assumption that as the distance increases from the existing bridge the amount of traffic that would be attracted to a new crossing diminishes and as such becomes less economically viable.

This economic analysis has been carried out on the basis of costs derived from year 2002 values appearing in the RTA's "Economic Analysis Manual".

Costs are of several types.

Economic Costs

The estimated cost of potential crossing sites has been calculated.

(Generally the higher the cost of the project the lower the benefit cost ratio (BCR.)

It is important therefore to identify sites that are affordable and designs that are efficient and feasible.

The estimated cost of each option is shown in Table 18 in the following section. These estimates are strategic costs.

Social Costs

The cost to individuals as a result of the project is taken into account separately to the economic analysis. This is often a subjective assessment undertaken as part of the environmental impact assessment. These costs are noise, loss of amenity, property effects, visual intrusion etc, which are considered in the Socio-economic Report. In this current economic analysis a dollar value has been estimated to address environmental issues for options that may directly affect residential streets.

Economic costs, social costs and environmental impacts are considered together to test the viability of the project.

Table 18

Grafton Bridge Feasibility Study - Road User Costs and Benefits
Benefits and Costs From 1/1/2004 to 31/12/2038

Option	1	2	3	4	5	6	7
Description	New bridge 1.5km U/S of existing.	New bridge 1.0km U/S of existing.	Duplicate existing bridge (U/S)	New bridge 1.1km D/S of existing.	New bridge 1.2km D/S of existing.	New bridge 3.0km D/S of existing.	New bridge 3.7km D/S of existing.
Strategic Estimate of Cost - $M (RTA)	45.00	45.00	40.00	45.00	40.00	50.00	55.00
Expenditure Net Present Value - Construction Costs ($M).							
4% discount rate	43.12	43.12	38.33	43.12	38.33	47.91	52.70
7% discount rate	41.82	41.82	37.17	41.82	37.17	46.47	51.11
11% discount rate	40.23	40.23	35.76	40.23	35.76	44.70	49.17
Savings Net Present Value - Road User Costs ($M).							
4% discount rate	91.99	88.30	110.01	71.21	65.96	43.63	11.54
7% discount rate	60.30	57.65	71.73	45.00	42.04	26.95	6.04
11% discount rate	38.01	36.18	44.95	27.21	25.66	15.83	2.75
Savings Net Present Value - Accident Costs ($M).							
4% discount rate	2.80	3.63	5.37	-1.14	-1.89	-0.47	1.71
7% discount rate	1.85	2.39	3.51	-0.73	-1.21	-0.30	1.09
11% discount rate	1.18	1.52	2.21	-0.45	-0.74	-0.18	0.66
Savings Net Present Value - Existing Bridge Maintenance Agreement							
4% discount rate							
7% discount rate							
11% discount rate							
TOTAL SAVINGS Net Present Value							
4% discount rate	94.79	91.93	115.37	70.07	64.08	43.15	13.25
7% discount rate	62.15	60.04	75.24	44.27	40.83	26.65	7.13
11% discount rate	39.19	37.70	47.16	26.76	24.92	15.65	3.42
Benefit Cost Ratio - All User and Owner Benefits							
4% discount rate	2.20	2.13	3.01	1.63	1.67	0.90	0.25
7% discount rate	1.49	1.44	2.02	1.06	1.10	0.57	0.14
11% discount rate	0.97	0.94	1.32	0.67	0.70	0.35	0.07

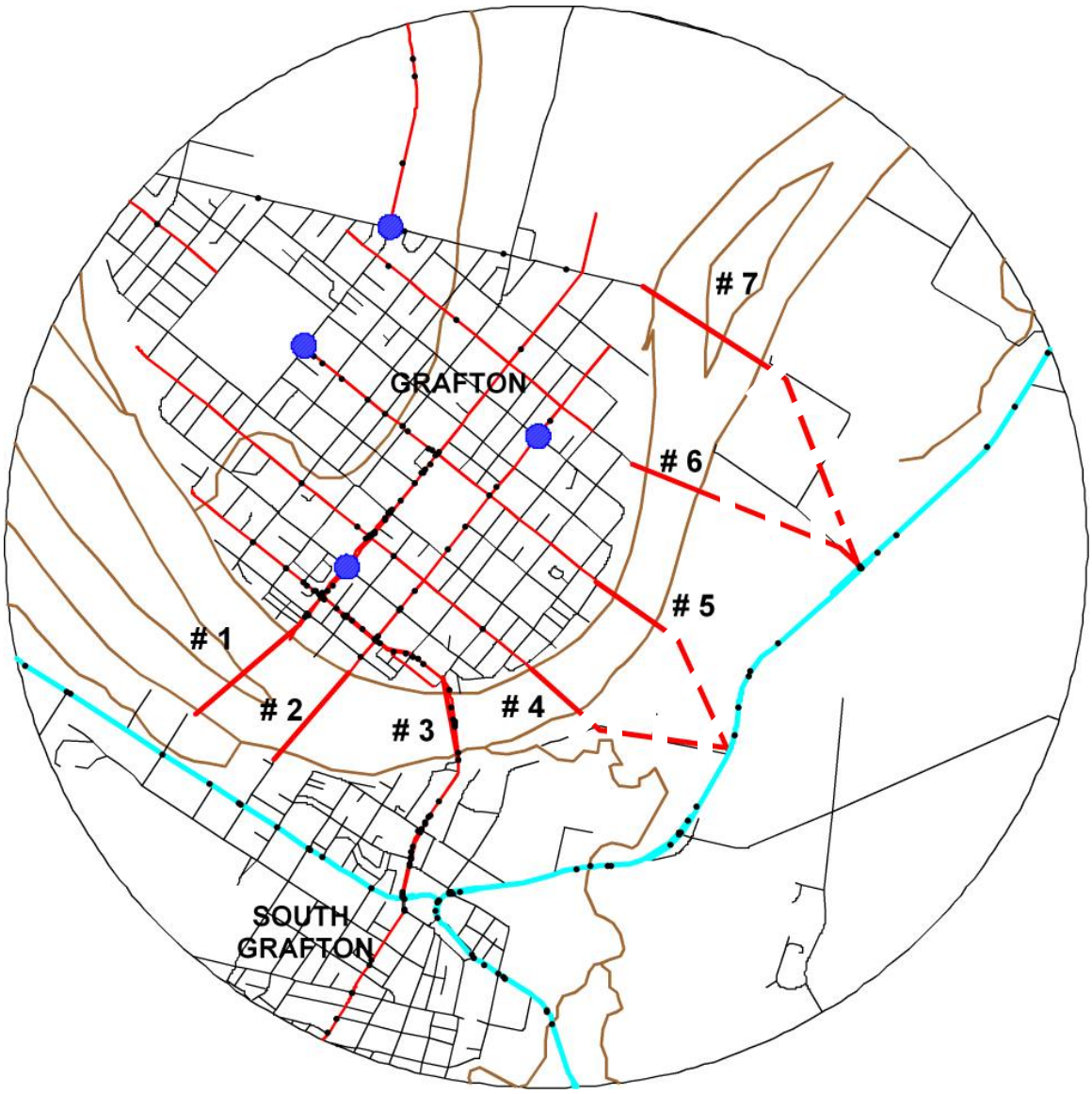
First Year Rate of return. Assumes all bridges are opened to traffic in 2007							
4% discount rate	10.3%	9.8%	13.7%	5.9%	6.3%	2.5%	0.0%
7% discount rate	9.7%	9.2%	12.9%	5.6%	6.0%	2.4%	0.0%
11% discount rate	9.1%	8.6%	12.0%	5.2%	5.6%	2.2%	0.0%

7 Accident Analysis

The RTA's accident database has been examined for the 5 year period 1998 to 2003 inclusive. Figure 14 below shows a plot of tow away or injury accidents with the area shown. The table below shows the results of a broad assessment across this area of increase or reduction in accidents for a 5 year period associated with each locality.

The river crossing lines shown represent the localities for crossings. The roads that connect on the Grafton side of the River have been selected for analysis purposes and do not necessarily indicate any alignment proposals.

Figure 14 - Map showing accidents on selected roads as black dots.



All localities will be designed in a way to maximise safety. However, it is difficult to accurately predict accident savings due to the high number of variables. As an indication of the safety performance of each locality an estimation of future traffic flows on existing and possible future major roads has been made across the network within the Grafton area. Existing accident rates have been calculated and applied to the change in traffic flow over the main routes.

Table 19 shows the comparison of options in terms of safety performance. Estimated accident savings for a 5 year period are shown. For example, an accident saving of –5.0 means that 1 accident per year would be saved. Those options that involve an increase in accidents results from additional traffic being allocated to sections of road with higher accident numbers, ie Pacific Highway between the Gwydir Highway and Duncans Lane and parts of the Gwydir Highway.

Table 19 Difference in Safety Performance across all major routes

Criteria	Do Nothing	Locality 1	Locality 2	Locality 3	Locality 4	Locality 5	Locality 6	Locality 7
5 Year Accident Savings **								
2003		-6	-8	-12	+2	+4	+1	-3
2013		-7	-9	-13	+3	+5	+1	-4
2023		-7	-9	-14	+3	+5	+1	-5
2033		-8	-10	-15	+4	+6	+2	-6

** The change in accident savings every 10 years is shown. The savings relate to the 5 year period leading up to the date shown. For example, Locality 1 year 2033 shows a saving of 8 accidents over 5 years or 1.6 accidents per year.

The accidents forming the basis of the analysis are those of a serious nature, that is tow away or injury accidents. Minor accidents that would occur on the bridge and on the approaches are not included because many of these go unreported to the Police and are not included in the accident database. In addition, the RTA places priority on preventing the more serious accidents.

8 Traffic Impacts on Local Roads

8.1 General

Table 20 indicates the potential changes in traffic volumes at certain points for each locality. An estimate of existing traffic volumes is shown where no recent counts have been undertaken. It is assumed that local streets may carry up to 3000 vehicles per day but possibly less. For example, Oliver Street, west of Prince Street, carries almost 2000vpd.

Table 20 Local Road Volumes

	Locality 1	**Locality 2**	**Locality 3**	**Locality 4**	**Locality 5**	**Locality 6**	**Locality 7**
Average weekday traffic in streets forming possible bridge connections	Sth of Fitzroy	Sth of Fitzroy		East of Villiers	East of Villiers	East of Villiers	East of Villiers
Existing traffic volumes (**2003)**	5000	3000	26000	3000	3000	3000	3000
Volumes with Do nothing **(2033)**	6500	3000	34000	3500	3500	3500	3000
Volumes with new bridge **(2033)**	18500	16000	34000	13000	12000	11000	9000

The changes in volumes are discussed in the following along with some implications.

Prince Street is the central part of Grafton's Central Business District. The intersection of Fitzroy and Prince Streets is a focal point for traffic that is attracted to the precinct that includes Shopping World parking areas in Duke Street.

Comparison of traffic flows at the Villiers Street roundabout shows that approximately twice as much traffic comes to / from the Prince Street precinct from the Bridge than to/from the Villiers Street area. Refer to traffic split diagrams in Appendix A.

It is possible that there could be an increase in peak hour traffic flows in excess of the predicted levels following the construction of a second crossing due to improved travel conditions. Motorists that currently defer trips until after peak hours may change their travel patterns. This latent demand is not expected to be high but may be sufficient to place additional stress on intersections towards the end of the planning period, 30 years.

8.2 Locality 1

This locality will attract a reasonable volume of traffic (10,000 vpd leaving 16,000 on the existing bridge). Traffic will disperse at Fitzroy Street but there will be increased volumes in Prince Street that may otherwise use Villiers Street.

The crossing locality would not attract much Pacific Highway traffic due to distance, possible delays associated with parking in the CBD and viaduct height restrictions. However, it will attract some South Grafton traffic and almost all of the Gwydir Highway traffic.

A second crossing at this locality would encourage traffic onto the main street (Prince Street) and this raises safety and amenity issues. It is likely that traffic management measures would be necessary to ensure that the Prince Street shopping environment remains compatible with business activities.

Measures such as diverting trucks via Duke Street may need to be considered. This would possibly result in trucks continuing to use the existing bridge.

If Prince Street flow is constrained in any way it is likely that some northbound traffic would use Fitzroy Street west and roads such as Queen Street.

The connection to the Gwydir Highway would be to the east of Minden Street with the likely traffic control being a roundabout.

8.3 Locality 2

This locality will attract considerable traffic (11,000 vpd) off the existing bridge, due to its proximity to the existing bridge and the Pacific Highway. Much of the South Grafton traffic and almost all of the Gwydir Highway traffic would be attracted.

For the purposes of the analysis it is assumed that the road connection in this locality is via Villiers Street.

Some traffic would use Victoria Street to disperse prior to reaching Fitzroy Street thereby putting slightly less traffic through the roundabout than the option of duplicating the existing bridge. This may provide improved performance for the roundabout at that location but additional traffic in Victoria Street will have an impact on parking, safety and amenity. The give way controlled cross intersection of Victoria Street and Villiers Street would need an improved form of traffic control to manage turning volumes and pedestrians.

Modelling shows that the Villiers Street / Fitzroy Street roundabout will require the Villiers Street approach to be widened to 2 entry lanes to achieve a LOS 'C' in 30 years. The intersection may need upgrading earlier depending upon growth and the level of latent demand that would be satisfied once a second crossing is provided.

The left turn lane from Clarence Street onto the bridge will need to be retained to relieve the Villiers Street roundabout in peak hours. Without the Clarence Street access the LOS at the roundabout would drop to 'F' in the afternoon in 30 years due to queuing in Villiers Street.

This crossing locality would not increase traffic volumes in Villiers Street to the north of Fitzroy Street to any significant degree.

8.4 Locality 3

A second bridge located parallel to the existing bridge provides the greatest traffic benefits of the Localities considered. This is reflected in the level of service calculations where a 4 lane facility provides good travel conditions along the route (LOS'A' in 30 years time). This assumes that the issue of the impact of the kinks on traffic flow can be addressed.

This locality has the greatest effect on existing intersections because it centralises traffic flows along the existing route. Other options distribute traffic more widely and consequently will have less delays at certain intersections.

Modelling shows that the Villiers Street / Fitzroy Street intersection will operate at LOS 'C' under its current configuration and will not require additional lanes or a change to traffic signals within the 30 year period. Ultimately, additional lanes or replacement by traffic signals may be necessary depending upon traffic growth and operational issues at the intersection.

Transport companies have indicated that a change of traffic control would be desirable because turning trucks find the existing roundabout tight.

Retention of the Clarence Street access onto the bridge would be necessary to help relieve traffic congestion in the long term. With two lanes in each direction on the bridge the impact of traffic 'pushing in' to travel south in the afternoon will be minor. The left turn lane from Clarence Street onto the bridge needs to be maintained or the LOS at the roundabout will drop to 'F' in the afternoon due to queuing in Villiers Street.

Intersections on the southern approach, Bent Street at Through Street and at Ryan Street, are shown to function satisfactorily but may also require traffic management or upgrading within 30 years. Again the replacement of the roundabouts with traffic signals is a long term option.

8.5 Localities 4 to 7

Downstream crossings have a certain traffic management appeal as they provide a more direct connection to the north of Grafton and the Summerland Way from the Pacific Highway. Localities 4 and 5 provide a direct connection to the future development area of Clarenza where three schools are located.

These crossing locations would attract 250 heavy trucks and 200 buses away from the existing bridge and direct them along residential streets. Refer to Table 25 - Summary table for comparison of Crossing Localities. As only 10% of heavy trucks are through vehicles the remaining 90% will stay within the Grafton town, including travelling back into the CBD. This would mean crossing under the viaduct at either Villiers Street or Duke Street.

The attractiveness to traffic of downstream localities diminishes as the distance for a second crossing increases from the existing bridge. The volumes taken off the existing Bridge ranges from 6,000vpd at locality 4 reducing to 3,000vpd at locality 7 Elizabeth Island. Table 17 shows that the downstream localities will attract traffic at an increasing rate over time due to development at Clarenza and to the north.

These four localities will reduce travel distance to Grafton for traffic to and from the north along the Pacific Highway. This however comprises only 11% of traffic using the existing bridge. These crossings would encourage additional local travel on the Pacific Highway from the south and require a new intersection with the Highway. These factors have safety and traffic flow implications for the Highway.

A summary of accident predictions is detailed in Section 7.

Traffic volumes will increase on local road connections giving rise to road safety and amenity impacts. There will be increased traffic past residences and sensitive developments such as nursing homes and Grafton Hospital.

Existing traffic volumes have been estimated up to 3000 vehicles per day on potentially affected local roads where counts are unavailable. As an indication of local road volumes Oliver Street to the west of Prince Street carries almost 2000 vehicles per day. Refer to Appendix A for a diagram showing local road volumes.

The socio economic and environmental impacts are discussed in separate reports.

8.6 Existing Issue - Clarence Street

There has been some concern expressed in community workshops about the impact of Clarence Street traffic entering the southbound traffic stream approaching the bridge. It has been suggested that some traffic is 'pushing in' to avoid congestion and delays in Villiers Street at the Fitzroy Street roundabout. Traffic counts have been taken in Clarence Street and Villiers Street and traffic conditions inspected during peak hours to quantify the extent of the issue and identify any measures that may improve traffic flow in the locality.

Classifier traffic counts are shown below for Thursday 18 September 2003.

Table 21

Clarence Street Counts Thu 18 Sep 2003

Time	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
SB	6	0	4	2	6	20	50	80	115	124	88	110	91	101	110	170	174	172	83	57	41	31	12	6
NB	0	1	2	1	0	3	7	11	12	20	21	22	20	26	18	15	27	21	29	20	16	15	7	5

Southbound Total=1653, Northbound Total=319

Villiers Street Counts Thu 18 Sep 2003

Time	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
SB	15	6	10	2	10	37	117	208	413	298	234	236	212	261	258	285	334	287	218	139	100	69	43	16
NB	15	6	4	3	14	54	108	176	230	225	233	215	273	240	262	330	366	332	196	163	91	121	44	34

Southbound Total=3808, Northbound Total=3735

There is reasonable correlation between am and pm hourly flows in Villiers Street but there is a distinct imbalance in Clarence Street. The left turn slip lane onto the Grafton Bridge appears to attract traffic into Clarence Street to travel across the bridge that would otherwise be on Villiers Street or may use Prince or Duke Street to pass straight though the roundabout.

A simple comparison of traffic flows between Villiers Street and Clarence Street indicates that the following traffic is using Clarence Street in favour of Villiers Street to access the bridge. This pattern also occurs throughout the day.

100 southbound trips in the AM peak hour
150 southbound trips in the PM peak hour

These traffic volumes were added to counts at the intersection of Villiers Street and Fitzroy Street to gauge the impact of a possible road closure in Clarence Street on the roundabout at the intersection. Figure 15 shows existing traffic volumes at the roundabout.

Figure 15 Intersection count carried out in April 2000.

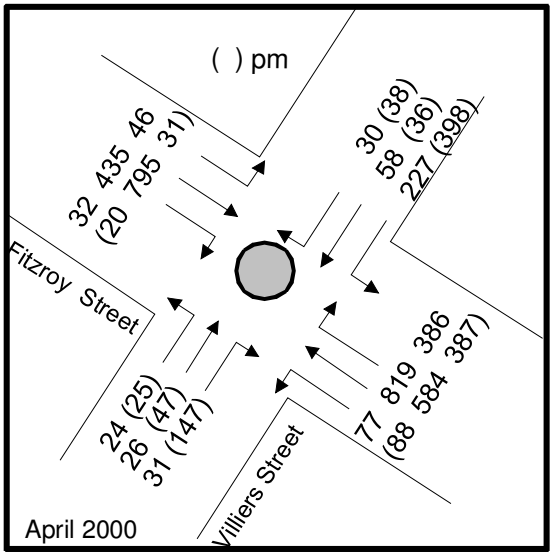


Table 22 Intersection Modelling Results

EXISTING ROUNDABOUT Villiers / Fitzroy		Period	Degree of saturation	Level of Service	Intersect av. Delay Secs	Highest av. Delay Secs	95% back of queue (vehs)
Existing traffic volumes	2003	am pm	0.43 0.57	B B	7.2 9.5	14.9 19.6	4 5
Future conditions Close Clarence Street and add	2003	am pm	0.43 0.79	B C	7.3 10.8	16.0 21.7	4 9
100vph am and 150vph pm left turners from Villiers to Fitzroy St	2033	am pm	0.58 1.19	B F	8.3 82	18 365	5 140

A comparison of the most recent data in Villiers Street (2003 classifier count) shows that it is less than the hourly volumes in the year 2000 count. It is possible that some traffic has transferred to Clarence Street. The reason for this may be to jump the queue in Fitzroy Street which extends back to and through the roundabout from the congestion on the bridge.

As previously indicated retention of the Clarence Street access onto the bridge is necessary to help relieve traffic congestion in the long term to avoid queuing in Villiers Street at the roundabout.

There are several issues associated with pm peak traffic flow on the bridge that may affect the decision of whether to take any action in Clarence Street in the short term to address the issue of left turners 'pushing in'.

Southbound traffic in Fitzroy Street freely gives way to traffic entering from Clarence Street because the queue is slow moving. Queuing from the bridge extends back past Clarence Street through the Villiers Street roundabout. Additional traffic entering from Clarence Street adds to the length of the queue from the bridge.

Any gap in the traffic stream created by the roundabout is taken up by the Clarence Street traffic and generally assists in overall traffic flow. The notion of closing Clarence Street to prevent 'pushing in' might make the afternoon queuing worse. This particularly the case when the peak hour is starting to build up.

Furthermore, long queues in Villiers Street as a result of a closure may cause safety problems at the roundabout because it would be more difficult to gain access.

The best traffic management arrangement would be to do nothing even though traffic pushing in from Clarence Street might be annoying to some drivers. This is a matter for further investigation by Council's Traffic Committee.

8.7 Existing Issue - Oliver Street

There have been complaints to Grafton City Council regarding traffic volumes in Oliver Street, including trucks using it as a bypass.

Classifier traffic counts were taken in Oliver Street near the High School to quantify the extent of the issue. Data for the highest day of the survey period (Wed 24 Sep 2003) are provided in Tables 23 and 24.

Table 23 – Vehicle Classification

Westbound

Class	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	Total
Vehicles	886	3	0	4	69	0	0	2	4	0	0	0	968
Percentage	91.5%	0.3%	0.0%	0.4%	7.1%	0.0%	0.0%	0.2%	0.4%	0.0%	0.0%	0.0%	

Eastbound

Vehicles	971	0	0	3	60	0	0	0	2	0	0	0	1036
Percentage	93.7%	0.0%	0.0%	0.3%	5.8%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	

CLASS C1 & C2 cars, C3 to C5 Buses and light commercials, C6 > Heavy Commercials

Table 24 - Hourly Volumes per direction

Westbound

Time	Cars	Lt Trucks & buses	Large Trucks
0-100	1	0	0
200	0	2	0
300	1	0	0
400	1	0	0
500	0	1	0
600	7	1	0
700	21	2	1
800	33	0	1
900	66	6	0
1000	61	6	0
1100	53	1	0
1200	59	8	0
1300	71	4	0
1400	52	2	0
1500	57	4	0
1600	92	8	1
1700	76	7	1
1800	79	8	0
1900	64	6	2
2000	26	4	0
2100	45	0	0
2200	13	2	0
2300	8	0	0
2400	3	1	0
Total	889	73	6

Eastbound

Time	Cars	Lt Trucks & buses	Large Trucks
0-100	4	2	0
200	0	0	0
300	2	1	0
400	2	1	0
500	2	2	0
600	13	1	0
700	23	0	0
800	50	5	0
900	129	8	0
1000	63	4	0
1100	71	2	0
1200	54	3	0
1300	60	2	0
1400	63	4	0
1500	72	1	0
1600	73	5	0
1700	61	3	1
1800	64	7	0
1900	68	1	0
2000	36	1	1
2100	34	2	0
2200	19	4	0
2300	6	2	0
2400	2	2	0
Total	971	63	2

The tables show that both directions of traffic flow are reasonably consistent in terms of volumes. There are more heavy vehicles travelling westbound than eastbound. No large trucks used the street in either direction during night time sleeping hours although there was some use by light commercial vehicles during that time. A review of origin and destination data indicates that there is possibly a small amount of through traffic that may use Oliver Street.

Traffic volumes are within the desirable range for a residential street in terms of environmental capacity. The environmental goal for a collector road is 300 vph or 3000vpd.

While the data collected does not indicate a traffic flow issue in Oliver Street, complaints to Council from residents indicates that there are traffic flow, heavy vehicle and road safety issues in the street. An inspection of Oliver Street reveals that the street contains many residential properties and a school. Many school children were observed walking and riding along the road. As a general rule a residential street of this nature should not carry unnecessary traffic that could use other routes.

Certain characteristics of Oliver Street give the impression of it being an important road. The street has priority at all intersections except for Prince Street and Turf Street. It is the prolongation of the high vehicle routes via Duke Street and the section of Oliver Street to Prince Street. It is easy for traffic (and trucks) to proceed from Oliver St west across Prince Street to avoid an additional turn on the trip to Turf Street. The street is marked with centre lines and edge lines. While this may have been done to define road space for cyclists, motorists may see it as a priority road.

The street has been examined from the viewpoint of State road traffic flows (Summerland Way through traffic). The data indicates that there could possibly be some through truck traffic but not a significant volume. The matter is therefore one for Grafton City Council to address in consultation with the RTA.

9 Comparison of Crossing Localities

The analysis contained in this report is summarised in the following table.

Table 25 Summary table for comparison of Crossing Localities

Criteria	Do Nothing	Locality 1	Locality 2	Locality 3	Locality 4	Locality 5	Locality 6	Locality 7
1. Transport and Traffic								
Volumes on crossings **2003**								
New bridge	-	10000	11000	13000	6000	5000	4500	3000
Existing bridge	26000	16000	15000	13000	20000	21000	21500	23000
Volumes on crossings **2033**								
New bridge	-	12000	13000	17000	10000	9000	8000	6000
Existing bridge	34000	22000	21000	17000	24000 **	25000 **	26000 **	28000 **
** Traffic on the existing bridge may not exceed 24,000 because it may transfer to other routes to avoid peak hour delays.								
Level of Service year **2033** peak								
New Bridge	-	D	D	C	C	C	C	B
Existing Bridge	F	E	E	C	E	E	E	E/F
Based on Florida DOT model for Urban Conditions with 8.4% peak hour flows and 63% tidal flow. Los A= Very Good, Los F= Very Poor, Los C is the project objective.								
Average weekday traffic in streets forming possible connection to localities.		Sth of Fitzroy	Sth of Fitzroy		East of Villiers	East of Villiers	East of Villiers	East of Villiers
Existing traffic volumes **(2003)**	-	5000	3000	26000	3000	3000	3000	3000
Volumes with Do nothing **(2033)**	-	6500	3000	34000	3000	3000	3000	3000
Volumes with new bridge **(2033)**	-	18500	16000	34000	13000	12000	11000	9000
Height Restrictions at Viaduct * Feasible to be increased in Villiers St		4.0m	4.0m *	4.0m *	Nil	Nil	Nil	Nil
Suitable for large vehicles including B-Doubles * Kinks are an issue along with tight turns at roundabouts ** Detour via Duke St to keep trucks out of CBD *** Additional truck traffic in residential streets	Yes *	Yes **	Yes	Yes *	Yes ***	Yes ***	Yes ***	Yes ***
Provision for cyclists and public transport by reducing delays for buses and improving access to growth area - Clarenza.	Poor	Fair	Good	Good	Very Good	Good	Good	Fair
Work required on intersections in approaches to existing bridge								
- Villiers/Fitzroy	U	N	U	U	N	N	U	U
- Bent/Through	U	N	N	U	N	N	U	U
- Bent/Ryan	U	N	N	U	N	N	N	U
N-No significant works needed, U-Upgrade by **2033**								

	Do Nothing	Locality 1	Locality 2	Locality 3	Locality 4	Locality 5	Locality 6	Locality 7
Existing traffic **2003**								
using the Bridge **All Vehicles**		300	400	1000	250	250	250	250
& Summerland **Large Trucks**		30	60	100	40	40	40	40
Way.								
Through traffic without stopping comprises approx 50% of volumes shown								
Total Large Trucks **2033**								
New bridge	-	130	270	250	260	260	240	190
Existing bridge	500	370	150	250	240	240	260	310
Light trucks and buses excluded								
Total Buses **2033**								
New bridge	-	130	200	200	170	150	140	110
Existing bridge	400	270	200	200	230	250	260	290
5 Year Accident Savings at								
10 year intervals **2003**		-6	-8	-12	+2	+4	+1	-3
2013		-7	-9	-13	+3	+5	+1	-4
2023		-7	-9	-14	+3	+5	+1	-5
2033		-8	-10	-15	+4	+6	+2	-6
Return on investment								
Project Cost (Strategic Est)		$45m	$45m	$40m	$45m	$40m	$50m	$55m
Benefit cost ratio @7%		1.49	1.44	2.02	1.06	0.94	0.57	0.14
First year rate of return @7%		9.7%	9.2%	12.9%	5.6%	5.1%	2.4%	0.0%

9.1 Public Transport Option

This section contains a brief discussion of the potential for a public transport option in lieu of another bridge crossing, at least to satisfy the short to medium term travel demand. This summary has been extracted from part of the Feasibility Study. The issue has not received further consideration in this report.

There are two means of public transport available – light rail and buses.

In order for a public transport initiative to be successful it would need to attract approximately 1000 additional people per hour onto public transport in the peak periods.

A light rail option did not appear to be feasible because the cost of new stations, sidings and rolling stock would be significant. In addition it would be unlikely that motorists would change mode where there does not appear sufficient incentive (time saving) to do so for a short trip across the River.

A bus option appears more attractive than the light rail option but this too would face customer resistance. Vehicle occupancy surveys conducted on the bridge show that only a handful of people currently use bus transport during peak hours.

Morning Peak Period (8:00 to 9:00) 2001

northbound - 32 buses (26 school buses) (5 empty buses)
(approx 15 passengers in 1 non school bus)

southbound - 32 buses (6 school buses) (26 empty buses)
(approx 15 passengers in 1 non school bus)

Afternoon Peak Period (3:00 to 5:00pm) 2001

northbound - 28 buses (12 school buses) (14 empty buses)
(approx 70 passengers in 2 non school buses)

southbound - 43 buses (28 school buses) (13 empty buses)
(approx 30 passengers in 2 non school buses)

The area potentially available for parking is limited with space for about 300 cars (500 passengers). The area near the viaduct could accommodate approximately 200 car parking spaces. Another 100 spaces could be provided on the western side of Bent Street at the cross roads.

In order to minimise the area needed for parking and to maximise patronage it would be desirable to service the residential areas of South Grafton, ie pick up passengers near their residence. Assuming that each bus would carry 50 passengers means that an additional 20 buses would be required to carry 1000 passengers per hour, most of these in the peak direction.

Most potential passengers who would use a parking area would be from the Pacific Highway. (Local residents would choose to catch a bus from near home rather than split their journey.) Those local residents already in cars at the Gwydir Highway and Bent Street intersection would probably not wish to change travel modes at this point.

Given the constraints on the area available for parking and the cost to provide for parking, approximately 500 South Grafton residents per hour would need to be attracted onto buses. This would account for the majority of the commuters who currently originate in South Grafton.

Certain initiatives would need to be implemented for the bus option to have the potential of being acceptable. It would need to be affordable, regular, easily accessed, provide improved travel times and be economically sustainable from an operator's perspective.

The implementation of a public transport strategy using buses would lead to the eventual demand for improvements to the existing bridge, in particular there would be pressure to have the bends removed and a busway installed on the existing structure.

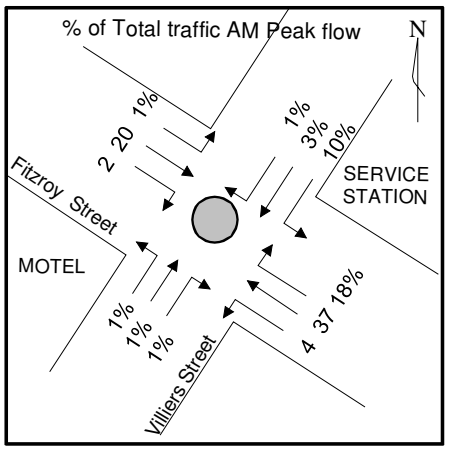
A public transport solution does not appear to be viable.

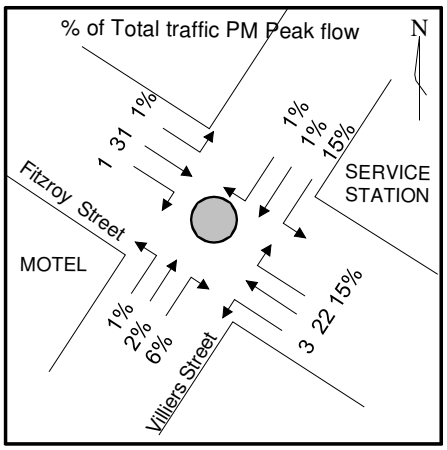
Appendix A

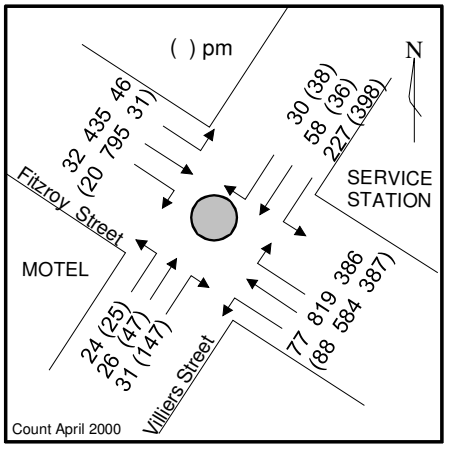
Traffic volumes and traffic survey data

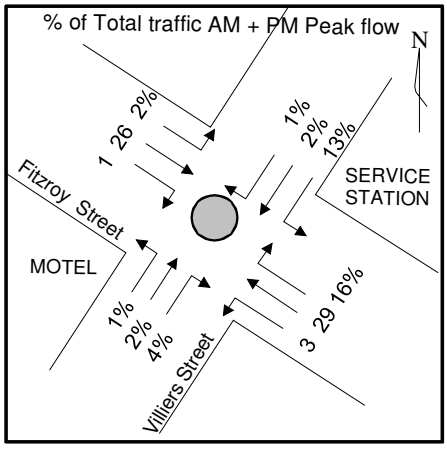
TRAFFIC SPLITS AT VILLIERS AND FITZROY STREETS

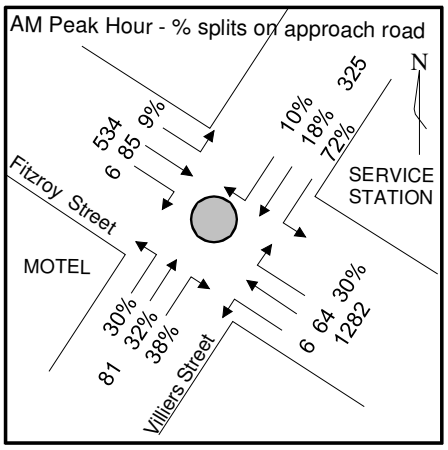
	Villiers EB Left turn	Villiers EB Thru	Villiers EB Right turn	Fitzroy NB Left turn	Fitzroy NB Thru	Fitzroy NB Right turn	Villiers WB Left turn	Villiers WB Thru	Villiers WB Right turn	Fitzroy SB Left turn	Fitzroy SB Thru	Fitzroy SB Right turn	Total
am	46	435	32	24	26	31	77	819	386	227	58	30	2191
%	2%	20%	1%	1%	1%	1%	4%	37%	18%	10%	3%	1%	
pm	31	795	20	25	47	147	88	584	387	398	36	38	2596
%	1%	31%	1%	1%	2%	6%	3%	22%	15%	15%	1%	1%	
am & pm	77	1230	52	49	73	178	165	1403	773	625	94	68	4787
%	2%	26%	1%	1%	2%	4%	3%	29%	16%	13%	2%	1%	

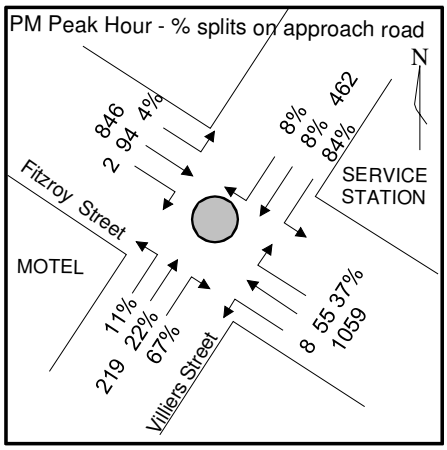


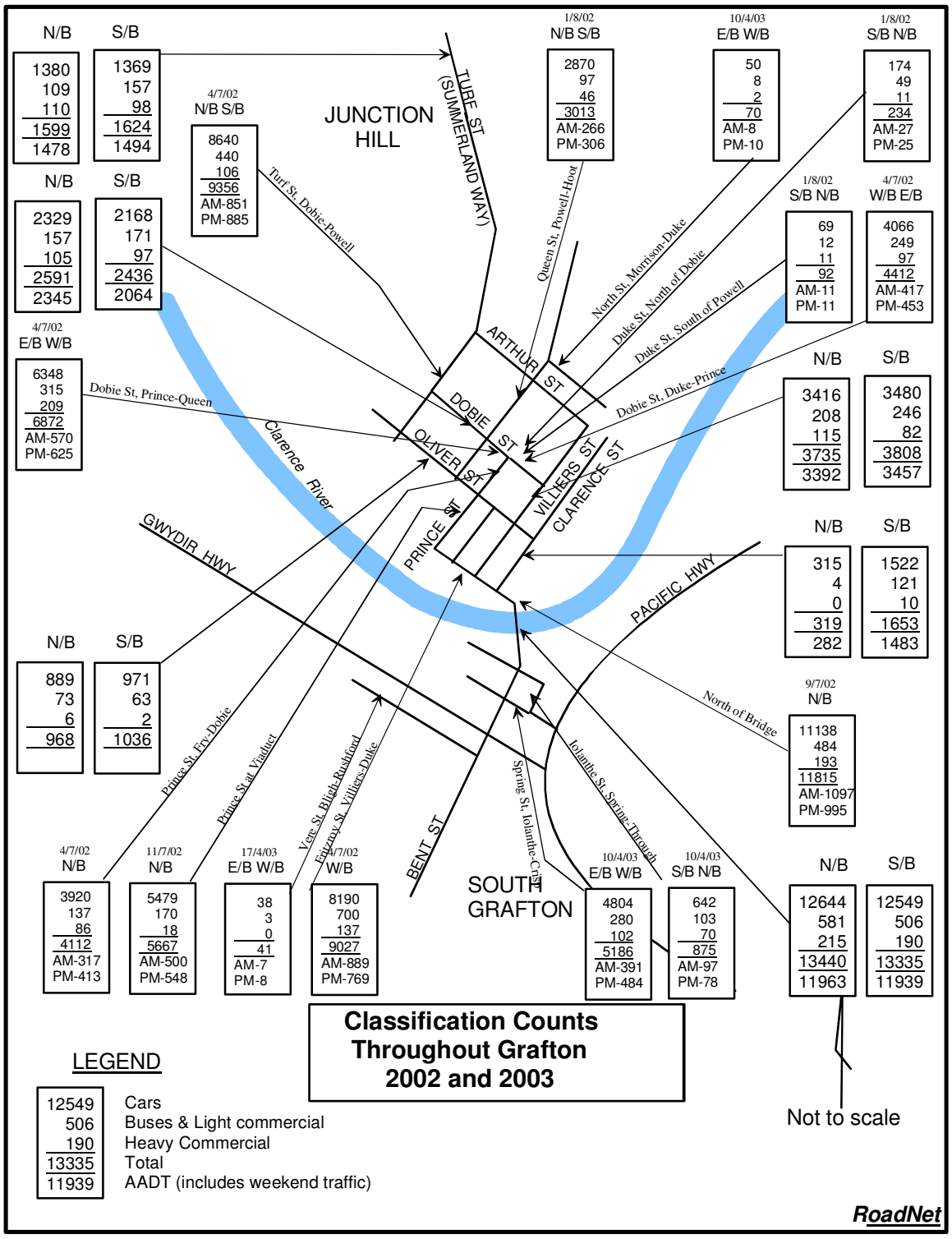






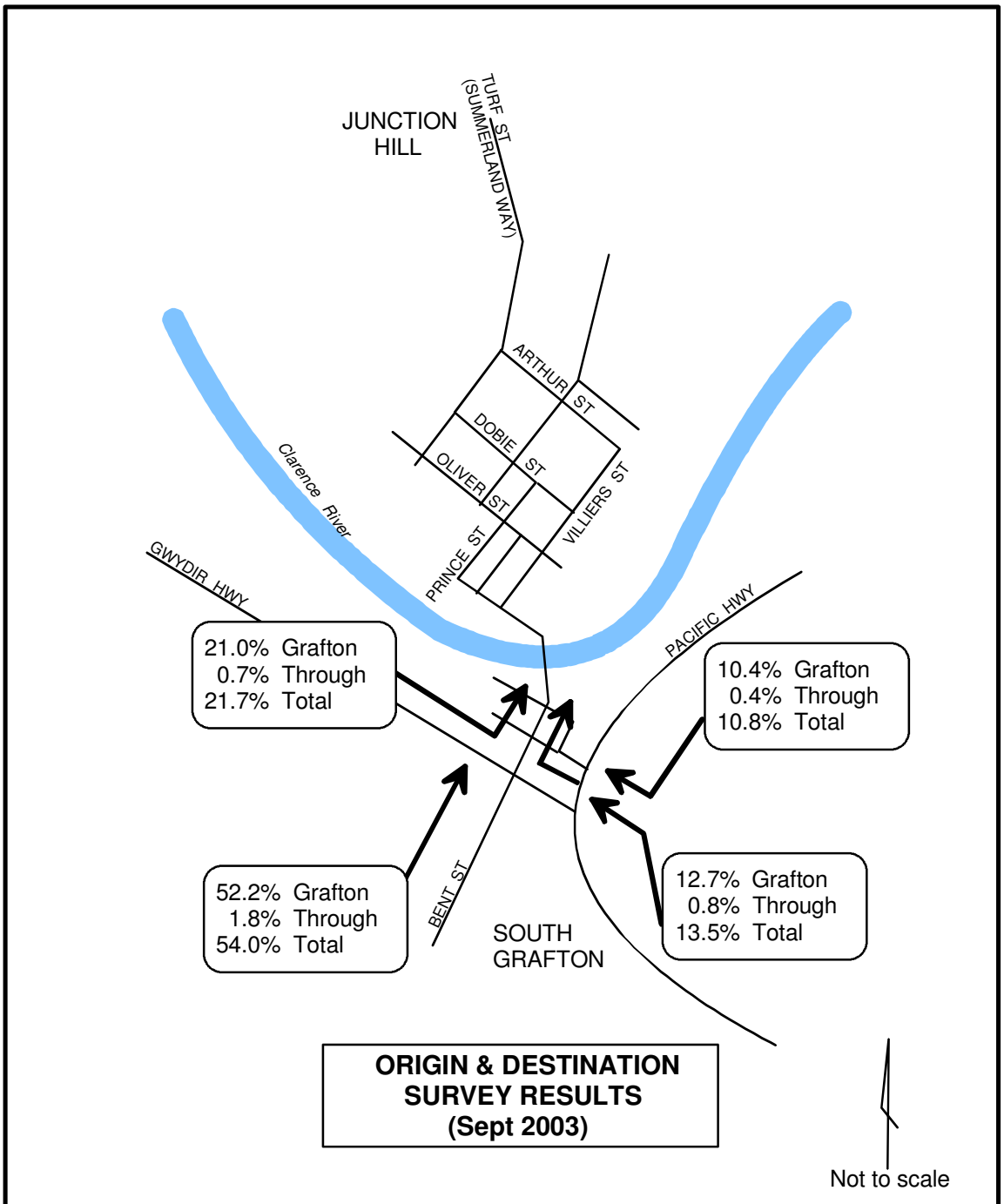





JUNCTION HILL
SOUTH GRAFTON
TURF ST (SUMMERLAND WAY)
ARTHUR ST
DOBIE ST
OLIVER ST
VILLIERS ST
CLARENCE ST
PRINCE ST
BENT ST
GWYDIR HWY
PACIFIC HWY
Clarence River
Turf St, Dobie-Powell
Queen St, Powell-Hoot
North St, Morrison-Duke
Duke St, North of Dobie
Duke St, South of Powell
Dobie St, Duke-Prince
Dobie St, Prince-Queen
North of Bridge
Prince St, Fry-Dobie
Prince St at Viaduct
Vere St, Bligh-Rushford
Fitzroy St, Villiers-Duke
Spring St, Iolanthe-Cross
Iolanthe St, Spring-Through
N/B S/B
1380 109 110 1599 1478
1369 157 98 1624 1494
4/7/02 N/B S/B
8640 440 106 9356
AM-851 PM-885
1/8/02 N/B S/B
2870 97 46 3013
AM-266 PM-306
10/4/03 E/B W/B
50 8 2 70
AM-8 PM-10
1/8/02 S/B N/B
174 49 11 234
AM-27 PM-25
N/B S/B
2329 157 105 2591 2345
2168 171 97 2436 2064
1/8/02 S/B N/B
69 12 11 92
AM-11 PM-11
4/7/02 W/B E/B
4066 249 97 4412
AM-417 PM-453
4/7/02 E/B W/B
6348 315 209 6872
AM-570 PM-625
N/B S/B
3416 208 115 3735 3392
3480 246 82 3808 3457
N/B S/B
315 4 0 319 282
1522 121 10 1653 1483
9/7/02 N/B
11138 484 193 11815
AM-1097 PM-995
N/B S/B
889 73 6 968
971 63 2 1036
4/7/02 N/B
3920 137 86 4112
AM-317 PM-413
11/7/02 N/B
5479 170 18 5667
AM-500 PM-548
17/4/03 E/B W/B
38 3 0 41
AM-7 PM-8
4/7/02 W/B
8190 700 137 9027
AM-889 PM-769
10/4/03 E/B W/B
4804 280 102 5186
AM-391 PM-484
10/4/03 S/B N/B
642 103 70 875
AM-97 PM-78
N/B S/B
12644 581 215 13440 11963
12549 506 190 13335 11939
Classification Counts Throughout Grafton 2002 and 2003
LEGEND
12549 Cars
506 Buses & Light commercial
190 Heavy Commercial
13335 Total
11939 AADT (includes weekend traffic)
Not to scale
RoadNet

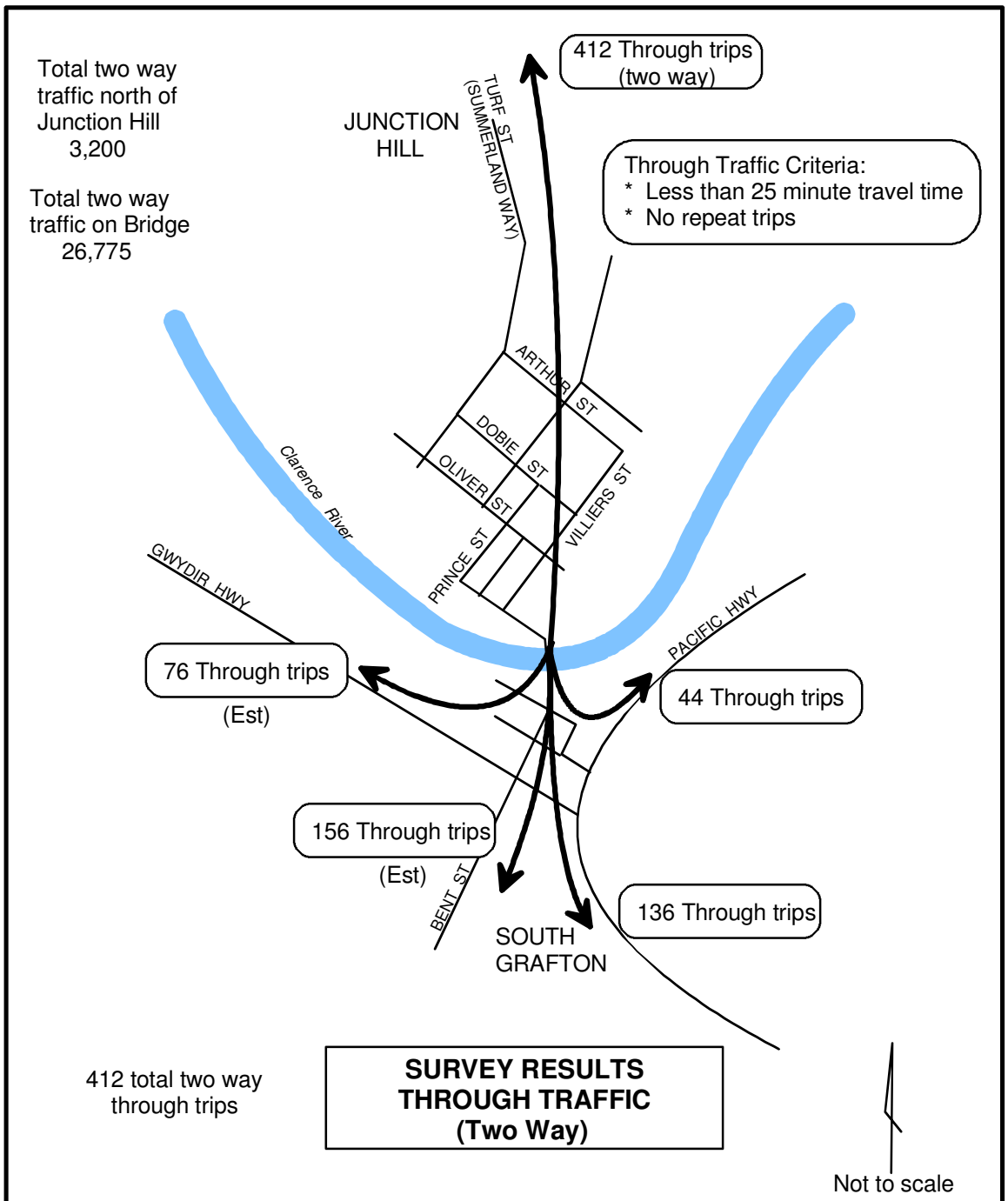
Appendix B

Origin and Destination Trip Tables

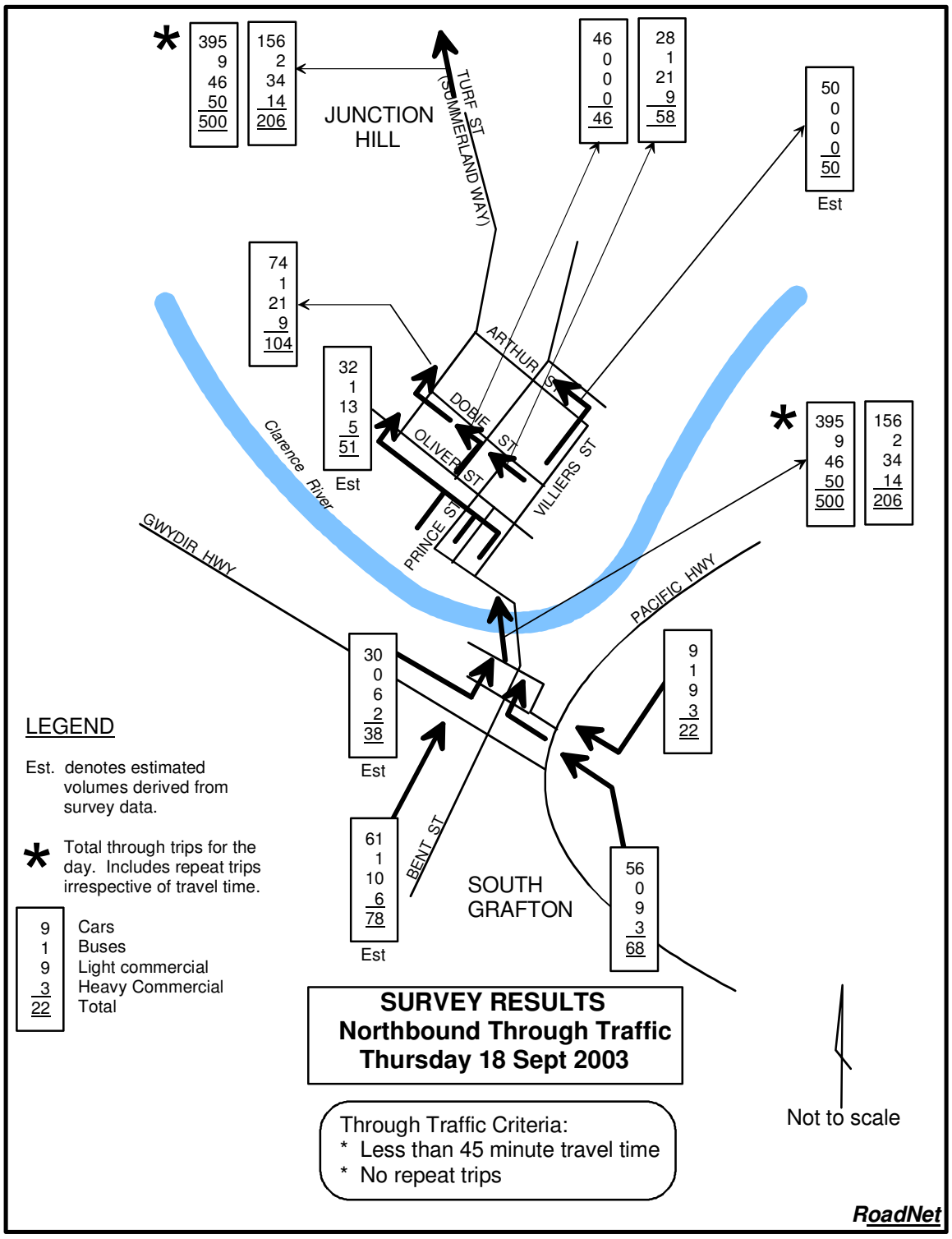


Through traffic shown includes repeat trips during the day and does not take account of trip times. Genuine through trips without stopping are less than 50% of the percentages shown.

RoadNet



NOTE: On the survey day (Thursday 18 Sept 2003) 1000 vehicles (two way) passed through Junction Hill and crossed the Grafton Bridge. Of these 210 were trucks and buses. More than half of the 1000 vehicles either stopped in Grafton or made more than one trip in the day.


*
395
9
46
50
500
156
2
34
14
206
JUNCTION HILL
TURF ST (SUMMERLAND WAY)
46
0
0
0
46
28
1
21
9
58
50
0
0
0
50
Est
74
1
21
9
104
32
1
13
5
51
Est
ARTHUR ST
DOBIE ST
OLIVER ST
VILLIERS ST
PRINCE ST
Clarence River
*
395
9
46
50
500
156
2
34
14
206
GWYDIR HWY
PACIFIC HWY
30
0
6
2
38
Est
9
1
9
3
22
61
1
10
6
78
Est
BENT ST
SOUTH GRAFTON
56
0
9
3
68
LEGEND
Est. denotes estimated volumes derived from survey data.
* Total through trips for the day. Includes repeat trips irrespective of travel time.
9 Cars
1 Buses
9 Light commercial
3 Heavy Commercial
22 Total
SURVEY RESULTS
Northbound Through Traffic
Thursday 18 Sept 2003
Through Traffic Criteria:
* Less than 45 minute travel time
* No repeat trips
Not to scale
RoadNet

Appendix C
Traffic Assignment

Appendix D
Economic Analysis

Appendix E

Glossary of Terms used in this Report

AADT	Annual average daily traffic. Describes the average traffic daily volume over the year. Includes weekday and weekend traffic.
AWT	Average Weekday Traffic. Describes the average daily traffic volume for the period Monday to Friday. This figure normally considerably higher than AADT. The analysis figure used in this report relates to AWT.
Benefit Cost Ratio (BCR)	Describes the value to the community of the project. Benefits derived from the improvement are quantified in terms of accident savings, reduced road users costs eg fuel usage, reduced travel time and better riding quality eg less wear and tear. These are added for every trip over 30 years and discounted to a 2003 dollar value. These benefits are divided by the project cost to give a ratio (BCR). A BCR of 2 means the community receives twice its investment and is a benchmark figure for public sector expenditure on major projects.
First Year Rate of Return	This is a measure of benefits gained in the first full year of operation.
Level of Service (LOS)	Describes the performance of lengths of road and intersections. LOS 'A' is very good travel conditions. LOS 'F' describes when the system exceeds capacity. LOS 'C' describes acceptable conditions. The LOS for lengths of road relates to freedom to move within the traffic stream. LOS at intersection relates to the extent of delays.
Origin and Destination	Describes the travel paths of vehicles. Surveys conducted identified all commercial vehicles (100% sample) and a sample of cars and tracked them through Grafton and Junction Hill. ('Red' cars comprise 12% of total cars and these were used as the sample.)
Through traffic	Traffic that does not stop in Grafton. Identified in the study by its travel time through the city.
Vehicles Classification	Describes the type of vehicle eg car, light commercial (small rigid truck), bus, heavy commercial (semi). Refer to diagram in Appendix A.
Viaduct	Railway line crossing over the roadway where traffic can pass underneath.