Shotover Property Investments Ltd

Proposed Private Plan Change

Transportation Assessment Report

March 2011

Traffic Design Group

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10837 transportation assessment final.doc

Shotover Property Investments Ltd

Proposed Private Plan Change

Transportation Assessment Report
Quality Assurance Statement

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Status: Final

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1. Introduction

1.1 Overview

Shotover Property Investments Ltd is seeking a private plan change to the Queenstown Lakes District Council (QLDC) District Plan. The plan change request would result in an area of land to the immediate west of Hansen Road and north of State Highway 6 (Ladies Mile) being rezoned from Low Density Residential to a new zone called the "Frankton Mixed Use Zone". This will facilitate a mix of land uses, such as retail, offices and high density residential.

This Transportation Assessment Report evaluates the potential transportation-related effects of the proposed rezoning on the existing and future transport networks, and includes a consideration of relevant strategic transportation strategies and policies. While this report includes an assessment of travel by private motor vehicle, it also recognises the importance of other forms of transport and consequently consideration has also been given to public transport, walking and cycling.

2. Existing Transport Infrastructure

2.1 Site Location

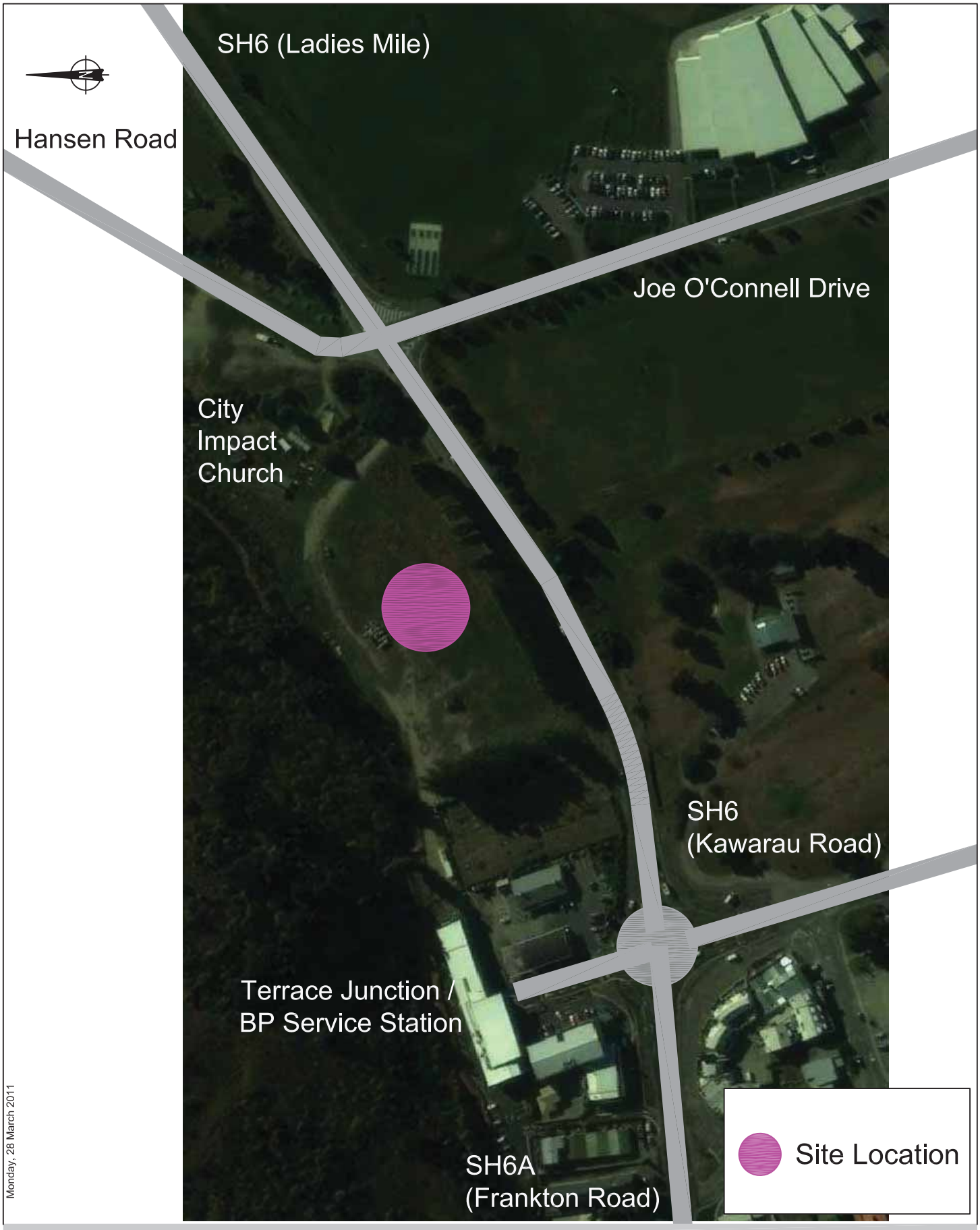
Figure 1 shows the location of the proposed plan change site, about 300m northeast of Frankton and 6km to the east of Queenstown. State Highway 6 (known in this location as Ladies Mile) lies to the immediate south of the plan change area with Hansen Road being to the east. The site is currently zoned as Rural towards the north and Low Density Residential towards the south.

2.2 Existing Roading Network

Hansen Road lies towards the east of the proposed plan change area. It is a single carriageway road and serves a small number of residential properties and a church. It is defined as a Local Road under the District Plan indicating a role in providing direct property access. The alignment of the road is generally flat at its southern end but further to the north the road ascends towards Lake Johnson. Although the legal road continues as far as Tucker Beach Road, some 1.5km further north, Hansen Road is unformed over much of this distance.

Photograph 1: Hansen Road looking north

At its southern extremity, Hansen Road meets Ladies Mile at a priority intersection. Ladies Mile runs with an east-west orientation and therefore Hansen Road forms the northern approach to the intersection with Joe O'Connell Drive forming the southern approach. The intersection is give-way controlled, with vehicles on Ladies Mile having priority. The Hansen Road approach has only one traffic lane, and vehicles approaching the intersection pass through a comparatively sharp curve towards the left on the immediate approach. However on Joe O'Connell Drive, two lanes are provided for approaching traffic (left-turn only and right-turn only respectively), and these are developed over a distance of around 35m. The lanes are separated by a short hatched area. Auxiliary right-turning lanes are also provided for vehicles undertaking manoeuvres from Ladies Mile (west) to Joe O'Connell Drive and Ladies Mile (east) to Hansen Road. These lanes are some 3.3m in width.



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Site Location Plan

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Q:\Projects\10837 SPI\Figures 20110328\Figure 1 Site Location.dwg

There is also a left-turning auxiliary lane for vehicles turning into Joe O'Connell Drive. In the immediate vicinity of the intersection this lane is separated from the traffic lanes of Ladies Mile by a flush hatched area, and vehicles turning left into Joe O'Connell Drive are required to give way to those turning right.

Photograph 2: Ladies Mile / Hansen Road / Joe O'Connell Drive intersection

Photograph 3: Termination of Left-Turning Lane into Joe O'Connell Drive

Joe O'Connell Drive is a Local Road and serves only the Queenstown Events Centre and Aquatic Centre. It is a sealed single carriageway road, of around 9.2m in width, abutted by grassed areas. It generally runs in a north-south direction with a straight horizontal and vertical alignment. Parking is prohibited on both sides of the road.

Photograph 4: Joe O'Connell Drive looking north towards Ladies Mile

Ladies Mile is a main strategic link through the district, forming part of the state highway network connecting Queenstown with Cromwell, Wanaka and the wider strategic network throughout the South Island. In the vicinity of the plan change area it provides one traffic lane in each direction of 3.5m width, with sealed shoulders of 0.7m on each side of the road. It is subject to a speed limit of 60km/h, although this rises to 80km/h approximately 100m to the east of the intersection with Hansen Road. To the east, Ladies Mile has only minimal gradient and curve. To the west the highway has a more noticeable gradient, with the height of the carriageway rising as distance from the plan change area increases.

In this location, Ladies Mile is designated as a Limited Access Road, meaning that NZTA is able to limit the number and location of access points onto the highway.

Photograph 5: Ladies Mile in vicinity of plan change area, looking east from Joe O'Connell Drive

Ladies Mile joins State Highway 6A (Frankton Road) at a roundabout some 300m west of Hansen Road. The southern arm of the roundabout is a continuation of State Highway 6 (known as Kawarau Road), which passes Queenstown airport en route to Invercargill around 180km to the south. The western arm of the roundabout is part of State Highway 6A (Frankton Road), which provides the main route to and from Queenstown. The northern arm serves a service station and also 'Terrace Junction', a retail development.

Photograph 6: Stage Highway 6/6A roundabout looking southeast

Each of the roundabout approaches has two lanes, except for the petrol filling station access which has only one lane. Generally, the roundabout provides for a one-lane circulatory carriageway, although localised widening immediately adjacent to the eastern, southern and western approaches together with the land markings means that a vehicle turning left can enter the roundabout at the same time as another vehicle travelling straight ahead or right.

Photograph 7: Stage Highway 6/6A roundabout looking west

Towards the south of the roundabout, State Highway 6 (Kawarau Road) runs with a straight and flat north-south alignment, providing one traffic lane in each direction which in this location are separated with a flush median. On the eastern side of the highway is a formal parking lane

Photograph 8: Kawarau Road, looking north

2.3 Public Transport

There is a bus stop provided adjacent to the Aquatic Centre on Joe O'Connell Drive, some 200m south of Ladies Mile. This has a shelter, seating and timetable information, as well as a layby for the bus to wait without blocking the traffic lane of Joe O'Connell Drive.

Photograph 9: Bus Stop on Joe O'Connell Drive

The Frankton Bus Exchange is some 120m south of the State Highway 6/6A roundabout, and provides shelters, seating, timetable information and toilets. It is the terminus for services serving eastern and southern parts of the district. The circulation route for is one-way (south to north).

Photograph 10: Frankton Bus Exchange

There is provision made on Kawarau Road for buses to turn into the exchange by way of a right-turning lane within the centre of the road, and a yellow hatched marking is present to assist buses in emerging from the exchange.

Photograph 11: Right-turn Lane on Kawarau Road into Frankton Bus Exchange

2.4 Pedestrian and Cycle Network

There is a formed footpath on the northern side of Ladies Mile between the cemetery and Hansen Road. This is gravelled and is 1.7m wide.

Photograph 12: Footpath on northern side of Ladies Mile

There is no footpath provision on Hansen Road, on the northern side of Ladies Mile to the east of Hansen Road, or on the southern side of Ladies Mile. However there is a footpath on Kawarau Road and two formal crossing points. There is a pedestrian refuge with associated resting rails and tactile paving just south of the Kawarau Road / Gray Street intersection.

Photograph 13: Footpath on eastern side of Kawarau Road

Photograph 14: Pedestrian refuge on Kawarau Road

There is also a signalised pedestrian crossing on Kawarau Road just south of the Kawarau Road / Ross Street intersection.

Photograph 15: Signalised pedestrian crossing on Kawarau Road

The signalised crossing links to a network of off-road pedestrian and cycle paths which pass through the Events Centre and Aquatic Centre and which in due course will link to the network of routes around the Five Mile development site. At present however the linkages have not been fully formed.

Photograph 16: Termination of footpath from Five Mile at boundary of Events Centre

There is no specific on-road infrastructure provision for cyclists in the immediate area.

3. Current Travel Patterns

3.1 Traffic Volumes

Data has been obtained from QLDC and the New Zealand Transport Agency for the most recent traffic counts carried out in the vicinity of the plan change area. The results are summarised in Table 1 below.

Location	Date	Average Daily Traffic Volume
SH6 (Ladies Mile) east of plan change area	2009	14,850
SH6 (Kawarau Road) south of Frankton Road	2009	15.050
SH6A (Frankton Road)	2009	16,650
Hansen Road	June 2008	500
Joe O'Connell Drive	June 2009	1,400

Table 1: Traffic Volumes

It can be seen that the traffic flows in the area are dominated by the state highway, with the two district roads carrying significantly less traffic. The amount of traffic recorded at Hansen Road seems unusually high given that just 92 vehicles per day were recorded in September 2007 and there has been no significant development served by Hansen Road since that time

3.2 Intersection Turning Movements

As part of this commission, peak hour turning surveys were undertaken at the State Highway 6/6A roundabout and the Ladies Mile / Hansen Road / Joe O'Connell Drive intersection. Details of the surveys and the methodologies used are set out in the Model Development Report included as Appendix A to this document.

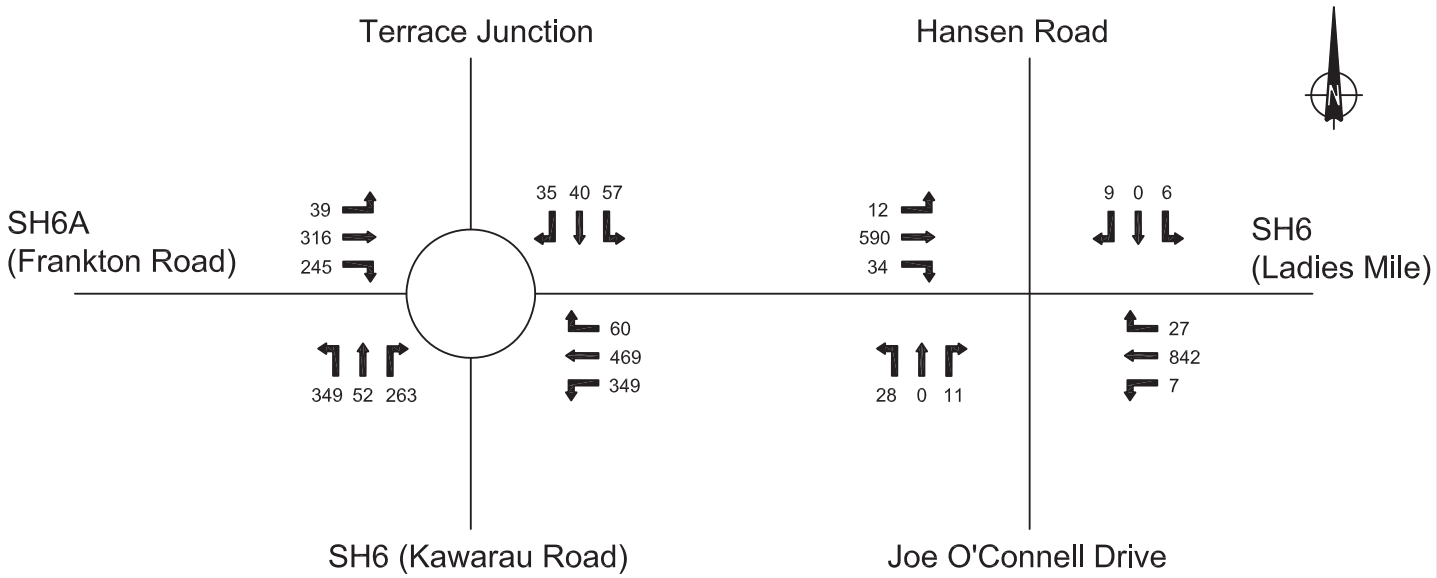
The results of the surveys are shown on **Figure 2**. The morning peak hour was observed between 8am to 9am and in this period a strong tidal flow was noted on Ladies Mile with around two thirds of all traffic travelling from east to west. Relatively little traffic was noted on Hansen Road (18 vehicles, or one movement every 3 minutes), compared to one vehicle every 4 seconds passing Hansen Road on the highway.

The evening peak hour occurred between 5pm to 6pm, and traffic flows were 30% greater than in the morning peak hour. No strong tidal flows were observed on Ladies Mile in this period but of note is that 49 vehicles were observed entering Hansen Road from the highway. This may be traffic associated with the church and/or the child day care centre run by the church..

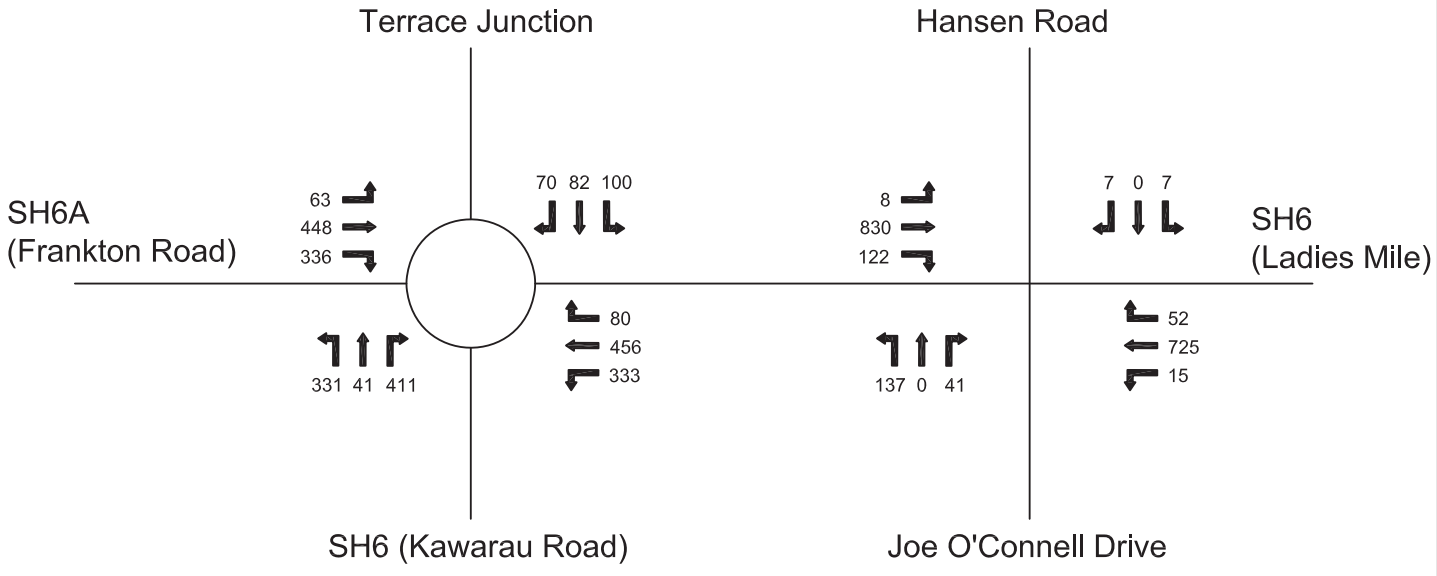
Unsurprisingly, the traffic flows in the peak hours were dominated by the state highway, with the district roads accounting for just 10% to 15% of all traffic movements.

3.3 Public Transport

Two Connectabus services pass the proposed plan change area. Service 10 (Arrowtown) runs between the Frankton Bus Exchange and Arrowtown, but does not stop near the site. Service 12 (Events Centre / Lake Hayes Estate) runs between the Frankton Bus Exchange and Lake Hayes Estate, and stops at the bus stop within the Events Centre.



2011 (Observed) Morning Peak Hour



2011 (Observed) Evening Peak Hour

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Shotover Property Investments Ltd.

Existing Intersection Turning Movements

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However, the Frankton Bus Exchange is an important interchange location, and all Connectabus services in Frankton stop at this location, including Service 11 (Queenstown / Airport / Remarkables Park) and Sevice 6 (Kelvin Heights) and well as Services 10 and 12 noted above. Service 11 operates with a 15-minute frequency with other services operating at a 30-minute to 2-hourly frequency.

3.4 Pedestrians and Cyclists

While no formal surveys have been undertaken, informal observations of pedestrians and cyclists using the roading network in the area indicate low levels of activity. A higher level of activity can be expected on the cycle paths to the south, although again there is little data on the extent of use.

3.5 Road Safety

The New Zealand Transport Agency Crash Analysis System (CAS) has been used to assess the accident history on Ladies Mile between the State Highway 6/6A roundabout and a point 100m east of the Ladies Mile / Grant Road intersection. The search identified all reported accidents which occurred in the five year period from 2005 to 2009 inclusive and the partial record available for 2010.

The search revealed that 15 accidents had occurred in this period. Five of these occurred within the car parking areas at Frankton Corner, and these have not been considered further in this analysis. Of the remaining 10 accidents, 6 occurred at the State Highway 6/6A roundabout. Two of these were as a result of one car hitting the rear of another while in a queue of traffic, 3 were as a result of the driver failing to give way at the roundabout, and one occurred when a driver failed to signal and was struck by another vehicle. None of these accidents resulted in injury.

Three accidents occurred on Ladies Mile and two of these were not associated with turning traffic at intersections. One occurred when a vehicle which had been parked, pulled out into the traffic stream and struck another vehicle and the other was as a result of a vehicle striking a straying animal. A further accident occurred east of Joe O'Connell Drive when a westbound vehicle struck another vehicle waiting in a queue. This occurred in heavy rain.

Only one accident was recorded on Hansen Road, which occurred just north of Ladies Mile when one vehicle turning right was mistakenly overtaken by another.

4. Future Changes to the Transport Networks

4.1 Road Network

The final report of the Wakatipu Transportation Strategy, a study commissioned by QLDC, was issued in November 2007. It is considered that there are many aspects to the strategy that will potentially affect travel demands across the Frankton Flats and therefore, the travel demands at the plan change area. The most significant of these is the stated desire to effect a significant change in travel behaviour with a critical objective of the Wakatipu Transportation Strategy being the need to reduce the predicted future traffic volumes on State Highway 6A Frankton Road to prevent "bumper to bumper traffic travelling at an average speed of 20km/h by 2026". It is expected that this will be achieved through the development of more frequent public transport services and parking restraint in Queenstown along with Park-and-Ride facilities in Frankton Flats. The final report states that "it is estimated that these measures could translate to approximately a 20% transfer of car trips to public transport by 2026".

The Wakatipu Transportation Strategy does not identify any targets for years before 2026 but indicates that a travel demand management programme would be initiated in the short term along with implementation of a high quality bus service. In this regard, of note is that the Connectabus services have recently been revised and increased in frequency. Also in the short term is the initial Implementation of park and ride schemes, continuing into the medium term as facilities are expanded.

The Wakatipu Transportation Strategy identifies seven road infrastructure improvement projects for the Frankton Flats which will serve to affect traffic flows on Ladies Mile, such as the construction of a new arterial road, the Eastern Access Road from State Highway 6 west of Glenda Drive, around the east end of the runway, through the RPZ and connecting with Hawthorne Drive. As part of the construction of this, the State Highway 6 / Glenda Drive intersection will also be modified and Glenda Drive will be separately linked to the Eastern Access Road. The staging strategy contained within the Wakatipu Transportation Strategy indicates that these improvements will be planned for the short term. The Glenda Drive intersection improvements are highlighted as urgent for road safety and efficiency reasons and should occur shortly.

Based upon the observed growth in traffic volumes on State Highway 6 and the additional traffic anticipated from proposed developments both east and south of Frankton, the State Highway 6/6A roundabout is envisaged by the Wakatipu Transportation Strategy to become a point of significant congestion in the near future. The strategy indicates that an intersection upgrade will be required in the medium term (2011-2016). This is likely to be implemented in conjunction with a public transport priority project for Frankton Road that aims to reduce traffic volumes through the introduction of park and ride schemes.

With the development enabled by the existing Frankton Flats Special Zone and also by the proposed Plan Change 19 (PC19) which is currently under appeal, significant growth in the traffic volumes using Grant Road is expected. The Wakatipu Transportation Strategy anticipates these developments and the construction of a roundabout at the State Highway 6 / Grant Road intersection was proposed for the short term. Since that time, the major developer in the immediate vicinity (Five Mile Holdings Limited) went into receivership and the status of the roundabout was uncertain. However, with a new owner of the site, the roundabout is again being progressed, although it is understood that the details of the layout are still being finalised.

4.2 Passenger Transport

The proposed bus routes described in the Wakatipu Transportation Strategy generally use Frankton Road and it is proposed that public transport priority measures be instigated for this road as part of travel demand management proposals designed to encourage the use of travel modes other than private motor vehicles.

As part of travel demand management measures, the Strategy proposes management of parking availability, particularly in central Queenstown, as a way to discourage commuter traffic and as an incentive to use the new public transport systems. Park and Ride facilities are also proposed within the northern sector of the Frankton Flats so that motorists can interchange to buses for the journey along Frankton Road. Although the location of the park and ride sites has not been determined at this time, it is of note that their location will influence the level of reduction in traffic volumes that will be achieved on the state highway across the Frankton Flats.

4.3 Walking

The Wakatipu Trails Strategy includes a conceptual map (page 20 of the strategy) which shows a proposed recreational trail using Hansen Road limiting access to the northern side of Ladies Mile. A new crossing of Ladies Mile is shown on the plan. The trails along the highway run to Quail Rise. However it is understood that the Trails Trust does not view this route as a priority, rather they would prefer to see trails on the southern side of Ladies Mile.

4.4 Plan Change 19

Proposed Plan Change 19 will enable mixed-use development of rural land between Queenstown Airport and Ladies Mile. The proposed structure plan includes residential and retail/commercial activity areas located beside the existing Frankton Flats Special Zone with access from Grant Road and the proposed Eastern Access Road. Around this new town centre, the land could be developed for light industrial purposes with the primary access route being the Eastern Access Road.

4.5 Traffic Growth

Between 2007 and 2009, traffic on Ladies Mile in the vicinity of the plan change area increased by less than 1% per annum (relative to the 2007 volume), equating to an increase of 131 vehicles per day each year. Conversely, between 2004 and 2007, the increase was 8.8% per annum (relative to the 2004 volume), equivalent to an increase of 1,000 vehicles per day each year.

This variation means it is extremely difficult to project historic traffic growth into future years, and more so when the likely changes in traffic flow associated with the forthcoming roading schemes and Wakatipu Transportation Strategy are considered. For the purposes of the analyses in this report, a ‘design year’ of 2021 has been adopted and traffic growth at a rate of 300 additional vehicles per day each year on the state highway has been allowed for. This equates to a 2% increase over and above the volumes in 2009.

5. Levels of Service

5.1 Roading Network

5.1.1 Overview

In this case, to determine the levels of service offered by the roading network, a microsimulation transport model has been constructed. This approach was selected because of the proximity of the State Highway 6/6A roundabout and Ladies Mile / Hansen Road / Joe O'Connell Drive intersection.

Microsimulation refers to simulating the movement of individual vehicles in a road network. The simulation is based on parameters such as vehicle dynamics, vehicle following, gap acceptance and lane changing characteristics, and broadly, each driver has different characteristics. For example, some drivers drive faster than others and some require longer gaps in the traffic stream to emerge at intersections. In this way, microsimulation provides an indication of the degree of natural variability that road users experience on a day to day basis. This approach differs from more traditional forms of modelling, which implicitly assume that for one set of inputs there is only one set of outputs and therefore the variability of traffic flow, driving and queuing behaviour is not accounted for.

When modelling busy road networks, microsimulation has another significant advantage over other forms of modelling because it can simulate queuing conditions and circumstances where events at one intersection affect others in the immediate vicinity. This is the case in this particular instance, as, for example, the State Highway 6/6A roundabout will affect the arrival of vehicles at the Ladies Mile / Hansen Road / Joe O'Connell Drive intersection. Similarly, queuing at the roundabout may affect whether vehicles can exit Hansen Road and Joe O'Connell Drive. Microsimulation has the ability to model these situations since vehicle arrivals are not random events.

In terms of its use within New Zealand, microsimulation is a recognised and widely-used tool. The AUSTROADS organisation, being the industry-recognised association of Australian and New Zealand road transport and traffic authorities (and which includes the New Zealand Transport Agency) notes that such models "have become accepted as useful tools…to analyse and identify solutions for traffic and transport planning" ('The Use and Application of Microsimulation Traffic Models', Austroads AP-R286 2006). Microsimulation models have also been used in assessing the merits of the Government's Roads of National Significance (RONS).

The development and calibration of the microsimulation model is set out in Appendix A to this report. In summary however, the model is considered to be ably replicating the current operation of the roading network.

The model has been used to assess the performance of the network in 2021, applying 2% annual increase in traffic volumes to the through traffic on the network. For clarity, traffic flows entering and exiting the service station and Terrace Junction have not been increased, and the analysis at this stage does not take account of any development at all on the plan change area or possible roading improvement schemes.

5.1.2 Peak Hour Network Performance in 2010

A summary of the model results is set out below for the morning and evening peak hours on the network.

Intersection	Approach	Mvt	Movement		Approach		Intersection	
			Av. Delay (s)	LOS	Av. Delay (s)	LOS	Av. Delay (s)	LOS
State Highway 6/6A roundabout	SH6 (Kawarau Rd)	L	15	B	18	B	12	B
		T	18	B				
		R	22	C				
	SH6 (Ladies Mile)	L	6	A	10	A		
		T	12	B				
		R	13	B				
	BP	L	1	A	3	A		
		T	4	A				
		R	4	A				
	SH6A (Frankton Rd)	L	5	A	10	A		
		T	10	A				
		R	12	B				
Ladies Mile / Hansen Rd / Joe O'Connell Drive	J OConnell Drive	L	1	A	46	E	46	E
		T	0					
		R	46	E				
	SH6 (Ladies Mile) E	L	1	A	5	A		
		T	1	A				
		R	5	A				
	Hansen Rd	L	18	C	31	D		
		T	0					
		R	31	D				
	SH6 (Ladies Mile) W	L	1	A	15	B		
		T	1	A				
		R	15	B				

Table 2: Microsimulation model results: 2010, morning peak hour

Intersection	Approach	Mvt	Movement		Approach		Intersection	
			Av. Delay (s)	LOS	Av. Delay (s)	LOS	Av. Delay (s)	LOS
State Highway 6/6A roundabout	SH6 (Kawarau Rd)	L	19	B	27	C	19	B
		T	29	C				
		R	33	C				
	SH6 (Ladies Mile)	L	9	A	16	B		
		T	21	C				
		R	21	C				
	BP	L	7	A	13	B		
		T	18	B				
		R	17	B				
	SH6A (Frankton Rd)	L	11	B	16	B		
		T	16	B				
		R	16	B				
Ladies Mile / Hansen Rd / Joe O'Connell Drive	J Oconnell Drive	L	17	C	489	F	489	F
		T	0					
		R	489	F				
	SH6 (Ladies Mile) E	L	1	A	15	B		
		T	1	A				
		R	15	B				
	Hansen Rd	L	26	D	81	F		
		T	0					
		R	81	F				
	SH6 (Ladies Mile) W	L	2	A	17	C		
		T	1	A				
		R	17	C				

Table 3: Microsimulation model results: 2010, evening peak hour

It can be seen that under the existing traffic conditions, the State Highway 6/6A roundabout operates with comparatively low delays and a high level of service (which is determined by the level of delay). However, delays for vehicles turning right from Hansen Road and Joe O'Connell Drive are significant and Level of Service F is provided in the evening peak hour.

The Otago Regional Land Transport Strategy sets out that such intersections should desirably operate with a minimum Level of Service D, and the model shows that this is presently achieved at the roundabout, but not at the Ladies Mile / Hansen Road / Joe O'Connell Drive intersection.

5.1.3 Peak Hour Network Performance in 2021

A summary of the model results for the morning and evening peak hours in 2021 is set out below.

Intersection	Approach	Mvt	Movement		Approach		Intersection	
			Av. Delay (s)	LOS	Av. Delay (s)	LOS	Av. Delay (s)	LOS
State Highway 6/6A roundabout	SH6 (Kawarau Rd)	L	31	C	35	C	20	B
		T	36	D				
		R	39	D				
	SH6 (Ladies Mile)	L	12	B	17	B		
		T	20	B				
		R	19	B				
	BP	L	2	A	4	A		
		T	6	A				
		R	5	A				
	SH6A (Frankton Rd)	L	6	A	12	B		
		T	11	B				
		R	13	B				
Ladies Mile / Hansen Rd / Joe O'Connell Drive	J OConnell Drive	L	3	A	67	F	67	F
		T	0					
		R	67	F				
	SH6 (Ladies Mile) E	L	1	A	9	A		
		T	1	A				
		R	9	A				
	Hansen Rd	L	18	C	31	D		
		T	0					
		R	31	D				
	SH6 (Ladies Mile) W	L	1	A	28	D		
		T	1	A				
		R	28	D				

Table 4: Microsimulation model results: morning peak hour, 2021 (2% growth per annum)

Intersection	Approach	Mvt	Movement		Approach		Intersection	
			Av. Delay (s)	LOS	Av. Delay (s)	LOS	Av. Delay (s)	LOS
State Highway 6/6A roundabout	SH6 (Kawarau Rd)	L	48	D	62	E	53	D
		T	69	E				
		R	73	E				
	SH6 (Ladies Mile)	L	60	E	73	E		
		T	81	F				
		R	83	F				
	BP	L	17	B	29	C		
		T	36	D				
		R	37	D				
	SH6A (Frankton Rd)	L	27	C	33	C		
		T	33	C				
		R	33	C				
Ladies Mile / Hansen Rd / Joe O'Connell Drive	J OConnell Drive	L	425	F	1372	F	1372	F
		T	0					
		R	1372	F				
	SH6 (Ladies Mile) E	L	25	C	69	F		
		T	42	E				
		R	69	F				
	Hansen Rd	L	86	F	160	F		
		T	0					
		R	160	F				
	SH6 (Ladies Mile) W	L	2	A	25	C		
		T	1	A				
		R	25	C				

Table 5: Microsimulation model results: evening peak hour, 2021 (2% growth per annum)

The model forecasts that by 2021 there will be extensive queues and delays, particularly at Joe O'Connell Drive where delays in the order of at least 7 minutes can be expected for emerging vehicles. Notably this is for *left-turning* vehicles, and arises because the westbound queue of vehicles approaching the Stage Highway 6/6A roundabout extends beyond Joe O'Connell Drive. Delays for right-turning vehicles are considerably greater than this.

Additionally, the eastern approach of the Stage Highway 6/6A roundabout being under pressure, with delays approaching a minute and a half for vehicles, and delays of more than a minute can be expected for vehicles approaching on Kawarau Road.

The level of service at the Ladies Mile / Hansen Road / Joe O'Connell Drive intersection and on the eastern and southern approaches to the Stage Highway 6/6A roundabout fall below the desirable minimum of the Regional Land Transport Strategy. Moreover, the forecast delays would suggest that the operation of the Events and Aquatic Centre would be significantly compromised by the inability of patrons to exit on the only access road.

5.1.4 Potential Mitigation Measures

The Wakatipu Transportation Strategy concluded that the Stage Highway 6/6A roundabout would be under pressure shortly and therefore contemplated an improvement scheme, and the analysis above confirms this conclusion. However, no mention was made in the Transportation Strategy of the performance of the Ladies Mile / Hansen Road / Joe O'Connell Drive intersection where emerging vehicles have no alternative route choice.

Given the future performance of the network and the Transportation Strategy, a number of potential schemes have been investigated as part of this report to identify what measures could be implemented in order to reduce queues and delays. The assessment firstly considered low-

cost solutions and only if such schemes did not improve the queues and delays were the benefits of more costly measures evaluated.

5.1.4.1 A Raised Median on Ladies Mile

The function of a raised median would be to enforce a prohibition on vehicles turning right into, or right from, both Joe O'Connell Drive and Hansen Road. Any vehicles wishing to undertake such a manoeuvre would therefore firstly turn left and then need to undertake a u-turn movement. However it would not be desirable to have large numbers of vehicles u-turning across the state highway unless some specific provision was made for that movement. Towards the west, the Stage Highway 6/6A roundabout creates such an opportunity. Consequently, towards the east, a raised median could only operate safely with the Ladies Mile / Grant Road roundabout in place.

Notwithstanding this, one outcome of the raised median is that the westbound traffic flow approaching the Stage Highway 6/6A roundabout increases. This approach already has a low level of service which is diminished further by this scheme. Consequently, this arrangement is not considered to be a viable solution.

5.1.4.2 Signalising the Stage Highway 6/6A Intersection

Given the extent of queues and delays at the Stage Highway 6/6A roundabout, a scheme has been considered whereby the roundabout is improved. Initially, consideration was given to a larger roundabout. However this would require a larger circulatory lane and island than the existing roundabout, in addition to additional approach lanes. By comparison, it is considered that signalising the intersection would result in a layout which occupies considerably less area and would therefore be less costly. The indicative layout assessed is shown on **Figure 3**.

The analysis of this arrangement showed that the signals results in a much-improved level of service at the Stage Highway 6/6A intersection. However the volume of traffic travelling west along Ladies Mile is such that there are very few opportunities for vehicles to turn right into Joe O'Connell Drive. Over time the queue of waiting vehicles extends to, and then blocks, the signalised Stage Highway 6/6A intersection.

5.1.4.3 Signalising the Stage Highway 6/6A Intersection and a Raised Median on Ladies Mile

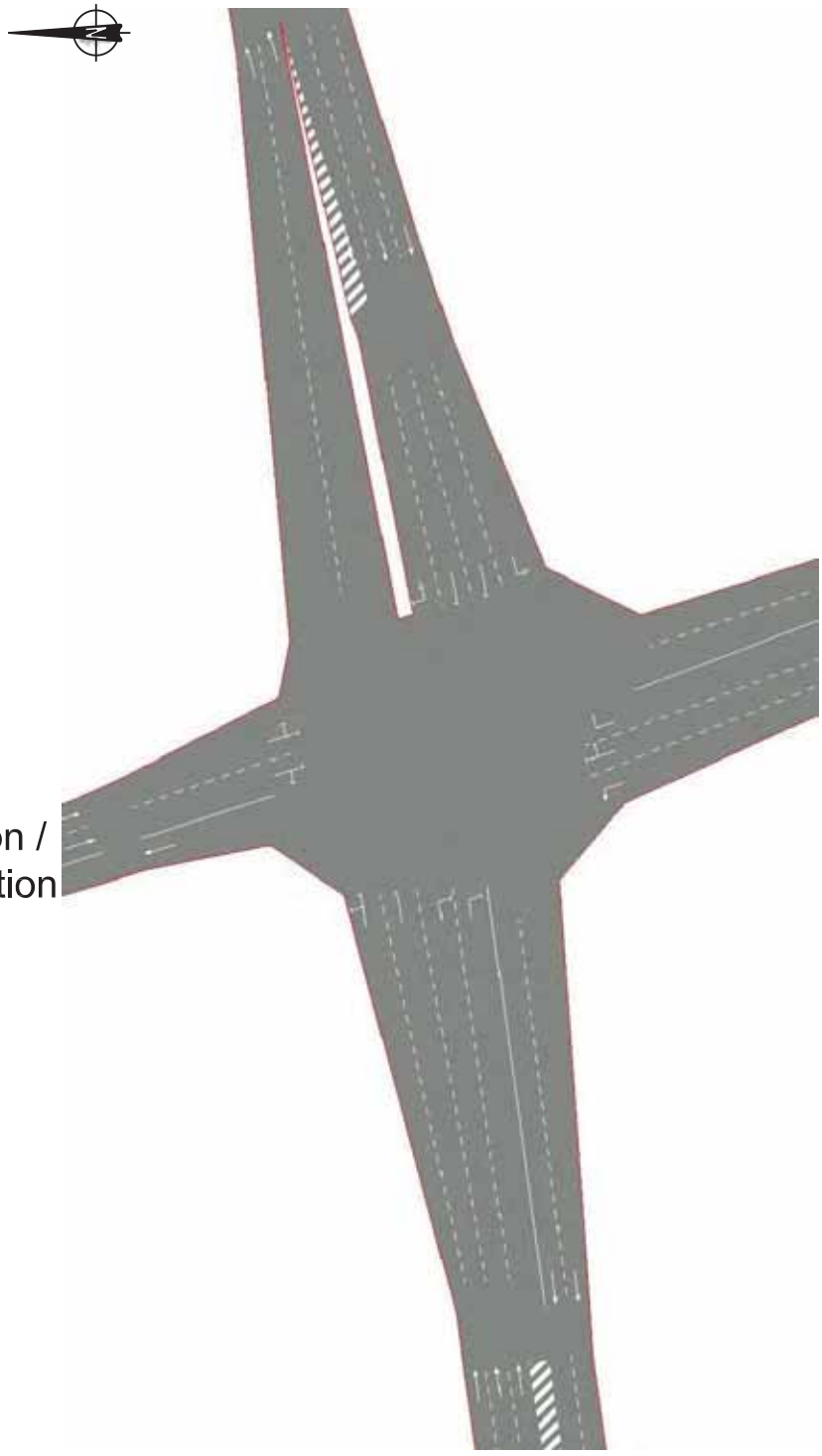
On the basis of the analyses above, it was concluded that right turn movements into Joe O'Connell Drive should be prohibited in order to ensure that the Stage Highway 6/6A intersection operates satisfactorily. Thus an assessment was carried out with both signalisation of the Stage Highway 6/6A intersection and the raised median.

The analysis showed that while a suitable level of service was achieved at the Stage Highway 6/6A intersection (Level of Service D), vehicles were still unable to emerge from Joe O'Connell Drive due to the very low frequency of suitable gaps in the traffic stream.

5.1.4.4 'Do Minimum' Roading Network

From the assessments undertaken, it is considered that as a 'do minimum' option to ensure that the roading network in this area operates satisfactorily in 2021, the following measures will be required:

SH6
(Ladies Mile)



SH6
(Kawarau Road)

Terrace Junction /
BP Service Station

SH6A
(Frankton Road)

Monday, 28 March 2011

Shotover Property Investments Ltd.

Indicative Intersection Layout

Traffic Design Group

3

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- Installation of a roundabout at Ladies Mile / Grant Road
- Signalisation of the Stage Highway 6/6A intersection
- Closure of Joe O'Connell Drive
- Right-turns prohibited out of Hansen Road (but right-turns in permitted)

The latter has been assumed to occur by way of a new roading link between the Events Centre and Aquatic Centre to a new road on Frankton Flats which then links to the Ladies Mile / Grant Road roundabout. This would require a change to the District Plan which prohibits access to the Events Centre from Grants Road (Appendix 1 (Designations), C22, A, Condition 4). It is understood that such a change has been contemplated but not yet progressed by Lakes Leisure.

It is understood that NZTA is considering the potential for Ladies Mile to be four-laned between the State Highway 6/6A intersection and the Ladies Mile / Grant Road roundabout. For clarity, such a scheme has not been included within the modelling undertaken within this report.

The traffic signals at the State Highway 6/6A intersection means that breaks are introduced into the eastbound traffic stream approaching Hansen Road, meaning that there are increased opportunities for vehicles to turn right from Ladies Mile into Hansen Road. One advantage of retaining a right-turn into Hansen Road is that drivers would otherwise have to travel to the State Highway 6/6A intersection and undertake a '-u-turn' movement and travel back to Hansen Road.

Given that the sequential testing of schemes described above highlights that there appears to be no other practical solution to the expected queues and delays in this area, for the remainder of this report, it is assumed that those schemes will be undertaken (and this is referred to as a 'do minimum' network). Adopting the above improvement schemes, the levels of service on the roading network are forecast to be as follows:

Intersection	Approach	Mvt	Movement		Approach		Intersection	
			Av. Delay (s)	LOS	Av. Delay (s)	LOS	Av. Delay (s)	LOS
State Highway 6/6A roundabout	SH6 (Kawarau Rd)	L	23	C	35	C	27	C
		T	49	D				
		R	48	D				
	SH6 (Ladies Mile)	L	9	A	26	C		
		T	37	D				
		R	34	C				
	BP	L	52	D	48	D		
		T	46	D				
		R	45	D				
	SH6A (Frankton Rd)	L	11	B	17	B		
		T	13	B				
		R	24	C				
Ladies Mile / Hansen Rd / Joe O'Connell Drive	J OConnell Drive	L	0		0		23	C
		T	0					
		R	0					
	SH6 (Ladies Mile) E	L	0		10	A		
		T	1	A				
		R	10	A				
	Hansen Rd	L	23	C	23	C		
		T	0					
		R	0					
	SH6 (Ladies Mile) W	L	3	A	3	A		
		T	1	A				
		R	0					

Table 6: Microsimulation model results: morning peak hour, 2021, 'do minimum' road network

Intersection	Approach	Mvt	Movement		Approach		Intersection	
			Av. Delay (s)	LOS	Av. Delay (s)	LOS	Av. Delay (s)	LOS
State Highway 6/6A roundabout	SH6 (Kawarau Rd)	L	30	C	44	D	39	D
		T	58	E				
		R	54	D				
	SH6 (Ladies Mile)	L	9	A	29	C		
		T	43	D				
		R	33	C				
	BP	L	67	E	58	E		
		T	55	D				
		R	49	D				
	SH6A (Frankton Rd)	L	41	D	41	D		
		T	48	D				
		R	32	C				
Ladies Mile / Hansen Rd / Joe O'Connell Drive	J OConnell Drive	L	0		0		28	D
		T	0					
		R	0					
	SH6 (Ladies Mile) E	L	0		20	C		
		T	1	A				
		R	20	C				
	Hansen Rd	L	28	D	28	D		
		T	0					
		R	0					
	SH6 (Ladies Mile) W	L	4	A	4	A		
		T	1	A				
		R	0					

Table 7: Microsimulation model results: evening peak hour, 2021, 'do minimum' road network

It can be seen that under this arrangement, queues and delays are significantly improved on the network. In the morning, the State Highway 6/6A intersection operates with an overall Level of Service C. While this degrades to Level of Service D in the evening peak hour, delays are less than those which would occur with the roundabout in place in practice, and optimising of the signals timings is likely to improve this further. The delays at Hansen Road are also improved, as a result of an increased number of gaps in the traffic stream created by the upstream traffic signals.

5.2 Road Safety

The accident records do not indicate any existing road safety issues on the roading network. However without any improvement schemes by 2021, it is considered that the increased levels of delay will lead to an increase in drivers failing to give way at the State Highway 6/6A roundabout; essentially the extent of delays means that they will attempt to merge into gaps which are unsuitable. However, the more positive traffic control created by traffic signals will serve to mitigate this form of accident.

At the Ladies Mile / Hansen Road / Joe O'Connell Drive intersection, again there is no evidence of any road safety issues but it is considered that the delays by 2021 will also give rise to accidents associated with drivers emerging into inappropriate gaps in the traffic. In practice, the right-turn movement will not be possible and instead drivers will turn left and u-turn at the State Highway 6/6A roundabout. This will further reduce gaps in the circulating traffic at the roundabout and lead to more accidents. Conversely, the movement of these vehicles to the Grant Road roundabout will mitigate any adverse safety effects.

5.3 Public Transport

There are a variety of measures to describe the level of service provided by a public transport system. Appendix B includes level of service descriptions for public transport service headway and for service operating hours. These are taken from the Highway Capacity Manual 2000 (HCM), given there is no equivalent for the New Zealand context.

With a daytime headway of 15 minutes, the public transport service on Ladies Mile has a service frequency Level of Service B with hours of operation that correspond to Level of Service C. It is considered therefore, that overall, the public transport system provides a high level of service.

5.4 Walking and Cycling

The existing infrastructure means that it is considered that a high level of service is provided for those walking and cycling. While there is no crossing facility on Ladies Mile, this is considered to be a function of the present low volumes wishing to cross the road.

6. Description of Private Plan Change

The proposed plan change will enable development of a new mixed use area. This could include retail, offices and residential development. However it is envisaged that the pattern of development will comprises small retail units (generally 1,000sqm GFA or less), Large Format Retail units are not anticipated. While the different land uses could be constructed on any floor level, commercial practice suggests that retail will be generally provided on the ground floor and although it is possible that commercial, office of residential use might also be constructed at ground floor level, it is more likely that they will be constructed at first floor level or above.

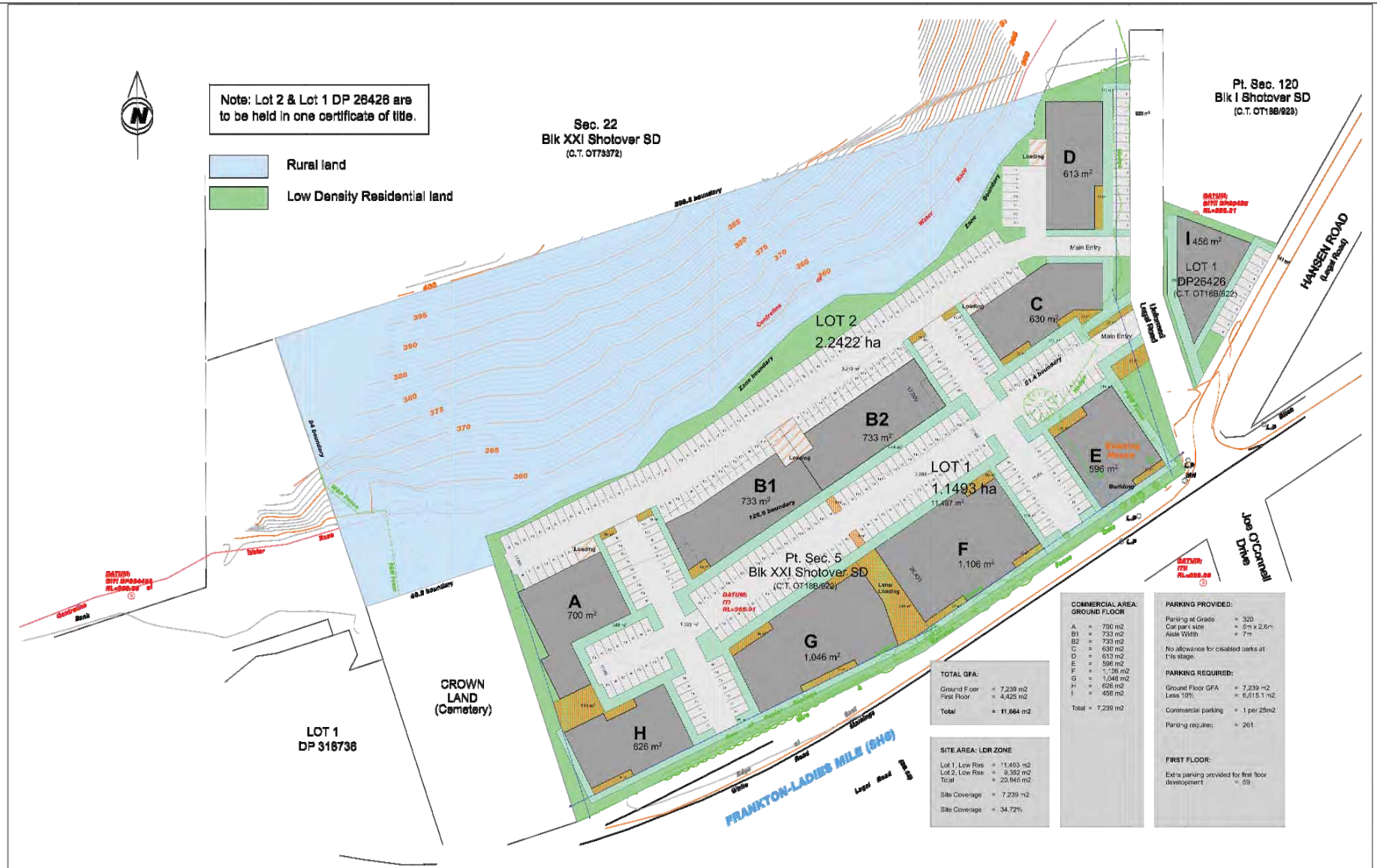
A possible Outline Development Plan is shown in **Figure 4**.

With regard to access issues, it is envisaged that all access to the plan change area will be achieved via Hansen Road, with no direct link being provided onto Ladies Mile. Similarly, there will be no link between the plan change area and Terrace Junction.

The modelling described above highlights that right-turn movements from Hansen Road and Joe O'Connell Drive give rise to significant queues and delays. Consequently, right-turns out of the site will not be permitted, and drivers exiting the site and wishing to travel west would firstly turn east and then undertake a 'u-turn' movement at the Ladies Mile / Grant Road roundabout. However right turns into the plan change area will be allowed.

For the purposes of modelling, the plan change area is expected to accommodate:

- Up to 7,250sqm GFA retail (ground floor)
- Up to 2,150sqm GFA offices OR 14 residences (floor 1)
- 14 residences (floor 2)



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09-12-10	Draft Issue - For Comment	A					
date	issue	rev	date	issue	rev		

Base Line Design - Commercial,Office & Visitor Accommodation Parking at Grade

Scheme C.1 - DRAFT

Project: Frankton Power Centre
Client: Shotover Property Investments
Location: Queenstown
Drawing title: Site Plan - Ground
Scale: 1:500 @ A1, 1:1000 @ A3
Date: 09-12-10
Job No.: 5117
Revision: A
Drawing No.: SK102

walker retail architects

Monday, 28 March 2011

REVISION	DATE	DESCRIPTION
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—	—	—
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Shotover Property Investments Ltd.

Possible Outline Development Plan

DRAWN: JBK
DATE: 28.03.2011
SCALE: NTS
DWG NO: FIGURE 4

Traffic Design Group

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7. Traffic Generation and Distribution

7.1 Baseline Comparison

7.1.1 Traffic Generation

The land is presently zoned as Low Density Residential. It is understood that this would allow for up to 41 residences to be constructed as of right.

Under the Council's Development Standards, each residential property is required to be assessed as generating 8 vehicle movements per day (two-way). Previous analyses undertaken in the area have allowed for between 0.8 and 1.0 vehicle movements per dwelling occurring in the 'typical' commuter peak hours. Of the peak hour movements, 30% enter the development and 70% exit in the morning peak hour, with 60% entering and 40% exiting in the evening peak hour.

Activity	Peak Hour	TRIP GENERATION (PER RESIDENCE)			TRIP GENERATION (41 RESIDENCES)		
		In	Out	Total	In	Out	Total
Residential	Morning	0.3	0.7	1.0	12	29	41
	Evening	0.6	0.4	1.0	25	16	41

Table 8: Trip Generation of Residential Land Use

7.1.2 Traffic Distribution

It is likely that the majority of the traffic associated with the plan change area in the peak hours will be travelling to or coming from employment. The vast majority of employment opportunities lie towards the west, but the Glenda Drive industrial area lies towards the east. Consequently a distribution of 80% of traffic being associated with the west and 20% being associated with the east has been adopted.

7.2 Proposed Plan Change

7.2.1 Traffic Generation

7.2.1.1 Ground Floor (Retail)

At this stage, the composition of the retail land use has not yet been determined. However given the proximity of Frankton Town Centre, it is considered unlikely that the plan change area will provide a similar offer.

If specialist retail establishes on the site, data collected by Traffic Design Group at the Gorge Road Retail Centre (which includes for activities such as dry cleaning, sign suppliers, a florist and computer equipment) suggests a relatively low level of traffic generation. Based on those observations, included within the Transportation Assessment Report for Terrace Junction, the following rates are considered appropriate:

Activity	Peak Hour	TRIP GENERATION (PER 100SQM GFA)			TRIP GENERATION (7,250SQM GFA)		
		In	Out	Total	In	Out	Total
Specialist Retail	Morning	2.3	2.4	4.7	167	174	341
	Evening	2.5	2.7	5.2	181	196	377

Table 9: Trip Generation of Specialist Retail

Note that since retail developments generate far less traffic in the morning peak hour, the Gorge Road Retail Centre was not surveyed during this period. However, there is some evidence that specialist retail does generate comparable traffic movements in the morning peak hour due to the specific nature of the retail offer, although this does depend on the site occupants. For this analysis, the morning peak hour has been considered to generate 90% of the traffic of the evening peak hour.

General retail has a greater trip generation rate than specialist retail. Based upon the rates included within the Trips and Parking Database and those that have been applied to other retail developments within the District, the following are considered appropriate.

Activity	Peak Hour	TRIP GENERATION (PER 100SQM GFA)			TRIP GENERATION (7,250SQM GFA)		
		In	Out	Total	In	Out	Total
General Retail	Morning	0.4	0.7	1.1	29	51	80
	Evening	4.4	6.6	11.0	319	479	798

Table 10: Trip Generation of General Retail

Again, there is comparatively little data regarding the traffic generation of a general retail development in the morning peak hour. For this analysis, this land use has been assessed as generating 10% of the traffic flows expected in the evening peak hour.

7.2.1.2 First Floor (Residential or Offices)

The traffic generation of the proposed residential use has been assessed using the same criteria as described above.

Activity	Peak Hour	TRIP GENERATION (PER RESIDENCE)			TRIP GENERATION (14 RESIDENCES)		
		In	Out	Total	In	Out	Total
Residential	Morning	0.3	0.7	1.0	4	10	14
	Evening	0.6	0.4	1.0	6	8	14

Table 11: Trip Generation of Residential Land Use

The traffic generation rate of offices is shown below.

Activity	Peak Hour	TRIP GENERATION (PER 100SQM GFA)			TRIP GENERATION (2,150SQM GFA)		
		In	Out	Total	In	Out	Total
Offices	Morning	1.8	0.2	2.0	39	4	43
	Evening	0.2	1.8	2.0	4	39	43

Table 12: Trip Generation of Office Land Use

7.2.1.3 Second Floor (Residential)

The traffic generation of the proposed residential use has been assessed using the same criteria as described above.

Activity	Peak Hour	TRIP GENERATION (PER RESIDENCE)			TRIP GENERATION (14 RESIDENCES)		
		In	Out	Total	In	Out	Total
Residential	Morning	0.3	0.7	1.0	4	10	14
	Evening	0.6	0.4	1.0	6	8	14

Table 13: Trip Generation of Residential Land Use

7.2.1.4 Overall Traffic Generation

From the rates set out above, it can be seen that the plan change area has a range of possible traffic generation figures, dependent most on the type of retail envisaged. The likely minimum and maximum of this range are set out below.

Level	Land Use	Size	TRIP GENERATION (AM PEAK)			TRIP GENERATION (PM PEAK)		
			In	Out	Total	In	Out	Total
Ground	Special retail	7,250sqm GFA	167	174	341	181	196	377
First	Residential	14 units	4	10	14	6	8	14
Second	Residential	14 units	4	10	14	6	8	14
		Total	**175**	**194**	**369**	**193**	**212**	**405**

Table 14: Minimum Traffic Generation of Proposed Plan Change Area

Level	Land Use	Size	TRIP GENERATION (AM PEAK)			TRIP GENERATION (PM PEAK)		
			In	Out	Total	In	Out	Total
Ground	General retail	7,250sqm GFA	29	51	80	319	479	798
First	Offices	2,150sqm GFA	39	4	43	4	39	43
Second	Residential	14 units	4	10	14	6	8	14
		Total	**72**	**65**	**137**	**329**	**526**	**855**

Table 15: Maximum Traffic Generation of Proposed Plan Change Area

It can be seen that in each case, the retail component of the development is the primary contributor to the overall traffic generation of the proposed plan change area, with between 58% and 93% of all traffic generated being associated with this land use.

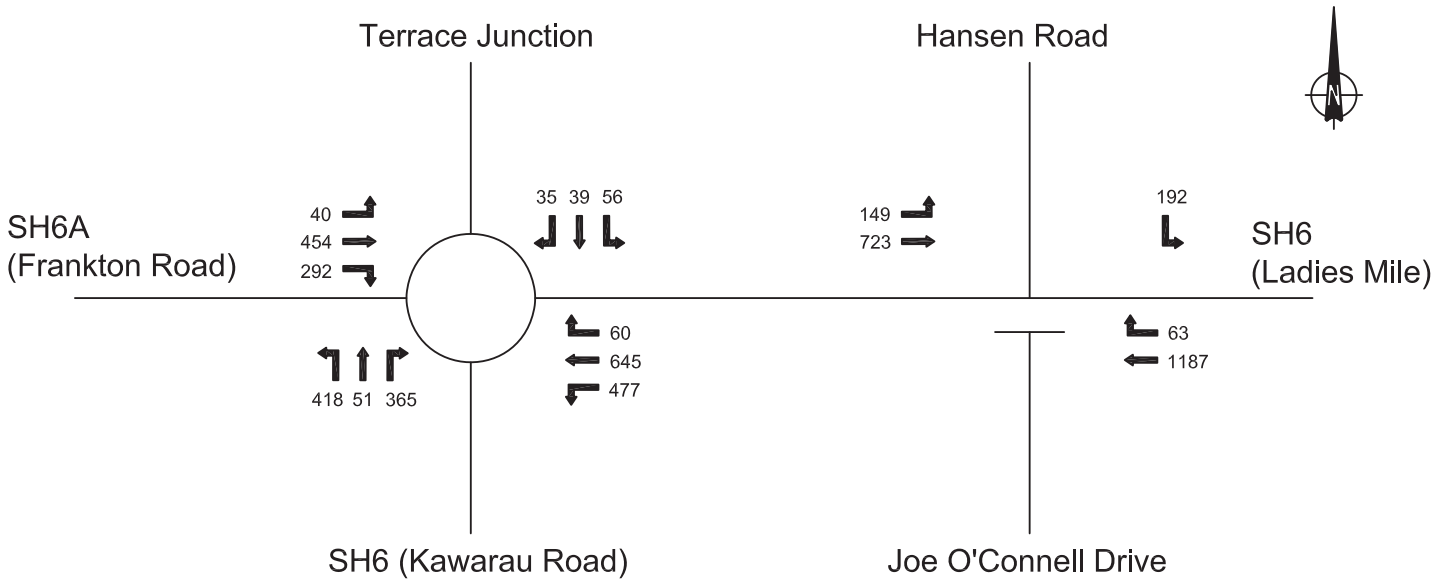
7.2.1.5 Pass-by Trips

A proportion of the visits to the plan change area are likely to be made by vehicles which are already on the roading network. Typically, a rate of 20% is applied in such circumstances (that is, 20% of the traffic generation is pass-by and 80% is newly-generated). This percentage is considered appropriate should the retail element be of general interest. Specialist retail is likely to have a lower pass-by percentage because the development is likely to be less attractive to the general public. Consequently, for the specialist retail, a 5% pass-by rate has been used.

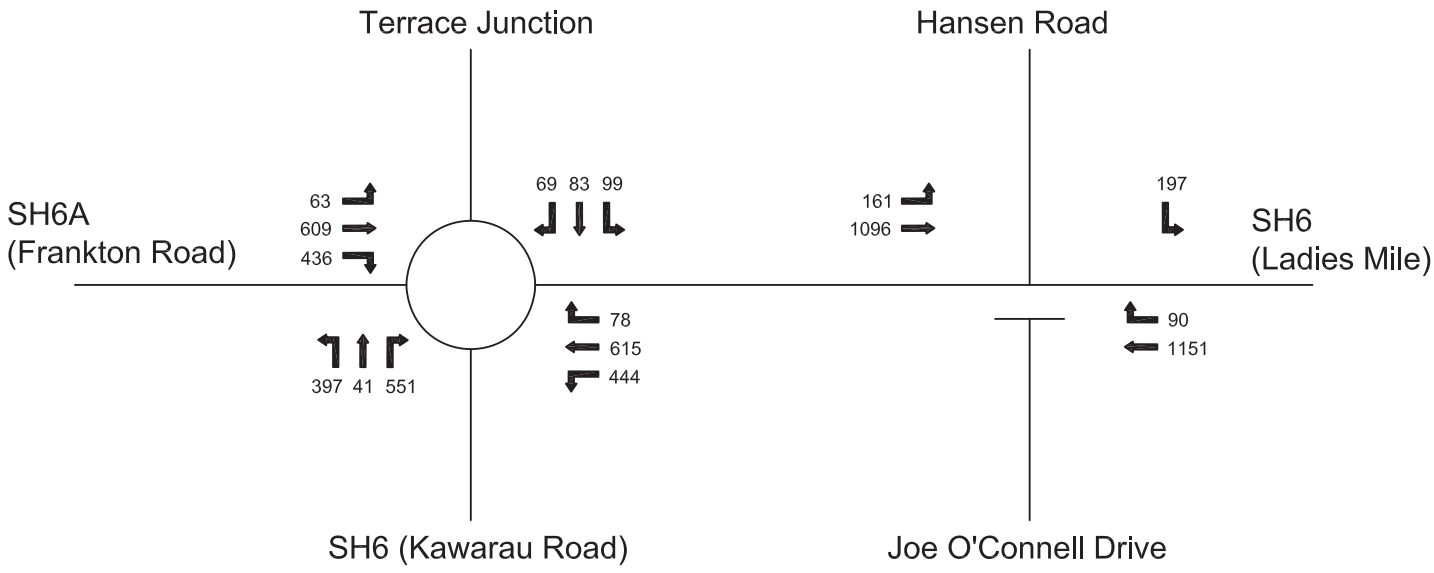
7.2.2 Traffic Distribution

Correspondence from NZTA (dated 29 October 2008) set out an opinion that for a retail development at this site, a distribution of 70% towards the west and 30% towards the east was appropriate. It is considered that a more appropriate approach would be to adopt an 80% / 20% distribution in order to better compare the results with the permitted development, but with a sensitivity test of applying a 70% / 30% distribution.

Figures 5 and 6 show the traffic volumes expected in 2021 under the scenarios described above.



2021 Morning Peak Hour



2021 Evening Peak Hour

Monday, 28 March 2011

Shotover Property Investments Ltd.

Minimum Traffic Generation of Plan Change Area

Traffic Design Group

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SCALE: NTS

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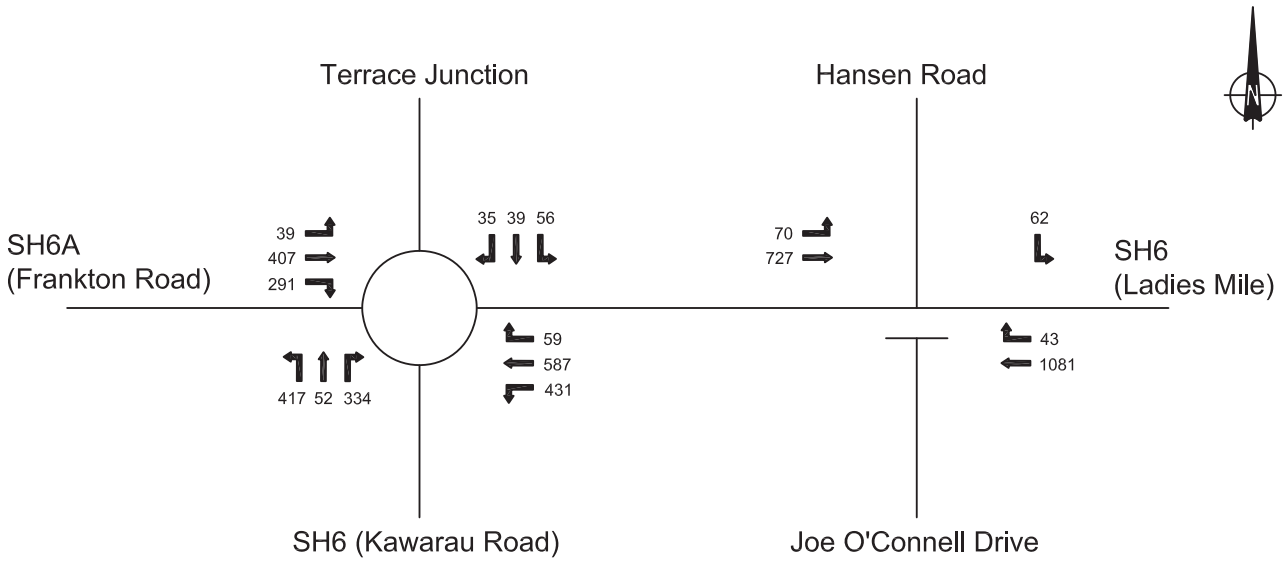
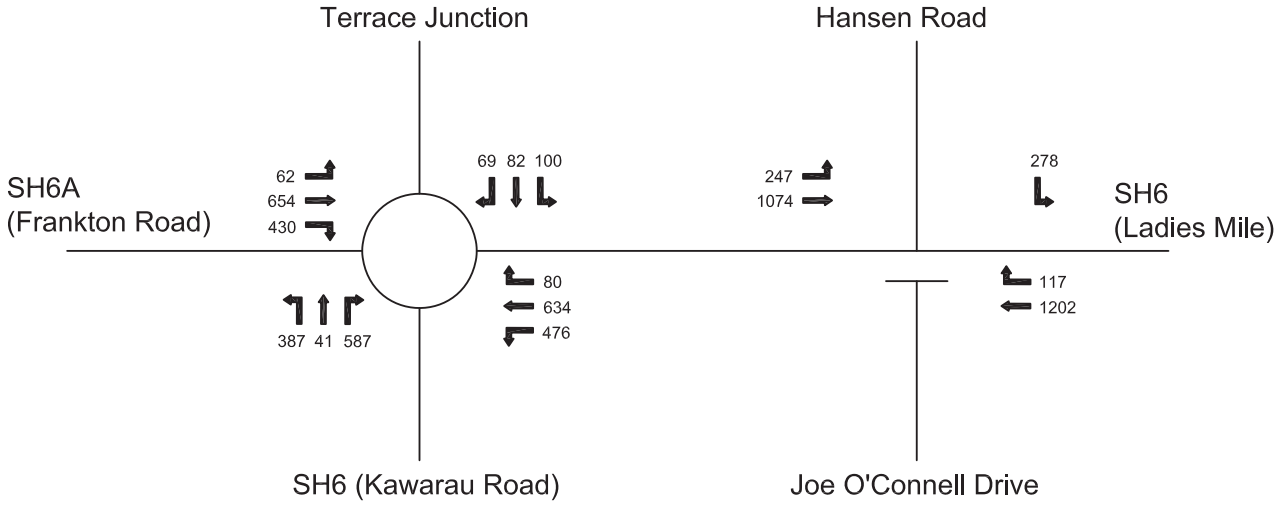


2021 Morning Peak Hour



2021 Evening Peak Hour

Monday, 28 March 2011

Shotover Property Investments Ltd.

Maximum Traffic Generation of Plan Change Area

Traffic Design Group

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SCALE: NTS

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8. Effects on the Transportation Network

8.1 Roading Network

The microsimulation model described above has been used to assess the performance of the Ladies Mile / Frankton Road and Ladies Mile / Hansen Road / Joe O'Connell Drive intersection. For this analysis, the 'do minimum' scenario has been adopted, being:

- Installation of a roundabout at Ladies Mile / Grant Road
- Signalisation of Ladies Mile / Frankton Road intersection
- Closure of Joe O'Connell Drive

As noted above, right turning movements out of the plan change area will not be permitted but drivers will be able to turn right into Hansen Road.

8.1.1 Permitted Development of the Area

Based upon the traffic generation shown in Table 8 above, the forecast peak hour levels of service anticipating development at the plan change area of 41 residences, as permitted under the current land zoning, are as follows.

Intersection	Approach	Mvt	Movement		Approach		Intersection	
			Av. Delay (s)	LOS	Av. Delay (s)	LOS	Av. Delay (s)	LOS
State Highway 6/6A roundabout	SH6 (Kawarau Rd)	L	22	C	36	D	30	C
		T	54	D				
		R	51	D				
	SH6 (Ladies Mile)	L	11	B	30	C		
		T	43	D				
		R	38	D				
	BP	L	57	E	54	D		
		T	52	D				
		R	53	D				
	SH6A (Frankton Rd)	L	12	B	20	B		
		T	15	B				
		R	27	C				
Ladies Mile / Hansen Rd / Joe O'Connell Drive	J OConnell Drive	L	0		0		21	C
		T	0					
		R	0					
	SH6 (Ladies Mile) E	L	0		11	B		
		T	1	A				
		R	11	B				
	Hansen Rd	L	21	C	21	C		
		T	0					
		R	0					
	SH6 (Ladies Mile) W	L	3	A	3	A		
		T	1	A				
		R	0					

Table 16: Microsimulation model results: morning peak hour, 2021, 'do minimum' road network with permitted development

Intersection	Approach	Mvt	Movement		Approach		Intersection	
			Av. Delay (s)	LOS	Av. Delay (s)	LOS	Av. Delay (s)	LOS
State Highway 6/6A roundabout	SH6 (Kawarau Rd)	L	30	C	44	D	41	D
		T	57	E				
		R	54	D				
	SH6 (Ladies Mile)	L	10	A	31	C		
		T	46	D				
		R	31	C				
	BP	L	77	E	65	E		
		T	57	E				
		R	55	D				
	SH6A (Frankton Rd)	L	41	D	41	D		
		T	50	D				
		R	31	C				
Ladies Mile / Hansen Rd / Joe O'Connell Drive	J OConnell Drive	L	0		0		27	D
		T	0					
		R	0					
	SH6 (Ladies Mile) E	L	0		22	C		
		T	1	A				
		R	22	C				
	Hansen Rd	L	27	D	27	D		
		T	0					
		R	0					
	SH6 (Ladies Mile) W	L	4	A	4	A		
		T	1	A				
		R	0					

Table 17: Microsimulation model results: evening peak hour, 2021, 'do minimum' road network with permitted development

It can be seen that both intersections operate at Level of Service D or better in both peak periods, although the approach from the service station and the through movement at Kawarau Road operate with Level of Service E. Notwithstanding this, delays are generally less than a minute on every approach

8.1.2 Proposed Plan Change Minimum Traffic Generation

Based upon the traffic generation shown in Table 14 above, the forecast peak hour levels of service are set out below.

Intersection	Approach	Mvt	Movement		Approach		Intersection	
			Av. Delay (s)	LOS	Av. Delay (s)	LOS	Av. Delay (s)	LOS
State Highway 6/6A roundabout	SH6 (Kawarau Rd)	L	26	C	41	D	36	D
		T	56	E				
		R	55	D				
	SH6 (Ladies Mile)	L	21	C	43	D		
		T	58	E				
		R	50	D				
	BP	L	51	D	51	D		
		T	51	D				
		R	50	D				
	SH6A (Frankton Rd)	L	12	B	20	B		
		T	15	B				
		R	28	C				
Ladies Mile / Hansen Rd / Joe O'Connell Drive	J OConnell Drive	L	0		0		28	D
		T	0					
		R	0					
	SH6 (Ladies Mile) E	L	0		12	B		
		T	3	A				
		R	12	B				
	Hansen Rd	L	28	D	28	D		
		T	0					
		R	0					
	SH6 (Ladies Mile) W	L	3	A	3	A		
		T	1	A				
		R	0					

Table 18: Microsimulation model results: morning peak hour, 2021, 'do minimum' road network with proposed plan change (minimum traffic generation)

Intersection	Approach	Mvt	Movement		Approach		Intersection	
			Av. Delay (s)	LOS	Av. Delay (s)	LOS	Av. Delay (s)	LOS
State Highway 6/6A roundabout	SH6 (Kawarau Rd)	L	40	D	57	E	54	D
		T	66	E				
		R	69	E				
	SH6 (Ladies Mile)	L	26	C	55	D		
		T	77	E				
		R	49	D				
	BP	L	81	F	67	E		
		T	60	E				
		R	57	E				
	SH6A (Frankton Rd)	L	49	D	48	D		
		T	58	E				
		R	33	C				
Ladies Mile / Hansen Rd / Joe O'Connell Drive	J OConnell Drive	L	0		0		46	E
		T	0					
		R	0					
	SH6 (Ladies Mile) E	L	0		24	C		
		T	1	A				
		R	24	C				
	Hansen Rd	L	46	E	46	E		
		T	0					
		R	0					
	SH6 (Ladies Mile) W	L	4	A	4	A		
		T	1	A				
		R	0					

Table 19: Microsimulation model results: evening peak hour, 2021, 'do minimum' road network with proposed

It can be seen that the network is under the greatest pressure in the evening peak hour. At this time however, the State Highway 6/6A continues to operate with Level of Service D (meeting the Regional Land Transport Strategy minima). Kawarau Road experiences Level of Service E but delays per vehicle are only in the order of 13 seconds greater than under the presently-permitted development. At the Ladies Mile / Hansen Road intersection, Level of Service E arises due to the delays associated with vehicles turning left out of Hansen Road. The vast majority of these are associated with development of the proposed plan change area, and each vehicle would be delayed for around 46 seconds. This is 19 seconds greater than under the presently-permitted development.

8.1.3 Proposed Plan Change Maximum Traffic Generation

The peak hour performance of the roading network under the expected maximum traffic generation shown in Table 15 above is set out below.

Intersection	Approach	Mvt	Movement		Approach		Intersection	
			Av. Delay (s)	LOS	Av. Delay (s)	LOS	Av. Delay (s)	LOS
State Highway 6/6A roundabout	SH6 (Kawarau Rd)	L	25	C	39	D	31	C
		T	55	D				
		R	53	D				
	SH6 (Ladies Mile)	L	13	B	33	C		
		T	46	D				
		R	42	D				
	BP	L	59	E	56	E		
		T	51	D				
		R	55	D				
	SH6A (Frankton Rd)	L	10	A	18	B		
		T	13	B				
		R	26	C				
Ladies Mile / Hansen Rd / Joe O'Connell Drive	J OConnell Drive	L	0		0		21	C
		T	0					
		R	0					
	SH6 (Ladies Mile) E	L	0		10	A		
		T	1	A				
		R	10	A				
	Hansen Rd	L	21	C	21	C		
		T	0					
		R	0					
	SH6 (Ladies Mile) W	L	2	A	2	A		
		T	1	A				
		R	0					

Table 20: Microsimulation model results: morning peak hour, 2021, 'do minimum' road network with proposed plan change (maximum traffic generation)

Intersection	Approach	Mvt	Movement		Approach		Intersection	
			Av. Delay (s)	LOS	Av. Delay (s)	LOS	Av. Delay (s)	LOS
State Highway 6/6A roundabout	SH6 (Kawarau Rd)	L	60	E	86	F	68	E
		T	99	F				
		R	103	F				
	SH6 (Ladies Mile)	L	32	C	60	E		
		T	82	F				
		R	56	E				
	BP	L	130	F	97	F		
		T	78	E				
		R	70	E				
	SH6A (Frankton Rd)	L	59	E	54	D		
		T	66	E				
		R	36	D				
Ladies Mile / Hansen Rd / Joe O'Connell Drive	J OConnell Drive	L	0		0		178	F
		T	0					
		R	0					
	SH6 (Ladies Mile) E	L	0		38	E		
		T	10	A				
		R	38	E				
	Hansen Rd	L	178	F	178	F		
		T	0					
		R	0					
	SH6 (Ladies Mile) W	L	4	A	4	A		
		T	1	A				
		R	0					

Table 21: Microsimulation model results: evening peak hour, 2021, 'do minimum' road network with proposed plan change (maximum traffic generation)

Allowing for the maximum traffic generation of the proposed plan change area, both the State Highway 6/6A and Ladies Mile / Hansen Road intersections operate with Level of Service C in the morning peak hour and delays per vehicle are almost the same as those with the presently-permitted development constructed. In the evening peak hour, the State Highway 6/6A intersection operates with Level of Service E, less than the Regional Land Transport Strategy indicates. Delays per vehicle on Kawarau Road are 40 seconds more than under the presently-permitted development with delays on Ladies Mile being 30 seconds greater. Delays for vehicles exiting Hansen Road are nearly three minutes, some 2.5 minutes greater than under the scenario tested in Section 8.1.2 of this report.

8.1.4 Summary of Modelling

The increase in delays for each turning movement set out above are summarised below.

Intersection	Approach	Mvt	Delays per Vehicles (Seconds)		
			Permitted Development	Plan Change: Minimum*	Plan Change: Maximum*
State Highway 6/6A intersection	SH6 (Kawarau Rd)	L	22	+4	+3
		T	54	+2	+1
		R	51	+4	+2
	SH6 (Ladies Mile)	L	11	+10	+2
		T	43	+15	+3
		R	38	+12	+4
	BP	L	57	0	+2
		T	52	0	0
		R	53	0	+2
	SH6A (Frankton Rd)	L	12	0	0
		T	15	0	0
		R	27	+1	0
Ladies Mile / Hansen Rd / Joe O'Connell Drive	J O'Connell Drive	L	-	-	-
		T	-	-	-
		R	-	-	-
	SH6 (Ladies Mile) E	L	-	-	-
		T	1	+2	0
		R	11	+1	0
	Hansen Rd	L	21	+7	0
		T	-	-	-
		R	-	-	-
	SH6 (Ladies Mile) W	L	3	0	0
		T	1	0	0
		R	-	-	-

*** compared to permitted development**

Table 22: Summary of microsimulation model results: morning peak hour, 2021, 'do minimum' road network

Intersection	Approach	Mvt	Delays per Vehicles (Seconds)		
			Permitted Development	Plan Change: Minimum*	Plan Change: Maximum*
State Highway 6/6A intersection	SH6 (Kawarau Rd)	L	30	+10	+30
		T	57	+9	+42
		R	54	+15	+49
	SH6 (Ladies Mile)	L	10	+16	+22
		T	46	+31	+32
		R	31	+18	+25

	BP	L	77	+4	+53
		T	57	+3	+21
		R	55	+2	+15
	SH6A (Frankton Rd)	L	41	+8	+18
		T	50	+8	+16
		R	31	+2	+5
Ladies Mile / Hansen Rd / Joe O'Connell Drive	J O'Connell Drive	L	-	-	-
		T	-	-	-
		R	-	-	-
	SH6 (Ladies Mile) E	L	-	-	-
		T	1	0	+9
		R	22	+2	+16
	Hansen Rd	L	27	+19	+151
		T	-	-	-
		R	-	-	-
	SH6 (Ladies Mile) W	L	4	0	0
		T	1	0	0
		R	-	-	-

*** compared to permitted development**

Table 23: Summary of microsimulation model results: evening peak hour, 2021, 'do minimum' road network

In the morning, the effects of the proposed plan change on vehicle queues are delays are minimal, being at most 15 seconds greater than under the presently-permitted development. In practice, revising the signal timings at the State Highway 6/6A intersection is likely to reduce this even further.

In the evening peak hour, delays at the State Highway 6/6A intersection increase by up to 30 seconds compared to the presently-permitted development. Again however, optimising the signal timings will assist in reducing these, particularly on Ladies Mile, but this will be of limited effect should the plan change site be developed to the maximum extent. At the Ladies Mile / Hansen Road intersection, delays associated with the plan change area generating 'minimum' levels of traffic are comparable to those under the presently-permitted development. The delays are considerably greater with the proposed plan change area generating the maximum amount of traffic, but any delays and associated queuing will generally be retained within the plan change area itself.

8.2 Road Safety

Although there is an increase in delays at the State Highway 6/6A intersection, it is not considered that any related road safety issues are likely to arise. This is because the positive traffic control created by the signals means that drivers are not required to identify whether gaps in the traffic stream are of a suitable length for them to emerge.

With the proposed plan change site generating the 'minimum' amount of traffic as described above, the delays for vehicles emerging from Hansen Road are such that it is unlikely driver gap acceptance will reduce. However, as delays increase further, it is likely that an increasing

proportion of drivers will seek to use gaps in the traffic stream that are unsuitable, with a consequent potential increase in the frequency of accidents.

9. District Plan

It is considered that the District Plan Rules set out in Appendix 7 and Council's Development and Subdivision Engineering Standards (Amendments and Modifications to NZS4404:2004) will form an appropriate basis for the proposed plan change.

No changes to the Rules are proposed within the plan change request.

10. Summary and Conclusions

Based upon current patterns of land development, this analysis has highlighted that delays for vehicles emerging from Joe O'Connell Drive are increasing such that by 2021, it will be extremely difficult for drivers to turn left and in practice it will not be possible to turn right from Joe O'Connell Drive onto Ladies Mile. At the same time, delays for right-turning vehicles emerging from Hansen Road will be approaching three minutes with delays of more than a minute for drivers turning left. Furthermore, delays at the State Highway 6/6A roundabout will increase such that traffic approaching the roundabout from Ladies Mile experiences delays approaching 1.5 minutes. Such results are supported by the Wakatipu Transportation Strategy which highlights that an intersection upgrade will be required in the medium term (2011-2016).

In view of this, prior to testing the effects of any plan change, it has been necessary to allow for an improvement scheme to be constructed in this area. It is considered that the lowest cost option would be for signalisation of the Stage Highway 6/6A intersection, closure of Joe O'Connell Drive in favour of traffic using Grant Road, and right-turns prohibited out of Hansen Road (but right-turns in permitted). In addition, this report assumes that the Ladies Mile / Grant Road roundabout currently being designed will be installed as part of the Frankton Flats zone development.

Allowing for these improvement schemes, the traffic associated with the presently-permitted development of the plan change area could be accommodated without significant changes in delays on the network. It is also considered that the proposed plan change could also be accommodated on the roading network under the 'minimum' traffic generation scenario assessed. Should the plan change area generate more traffic than this, delays at the State Highway 6/6A roundabout will increase, although to an extent these can be offset by revised and optimised signal timings. However, at Hansen Road, the delays for vehicles emerging from the plan change area are in the order of three minutes. Such delays are likely to lead to increased road safety risks as drivers attempt to use gaps in the traffic stream that are unsuitable.

Traffic Design Group Ltd
March 2011

Appendix A

Model Development Report

Shotover Property Investment Ltd

Microsimulation Transport Modelling - Proposed Private Plan Change

Model Development Report

March 2011

Traffic Design Group

Shotover Property Investments Ltd

Microsimulation Transport Modelling - Proposed Private Plan Change

Model Development Report
Quality Assurance Statement

Prepared by:

Brenda O'Donoghue

Transportation Engineer

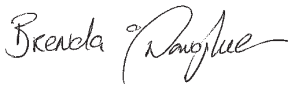

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Table of Contents

1. Introduction

1.1 Background

Traffic Design Group has developed a series of S-Paramics microsimulation models to assess the effects of a proposed plan change to land in the Frankton area of Queenstown Lakes, towards the eastern side of the BP filling Station and to the north of SH6. This work forms part of the Transportation Assessment being undertaken on behalf of Shotover Property Investments Ltd. This report outlines details of the base model development and calibration and validation of the key Weekday AM and PM peak periods.

The models are to be used in assessing the future operation of the road network with traffic growth applied to the existing State Highway traffic flows and the additional traffic activity associated with the existing permitted zone activity and the proposed commercial zone plan change. For this purpose, the extent of the model includes the Frankton Road/Kawarau Road roundabout and the intersections located at Ladies Mile/Hansen Road/Joe O'Connell Drive and Ladies Mile/Grants Road, as shown in Figure 1.

Figure 1: S-Paramics Model Network

The purpose of the model is to assess the traffic effects associated with the proposed plan change on the surrounding road network.

1.2 Microsimulation Modelling

The S-Paramics microsimulation software has the ability to simulate traffic flows on the network and, through the reporting of various performance criteria such as turning volumes, queues and journey times, can be used to provide a comparative assessment between the future traffic flows and the existing traffic situation. S-Paramics achieves these comparisons by simulating individual vehicles and then modelling their interaction with other vehicles and the roading environment. One advantage of using microsimulation over more traditional 'intersection in isolation' modelling packages such as SIDRA Intersection, is that S-Paramics is able to model how vehicle interactions are influenced by intersections that are located in close proximity to each other, as exists in the case of the road network adjacent to the proposed plan change site.

As with real traffic conditions which vary from day to day, the interactions modelled within S-Paramics software can vary each time the model is run. S-Paramics also has the ability to stochastically apply the traffic flows to the road network allowing for a more realistic representation of real world conditions by testing the network under varying flow conditions. For the purpose of this assessment, 10 runs of the model have been undertaken and the results averaged.

The two times periods that have been developed include:

1. Weekday AM: 07:30-09:30

2. Weekday PM: 16:30-18:30

These time periods represent the peak traffic periods and cover the full effects of the anticipated traffic generation.

2. Data Collection

2.1 Traffic Demand Data

A series of detailed classified vehicle movement counts were undertaken at both the Frankton Road/Kawarau Road roundabout and at the Ladies Mile/Hansen Road/Joe O'Connell Drive intersection.

In addition to the vehicle movement counts, NZTA TMS tube count 00600993 (200m east of Hansen Road) has provided additional link flow data between Hanson Road and Grants Road from the same day as the vehicle movement survey. The surveyed vehicle movement data and NZTA tube data has been used to develop the demand information, Origin – Destination (OD) matrices and traffic flow profiles.

The vehicle movement survey was undertaken on the 25 November 2010, using video cameras to record the time periods mentioned in Section 1.2. At Frankton Road/BP/Kawarau Road Roundabout, the time periods between 07:30 and 08:00, and 18:00 and 18:30 have not been recorded on video. The traffic data for all movements during these time periods have been calculated from the remaining recorded data of the time period. At Ladies Mile/Hansen Road/Joe O'Connell Drive the time periods between 07:30 and 07:45, and 17:30 and 17:40 have not been captured on video. In this case the turning movements were manually recorded on the day of the survey and only the Ladies Mile through movements were calculated from the remaining recorded data.

The vehicle movement counts classified vehicles into Private Cars (Cars), Light Good Vehicles (LGVs), Medium Goods Vehicles (MGVs) and Heavy Goods Vehicles (HGVs) in five minute intervals during the time periods shown in section 1.2.

Video footage recorded of Frankton Road/BP/Kawarau Road roundabout and Ladies Mile/Hansen Road/Joe O'Connell Drive intersection were also used to note vehicle behaviour, road markings, and any network features affecting traffic flows and operation such as intersection approach visibility.

2.2 Traffic Performance Data

In an addition to the count data, data was collected to verify the performance of the road network.

Maximum queued vehicle data was recorded on each approach to the roundabout and intersection, in 5 minute intervals. Queue data was also recorded for Ladies Mile/Hansen Road/Joe O'Connell Drive intersection; however the only queuing at this intersection occurred during the PM period along Joe O'Connell Drive.

Journey time data has not been collected due to the small length of road network. The comparison of observed and modelled queues in a small network provides a good representation of how well the modelled traffic trends reflect the observed traffic patterns.

3. Model Construction

3.1 Overview

The model has been developed in version 2010.0 of the S-Paramics software.

The modelled network has been constructed on top of an aerial photograph by placing nodes and links of certain lane and speed ranges along the road network to reflect detail changes or driver decision points. The aerial has been aligned with a Terralink overlay representing the land parcels around Frankton to confirm the dimensions and coordinates of the aerial are accurate.

On completion of the model structure, adjustments were made to the position of curves, kerbs, stoplines to replicate the network shown on the aerial photograph and to help simulate actual vehicle reactions.

3.2 Global Settings

The default intergreen signal settings were altered to reflect NZ conditions (i.e. red–to-green amber signal times and green–to-amber were set to 0 and 4 seconds respectively) and model units set to metric.

No other global parameter settings were altered from the default value.

3.3 Intersection Modelling Method

The Ladies Mile/Hansen Road/Joe O'Connell Drive intersection and Ladies Mile/Grants Road intersections have been modelled as a standard priority controlled intersections, with priority given to those vehicles travelling along Ladies Mile.

The roundabout at Frankton Road/BP/Kawarau Road has been modelled as a complex roundabout, in order to represent different number of lanes available on the roundabout as well as the splitter islands on approach to the roundabout from Frankton Road and Kawarau Road. The roundabout has been modelled with 2 lanes from the Frankton Road western arm continuing past BP and finishing at the Frankton Road eastern arm exit. One lane continues to circulate from Frankton Road eastern exit for the remainder of the roundabout. In order to replicate on-street vehicle behaviour, lane 1 and 3 opposite the Frankton Road western arm splitter island has been 'barred' to assist in the modelling of observed lane utilisation.

Based on site visits and from recorded video data of the study area, alterations to the local calibration parameters included amendments to the visibility settings on each approach arm to the intersections and roundabout. Visibility was judged a slight, medium or good, which is represented as 10m, 20m and 40m respectively in the model.

3.4 Localised Calibration

As part of the model calibration the default lane merge and lane cross were reduced from the default setting of 4 seconds in order to adequately represent the observed queuing conditions at the approach arms to Frankton Road/BP/Kawarau Road Roundabout and the Joe O'Connell Drive approach arm to the SH6 intersection.

Approach Arm	Modified Gap Acceptance (s)
Frankton Road – west	3.0
BP station exit	2.0
Frankton Road – east	0.4
Kawarau Road	3.0
Joe O'Connell Drive	3.0

The gap acceptance at Frankton Road east on approach to the Frankton Road/BP/Kawarau Road Roundabout has been reduced to a greater extent than the neighbouring arms. Vehicles travelling westbound on SH6 are entering the network from a high-speed environment that exists east of Joe O'Connell Drive. Although a vehicle speed transition of 80kph to 50kph occurs east of Joe O'Connell Drive, drivers may have a tendency to continue to travel at a higher speed and result in taking smaller gaps at the Frankton Road east approach to the roundabout.

4. Demand Development

4.1 Vehicle Types

In accordance with the classified vehicle counts adopted during the data collection surveys, four separate vehicle types were utilised in the model, as follows;

- Private Car (Cars)
- Light Goods Vehicles (LGVs)
- Medium Goods Vehicles (MGVs)
- Heavy Goods Vehicles (HGVs)

Table 1 indicates the percentage splits for each of the four vehicle classification categories, as included within the model. The vehicle classification splits were calculated from the observed classified traffic movement data as discussed in Section 2.1.

	Matrix 1: Lights				Matrix 2: Heavies		
Period	Cars	LGVs	Lights		MGVs	HGVs	Heavies
AM	81%	19%	90%		59%	41%	10%
PM	84%	16%	94%		73%	27%	6%

Table 1: Vehicle Type Proportions

4.2 Traffic Flow Profiles

Vehicle flows are not constant and vary through the peak periods. To account for this S-Paramics allows the release of vehicles into the network to be controlled by traffic flow release profiles in 5 minute intervals. The traffic count data collected was used to develop the percentage release profile through each of the time period models on the key vehicle movements in the network

In order to achieve a robust representation of the observed traffic behaviour, a total of nine (6 light vehicles and 3 heavy vehicle) profiles were developed for this model. These profiles are identified in Table 2 below:

Proflie	Classification	Description
1	Lights	Frankton Rd west: Left and Through movements
2	Heavies	Frankton Rd west: Left and Through movements
3	All	Frankton Rd west: Right movements
4	Lights	Kawarau Rd: Leth and Through movements
5	Heavies	Kawarau Rd: Leth and Through movements
6	All	Kawarau Rd: Right movments
7	Lights	SH6 east: All movements
8	Heavies	SH6 east: All movements
9	All	General Profile: All movements

Table 2: Traffic Flow Release Profiles

These profiles were developed to reflect the different traffic profiles observed from the traffic surveys.

4.3 Demand Matrix Development

The demand matrices have been developed using the proportional turning movements observed during the traffic count surveys and NZTA ADT data, along with assumptions of likely traffic patterns based on the current road hierarchy and surrounding land uses. From these initial assumptions the distribution of travel patterns was established for each origin in the network, this was then refined manually to match the turning movement volumes.

These matrices provide origin/destination numbers for vehicles travelling between each of the zones included within the model for the total two hour period. As with the profiles, separate matrices were developed for both light (Private Car and LGV) and heavy vehicles (MGV and HGV).

It is noted that the base scenario only includes recorded vehicle movements out of and into Hansen Road; no development traffic due to the proposed plan change has been included at this stage. Traffic demand for the proposed plan change will be added in the future year scenarios through trip distribution and generation calculations.

5. Calibration and Performance

5.1 Overview

Calibration is the process of comparing adjusting the model parameters to reflect the observed data as well as necessary to satisfy the model objectives. A typical validation has not been included as this usually involves journey times which were not recorded due to the short nature of the study area, The models performance is based on the comparison of observed and modelled maximum queued vehicles.

The initial model calibration involved a visual check of the model to ensure the traffic behaviour observed during the recorded site survey were being properly replicated within the S-Paramics model. This level of calibration is useful in ensuring that the lane choice, lane change and give way behaviour, and general presence of queues are representative of the observed conditions. These visual checks were undertaken for both the AM and PM periods, and indicate that the models provide a good representation of the observed behaviours. This a critical calibration step for complex network features such as the Frankton Road/BP/Kawarau Road roundabout.

In order to confirm that the S-Paramics models are providing a realistic representation of the existing traffic conditions, calibration was completed by comparing the observed and modelled hourly turn counts for each turning movement in the network.

5.2 Traffic Count Comparison

Calibration guidelines commonly involve comparing observed and modelled traffic count data and summarising against specified criteria. The GEH statistic is commonly used as the criteria as it is tolerant on larger percentage differences on small flows, and larger absolute differences on higher flows. Comparison criteria, such as specified in the NZTA's Economic Evaluation Manual (EEM) and the UK's Design Manual for Roads and Bridges (DMRB), is generally specified for much larger networks and therefore is not an appropriate in this situation.

A GEH value of 5 is often used as a target level for a robust comparison of observed and modelled flows, Table 3 and Table 4 below summarise the observed vs. modelled hourly counts.

GEH	07:30-08:30	08:00-09:30	08:30-09:30
<7.5	100%	100%	100%
<5.0	96%	100%	100%
<3.0	92%	92%	100%

Table 3: AM Period: Observed Vs Modelled Turning Movement Comparison Summary

GEH	16:30-17:30	17:00-18:00	17:30-18:30
<7.5	100%	100%	100%
<5.0	100%	100%	96%
<3.0	79%	100%	83%

Table 4: PM Period: Observed Vs Modelled Turning Movement Comparison Summary

Table 3 and Table 4 demonstrate a good correlation between the observed and modelled counts.

In addition, the observed and modelled hourly turning counts have been plotted on an XY scatter graph and the trendline and R squared values calculated. The equation of the trendline

demonstrates how well the model represents the observed data where counts have been collected at a series of adjacent intersections, a range of y = 0.95x to 1.05x is generally deemed acceptable. The R squared value demonstrates how well the estimated trendline fits the two datasets, a value closer is 1.0 demonstrates that the trendline is reliable and values greater than 0.95 are generally deemed acceptable. Figure 2 and Figure 3 show the hourly observed vs. modelled XY scatter graphs for the AM and PM periods.

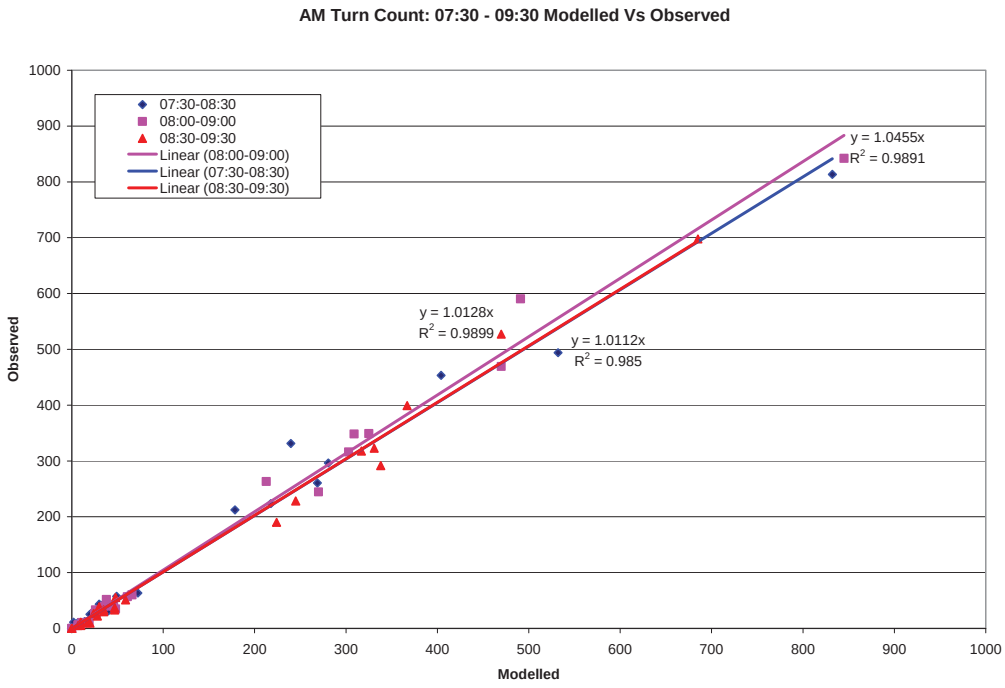

Figure 2: AM Period: Observed Vs Modelled Turning Counts

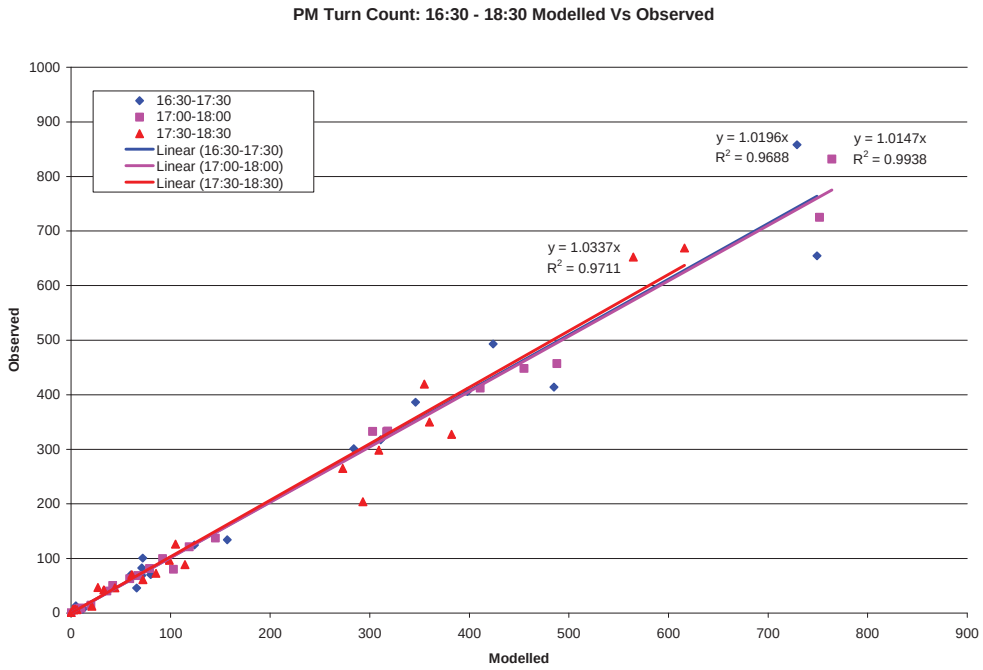

Figure 3: PM Period: Observed Vs Modelled Turning Counts

Figure 2 and Figure 3 demonstrate that the model represents the observed count data well in the in both the AM and PM modelled period, indicating a robust calibration outcome.

5.3 Queue Length Performance

The queue length performance provides a comparison between the observed maximum number of queued vehicles and the maximum modelled number of queued vehicles. The purpose of comparing the observed and modelled queued vehicles is to confirm that the build-up and dissipation of traffic on street is replicated in the model.

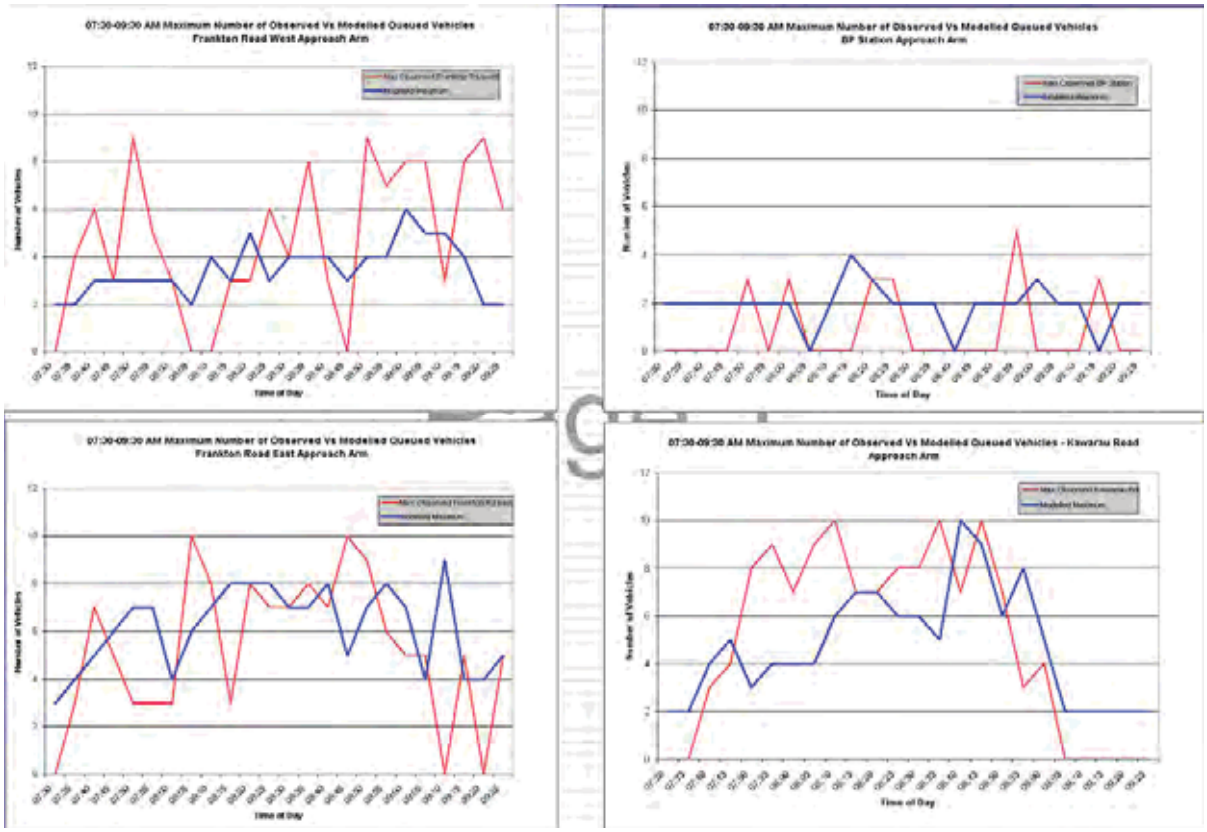

Figure 4: AM Period: Observed Vs Modelled Queued Vehicles

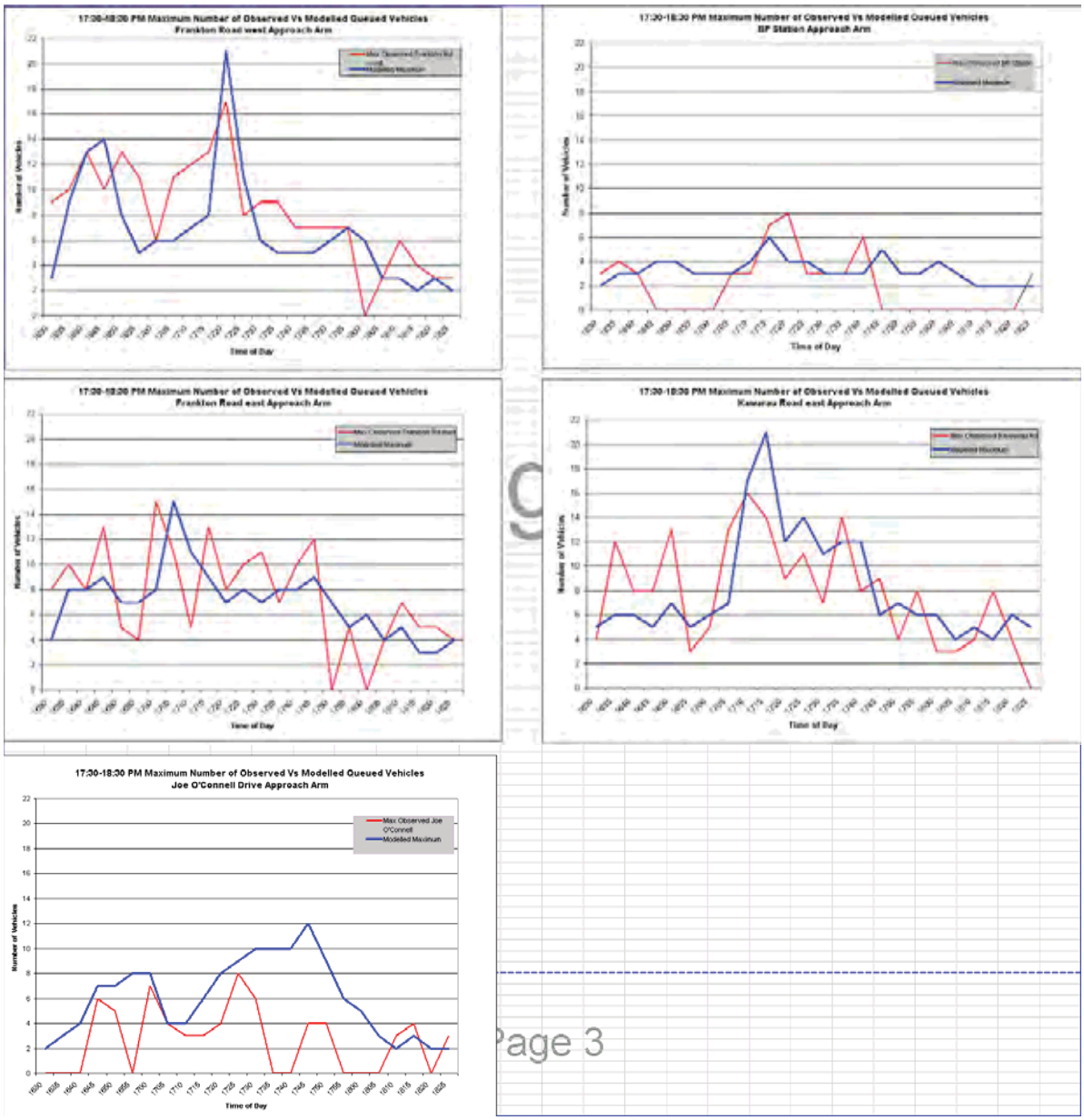

Figure 5: PM Period: Observed vs Modelled Queued Vehicles

Figures 4 and 5 demonstrates that not only is the build up and dissipation trend of the observed and modelled maximum queued vehicles achieved, the actual number of queued vehicles closely matches over the full simulation period.

6. Summary

An S-Paramics microsimulation model of the road network from Frankton Road/BP/Kawarau Road Roundabout to Ladies Mile/Grants Road has been developed to represent existing traffic conditions. The model has been calibrated against the observed and recorded operation of the network and observed traffic count data. The maximum observed and modelled number of queued vehicles has been compared to assess the model performance.

The good fit between the observed and modelled traffic flows and road network performance demonstrates that the model is suitable for testing the effects of a proposed plan change to land adjacent to the north of SH6.

Traffic Design Group Ltd
29 March 2011

Appendix B

Level of Service Definitions

Level of Service Definitions

The level of service (LOS) is a measure for the quantitative assessment of the quality of service provided by a road network that describes the operational conditions generally in terms of measures such as speed and travel time, freedom to manoeuvre, traffic interruptions, comfort and convenience.

In general, six levels of service are defined with letters from A to F used to designate each level. A level of service A represents the best operating conditions while LOS F represents the worst conditions. Each level of service represents a range of operating conditions and the driver's experience of those conditions. Safety does not form part of the measures used to assign a level of service nor does individual perception of journey times or congestion.

The following descriptions for individual levels of service have been taken from the Austroads Guides to Traffic Engineering Practice:

- **Level of Service A** – represents free flow. Individual users are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high. The general level of comfort and convenience provided to the motorist or passenger is excellent.
- **Level of Service B** – is in the range of stable flow, but the presence of other users in the traffic stream begins to be noticeable. Freedom to select desired speeds is relatively unaffected, but there is a slight decline in the freedom to manoeuvre within the traffic stream from level of service A. The level of comfort and convenience provided is somewhat less than at level of service A, because the presence of others in the traffic stream begins to affect individual behaviour.
- **Level of Service C** – is the range of stable flow, but marks the beginning of a range of flow in which the operation of individual users becomes significantly affected by interactions with others in the traffic stream. The selection of speed is now affected by the presence of others, and manoeuvring within the traffic stream requires substantial vigilance on the part of the user. The general level of comfort and convenience declines noticeably at this level.
- **Level of Service D** – represents high-density, but stable-flow. Speed and freedom to manoeuvre are severely restricted, and the driver experiences a generally poor level of comfort and convenience. Small increases in traffic flow will generally cause operational problems at this level.
- **Level of Service E** – represents operating conditions at or near the capacity level. All speeds are reduced to a low, but relatively uniform value. Freedom to manoeuvre within the traffic stream is extremely restricted, and is generally accomplished by forcing a vehicle to "give way" to accommodate such manoeuvres. Comfort and convenience levels are extremely poor, and driver frustration is generally high. Operations at this level are usually unstable, because small increases in flow or minor perturbations within the traffic stream will cause breakdowns.
- **Level of Service F** – is used to define a forced or breakdown flow. The condition exists wherever the amount of traffic approaching a point exceeds the amount that can traverse the point. Queues form behind such locations. Operations within the queue are characterised by stop-and-go waves, and they are extremely unstable.

Highway Capacity Manual 2000

The US Highway Capacity Manual 2000 (HCM2000) describes methods for determining the levels of service for roads and intersections. For urban roads, a level of service can be allocated by measuring the average vehicle speed on the road. At intersections, the level of service is determined by the average control delay for each vehicle travelling through the intersection.

Average Control Delay (s/veh)	Level of Service
≤ 10	A
11 – 20	B
21 – 35	C
36 – 55	D
56 – 80	E
> 80	F

Table 24: Level of Service Definitions - Signalised Intersections (HCM 2000)

Average Control Delay (s/veh)	Level of Service
≤ 10	A
11 – 20	B
21 – 35	C
36 – 55	D
56 – 80	E
> 80	F

Table 25: Level of Service Definitions - Roundabouts

Average Control Delay (s/veh)	Level of Service
≤ 10	A
11 – 15	B
16 – 25	C
26 – 35	D
36 – 50	E
> 50	F

Table 26: Level of Service Definitions – Priority Controlled Intersections (HCM 2000)

Average Vehicle Speed (km/h)	Level of Service
> 50	A
40 – 50	B
29 – 39	C
23 – 28	D
18 – 22	E
<= 17	F

Table 27: Level of Service Definition – Urban Roads with 55km/h Typical Free-flow Speed

Public Transport

There are a variety of measures to describe the level of service provided by a public transport system. The tables below show level of service descriptions for the service headway and for the service operating hours. These are taken from the Highway Capacity Manual 2000 (HCM), given there is no equivalent for the New Zealand context.

LOS	Headway (min)	Comments
A	< 10	Passengers do not need schedules
B	10 – 15	Frequent Service; passengers consult schedules
C	16 – 20	Maximum desirable time to wait if bus is missed
D	21 – 30	Service is unattractive to passengers
E	31 – 60	Service available during the hour
F	> 60	Service unattractive to all riders

Table 28: Service Frequency LOS for Urban Transit Service (HCM 2000)

LOS	Hours per day	Comments
A	> 18	Night service provided
B	17 – 18	Late evening service provided
C	14 – 16	Early evening service provided
D	12 – 13	Day time service provided
E	3 - 11	Peak hour service / limited interpeak service
F	< 3	Very limited or no service

Table 29: Hours of Service LOS for Urban Transit Service (HCM 2000)