Integrated Traffic Assessment
Caversham Valley Safety Improvements

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1 Introduction

State Highway 1 between Anderson Bay Road and Lookout Point provides the key strategic link to and from Dunedin to the south, while also acting as an important link for local trips between Dunedin South and the Green Island area. The State Highway also acts as the key heavy vehicle link to the city and the port area. Furthermore, the road in its current form acts as a frontage and primary access for residents along Caversham Valley. This corridor runs between the communities of Caversham and Mornington, providing a number of at-grade intersections.

The primary purpose of the road is the movement of motor vehicles, however the presence of residential housing and close proximity of shops in Caversham result in a number of pedestrian and cycle movements both along and across the corridor. Between Barnes Drive and Lookout Point pedestrian and cyclist facilities typical of an urban environment are provided, in the form of footpaths adjacent to the road. As a result of the traffic and heavy vehicle demands through this area, the State Highway acts to sever the communities on either side, and creates poor and undesirable accessibility. There are also significant safety concerns associated with side road access, intersection design, vehicle interaction and general operating conditions.

As a result of the importance of this section of State Highway One in addition to the challenges it faces, the Caversham Valley Safety Improvements Project is being progressed to improve the safety of SH1. Specifically, the objectives of this project are to:

- improve the safety and efficiency of the corridor for highway users;
- improve corridor amenity for cyclists and pedestrians; and
- more safely manage parking and access for remaining residences.

This project is the second stage of the Caversham Highway Improvements. The first stage (Caversham Four Laning) is focused on the section of SH1 from Barnes Drive to Andersons Bay Road. The first stage is currently under construction and is scheduled to be complete in 2012. For the purposes of this report, the Caversham Four Laning is regarded as existing. The second stage (Caversham Valley Safety Improvements) is from Barnes Drive to Lookout Point and is shown in Figure 1.1. Stage 2 is currently being investigated and is the focus of this transport assessment which is being prepared as part of the documentation in support of the Notice of Requirement being submitted for the Caversham Valley Safety Improvements.

Figure 1.1: Caversham Valley Safety Improvements Study Area (Shown in yellow)

This assessment builds upon the work completed as part of the Interim Scheme Assessment[1]. Over the course of the project a wide range of options for improving Lookout Point have been considered and assessed, as documented in the reports mentioned above. However, the focus of this assessment is to understand and assess the effects associated with changes to the transport facilities in the study area.

The three options presented as part of the March 2011 public consultation have been analysed. Public consultation Option A is Base while public consultation Options B and C are Alternative 1 and Alternative 2, respectively To provide context and a point of comparison, the Existing Layout Scenario is also analysed.

As a result of feedback from the public consultation additional variations are being considered. These variations include creating a direct link from South Road to Caversham Valley Road and continuing to permit the left turn from Caversham Valley Road to Burnett Street. Both of these variations fall within the boundaries of the project area and would not result in additional land take. Detailed designs for these variations have not yet been developed. If either of these variations progress, a separate traffic assessment or addendum for the variations may need to be prepared.

[1] Caversham Highway Improvements I&R Phase Stage 2 Interim Scheme Assessment Report, May 2009, prepared by Opus International Consultants Ltd. on behalf of NZTA.

2 Assessment Framework

A range of qualitative and quantitative measures are used to assess transportation effects associated with any roading project. This Integrated Transport Assessment begins with an assessment of the existing layout and a problem description. Next the base option and two alternative options are discussed. Sections 7 and 8 cover the traffic demands and intersection performance before the national and regional policy context is summarised in Section 9. The assessment ends with sections covering construction effects, recommended mitigation, summary and conclusions.

Changes to the roading network in one location have the potential to change travel patterns across the network. For this reason the Dunedin TRACKS traffic model has been developed by Gabites Porter and is able to forecast how travel patterns will change based on changes to the roading network. Therefore, the model is an important tool when assessing the effects associated with changes to the transport network and is an appropriate tool for assessing the relative change between different options. Appendix A contains further documentation related to the model development, including a letter from the model peer reviewer to confirm the review that was undertaken and the suitability of the model.

The existing layout, base and both alternatives have all be modelled[2] for the base year of 2008 and forecast years of 2021 and 2041. The AM, interpeak and PM peak periods have been modelled for all years. All modelling includes Dunedin City Council's improvements to the network including improvements such as a signalised dumbbell[3] at Andersons Bay Road.

The annualisation factors used to convert the model flows to the average annual daily traffic[4] (AADT) are summarised in Table 2.1 below.

Table 2.1: Annualisation Factors

Model Period	Periods per Day	Days per Year
AM	1.17	365
IP	11.16	365
PM	1.36	365

[2] Modelling has been completed using the 2008 Base Dunedin TRACKS Model.
[3] A signalised dumbbell is a type of intersection in which a pair of adjacent signalised roundabouts operates as a single intersection.
[4] AADT is the average number of vehicles on a segment of road during a 24-hour period.

3 Existing Layout –Problem Description

The Existing Layout Scenario[5] is based on the existing road network; however, it is assumed that the construction of the Caversham Four Laning (Stage 1) is complete. Caversham Four Laning construction is currently in progress and is scheduled to be complete in 2012. The Existing Network Scenario represents the network's performance and problems experienced by motorists on a daily basis. Therefore, this description and assessment of the Existing Network Scenario can be considered the problem description.

The existing Lookout Point (South Road, Mornington Road, and SH1) intersection layout is constrained, due to the proximity of the Lookout Point Fire Station and the requirement to provide access to private housing, and has resulted in a relatively narrow corridor with no provision for shoulders. The two staggered T intersections, tight horizontal geometry, high traffic volumes and steep approach gradients also contribute to the challenges at this location.

Currently for motorists to cross SH1 near Lookout Point, they are forced to make a left turn to Caversham Valley Road (SH1), and then make an immediate right turn from Caversham Valley Road. Caversham Valley Road has a 4-lane cross section, high traffic volumes, and the intersections of Caversham Valley Road/ Mornington Road, and Caversham Valley Road/ South Road are both priority controlled resulting in making the manoeuvre to cross SH1 very difficult and dangerous. The intersections are only 75m apart which gives limited stacking lengths for turning vehicles.

Lookout Point has major sight distance deficiencies with steep approach gradients. The problem is especially bad from the southern direction where traffic is approaching the city area from a 100km/h zone and although the speed limit is reduced to 50km/h approximately 300m from the crest the majority of vehicles are still travelling at speeds around 60 to 70km/h. The horizontal radius is also tight at 130m and superelevation of 6% (approx) which gives a design speed of 60km/h.

Sight distance to the west from both South and Mornington Roads is also poor and is in the range of 80 to 85m. On the basis that northbound SH1 traffic is travelling towards the city at 60km/h the required Safe Intersection Sight Distance (SISD) is 123m and requires a vertical curve with a K value[6] of 16. The vertical crest curve actually has a 'K' value of 7 which provides stopping sight distance at 55km/h.

Caversham Valley Road has medium density residential development along the south eastern side of the highway while on the north western side many of the former residences have since been removed. The highway has four lanes with on-street parking along the south eastern side and no refuge provision (e.g. flush median) for vehicles turning into properties. The highway is intersected with at-grade 'T' intersections at Burnett and

[5] The Existing Layout Scenario is also known as Modelling Scenario 1.

[6] The K value is a constant based on design speed and is used in the design of roads. It is defined as the length of a vertical curve in metres for one percent change in grade. As the design speed increases, the minimum stopping sight distance increases and therefore, the corresponding K value for vertical curves also increases.

Aberfeldy Streets both of which are left turn in/left turn out. A 50km/h speed limit applies. Within Caversham Valley the constrained geometric environment contributes to the safety risk. The traffic lanes over a major part of this section are of limited width, shoulders are non-existent and side friction[7] is a problem with the residential and commercial activities adjoining the road.

The at-grade intersection at Barnes Drive is signal controlled to provide for traffic turning into Caversham and for access to the small residential areas on the northern side of SH1. This intersection is operating near or at capacity resulting in delays for motorists and driver frustration.

3.1 Crash History and Safety

The crash history for the five year period from 1 January 2001 to 31 December 2010 was extracted from NZTA's Crash Analysis System (CAS) and analysed. The analysis focused on three areas: Lookout Point, SH1 from Lookout Point to Barnes Drive, and the Barnes Drive Intersection, in particular the western approach. Appendix B contains a summary of the crash data.

3.1.1 Lookout Point

At Lookout Point there have been a total of 41 crashes within a 50 metre radius of the South Road/SH1 and/or Mornington Road/SH1 intersections. 15 percent of these crashes resulted in a fatality or serious injury with another 24 percent resulting in minor injuries. Looking at this over the past 5 years displayed a worsening in the severity of crashes at this location, which suggests the situation is getting worse as traffic demands increase.

Rear end/ obstruction is the most common crash type at Lookout Point accounting for 14 crashes. Crossing/ turning is the next most common crash type accounting for 10 crashes. Six of these crashes involved motorists turning right to or from Mornington Road, another two involved motorists turning right to or from South Road. The remaining two crossing/turning crashes involved a motorist turning left from Mornington Road or South Road (one in each location).

There have been two crashes which involved pedestrians. In both instances they involved a northbound motorist on SH1 hitting a pedestrian crossing from the right with no regard of traffic.

The fatal crash was a single vehicle accident where the motorist lost control while attempting to turn. Excess speed and drugs were contributing factors.

3.1.2 Midblock Section

There have been a total of 47 crashes on the section of SH1 between South Road and Barnes Drive (exclusive of crashes within a 50m radius of either intersection). Of the midblock crashes there was 2 serious injury and 11 minor injury collisions. The most

[7] Side friction is defined as all events along the road which have an impact on speed and capacity, such as pedestrians, bicycles, and roadside parking.

common crash type was rear end/obstruction (31 crashes) followed by overtaking (7 crashes) and bend-lost control/head on (4 crashes).

14 of the rear-end crashes involved a vehicle parked on the southern side of Caversham Valley Road between Barnes Drive and Aberfeldy Street. 50 percent of the lost control crashes resulted in a vehicle crossing the centre line. Additionally there were three crashes caused by a motorist attempting to complete a U-turn.

3.1.3 Barnes Drive Intersection

A total of 43 crashes have been recorded in CAS within a 50m radius of the intersection of Barnes Drive, Caversham Valley Road, South Road, and Caversham Bypass. 26 of the crashes involve vehicles travelling on the westbound approach. The crash analysis will focus on these crashes since the intersection changes being considered as part of this phase of the project are only occurring on the westbound approach.

There was one fatal, one serious injury, and thirteen minor injury crashes. The remaining eleven crashes resulted in no injuries.

Twenty crashes were of the crossing/turning type. Seventeen of these crashes involved a motorist turning right from Caversham Valley Road failing to give way to oncoming through (westbound) traffic. Two of the crossing/turning collisions occurred as a result of an eastbound motorist failing to stop at a red light and hitting a vehicle travelling from South Road to Barnes Drive. One of these crashes resulted in a fatality. The remaining crossing/turning crash involved a motorist turning right from Caversham Bypass failing to give way to an oncoming through (eastbound) vehicle.

The remaining six crashes were all rear end. Five of these occurred when a driver failed to notice the car ahead slowing or stopping for the traffic signals or a queue.

3.2 Travel Patterns and Behaviours

In the existing layout at Lookout Point the local roads (Mornington Road and South Road) have a direct connection with SH1 in the form of two priority T-intersections. Traffic wishing to access SH1 in addition to traffic wishing to cross SH1 must use these intersections. The high volume of through traffic on SH1 makes completing right turns at these intersections challenging and motorists often experience lengthy delays.

Table 3.1 summarises the travel time for motorists travelling in either direction between South Road and Mornington Road in 2021, if no changes are made to Lookout Point. For traffic travelling from South Road to Mornington Road the travel time includes the delay associated with making the left turn from South Road to SH1, getting across into the right lane, then making a right turn from SH1 to Mornington Road. For traffic travelling in the other direction from Mornington Road to South Road, the travel time includes the delay associated with motorists making a left turn from Mornington Road to SH1, getting across into the correct lane then making a right turn from SH1 to South Road.

Table 3.1: Existing Layout Travel Time 2021 [min:sec]

Direction	AM Peak	PM Peak
South Rd to Mornington Rd	2:36	1:01
Mornington Rd to South Rd	1:06	2:44

Depending upon the direction and peak period, travelling between South Road and Mornington Road would take between 1 and 3 minutes in 2021, if there are no changes at Lookout Point. This is excessive delay for a trip that is less than 200m. As a result of the difficulty and safety risks associated with completing this manoeuvre, very few motorists choose to cross SH1 in this location. Instead motorists on the southern side tend to stay on the southern side and motorists on the northern side generally stay on the northern side, however others use the Barnes Drive intersection as an alternative to access the south side of SH1.

Further discussion of the traffic modelling and forecast traffic volumes is included in Section 7, below.

3.3 Passenger Transport

Currently there are two bus routes in the vicinity:

- Corstorphine – Lookout Point, and
- Pine Hill – City - Caversham – Lookout Point

The Corstorphine – Lookout Point route only operates on evenings and weekends and crosses Caversham Valley Road at Lookout Point (via Mornington Road and Riselaw Road) to provide service to Mornington Road. The services on this route are timed to coincide with periods of lower traffic volumes on the highway, when crossing the highway is easier.

The second bus route in the vicinity does a loop via South Road, Sidey Street, Ryehill Street, Riselaw Road and back to South Road. This route operates on weekdays between 6:30am and 7:00pm.

3.4 Walking and Cycling

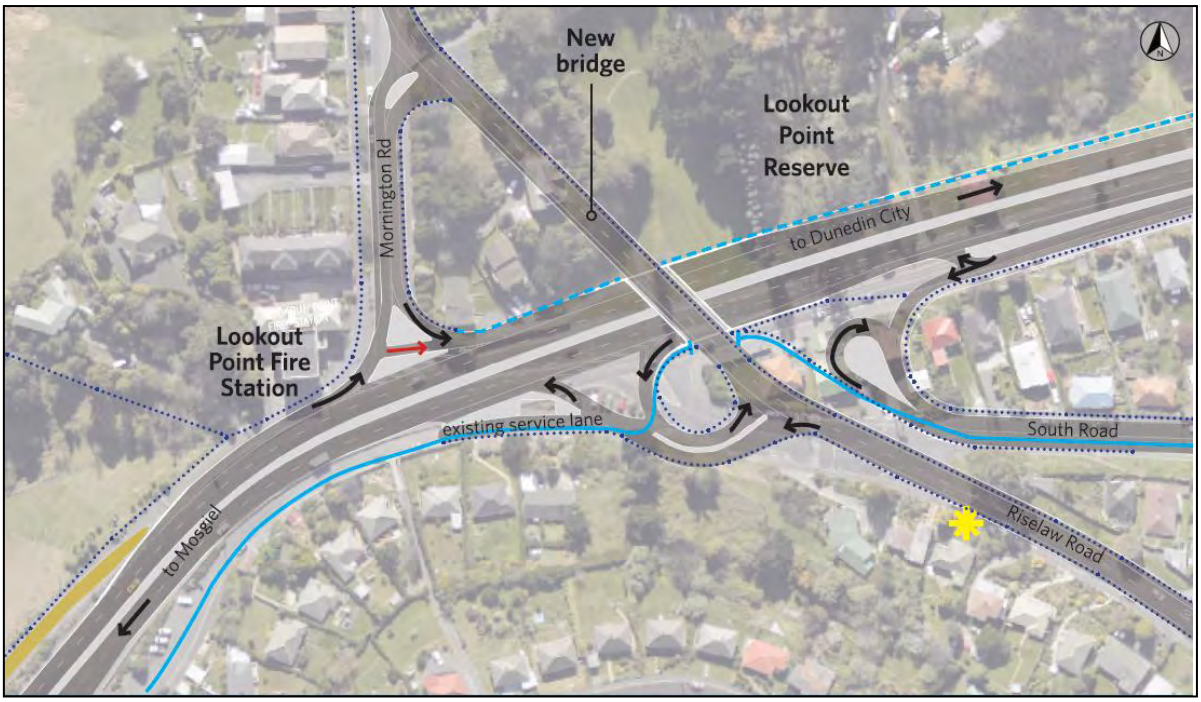
Footpaths are provided on the existing network along both sides of Caversham Valley Road, but there is no formal provision for pedestrians or cyclists to cross SH1 at Lookout Point. Informally, pedestrians may utilise the central island on the north side of South Road to cross SH1. The nearest formal crossing point is the signalised intersection at Barnes Drive 1km away. This results in significant severance and poor connectivity for pedestrians and cyclists.

4 Base Option

The base option[8] includes a grade separated bridge across Lookout Point in addition to improvements along Caversham Valley Road and at the Barnes Drive intersection.

The grade separated bridge will link Mornington Road to South Road and provide access to and from SH1 in both directions. However, due to vertical constraints, the vehicular connection between South Road and Riselaw Road will be eliminated. However, a pedestrian and cyclist link between South Road and Riselaw Road will be maintained. Southbound SH1 motorists will be able to access South Road via the service lane. Figure 4.1 shows the base option and vehicle movements at Lookout Point. A full set of drawings for the base option are contained in Appendix C.

Figure 4.1: Plan of the Base Option



The grade separation will eliminate the severance currently created by SH1 by enabling all modes to easily travel between Mornington Road and South Road.

On Caversham Valley Road, the horizontal curve radius will be increased to 180m however there will be no improvement to the vertical curve which is only adequate for 55km/h. Caversham Valley Road will be widened to provide a kerbed central median and the roadside shoulders will be widened to between 1.5m and 1.8m with no parking permitted in the shoulder. A southbound service lane from approximately house number 119 to 163 Caversham Valley Road will be constructed to provide improved access and parking to the intermediate properties.

[8] The Base Option is referred to as Option A in the March 2011 public consultation material. It is also known as Modelling Scenario 6.

At Barnes Drive on the western approach a separate lane for left turning traffic will be added. The right turn bay on the western approach will also be lengthened to 215m. This has been proposed to provide for the heavy right turn movements and reduce the impact that queued traffic has on safety and operation of through traffic movements.

At Burnett Street, only left turns from Burnett Street onto the highway will be able to be made. To access Burnett Street motorists will need to approach from South Road (by turning off the highway at the Barnes Drive traffic signals).

At Short Street vehicular access onto the highway will be closed and a turnaround area constructed instead. To access SH1 motorists will have to either use Main South Road to access the highway at Burnside or travel north on Kaikorai Valley Road then via Barr Street to Mornington Road and access the highway at Lookout Point. The closure of Short Street is to allow for the creation of a higher priority left turn deacceleration lane for Mornington Road, as well as to mitigate the geometric deficiencies that currently exist at this intersection. The pedestrian link from Short Street to Mornington Road will be maintained.

The speed limit on the State Highway from Barnes Drive to a point just south of Lookout Point will be increased from 50 km/h to 60 km/h.

4.1 Safety

The removal of the at-grade connections of South Road and Mornington Road to SH1 will eliminate the risk of crossing/turning crashes at Lookout Point. Additionally, with the elimination of right turns and the provision of diverge tapers for left turns, turning vehicles will clear the through lanes more easily, effectively and safety. This will reduce the risk of rear end crashes. However, the addition of on ramps could increase the risk of sideswipe crashes as the entering traffic merges with the through traffic on SH1.

The kerbed central median will reduce the risk of vehicles crossing the centre line or attempting to complete u-turn manoeuvres. The removal of parking, wider shoulders and service lane will mitigate the risk of collisions involving parking and parked cars.

4.2 Passenger Transport

With the grade separation in the base option, buses will be able to cross SH1 at Lookout Point safely and with no delay. This should create a significant opportunity to provide improved bus service to Lookout Point.

The Pine Hill – City - Caversham – Lookout Point route can be altered to create a loop from South Road going north on Burnett Street to SH1, to the new southbound Service Lane, back along SH1 to the off-ramp, then southbound on Riselaw Road then along Waimea Avenue, Ryehill Street, and Sidney Street back to South Road. A plan showing this routing is included in Appendix D. This change in bus routing results in the loss of bus service on South Road between Sidney Street and Riselaw Road, but provides the opportunity for new bus stops on Burnett Street and on the new SH1 Service Lane.

4.3 Walking and Cycling

The grade separated link at Lookout Point is designed to accommodate both pedestrians and cyclists in addition to vehicles. While the vehicular connection between South Road and Riselaw Road will be severed in this option, a pedestrian and cyclist connection will be maintained.

A footpath for shared pedestrian and cycle use is also proposed along the northern side of SH1 from Mornington Road heading towards the city.

An on-road cycle route from South Road, under the overpass structure then connecting to the existing service lane on the south side of SH1 will also be constructed.

All the existing pedestrian and cyclist connectivity is maintained in this option. The addition of a grade separated pedestrian and cyclist link across SH1 is a significant improvement over the existing layout.

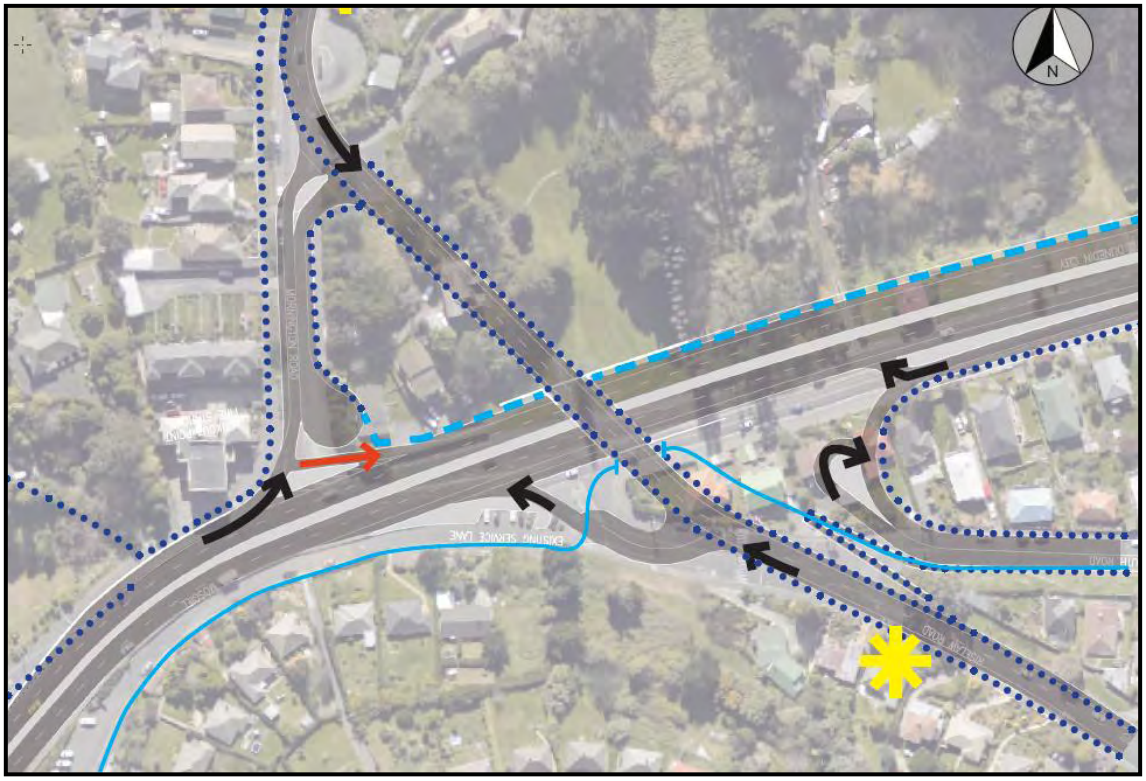
5 Alternative 1

Alternative 1[9], is very similar to the base option in that it provides a grade separated link across SH1 for vehicles, pedestrians and cyclists and improvements along Caversham Valley Road and at the Barnes Drive intersection. However, at Lookout Point there is limited connectivity to SH1 from the local road network.

A northbound off ramp and southbound on ramp are provided, but there are no connections to facilitate trips to or from the north. A special laneway will be constructed to enable fire trucks from the Lookout Point Fire Station to access SH1 in a northbound direction. To travel southbound on SH1 the fire trucks will use the new road link across SH1 and then the normal on ramp for southbound motorists.

Due to vertical constraints, the vehicular connection between South Road and Riselaw Road will be eliminated. A pedestrian and cyclist link between South Road and Riselaw Road will be maintained. Southbound SH1 motorists will be able to access South Road via the service lane. Figure 5.1 shows Alternative 1 and the vehicle movements.

Figure 5.1: Plan of Alternative 1



Alternative 1 shares the following characteristics with the Base Option:

- On Caversham Valley Road, the horizontal curve radius will be increased to 180m however there will be no improvement to the vertical curve which is only adequate for 55km/h.

[9] In previous work Alternative 1 was known as LP 4, Modelling Scenario 4 and public consultation Option B.

- Caversham Valley Road will be widened to provide a kerbed central median and the roadside shoulders will be widened to between 1.5m and 1.8m with no parking permitted in the shoulder.
- A southbound service lane from approximately house number 119 to 163 Caversham Valley Road will be constructed to provide improved access and parking to the intermediate properties.
- At Barnes Drive on the western approach a separate lane for left turning traffic will be added. The right turn bay on the western approach will also be lengthened to 215m.
- At Burnett Street, only left turns from Burnett Street onto the highway will be able to be made. To access Burnett Street motorists will need to approach from South Road (by turning off the highway at the Barnes Drive traffic signals).
- At Short Street vehicular access onto the highway will be closed and a turnaround area constructed instead. The pedestrian link from Short Street to Mornington Road will be maintained.
- The speed limit on the State Highway from Barnes Drive to a point just south of Lookout Point will be increased from 50 km/h to 60 km/h.

5.1 Safety

In terms of safety, Alternative 1 is very similar to the Base. The grade separation will eliminate the risk of crossing/turning crashes on SH1 at Lookout Point and the diverge taper will reduce the risk of rear-end collisions since the traffic exiting SH1 will be able to clear the through lanes before deaccelerating. However, the addition of an on ram could increase the risk of sideswipe crashes as the entering traffic merges with the through traffic on SH1.

The kerbed central median will reduce the risk of vehicles crossing the centre line or attempting to complete u-turn manoeuvres. The removal of parking, wider shoulders and service lane will mitigate the risk of collisions involving parked cars.

5.2 Passenger Transport

Similar to the base option, with the grade separation, buses will be able to cross SH1 at Lookout Point safely and with no delay.

The Pine Hill – City - Caversham – Lookout Point route will need to be significantly altered in this option. One possible routing involves buses travelling via Barnes Drive, SH1, Burnett Street, Sidney Street, Ryehill Street, Waimea Avenue, Riselaw Road, over the new link across the SH to Lookout Point then back along SH1 to Barnes Drive. A plan showing the possible bus routing is included in Appendix D.

This change in bus routing results in the loss of bus services on South Road between Barnes Drive and Riselaw Road, which provides bus service during the week to Mornington Road.

5.3 Walking and Cycling

For pedestrians and cyclists this option is very similar to the base option, in that:

- The grade separated link at Lookout Point is designed to accommodate both pedestrians and cyclists in addition to vehicles;
- A pedestrian and cyclist connection between South Road and Riselaw Road will be maintained;
- A footpath for shared pedestrian and cyclist use is proposed along the northern side of SH1 from Mornington Road heading towards the city; and
- An on-road cycle route from South Road, under the overpass structure then connecting to the existing service lane on the south side of SH1 is planned.

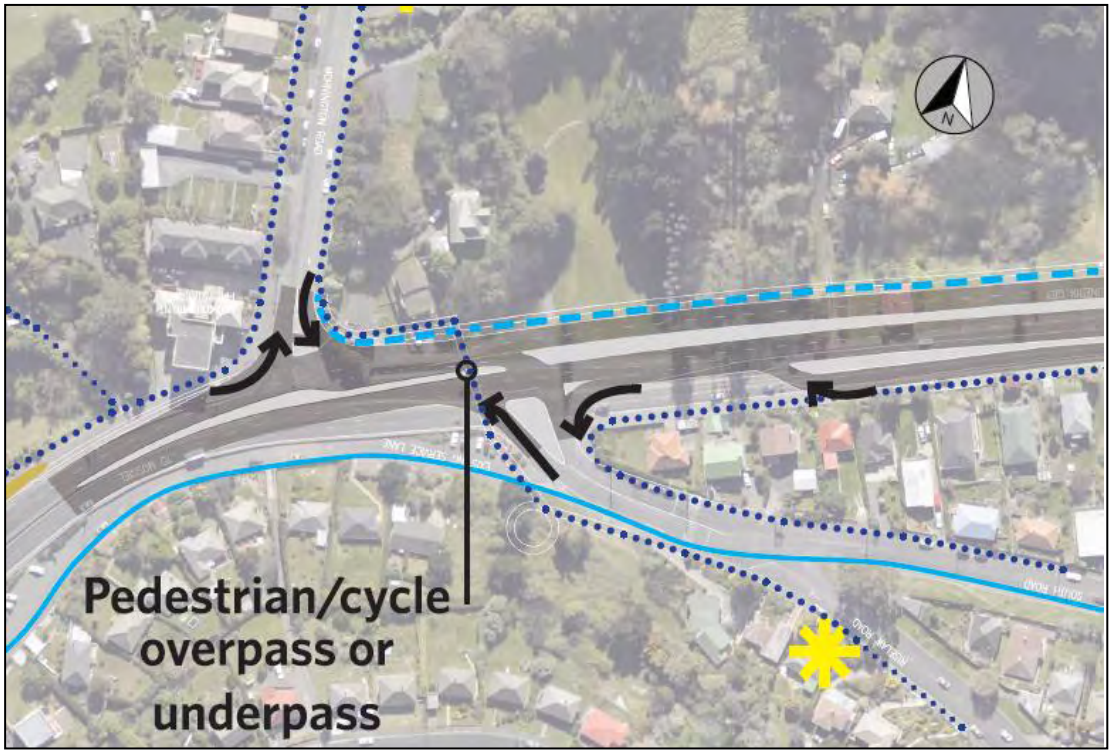
All the existing pedestrian and cyclist connectivity is maintained in this option. The addition of a pedestrian and cyclist link across SH1 is a significant improvement over the existing layout.

6 Alternative 2

This alternative is being considered since it is lower cost than the base while providing some safety improvement over the current layout. Alternative 2[10], includes changes at Lookout Point, Barnes Drive and the section of Caversham Valley Road between Lookout Point and Barnes Drive.

To address the safety issues associated with the right turns to and from South Road and Mornington Road, the Alternative 2 proposal is to ban all right turns with the exception of the eastbound right turn from SH1 to South Road. A plan of the Alternative 2 proposal for Lookout Point is included in Figure 6.1, below.

Figure 6.1: Plan of Alternative 2



Similar to the Base Option and Alternative 1, the road alignment will be eased, providing a horizontal curve radius of 180. Therefore, sight distance from Mornington Road to the west will still be in the range of 80 to 85m

It is intended to adopt a 60km/h speed limit for Caversham Valley Road (increased from the current 50km/h).

Eliminating the right turn into Mornington Road from SH1 will allow the turn bay for traffic turning right to South Road to be extended to provide increased stacking room and allow turning traffic to clear the through lanes more easily and efficiently.

[10] In previous work, this alternative was known as LP1 or Modelling Scenario 2B. The March 2011 public consultation material refers to this as Option C.

Vehicles travelling from Mornington Road to South Road will still have to cross two traffic lanes in a short weaving length (20m approx).

While addressing some of the safety issues at Lookout Point, this option does not address the severance caused by the highway for motorists. Motorists travelling from Mornington Road to South Road will still be able to complete this manoeuvre, but the existing safety issues and delay has not been addressed. Additionally, it will no longer be possible to drive in the other direction (northbound) from South Road to Mornington Road.

The existing severance for pedestrians and cyclists will be addressed by constructing a pedestrian and cyclist underpass or overpass across the highway.

The Lookout Point Fire Station is located on the north eastern corner of Mornington Road and SH1. The physical barriers that would be constructed to ban the turning movements will require fire tenders wishing to travel southbound on the highway to travel via Riselaw Road and Stevensons Road. These roads are residential in nature and the detour results in the fire tenders having to travel 2 km further than they currently do in the existing situation.

A southbound service lane from approximately house number 119 to 163 Caversham Valley Road will be constructed to provide improved access and parking to the intermediate properties.

A kerbed central median will be constructed along Caversham Valley Road and wider shoulders (1.5m to 1.8m) provided. No parking will be permitted on the side of Caversham Valley Road, except in the new service lane.

At Burnett Street, only left turns from Burnett Street onto the highway will be able to be made. To access Burnett Street motorists will need to approach from South Road (by turning off the highway at the Barnes Drive traffic signals).

At Barnes Drive the current traffic signals will remain, but be improved with the provision of a separate turn bay for left turning traffic on the Caversham Valley Road (west) approach.

In the traffic modelling of this option, the Short Street link has been kept open. The traffic model predicts that approximately 1300 vehicles per day will access SH1 from Short Street in 2021. Most of these vehicles are generated by motorists using Short Street as a short cut to access SH1, not residents living on the street. Given the geometric deficiencies of this intersection, it is proposed to close this intersection. The closure may result in small changes in the demands forecast by the model on the local road network in the vicinity. However, the closure should not have a significant impact on the overall trends predicted by the model and the assessment.

6.1 Safety

With right turns out of South Road and in and out of Mornington Road banned, up to 70 percent of the turning crashes at Lookout Point could be prevented. Additionally, the elimination of most right turns and the increased turn bay length for the right turn to South Road may reduce the number of rear end crashes as these are possibly caused by vehicles

slowing to enter the right turn bay pockets or vehicles stopped on SH1 waiting for an appropriate gap to complete their turning manoeuvre.

The kerbed central median will reduce the risk of vehicles crossing the centre line and could have potentially prevented the head on crashes where a vehicle crossed the centre line. It will also discourage motorists from attempting to complete u-turn manoeuvres. The wider shoulder, removal of some parking and provision of a service lane will mitigate the risk of collisions involving parking and parked cars.

6.2 Passenger Transport

In this scenario due to the turn restrictions it will not be possible for the Corstorphine – Lookout Point bus route to operate since the bus will not be able to cross the highway. The loss of this bus route will further compound the severance caused by the highway currently and potential to provide improved PT provision in the future.

6.3 Walking and Cycling

The proposed grade separated pedestrian and cyclist link across SH1 at Lookout Point will reduce the severance currently caused by SH1 by enabling pedestrians and cyclists to safely cross the highway at this location.

A footpath for shared use by pedestrians and cyclists is proposed along the northern side of SH1 from Mornington Road heading towards the city. Additionally, the road shoulders on the highway will be widened over this section for those cyclists who prefer to travel on the highway. The existing on-road cycle route via South Road will continue to be available.

7 Traffic Demands

Traffic volumes have been extracted from the Dunedin Tracks Model to enable an analysis of the traffic patterns and how they change with each scenario to be completed. The Tracks Model was discussed in more detail in Section 2. The analysis in this section has focused on 2021 AADT flows to be consistent with the forecast year of the model.

Table 7.1 summarises the 2021 AADT on key links in the study area and the percent change between the different scenarios. Plots showing demands on the wider network for the Existing Layout and then how these change in the Base are included in Appendix E.

Table 7.1: Link Flows and Percent Change 2021 AADT

Location	Direction	Existing Layout	Base	Alt 1	Alt 2	% Increase Base over Existing	% Increase Alt 1 over Base	% Increase Alt 2 over Base
Caversham Valley Rd -SH1 Between Lookout Pt and Barnes Dr	NB	19,180	18,960	18,253	19,250	-1.1%	-3.7%	1.5%
	SB	18,350	17,550	16,971	18,320	-4.4%	-3.3%	4.4%
Mornington Rd N of SH1	NB	2,240	2,260	1,981	1,810	0.9%	-12%	-20%
	SB	1,080	2,080	1,651	580	93%	-21%	-72%
Riselaw Rd S of South Rd	NB	710	1,270	997	470	79%	-21%	-63%
	SB	970	1,550	994	990	60%	-36%	-36%
South Rd E of Riselaw Rd	EB	970	320	317	840	-67%	-1%	163%
	WB	390	130	128	240	-67%	-2%	85%
Barnes Dr N of SH1	NB	660	570	820	970	-14%	44%	70%
	SB	680	630	798	790	-7.4%	27%	25%
South Rd S of SH1 (adjacent to Barnes Dr)	NB	4,730	4,600	4,968	5,020	-2.7%	8.0%	9.1%
	SB	3,360	3,990	4,242	3,630	19%	6%	-9%
Kaikorai Valley Rd S of Short St	NB	6,821	6,429	6,410	6,907	-5.7%	-0.3%	7.4%
	SB	7,335	7,111	7,225	7,660	-3%	2%	8%
Stevenson Rd W of Riselaw Rd	EB	2,117	2,511	2,641	2,135	19%	5.2%	-15%
	WB	2,112	2,651	2,649	2,194	25%	0%	-17%

SH1 is predicted to carry just under 20,000 vehicles per day in each direction. Overall there is minimal change in demand on SH1 for any of the scenarios with a slight reduction in demand in the Base and Alternative 2 relative to the existing layout scenario.

On Mornington Road there is a large reduction in demand in Alternative 2 since motorists used alternative routes due to the turn restrictions. There is an increase in demand in the base on Mornington Road, particularly in the southbound direction.

South Road experiences a significant decrease in demand in the Base and Alternative 1 since the direct link between Lookout Point and South Road is eliminated.

Riselaw Road has a significant increase in demand in the base since the grade separation attracts more traffic and all the traffic must use Riselaw Road. (In the Existing Layout some traffic turns onto South Road.) There is a large reduction in northbound demand on Riselaw Road in Alternative 2 relative to the Existing Layout since motorists are not able to turn right onto SH1.

The function of collector roads is to, "distributute and collect local traffic within and between neighbourhoods[11]". Riselaw Road, South Road and Mornington Road are all identified as collector roads in the Dunedin City District Plan. While the relative change in demand on these links appears large the total daily volume remains relatively low and is within the volume that can be expected on a collector road.

Given that traffic is able to easily cross SH1 at Lookout Point in the Base and Alternative 1 there is a reduction in the traffic on Kaikorai Valley Road. Similarly, Stevenson Road experiences an increase in traffic demand since some motorists are travelling via the Lookout Point bridge and Riselaw Road instead of via Main South Road.

7.1 Lookout Point Traffic Volumes

The AADT for traffic crossing SH1 at Lookout Point was extracted from the model and is summarised in Table 7.2 below. For the movement from South Road/ Riselaw Road to Mornington Road, Alternative 2 is not included since this movement is not possible due to the right turn from SH1 to Mornington Road being banned.

Table 7.2: AADT Crossing SH1 Directly at Lookout Point

Year	South/Riselaw Rd to Mornington Rd			Mornington Rd to South/Riselaw Rd			
	Existing Layout	Base Option	Alt 1	Existing Layout	Base Option	Alt 1	Alt 2
2008	329	1025	518	240	2006	1841	270
2021	388	1357	627	308	2343	2077	345
2041	446	1584	762	362	2776	2489	398

The above data shows that the model predicts the volume of traffic crossing SH1 at Lookout Point would significantly increase with the provision of a grade separated link relative to the Existing Layout. From South Road to Mornington Road the volume of traffic crossing SH1 with a grade separated link in the Base increases 3 to 4 fold. Crossing in the other direction, from Mornington Road to South Road the volume of traffic increases six to nine fold with grade separation. However, in reality, the demand on a grade separated link could be even greater due to the way the model predicts the traffic volume on each link.

The model uses origin and destination matrices as an input when predicting the volume of traffic on each link. Since currently crossing SH1 at Lookout Point is challenging and unsafe some motorists may choose to complete a trip all on one side of SH1 instead of crossing it. For example a school or shop located on the other side of SH1 may be closer to the motorist's home, but due to the delay and difficulty of crossing SH1 at the current time, the motorist chooses to travel further to a school or shop located on the same side of SH1. With

[11] Section 20.4 of the Dunedin City District Plan

a grade separated link across SH1 the motorist may choose to cross SH1 to have their children attend the nearest school or shop at the nearest stores. However, the origin and destinations matrices would fail to predict this change in behaviour and therefore the model could be under predicting the number of trips across SH1 with a grade separated link.

8 Link and Intersection Performance

The link and intersection performance in the project area and in the surrounding areas has been analysed. The analysis focuses on the intersection of Barnes Drive and SH1, Lookout Point and the performance of the wider network. Each are discussed in more detail below.

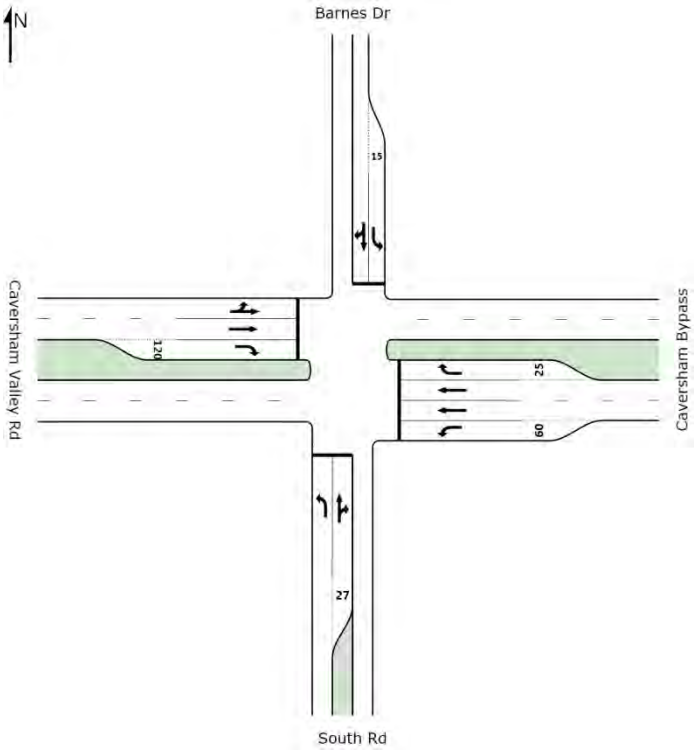
8.1 Barnes Drive and SH1 Intersection

The intersection of Barnes Drive, South Road and SH1 has been modelled using SIDRA[12] to assess its performance. This assessment has focused on 2021 demands for the existing network, base and alternative options.

The pedestrian demand at this intersection is low. Therefore, the pedestrian phase will only run when it is activated by a push button. The performance of the intersection is significantly reduced with the pedestrian phase, however, due to the low demand for this phase it should not have a significant impact on the overall intersection performance. This is especially the case since the intersection is on the SCATS system, which will optimise the signal timing and seek to clear vehicle queues resulting from the pedestrian phase as efficiently as possible. Therefore, the intersection has been modelled with no pedestrian phase.

The existing layout scenario, shown in Figure 8.1, includes the changes to the westbound SH1 approach, which are currently under construction.

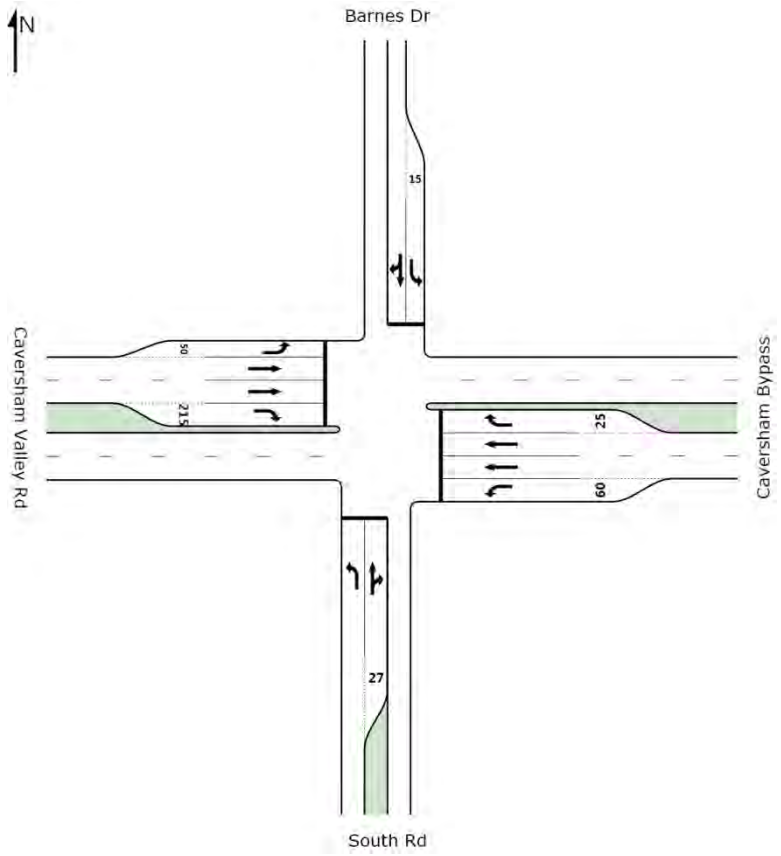
Figure 8.1: Existing Layout Scenario



[12] SIDRA is traffic modelling software which can be used to analyse intersection capacity, level of service and performance.

The layout of the intersection for the Base and both Alternatives is identical. Relative to the Existing Layout Scenario, it includes enhancements to the eastbound approach (Caversham Valley Road). Specifically, a 50m long left turn bay is added and the right turn bay is lengthened to 215m on Caversham Valley Road. The intersection layout for the Base and both Alternatives is shown in Figure 8.2, below.

Figure 8.2: Base and Alternatives Layout



In the TRACKS model, the intersection is operating near or at capacity. This results in some eastbound traffic on SH1 turning left onto Aberfeldy Street, rat running along Rockyside Terrace, then accessing the intersection from Barnes Drive. However it is anticipated that in reality motorists will not use Aberfeldy Street due to the limitations in capacity and ability for vehicles to make this movement in a safe and efficient manner. Therefore, the traffic volumes for the intersection from TRACKS have been adjusted to take this into account[13].

[13] In the Existing Layout Scenario and Alternative 1 motorists use Aberfeldy Street to avoid making a right turn from SH1 to South Road. Therefore the volume of traffic travelling through the intersection from Barnes Drive has been reduced by the number of vehicles using Aberfeldy Street while the demand for the right turn from SH1 to South Road has been increased. In the Base and Alternative 2 motorists use Aberfeldy Street to minimise the delay associated with travelling through the intersection. Therefore the demand for the eastbound through movement on SH1 has been increased accordingly while demand for the left turn from Barnes Drive to SH1 has been reduced.

Table 8.1, below, summarises the intersection performance for each scenario. The PM and AM peak level of service[14] (LOS) is shown. Detailed outputs from SIDRA are included in Appendix F.

Table 8.1: 2021 Barnes Drive and SH1 Intersection Performance

Approach	LOS by Approach							
	Existing Layout		Base		Alternative 1		Alternative 2	
	PM	AM	PM	AM	PM	AM	PM	AM
South Rd	F	C	F	C	E	C	F	C
Caversham Bypass	B	D	B	B	B	C	C	B
Barnes Dr	C	C	B	C	B	C	B	D
Caversham Valley Rd	E	D	E	D	D	E	E	C
Overall	**D**	**D**	**D**	**C**	**C**	**D**	**E**	**C**

In the Existing Layout Scenario, the South Road approach performs poorly in the PM due to the high demand for the left turn movement to SH1. Caversham Valley Road also performs poorly in the in the PM peak due to significant demand for the right turn to South Road. The intersection performs better in the AM peak with a LOS of C or D for all approaches.

For the Base option in the PM peak, the average delay per vehicle has reduced by 5 seconds relative to the existing layout scenario. The demand for the left turn from South Road to SH1 and the right turn from SH1 to South Road remains high, in the PM peak, and results in these approaches performing poorly. In the AM peak the performance of the Base option is improved over the existing layout.

In the PM peak Alternative 1 performs better than the Base. This improvement is a result of very slight changes in traffic volumes at the intersection. There is an increase in demand for some movements and a reduction in demand for others; however in Alternative 1, there is an overall reduction in demand of 27 vehicles relative to the Base. In the AM peak Alternative 1 performs worse than the Base with the overall LOS becoming D compared to C for the Base.

Alternative 2 performs worse than the Base in the PM peak while the performance in the AM peak is very similar.

[14] LOS relates to the type of conditions a motorist can expect to encounter. LOS A corresponds to a road that is below capacity with minimal delays while at LOS F there is severe congestion and extensive delays. The Highway Capacity Manual defines the LOS for signalised intersections based on the average delay per vehicle. LOS A corresponds to 10 seconds or less delay; LOS B is 10 to 20 seconds delay; LOS C is 20 to 35 seconds delay; LOS D is 35 to 55 seconds delay; LOS E is 55 to 80 seconds delay; and LOS F is more than 80 seconds delay.

8.2 SH1 and Local Road Connections at Lookout Point

This section focuses on the performance of the connections between the local road network and SH1 at Lookout Point for the Existing Layout, Base and Alternatives.

8.2.1 Existing Layout Scenario

In the existing layout at Lookout Point the local roads (Mornington Road and South Road) have a direct connection with SH1 in the form of two priority T-intersections. Traffic wishing to access SH1 in addition to traffic wishing to cross SH1 must use these intersections. The high volume of through traffic on SH1 makes completing right turns at these intersections challenging and motorists often experience lengthy delays.

Table 3.1 summarised the travel time for motorists travelling in either direction between South Road and Mornington Road in 2021, if no changes are made to Lookout Point. Depending upon the direction and peak period, the travel time between South Road and Mornington Road could take between 1 and 3 minutes in 2021, if there are no changes at Lookout Point. This is considered to be excessive delay for a trip that is less than 200m.

8.2.2 Base Option

The grade separation in the Base option enables motorists to safely and efficiently travel across SH1. The journey across SH1 will take just over 10 seconds.

Access to and from SH1 is via on and off ramps, as shown in Figure 8.3. The northbound on ramp is modelled as a merge and therefore there is little or no delay associated with traffic entering SH1 from the on ramp. However, there is insufficient space to provide an adequate merge lane in the southbound direction on SH1, so instead motorists must give way. In 2021 motorists can expect an average delay of 7 seconds in the AM peak and 17 seconds in the PM peak, based on TRACKS model outputs.

Figure 8.3: Schematic of the On/ Off Ramps

The on and off ramps for each direction then forms a priority T-intersection with the overpass (Riselaw Rd). The performance of these intersections has been modelled using SIDRA. The intersections perform very well with all movements having a LOS of A or B in 2021. Table 8.2 and Table 8.3, below, summarises the LOS and average delay on each

approach at both intersections for the AM and PM peak periods. The SIDRA outputs are included in Appendix G.

Table 8.2: Base Intersection of Southbound Ramp and Riselaw Road LOS and Delay

	Riselaw Road (south)	Riselaw Road (north)	Southbound On / Off Ramp
AM	A (1.4s)	A (2.8s)	A (8.6s)
PM	A (2.5s)	A (3.6s)	B (10.7s)

Table 8.3: Base Intersection of Northbound Ramp and Riselaw Road LOS and Delay

	Riselaw Road (south)	Riselaw Road (north)	Southbound On / Off Ramp
AM	A (1.9s)	A (1.5s)	A (8.5s)
PM	A (1.2s)	A (1.2s)	B (10.8s)

8.2.3 Alternative 1

Similar to the Base, access to and from SH1 is via on and off ramps. There is an off ramp for northbound SH1 traffic in Alternative 1 and an on ramp for traffic wishing to head southbound on SH1. At the junction of the southbound on ramp and SH1 the entering traffic must give way to the through traffic on SH1. Based on the TRACKS model, these motorists experience an average delay of 11 second and 22 seconds in the AM and PM peak periods, respectively.

The on and off ramps then form a priority T-intersection with the overpass (Riselaw Road). The performance of these intersections has been modelled using SIDRA. As summarised in Table 8.4 and Table 8.5, below, these intersections perform very well in 2021 with no significant delays. The SIDRA outputs are also included in Appendix G.

Table 8.4: Alternative 1 Intersection of Southbound Ramp and Riselaw Road LOS and Delay

	Riselaw Road (south)	Riselaw Road (north)	Southbound On / Off Ramp
AM	A (2.0s)	A (3.1s)	A (7.9s)
PM	A (2.9s)	A (3.3s)	A (9.3s)

Table 8.5: Alternative 1 Intersection of Northbound Ramp and Riselaw Road LOS and Delay

	Riselaw Road (south)	Riselaw Road (north)	Southbound On / Off Ramp
AM	A (0.1s)	A (0.4s)	A (7.4s)
PM	A (0.1s)	A (0.4s)	A (8.6s)

8.2.4 Alternative 2

The Alternative 2 scenario is very similar to the Existing Layout Scenario, but all the right turns to and from South Road and Mornington Road are banned with the exception of the right turn from SH1 to South Road. Table 8.6 summarises the travel time for motorists crossing SH1 at Lookout Point. With the right turn from SH1 to Mornington Road banned, it is no longer possible for motorists to travel directly from South Road to Mornington Road resulting in the need for motorists to take an alternative route such as Barnes Drive or Main South Road/Kaikorai Valley Road which significantly increases journey times. For the journey from Mornington Road to South Road there is essentially no change in the travel time relative to the Existing Layout.

Table 8.6: Alternative 2 Travel Time 2021 [min:sec]

Direction	AM Peak	PM Peak
South Rd to Mornington Rd	n/a	n/a
Mornington Rd to South Rd	1:06	2:42

While banning the right turns addresses some of the safety concerns at Lookout Point, it is not an effective solution for addressing the poor performance of the intersections. By banning the right turns and not providing an alternative route the current severance caused by SH1 will be further compounded.

8.3 Wider Network LOS

Performance of the wider network has also been considered. Plots from TRACKS which show any link that has a LOS of D or worse have been analysed for the Existing Layout, Base, and Alternative 2 in 2021. The only links in the vicinity of the project area which have a LOS of D or worse are located on the State Highway. The performance assessment is based on the LOS criteria contained in the Highway Capacity Manual. LOS plots for the wider network are included in Appendix E.

Table 8.7 summarises the link performance of various segments of SH1 for each of the scenarios. The LOS relates to the peak direction of flow for each time period (northbound in the AM peak on SH1 and southbound in the PM peak).

Table 8.7: LOS for Key Links

Link	Period	Existing Layout	Base Option	Alternative 2
SH1 west of Lookout Pt	AM	E	E	E
	PM	D	D	D
SH1 between Lookout Pt & Barnes Dr	AM	E	D/E	E
	PM	D	D	D
SH1 between Barnes Dr & Anderson Bay Rd	AM	D	D	D
	PM	D	C*	D

*LOS is C or better

There is no change in the LOS for motorists on SH1 between the Existing Layout and Alternative 2 scenarios. The State Highway LOS in the Base option is also very similar to the Existing Layout and Alternative 2 scenarios. There are two changes to the LOS:

- During the AM peak part of the section of SH1 between Lookout Point and Barnes Drive improves to a LOS of D, and
- During the PM peak SH1 between Barnes Drive and Andersons Bay Road has a LOS of C or better.

9 National and Regional Policy Context

The need to improve this section of road has also been listed in a number of national, local and regional long term strategic development documents for the City and the Region. The key documents are discussed below.

9.1 Land Transport Management Act 2003 (and Amendment Act 2008)

This project will contribute to many aspects that must be considered as part of the LTMA, in particular, Assisting Safety & Personal Security and the Improving Access and Mobility. These aspects have been assessed in more detail as part of the Interim Scheme Assessment Report.

9.2 NZ Transport Strategy 2008

The Government's vision for transport in 2040 is that:

"*People and freight in New Zealand have access to an affordable, integrated, safe, responsive and sustainable transport system*."

The Caversham Valley Safety Improvements will contribute to the achievement of this vision for transport given the strategic importance of the corridor for the movement of vehicles and freight to and from Dunedin and the port.

9.3 Regional Land Transport Programme (2009-2012)

Improving Caversham Valley Road is also listed as in the Regional Land Transport Programme (2009-2012). It was also noted that the Regional Transport Committee considers the improvements to the Caversham corridor through Dunedin on SH 1 to be of national as well as regional significance.

9.4 Dunedin City Council Strategies and Plans

The DCC Transportation Strategy 2006 sets a direction for transport within district and the issues raised in the strategy feed into LTCCP. In relation to the LTCCP "Community Well-Being" and "Safe and Healthy People" outcomes, the strategy has an objective of:

"Support sustainable transportation that minimises energy consumption and engine emissions into the environment, is an efficient use of Dunedin's infrastructure, and encourages physical activity."

The strategy identifies "congestion at key points on the network" as a key issue for meeting this objective. Related to this, Caversham Valley Rd is noted as a key route and one of the most congested points in the city.

Together, these policies show that Dunedin City Council encourages positive development while supporting the social and physical environment.

The proposed works are also consistent with the District Plan's is most significant objectives regarding roading which are the safety, efficiency and effectiveness of the city's

roads (Refer to Objective 20.2.4 of the Transportation section of the Dunedin City District Plan).

10 Construction Effects

State Highway 1 is a key strategic corridor to and from Dunedin City and surrounding suburbs. As a result it will be critical to manage the effects of construction to avoid significant disruption, delay, congestion, and transport user frustration. It is however important to recognise that this corridor will need to be maintained operational during peak times and any diversions or delays kept to a minimum during construction.

The proposed design seeks to create additional road capacity to the north of the existing SH1 corridor, therefore it is anticipated that this could be constructed to allow traffic to be shifted over once completed, thus providing space to complete the proposed service lane and associated southbound facilities. The severance of the linkage at Lookout Point is likely to be inevitable, however this should be timed to minimise disruption to transport users and the community.

A detailed assessment of the construction effects on traffic has not been completed at this point in time. As the project progresses, the assessment will need to be completed and form part of the traffic management plan for the project. The following items should be considered as part of the assessment of construction effects:

- Road closures including their duration, identification of alternative roads and ensuring the public are informed. If the road closures are extensive additional modelling of the impact of these road closures may be required.
- Local access and parking for all property owners.
- Pedestrian and cyclist disruption and severance.
- Construction machinery, along with associated construction activities will cause delays and potential safety hazards for motorists.

It is anticipated that the contractor will produce construction management plans and associated temporary traffic management plans which would be submitted to NZTA and DCC for approval prior to construction works starting.

11 Recommended Mitigation

The following are a list of possible mitigation that could be considered by NZTA and local transport providers beyond those measures which are directly related to the project:

- As the project progresses and changes occur prior to construction, a pre and post construction road safety audit will need to be completed.
- Review of lane markings and traffic signal configuration at Barnes Drive post construction.
- Development of a construction management plan and associated temporary traffic management plans for the construction of the project.
- Active management of traffic during construction and limited disruption to peak time through traffic movements.
- Publicity to encourage awareness of construction and post construction accessibility.
- Signage and information for motorists, cyclists and pedestrians to improve way finding and new access provision.

12 Summary and Conclusions

It is widely recognised and accepted that there are many deficiencies with the existing configuration at Lookout Point and it has been stated on numerous occasions that the state highway bisects and divides suburban communities in the area.

It has also been stated that many motorists use alternative, much longer routes, to travel to parts of the city rather than use the current at-grade intersection at Lookout Point. The current situation is a deterrent to providing a more direct route to access large commercial and retail outlets in the wider South Dunedin area.

The situation is exacerbated by the steep approach gradients and sharp crest curve which severely restricts sight distances and ultimately has a huge impact on safety.

The base option and one of the alternatives includes construction of a grade separated bridge at Lookout Point, while the second alternative involves some turn restrictions at Lookout Point. The base option and both the alternatives also include the addition of a dedicated right turn bay on the eastbound approach to the intersection of Barnes Drive and Caversham Valley Road, and significant improvements to SH1 between Lookout Point and Barnes Drive. The SH1 improvements include a kerbed central median, wider shoulders and a service lane for property access and parking. As a result of feedback during public consultation some enhancements to the base and alternatives are also being considered.

The options considered meet the project objectives while addressing the issues at Lookout Point by providing a safe, direct route between Mornington Road and Riselaw Road for all road users.