Transport
Roads & Maritime
Services

NSW GOVERNMENT

Foxground and Berry bypass

Princes Highway upgrade

Environmental assessment

Volume 2 – Appendix D

Technical paper: Traffic and transport

NOVEMBER 2012

RMS 12.457B
ISBN 978-1-922041-61-6

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Foxground and Berry bypass

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November 2012

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Executive summary

The Roads and Maritime Services (RMS) is seeking approval under Part 3A of the *Environmental Planning and Assessment Act 1979* for the upgrade of 11.6 kilometres of the Princes Highway, to achieve a four lane divided highway (two lanes in each direction) highway with median separation between Toolijooa Road north of Foxground and Schofields Lane, south of Berry (the project). The project would include bypasses of Foxground and Berry.

The project is one of a series of upgrades to sections of the Princes Highway which aims to provide a four lane divided highway between Waterfall and Jervis Bay Road, Falls Creek. This would improve road safety and traffic efficiency, including for freight, on the NSW south coast.

The outcomes of the Foxground and Berry bypass preliminary environmental investigations indicate that traffic and transport is one of the key environmental issues for the project. Key issues are those that may have moderate or high impacts (actual or perceived) and a detailed assessment is necessary to determine the level of potential impacts and to develop appropriate measures to mitigate and manage the impacts. This report details and summarises the Traffic and Transport Assessment undertaken as part of the environmental assessment of the Foxground and Berry bypass.

Existing traffic and transport environment

Between 1990 and 2010, annual average daily traffic (AADT) on the Princes Highway north of Rose Valley Road increased by an average of over 400 vehicles per year; equating to a linear growth rate of around 3.2 per cent per annum. More recently, between 2007 and 2010, daily traffic volumes increased by 2097 vehicles; which equates to an average linear growth rate of around 3.6 per cent per annum.

North of Berry, surveys showed traffic on the Princes Highway to be around 10,150 vehicles per day, with 8700 vehicles using the alternative 'Sandtrack' route. This equates to a 54 per cent / 46 per cent split of traffic using the Princes Highway / 'Sandtrack'. South of Berry, the AADT is 12,575 vehicles on the Princes Highway compared to 6650 using the 'Sandtrack'. At these locations, the bias of traffic is more heavily weighted towards the Princes Highway, with 65 per cent of the total using the highway, compared to 35 per cent using the 'Sandtrack'.

Overall, origin-destination (O-D) surveys indicate that during a typical day, non-stopping through traffic contributes around 80 per cent of total traffic travelling through Berry on the Princes Highway. During the 100th highest hour peak periods (eg holiday periods or morning and afternoon peak periods), traffic volumes are higher and travel patterns vary. As a result, through traffic fluctuates considerably between 50-75 per cent of total traffic.

Local and regional bus and coach services utilise the Princes Highway in the project area, although the number of routes and frequency of services available to the general public are limited.

Existing road network performance

The section of the Princes Highway between Toolijooa Road and Schofields Lane has a poor crash record in comparison to connecting sections of the Princes Highway and other major highways in NSW. Between 1 July 2003 and 30 September 2010 a total of 118 crashes were recorded on the Princes Highway, including three fatal and 61 injury crashes. On the alternative 'Sandtrack' route, five fatal and 81 injury crashes occurred during the same period.

The results of the travel time analysis indicates that the Princes Highway currently has an average travel time of around 14-15 minutes within the project area between Toolijooa Road and Schofields Lane. The equivalent route via the 'Sandtrack' is shorter in length and operates at a higher average speed, taking less than eight minutes on average. Although the 'Sandtrack' is significantly quicker in terms of travel time within the project area, traffic modelling shows that within the traffic impact footprint (between Gerringong and Bomaderry), the routes are comparable in both length and travel time. Between these towns the Princes Highway is around 33.2 kilometres long with a travel time of around 32-33 minutes, while the 'Sandtrack' is around 32.4 kilometres long with a travel time of around 30 minutes.

The Princes Highway both north and south of Berry currently operates with a midblock level of service (LoS) D during typical AM peak and PM peak periods, while the alternative 'Sandtrack' route is currently operating at LoS C for both periods. The analysis indicates that during the 100th highest hour (eg holiday periods or morning and afternoon peak periods), the operational performance of the Princes Highway deteriorates to an unacceptable LoS E at most locations and the 'Sandtrack' operates at LoS D.

Future conditions without the project

Analysis indicates that midblock locations on the Princes Highway in the project area would operate at an unacceptable LoS E or LoS F for all peak periods in the absence of the project, should traffic continue to grow at current rates. This compares to LoS D during AM and PM peak hours and LoS E during 100th peak hours at present.

Paramics modelling shows that as well as significant traffic delays at intersections, traffic queuing back to adjacent intersections may also become an issue, further diminishing the performance of the local road network in Berry. The results of the modelling undertaken illustrate that the performance of local roads and intersections in Berry would deteriorate based on the predicted increase in traffic; if the current road network remains unchanged.

Travel times throughout the project area would increase as the level of traffic and congestion grows on the existing road network. In the west of the project area, intersection delays in Berry would significantly increase, especially during the peak periods.

The forecast growth in traffic on the existing road network within the traffic impact footprint would result in a considerable increase in the total number and cost of crashes occurring. Assuming current crash rates and costs remain constant, the total number and cost of crashes would increase by 78 per cent by the design year of 2037.

Traffic impact assessment - construction

The performance analysis for the worst-case construction scenario indicates that midblock locations on the Princes Highway would operate at LoS E during both the 100th highest hour northbound and southbound scenarios. Average travel speeds on the Princes Highway would be expected to drop to around 50 kilometres per hour or less. Key factors contributing to this deterioration include the expected increase in traffic, speed restrictions, and the prevention of overtaking through construction zones in the project area. The analysis indicates that despite a poor LoS and low travel speeds during peak hours, the Princes Highway does have the capacity to accommodate worst-case traffic volumes during construction.

The results show the roadway LoS on the 'Sandtrack' would remain relatively unchanged despite a reduction in traffic (with traffic expected to transfer to the Princes Highway in the worst-case scenario), operating at LoS C during the 100th highest hour northbound period, and deteriorating to LoS D during the busier 100th highest hour southbound period.

In summary, it can be concluded that due largely to the offline construction of the Berry bypass, the local road network and intersections in Berry would still perform adequately during both the most-likely and worst-case construction scenarios; without the provision of additional temporary traffic management measures.

Traffic impact assessment - operational

On the Princes Highway south of Berry (Victoria Street), the AADT is expected to grow by around 16,000 vehicles between 2017 and 2037. This increase includes a predicted transfer of traffic from the 'Sandtrack' due to improved traffic efficiency, road safety and travel time savings on the upgraded highway.

In 2037, the bypass of Berry would accommodate around 28,000 vehicles per day, which equates to an average annual growth of around 750 vehicles from 2017 and constitutes 86 per cent of the AADT on the highway south of Victoria Street.

The split between the Princes Highway and the 'Sandtrack' traffic is estimated to change from 55 per cent / 45 per cent to the north of Berry (60 per cent / 40 per cent to the south) in 2009 to 84 per cent / 16 per cent in 2037 (87 per cent / 13 per cent to the south), with the majority of traffic switching from the 'Sandtrack' in favour of the Princes Highway by 2037.

The predicted midblock LoS for all highway locations and scenarios falls within the Concept Design Criteria set out for the project, which states that the project must perform at LoS C (represents optimum free flow conditions) or better for the 100th highest hour (holiday peak hour) in its design year of 2037.

Victoria Street currently intersects with the Princes Highway at the southern extent of Berry adjacent to Mark Radium Park; allowing for all turning movements between the two roads. Under the project, various treatments could occur at this intersection, which would change the volume and distribution of traffic on local roads; particularly along and between Victoria Street and Queen Street.

The local road traffic impacts for each Victoria Street option would vary depending on location, with the magnitude varying for each option. However, for all options, the predicted traffic volumes in 2037 would not significantly change the residential nature of the local road network in Berry.

RMS is required to present one option for the purpose of the environmental assessment and has moved forward with Victoria Street closed in the concept design. Nonetheless, RMS is able to deliver any of the Victoria Street design options through the project, and will continue discussions and encourage feedback and submissions through the environmental assessment display period to finalise the design.

Paramics modelling shows that intersection approach roads in Berry, including the two grade-separated interchanges, would operate at LoS A in the 2037 design year and experience negligible congestion or delay; as the bypass of Berry would remove large volumes of through-traffic from the centre of town. In addition, sensitivity analysis shows that a second northbound off-ramp in Berry is not required to accommodate projected traffic volumes and is therefore not being provided as a project design feature.

The project would create a shorter travel time on the Princes Highway than the 'Sandtrack' in the project area in the future, with estimated travel time savings of over seven minutes on the Princes Highway between Toolijooa Road and Schofields Lane. It is estimated that average travel times along the 'Sandtrack' would remain roughly constant at around 7.5 minutes.

Once a central median and safety barriers are installed, local roads and accesses in rural areas would be provided with left turn in and left turn out only facilities. Low daily volumes of traffic, which would previously have turned right from, or into a minor road, would be required to travel to the nearest u-turn facility to make a safe right hand turn to proceed in the desired direction. This would inconvenience some local traffic as it would require additional travel when compared to existing arrangements.

The proposed highway upgrades are expected to significantly improve road safety, along and adjacent to the project. In summary, the project could be expected to significantly reduce the frequency and severity of crashes occurring on the Princes Highway in the project area for existing users. It would also provide an alternative with a higher level of safety than experienced by current users of the 'Sandtrack'. This would both increase the level of road safety for highway users and reduce the cost attributable to crashes that occur across the traffic impact footprint.

Bus travel times would also be improved. The project would enable higher safe travel speeds on the Princes Highway, while intersection delays in Berry would reduce as a result of fewer vehicles travelling through the town. A reduction of traffic on the 'Sandtrack' would also benefit travel times for buses using this alternative route.

Management of impacts - construction

A traffic management plan (TMP) would be prepared as part of the construction environmental management plan. The TMP would be submitted in stages to reflect the progress of work and would include signage requirements (eg temporary speed restrictions, changes to the road environment, traffic management controls deployed); lane allocation and restrictions during periods of online construction (eg linemarking and temporary barriers); traffic control devices such as temporary traffic signals; and a local and regional communications strategy. This would include methods to provide advanced notice of any major or prolonged impacts (eg leaflets and local media), and real-time information regarding current impacts (eg variable message signs and radio traffic news).

Management of impacts - operational

Traffic levels and operational performance would be monitored following construction, particularly during peak periods, to check whether the road network is performing as expected. Traffic monitoring would be undertaken on the Princes Highway and key local roads in Berry including the bypass, on- and off- ramps, Kangaroo Valley Road and Queen Street. Traffic volumes would be assessed against those predicted. The performance of climbing lanes provided by the project would be similarly monitored. A comparison of actual versus modelled performance of the road network in this way would identify any significant differences at an early stage. As a result, revised traffic forecasting would be undertaken and the adjusted traffic predictions would be input to the Paramics modelling to re-assess the future operational performance of the project and plan in advance of any major impacts occurring.

Within Berry changes to the existing road network raised concerns by the community, with the potential to reduce amenity for pedestrians and cyclists. This would include pedestrians and cyclists re-routed from North Street following its severance by the Berry bypass.

Suitable pedestrian and cyclist arrangements are proposed according to relevant guidelines to ensure that safe access would be maintained following construction of the project.

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Glossary of terms and abbreviations

Term	Meaning
100th highest hour	A 100th highest hour of traffic volume is either derived or factored from a year of hourly (ranked 100 of 8760 hours) traffic count data and represents a true period of peak traffic demand; in which to base the operational analysis of the concept design.
100SB	100th highest hour southbound peak period that reflects traffic patterns in the project area recorded on Thursday 21 April 2011 (southbound peak holiday direction).
100NB	100th highest hour northbound peak period that reflects traffic patterns in the project area recorded on Tuesday 26 April 2011 (northbound peak holiday direction).
A	
AM peak period	Unless otherwise stated, this refers to vehicle trips arriving at their destination between 6.31am–9.30am on a weekday.
Arterial roads	The main or trunk roads of the State road network.
AADT	Average annual daily traffic The total volume of traffic passing a roadside observation point over a period of a year, divided by the number of days per year. It is calculated from mechanically obtained axle counts.
ATC	Automatic traffic count (ATC)
B	
Base case	Also known as “Do nothing” case. Used in evaluating projects to compare the cost and benefit of the existing road (the base case) with another or a number of other projects or options.
BBU	Berry to Bomaderry upgrade
C	
Capacity	The nominal maximum number of vehicles that can travel along a road in a given time.
Carriageway	The portion of a roadway used by vehicles including shoulders and ancillary lanes.
Chainage	Any point on a control line selected to provide more detailed information about the cross-section or any other feature mentioned in the drawings. Also known as a station.
Climbing lane	An auxiliary lane, usually on a long upgrade, primarily for the use of slow moving vehicles. Differs from overtaking lanes as linemarking does not initially direct all traffic to the left hand side of the road.
Concept design	Initial functional layout of a road/road system or other infrastructure. Used to facilitate understanding of a project, establish feasibility, and provide a basis for estimating and to determine further investigations needed for detailed design.
CEMP	Construction environmental management plan. A plan used to manage environmental impacts during construction of the project. It is a synthesis of all proposed mitigation, management and monitoring actions, set to a timeline with defined responsibilities and follow up actions.

Term	Meaning
D	
Degree of saturation	The ratio of the traffic volume entering an intersection to the total capacity of the intersection in a specific period.
DEH	Department of Environment and Heritage
Design traffic	The cumulative traffic count expressed in terms of equivalent standard axles, predicted to use a road over the structural design life of the pavement. An hourly volume used to determine the geometric layout of the road which takes into account the variations in volume at various times of the day and the maximum turning volumes at intersections.
Design year	The predicted year in which the design traffic would be reached.
Detour	An alternative route, using existing roads, made available to traffic during temporary closure of a road.
Dir	Direction
Divided road	A road with a separate carriageway for each direction of travel created by placing a physical obstruction (eg central median and safety barrier) between the opposing traffic directions.
Do nothing	No upgrade of the Princes Highway between Gerringong and Bomaderry. This represents the consequence of no action environmental assessment measure.
Do minimum	Construction of only the Gerringong upgrade and Foxground and Berry bypass. This represents the operational impacts environmental assessment measure.
Do something	Construction of the full Gerringong to Bomaderry Princes Highway upgrade. This represents the operational impacts environmental assessment measure.
DPI	NSW Department of Primary Industries
Driveway	A defined area for vehicles to travel between a carriageway and a property adjacent or near to the road.
DGRs	Director-General's requirements. Requirements and specifications for an environmental assessment prepared by the Director-General of the Department of Planning under section 75F of the *Environmental Planning & Assessment Act 1979*.
E	
Environment	All aspects of the surroundings of humans, whether affecting any human as an individual or in his or her social groupings (from EP&A Act).
EP&A Act	*Environmental Planning and Assessment Act 1979*
F	
Footpath	The paved area in a footway.
Footprint	The extent of the impact that a development in plan view makes on the land.
Footway	An area open to the public designated for the movement of pedestrians or has one of its main uses for pedestrians.

Term	Meaning
Foxground bends	The existing section of the Princes Highway between Toolijooa Road and Austral Park Road.
Freeways	Fast, high volume, access controlled roads or large scale that primarily link regional hubs and cities usually with grade separated intersections and without traffic lights.
FBB	Foxground and Berry bypass (the project).
G	
Grade separation	The separation of road, rail or other transport modes, so that crossing movements at intersections are at different levels.
GU	Gerringong upgrade
H	
Haul road	A designated road, often temporary, used for moving materials (often used when new infrastructure is being constructed).
Horizontal and vertical geometry	Winding (horizontal) and undulating (vertical) sections of the existing Princes Highway.
h	Hour
ha	Hectare/s.
HV	Heavy vehicle, which is classified as a Class 3 vehicle (a two axle truck) or larger, in accordance with the Austroads Vehicle Classification System.
I	
Impact	Influence or effect exerted by a project or other activity on the natural, built and community environment.
Interchange	An intersection of two or more roads that typically uses grade separation, and one or more ramps, to permit traffic on at least one carriageway to pass through the junction without directly crossing any other traffic stream.
Intersection at-grade	An intersection where carriageways cross at a common level.
J	
Junction	A place where two or more roads meet.
K	
km/h	Kilometres per hour.
L	
Local road	A road or street used primarily for access to abutting properties.
LGA	Local government area.
LoS	Level of service. A qualitative measure describing operational conditions within a traffic stream and their perception by motorists and/or passengers.
LV	Light vehicle, which is less than five tonnes gross, in accordance with the Austroads Vehicle Classification System.

Term	Meaning
M	
Median	The central reservation which separates carriageways from traffic travelling in the opposite direction.
Midblock	A general location on the Princes Highway or local roads between two intersections.
Mode	A type or method of transport movement – including for the road corridor: cars, buses, bikes and pedestrians.
Modal split	Proportion of the transport task which is carried by the various carriers (ie road, rail, ferry, bike, pedestrian).
MVKT	Million vehicle kilometres travelled.
N	
NB	Northbound.
O	
O-D	Origin-Destination
Overtaking lane	An auxiliary lane provided to allow for slower vehicles to be overtaken. Line marked so that all traffic is initially directed into the left hand lane with the inner lane being used to overtake.
P	
PAMP	Pedestrian Access and Mobility Plan
PM peak period	Unless otherwise stated, this refers to vehicle trips arriving at their destination between 3.01pm–6pm on a weekday.
Project area	The Princes Highway and adjacent area (local land use and road network) between the junctions with Toolijooa Road (north of Foxground) and Schofields Lane (south of Berry).
Private vehicle	Includes all motorised vehicles such as cars, 4WDs, vans, motorbikes, motor scooters, utes and trucks.
Public transport	Includes train, bus (government and private) and ferry (government and private).
Q	
-	-
R	
RMS	NSW Roads and Maritime Services (formerly NSW Roads and Traffic Authority (RTA)).
Road furniture	A general term covering all signs, street lights and protective devices for the control, guidance and safety of traffic and convenience of road users.
Road reserve	A legally defined area of land within which facilities such as roads, footpaths and associated features may be constructed for public travel.
Roadside	The area from the edge of the carriageway to the boundary of the road reserve.
Roundabout	An intersection where all traffic travels in one direction clockwise around a central island.
RTA	NSW Roads and Traffic Authority.

Term	Meaning
S	
Safe intersection sight distances	The minimum sight distance which should be available from vehicles on legs of an intersection.
Safety ramp	A short trafficable spur road usually with a steep upgrade, provided for emergency use by vehicles on steep downgrades.
'Sandtrack'	An alternative route to the winding, hilly section of Princes Highway between Gerringong and Bomaderry (via Fern Street, Crooked River Road, Gerroa Road and Bolong Road).
Shared path	A pathway used for both cyclists and pedestrians, usually located on the side of the road.
Shoulder	The portion of the carriageway beyond the traffic lanes adjacent to and flush with the surface of the pavement.
Side track	A track to take traffic while a road is temporarily closed for construction or maintenance activities.
Sight distance	The distance measured along the carriageway over which objects of defined height are visible to a driver whose eyes are at a specified height above the pavement surface level.
Slip lane	A lane providing for left turning vehicles allowing them to avoid stopping at an intersection.
s	Seconds.
SB	Southbound.
T	
Tie-in	Location where an existing road (Princes Highway) joins with a new road (Berry bypass).
TMP	Traffic Management Plan
Traffic impact footprint	The regional and local road network between Gerringong and Bomaderry bounded by the Princes Highway and 'Sandtrack' routes.
U	
Underpass	A grade separation where the subject carriageway passes under an intersecting carriageway (or railway). A tunnel constructed for the use of pedestrians, cyclists, fauna and/or stock under the carriageway.
Urban design	The process and product of designing human settlements, and their supporting infrastructure, in urban and rural environments.
V	
Veh	Vehicle.
Veh/h	Vehicle per hour.
VKT	Vehicle kilometres travelled.
W, X, Y, Z	

1 Introduction

1.1 Background

1.1.1 Project overview

The Roads and Maritime Services (RMS) is seeking approval under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for the upgrade of 11.6 kilometres of the Princes Highway, to achieve a four lane divided highway (two lanes in each direction) highway with median separation between Toolijooa Road north of Foxground and Schofields Lane, south of Berry (the project). The project would include bypasses of Foxground and Berry.

The project is one of a series of upgrades to sections of the Princes Highway which aims to provide a four lane divided highway between Waterfall and Jervis Bay Road, Falls Creek. This would improve road safety and traffic efficiency, including for freight, on the NSW south coast.

Further details on the project description and objectives are included in Chapter 6.

1.2 Director-General's requirements – traffic and transport

The outcomes of the Foxground and Berry bypass preliminary environmental investigations indicate that traffic and transport is one of the key environmental issues for the project. Key issues are those that may have moderate or high impacts (actual or perceived) and a detailed assessment is necessary to determine the level of potential impacts and to develop appropriate measures to mitigate and manage the impacts.

For each key issue, the Department of Planning and Infrastructure has issued a list of Director-General requirements (DGRs) that inform the environmental assessment. **Table 1.1** displays the DGRs that are specific to traffic and transport; and also provides a cross reference to the relevant section(s) of this report which address these requirements.

In addition, four agency letters, which accompany the DGRs, were issued by Shoalhaven City Council, Kiama Municipal Council, Office of Environment and Heritage (OEH, formerly the Department of Environment, Climate Change and Water (DECCW)) and Department of Primary Industries (DPI, formerly Industry and Investment NSW). Specifically, the Shoalhaven City Council letter included a request to justify the proposed access arrangements to Berry from the Princes Highway northbound, which has been addressed in Section 7.2.2 of this report.

Table 1.1: Traffic and transport DGR checklist

Director-General's Requirements (DGRs)	Section addressed
Key issues (General requirements)	
The EA must include an **assessment of the key issues**, including an assessment of the **worst case and representative impact** for each issue for all aspects of the project (**including the proposed locations of and/or options** for the **ancillary facilities**) with the following aspects addressed for **each key issue** (where relevant):	
• Describe the existing environment.	Chapter 2 Chapter 3
• Assess the potential impacts of the proposal including: – At the construction stage. – At the operation stage. – In accordance with relevant policies and guidelines. – Consider direct impacts including potential interactions with the existing Princes Highway (as relevant). – Consider indirect impacts including potential interactions with the existing Princes Highway (as relevant).	Chapter 7
• Identify how relevant planning, land use and development matters, (including relevant strategic and statutory matters), have been considered in the impact assessment and/or in developing management/mitigation measures.	Chapter 4
• Describe measures to be implemented to avoid, minimise, manage, mitigate, offset and / or monitor the impacts of the project and the residual impacts.	Chapter 8
Traffic and transport	
Addresses the relevant general requirements for key issues (above).	
The EA must include an assessment of **construction traffic** impacts, including but not limited to:	
• Identification of construction routes and the nature of existing traffic on these routes.	Section 7.1.2
• Quantification of traffic volumes, including: – Spoil haulage. – Other.	Section 7.1.2
• Potential impacts to regional and local road network, including: – Safety. – Level of service. – Other.	Section 7.1.3 Section 7.1.4 Section 7.1.5
• Potential disruption to existing: – Public transport services. – Access/service lanes to local properties.	Section 7.1.3

Director-General's Requirements (DGRs)	Section addressed
The EA must include an assessment of **operational traffic and transport** impacts to the **local and regional road network** including but not limited to:	
• Changes to access arrangements / service lanes to local properties.	Section 7.2.5
• Changes to local road connectivity and access.	Section 7.2.2 Section 7.2.5 Section 7.2.6
• Assessment of impacts (including direct impacts from the replacement of the existing highway that currently passes through Berry) on: – Local traffic arrangements. – Local road capacity. – Safety from traffic rerouting. – Modified access to the upgraded highway.	Section 7.2
• The assessment must take into account: – Potential interactions with local traffic associated with the residential sub-division at Huntingdale Park, Berry (including future growth). – Any severance impacts on local connectivity within Berry as a result of the proposed route.	Section 7.2.2 Section 7.2.5 Section 7.2.6
• Consideration must be given to potential impacts of changed traffic arrangements on: – Local and / or school bus services. – Access for emergency services. – Garbage truck routes.	Section 7.2.6 Section 7.2.8 Section 7.2.9
• Traffic capacity of the proposal and its ability to cater for predicted growth.	Section 7.2.1 Section 7.2.2
• What effect potential major land use changes in the locality may have on the traffic assessment outcomes.	Chapter 4 Section 7.2
• Opportunity for the provision of cycle way connections along the highway and to adjoining communities.	Section 7.2.9 Section 8.2

1.3 Objectives of the traffic and transport assessment

The objective of this traffic and transport assessment is to address the DGRs by reporting existing and future conditions in terms of:

- Traffic volumes for the Princes Highway between the junctions with Toolijooa Road (north of Foxground) and Schofields Lane (south of Berry), including the predicted transfer of traffic to the project from the alternative 'Sandtrack' route. In addition, future traffic volumes would also be reported for key local roads in the project area, including the predicted reduction in traffic volumes on Queen Street due to the Berry bypass.
- Level of service (LoS) at key intersections, interchanges and roadway locations.
- Construction impacts, including the potential impacts on the road network between Gerringong and Bomaderry. These impacts include the effects of traffic diverting along the 'Sandtrack' route to avoid the construction zone.
- Operational impacts of the project on road users including motorists, public transport, freight, pedestrians and cyclists; on the local (within Berry) and regional (Princes Highway) road networks.
- Travel speeds and travel time analysis.
- Road safety analysis.

More specifically, the assessment includes the following objectives:

- Develop detailed strategic and microsimulation traffic models encompassing the project and the local and regional road networks.
- Assess the construction traffic impacts including route identification, number, frequency and size of construction related vehicles, the nature of existing traffic, and the need to close, divert or otherwise reconfigure elements of the road network associated with construction of the project.
- Determine the operational traffic impacts including an assessment of existing local and regional traffic volumes and traffic patterns against forecast volumes and potential changes to traffic patterns associated with the project and public transport impacts.
- Recommend traffic and transport mitigation measures.

1.4 Structure of the report

This report has been structured into the following chapters:

- Chapter 2 provides an overview of the existing traffic and transport conditions, including a description of the route, details of public transport frequency and patronage, a review of walking and cycling routes and a summary of daily and peak period traffic patterns.
- Chapter 3 includes a summary of the operational performance of the existing Princes Highway in terms of midblock and intersection level of service, travel time analysis and a review of historical crash data.
- Chapter 4 documents the traffic modelling methodology which has been adopted to predict future traffic volumes for the project and key local roads in the traffic impact footprint.
- Chapter 5 provides details of the traffic impact assessment that was undertaken to determine the operational performance of the Princes Highway without the upgrade, which is referred to as the consequence of no action 'Do nothing' option.
- Chapter 6 includes an overview of the project concept design.
- Chapter 7 of this report provides details of the operational impact assessment that was completed for both construction and operational staging scenarios.
- Chapter 8 includes management measures that have been developed to mitigate the impacts of the traffic and transport issues.

2 Existing traffic and transport environment

This chapter outlines the existing traffic and transport environment within the traffic impact footprint. All data presented in this chapter represents the base or existing conditions and is based on the latest publicly available information or was specifically sourced for the project between 2009 and 2011.

2.1 Route description

The Princes Highway is the main north-south regional road corridor between Sydney, the Illawarra and through the south coast of NSW to Victoria. It is an important corridor for the following purposes:

- Commuter route between Sydney, Wollongong and Nowra.
- Local route for residents of surrounding smaller towns and rural residences.
- Major tourist route for key destinations including Gerringong, Berry, Nowra and the south coast, resulting in high volumes of peak period traffic on weekends and holiday periods.
- Important freight and bus route, particularly for the south coast and far south coast where there are no rail services.

In the project area the Princes Highway is a road of both local and regional importance. It provides the primary route for regional traffic travelling to, from, or through the project area. It also serves as a key route for traffic travelling on the local road network within Berry, and between Berry and surrounding towns and residences. Outside Berry, the highway intersects with key local roads including Toolijooa Road, Foxground Road, Austral Park Road, and Tindalls Lane.

Within Berry the highway intersects with Kangaroo Valley Road, Tannery Road, and Prince Alfred Street, which provide access to both local residences and wider regional destinations. In the town, the highway also intersects with numerous other local roads such as Victoria Street, Alexandra Street and Albert Street, providing access to residences, businesses, and other local areas and facilities.

In the wider traffic impact footprint, the 'Sandtrack' fulfils a similar role to the Princes Highway as a road of both local and regional importance. This route is commonly used by regional traffic to bypass the project area to the north; it also intersects with numerous local roads and therefore provides a key element of the road network to local residents and businesses within the traffic impact footprint.

The project would involve widening and realigning of 11.6 kilometres of the Princes Highway between the junctions with Toolijooa Road (north of Foxground) and Schofields Lane (south of Berry); located within the Kiama and Shoalhaven local government areas (LGAs).

Figure 2.1 highlights the 'project area' and also shows key roads that encompass the 'traffic impact footprint' between Gerringong and Bomaderry.

The existing highway is a two lane single carriageway and the horizontal and vertical geometry requires upgrading to meet current design safety and traffic efficiency requirements; particularly in the winding and undulating sections near Toolijooa Ridge and through the 'Foxground bends' and Broughton Village. The highway has two short overtaking lanes for southbound traffic only, several junctions with local rural roads and many uncontrolled private accesses. The Princes Highway passes through Berry and becomes Queen Street from about Tannery Road to Kangaroo Valley Road. This results in highway traffic, including heavy vehicles, travelling through the town centre.

Figure 2.1: Project area and traffic impact footprint

(Source: AECOM)

Currently, the Princes Highway has various posted speed limits between Toolijooa Road and Schofields Lane ranging from 80 kilometres per hour on the section north of the Broughton Creek crossing, then 90 kilometres per hour to the northern edge of Berry, reducing to 50 kilometres per hour through the town and increasing to 100 kilometres per hour on the southern section south of Berry.

Existing major heavy vehicle rest areas on the Princes Highway within and surrounding the project area are limited. In the southbound direction, the north Kiama (Nungarry) rest area has recently been upgraded to provide parking for 7 heavy vehicles and associated facilities; and is located around 15 kilometres north of the project area. In the northbound direction, the Clive Bissell rest area provides the closest major facilities to the north, at around 50 kilometres from the project area. The Bewong rest area provides facilities for northbound traffic around 50 kilometres south of the project area. The RMS Strategy for Major Heavy Vehicle Rest Areas on Key Rural Freight Routes in NSW indicates that both the Clive Bissell and Bewong rest areas require upgrading to fill a gap in rest area facilities on the Princes Highway.

Figure 2.1 also shows the 'Sandtrack', which is an alternative route for light vehicles between Gerringong and Bomaderry via Fern Street, Crooked River Road, Gerroa Road and Bolong Road; enabling motorists to avoid the winding, hilly sections of the Princes Highway between these two towns. As a consequence, many private vehicles use this route to avoid delays behind slow moving heavy vehicles (which are prevented from using the 'Sandtrack' by a five tonne load limit). The 'Sandtrack' is slightly shorter than the highway and has a posted speed limit of 90 kilometres per hour or 100 kilometres per hour for much of its length between Gerringong and Bomaderry.

2.2 Modes of travel

2.2.1 Private vehicles

Berry is about a two and a half hour drive from Sydney and typically it takes an additional 15 minutes to drive further south to Bomaderry. The town is located about half way between Gerringong and Bomaderry, with Foxground and Broughton Village roughly half way between Gerringong and Berry. Private vehicles are the predominant mode of transport in the project area, which is reflected by higher than average vehicle ownership in the Kiama and Shoalhaven LGAs. The average vehicle ownership per household in Kiama and Shoalhaven is 1.73 and 1.69 respectively, compared to an average of 1.47 in the Sydney greater metropolitan area.

The *NSW Transport Data Centre, 2007 Household Travel Survey Summary Report, 2009 Release* provides details of the mode share of average weekday travel demand made from each LGA in NSW. Travel mode shares for the Kiama and Shoalhaven LGAs in comparison to the Sydney greater metropolitan area are shown in **Table 2.1**.

Findings from the household travel survey show that around 85 per cent of total trips on a typical weekday made in Kiama and Shoalhaven are car-based, compared to an average of 72 per cent in the Sydney greater metropolitan area.

Table 2.1: Average weekday travel mode share for Kiama/Shoalhaven LGAs (2007)

Local government area	Private vehicle			Rail passenger	Bus passenger	Walk only	Other modes
	Driver	Passenger	Total				
Kiama	59 %	24 %	83 %	1 %	4 %	9 %	3 %
Shoalhaven	59 %	27 %	86 %	1 %	2 %	10 %	1 %
Sydney greater metropolitan area	50 %	22 %	72 %	4 %	5 %	17 %	2 %

(Source: NSW Transport Data Centre - 2007 Household Travel Survey Summary Report, 2009 Release)

2.3 Public transport services

2.3.1 Bus services

Although the project area is serviced by bus routes the frequency of services is limited, resulting in a low bus passenger mode share when compared to other forms of travel. **Table 2.1** shows that bus passengers represent between two per cent and four per cent of the mode share of average weekday travel demand generated from the Shoalhaven and Kiama LGAs respectively.

Local and regional bus and coach services utilise the Princes Highway in the project area. School services transporting students between Gerringong, Berry and Bomaderry frequent the route during term time, although patronage figures provided by local bus operators indicate that only around 20 students typically use these services on a daily basis.

Premier Motor Service provides two daily bus services in each direction between Sydney and Melbourne via Kiama, Gerringong and Nowra using the Princes Highway in the project area. This is a service typically used by passengers travelling long distances/interstate, rather than a service for local residents. Premier Motor Service also provides a school service between Bomaderry and Toolijooa Road along the Princes Highway in the project area.

Private operator Shoal Bus offers services to and through Berry, as shown in **Figure 2.2**. Service 705 extends from Werri Beach in the north east of Gerringong to Berry via the 'Sandtrack' and Beach Road; and then on to Bomaderry and Nowra via the Princes Highway. Shoal Bus users can change services at Berry and Bomaderry to access other areas further south. For instance, the service from Shoalhaven Heads to Berry (SB), or service 735 from Bomaderry/Nowra to travel further south towards St Georges Basin.

Shoal Bus service 705 operates a minimum of two services per day on weekdays, although an additional two 'Shoal Shopper' services operate on Tuesday and Friday, bringing the total services on these days to four. The timetable for this service depends primarily on school holiday schedules, although there is a minimum of one morning and one afternoon service. Two services operate between Berry and Nowra on the weekend with one service in the morning and another in the afternoon.

The primary stops for service 705 are located in Gerringong, Berry and Nowra, with additional stops for all stop routes at Werri Beach, Gerroa and Shoalhaven Hospital. The express service travelling between Gerringong and Nowra typically takes between 30 and 45 minutes, while all stop services can take in excess of one hour.

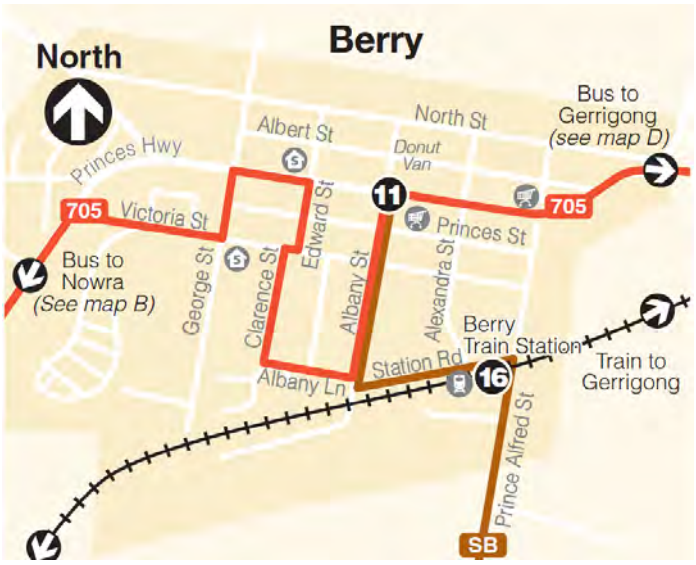


Figure 2.2: Shoal Bus scheduled service routes to Berry

(Source: www.shoalbus.com.au)

Several school-specific buses and coaches also use the Princes Highway and local roads in the project area. Shoal Bus school service SB operates between Berry and Shoalhaven Heads via Prince Alfred Street and Coolangatta Road. Two services operate on a typical weekday with one service operating in the morning and the other in the afternoon. Only one service is provided on Saturday, with no service on Sundays or Public Holidays. The primary stops for service SB are located in Berry at the 'Donut Van' via Albany Street, Berry Train Station and Shoalhaven Heads (Heads Bowling Club). On a typical weekday, the travel time between Berry and Shoalhaven Heads is about 30 minutes in the morning and 15 minutes in the afternoon.

In addition, Shoal Bus operates two weekday school-specific services which travel from the locality of Gerringong to Nowra and Bomaderry through the project area during the morning pick-up and afternoon drop-off periods. One service operates from Gerringong, travelling down the 'Sandtrack' (Gerroa Road), before heading across from the 'Sandtrack' to Berry via Beach Road; and then further south to Bomaderry via the Princes Highway. The other service commences in the Foxground area and travels south along the Princes Highway through Berry and on to Nowra. This service has informal pick-up and drop-off locations, stopping at property accesses in rural areas along the Princes Highway where children reside, as well as at numerous intersections between the Princes Highway and local roads in the project area.

2.3.2 Rail services

Table 2.1 shows that rail passengers represent one per cent of average weekday travel mode share in the project area, partly due to the south coast line terminating at Bomaderry, north of the Shoalhaven River. The south coast rail line links Sydney, Wollongong and North Nowra/Bomaderry. There is a station serving the project area located in Berry. North Nowra/Bomaderry Station is located to the south of Berry, while Gerringong is the nearest station to the north. As there are no direct services from Berry to Sydney, passengers are required to change trains at Wollongong, Dapto or Kiama.

There are 18 services in each direction stopping at Berry during weekdays, with 14 services in each direction during the weekends. Services operate about once every hour during morning and afternoon peak hours through the week. There are train services every two hours during the inter-peak period between 9.30am–3pm.

Indicative travel times for rail services between the project area and surrounding areas are shown in **Table 2.2**. Rail travel between Bomaderry and Berry, and Gerringong and Berry takes about 10 minutes. Rail travel between Berry and Wollongong takes around 70 minutes, while travel between Wollongong and Sydney takes between 90 and 105 minutes.

Table 2.2: Rail travel times to / from project area (Berry) and surrounding areas

Approximate travel time (minutes)		To				
		Berry	Bomaderry (Nowra)	Gerringong	Wollongong	Sydney
From	Berry	-	10	10	70	>160
	Bomaderry (Nowra)	10	-	20	80	>170
	Gerringong	10	20	-	60	>150
	Wollongong	70	80	60	-	>90
	Sydney	>160	>170	>150	>90	-

(Source: CityRail South Coast Line Train Timetables, (RailCorp, September 2011))

RailCorp publishes annual NSW station entry and exit statistics. The latest data was released in 2010 and is contained in *A Compendium of CityRail Travel Statistics, Sixth Edition, June 2010*.

Table 2.3 displays the 2009 average weekday station entries and exits between 6am–6.30pm and also the total passenger throughput over the corresponding 24 hour period. All three stations at Gerringong, Berry and Bomaderry show a similar tidal profile; in that the majority of passengers depart from the station in the AM peak and arrive back at the station during the PM peak. The table also shows that daily and peak period passenger demand at these stations is low, particularly at Gerringong and Berry which have only 70 entries and exits on a typical 24 hour period.

Table 2.3: 2009 average weekday station entries and exits

Train station	AM peak 6am–9.30am		Inter peak 9.30am–3pm		PM peak 3pm–6.30pm		24 hours	
	In	Out	In	Out	In	Out	In	Out
Bomaderry (Nowra)	140	30	80	100	80	140	340	340
Berry	30	10	10	20	20	30	70	70
Gerringong	40	0	10	20	10	40	70	70
Wollongong	680	540	620	570	760	700	2320	2320

(Source: A compendium of CityRail Travel Statistics, Sixth Edition (RailCorp, June 2010))

2.3.3 Walking and cycling

External to Berry, there are no footways along the Princes Highway within the project area and very few pedestrians travel along this route. Shoulders and verges provide a means for pedestrians to travel along the Princes Highway; however the speed of traffic on this route combined with significant travel distances to nearby towns (eg Gerringong and Berry) result in very low pedestrian flows.

Footways are provided in Berry between Woodhill Mountain Road and Kangaroo Valley Road to service local shops and businesses on Queen Street. Residential streets in the town have either one-sided, partial or no footways.

The results of pedestrian crossing surveys of Queen Street (Princes Highway) in the main commercial precinct of Berry, between Alexandra Street and Prince Alfred Street, are shown in **Table 2.4**. In addition the results of pedestrian demand surveys undertaken on Friday 1 June and Saturday 2 June 2012 are also shown. The latter surveys were undertaken on North Street, at the intersection with Rawlings Lane, and Kangaroo Valley Road, at the intersection with Huntingdale Park Road. These locations were surveyed as during consultation the community identified these routes as particularly significant pedestrian connections within the town.

Table 2.4: Pedestrian and cyclist survey results – Berry

Location	Approach	Total pedestrian and cyclist demand			
		Fri 2 June 2012: 7am-10am	**Fri 2 June 2012: 2pm-5pm**	**Sat 2 June 2012: 10am-2pm**	**Sun 14 Aug 2002: 11am-3pm**
North Street | Rawlings Lane | George Street Intersection	North Street westbound	7	8	8	-
	George Street	1	1	2	-
	North Street eastbound	7	7	10	-
	Rawlings Lane	1	0	2	-
	Total	**16**	**16**	**22**	**-**
Kangaroo Valley Road | Huntingdale Park Road Intersection	Kangaroo Valley Road westbound	5	24	4	-
	Huntingdale Park Road	4	6	3	-
	Kangaroo Valley Road eastbound	11	8	3	-
	Total	**20**	**38**	**10**	**-**
Queen Street between Alexandra Street and Prince Alfred Street	**Total – Queen Street crossings**	**-**	**-**	**-**	**3953**

(Source: AECOM, June 2012; AECOM, based on RMS Southern Region Traffic Survey Data, Aug 2002)

The results of these surveys show substantial pedestrian activity in the vicinity of Queen Street between Alexandra Street and Prince Alfred Street, with demand generated by the commercial development in this area. Pedestrian volumes on North Street and Kangaroo Valley Road are significantly lower, with these routes providing connections for pedestrian and cyclist movements over longer distances to and from residential areas to the north and west of the town.

There are no formal cycle specific facilities in Berry, but Shoalhaven Council does promote various cycle routes to and from Berry utilising the Princes Highway and other local and regional roads (for example Berry to Seven Mile Beach via the Princes Highway, Tannery Road and Beach Road, and Berry to Kangaroo Valley via Berry Mountain).

A proposed 1400 kilometre coastal cycleway stretching from the Queensland border, through NSW to the Victorian border includes a section within the study area that follows the route of the 'Sandtrack'. This connects to the Berry to Seven Mile Beach route described above. The purpose of the cycleway program is to deliver more sustainable transport choices, increase tourism, provide better coastal recreation access and grow bicycle-tourism industries. It is largely funded by RMS and implemented by local government, and has already resulted in over 330 kilometres of the route being constructed, or committed to, in the form of shared pedestrian/cycle paths or on-road cycle lanes along local streets. There are opportunities for Shoalhaven and Kiama Councils to apply for grants to improve the route for cyclists.

In the surrounding area, an off-road cycle route linking Gerringong and Gerroa along Fern Street was completed in 2000 and a six kilometre walking track between Kiama and Gerringong along the coast was opened in October 2009.

2.4 Existing traffic volumes and patterns

2.4.1 Introduction

This section provides details of vehicular traffic flows that have been recorded within the traffic impact footprint. In addition to annual average daily traffic (AADT), average AM peak, PM peak and 100th highest hour traffic volumes are reported to show the fluctuation in traffic demand for different time period scenarios.

As the Princes Highway (in the project area) is in a rural area and is a major route for tourism with significant peak period traffic during school holidays, it is not necessarily appropriate to focus the analysis of existing conditions on typical weekday morning and evening peak periods. Therefore, further analysis was carried out to identify the true periods of peak demand and found that these usually occurred on the first evening of a holiday period southbound and the last afternoon of a holiday period northbound during a Public Holiday weekend or other holiday period.

Since it is not economical to design to a level of operational road capacity that is required only for a few hours per year, a design hour must be selected upon which to base design analysis. The design hour is usually chosen between the 30th and 100th highest hour of the year, with the 100th highest hour selected to assess carriageway and access operational performance measures for the project.

Historic data recorded at locations within the traffic impact footprint shows that traffic volumes typically reach 100th highest hour levels during the Easter period. Therefore in order to quantify the magnitude and change in traffic patterns associated with 100th highest hour volumes, traffic surveys were undertaken during the Easter and Anzac Day 2011 public holiday weekend (Thursday 21 April – Tuesday 26 April 2011) at two locations on the Princes Highway to the north and south of Berry.

Analysis of the survey data showed that the traffic volumes peaked in the southbound direction on the Thursday evening (preceding Good Friday) and then in the northbound direction on the Tuesday afternoon (ANZAC day). Traffic volumes recorded during the southbound peak period represented 12.6 per cent of the AADT and 11.6 per cent of the AADT in the northbound direction; compared to around seven per cent and nine per cent of the AADT during the AM peak and PM peak respectively. Due to the significant directional variations of peak holiday traffic demand in the traffic impact footprint, it was determined that existing and future conditions of the highway would be assessed for two 100th highest hour peak scenarios.

Therefore the following time periods have been selected to report existing traffic flows within the traffic impact footprint:

- Annual Average Daily Traffic (AADT).
- Average one hour AM peak (7am–11am).
- Average one hour PM peak (3pm–7pm).
- 100th highest single hour (100th highest hour) traffic volumes, which have been reported for two sub-scenarios:
  - 100SB: 100th highest hour southbound peak period that reflects traffic patterns in the project area recorded on Thursday 21 April 2011 (southbound peak holiday direction).
  - 100NB: 100th highest hour northbound peak period that reflects traffic patterns in the project area recorded on Tuesday 26 April 2011 (northbound peak holiday direction).

2.4.2 Annual traffic growth

Table 2.5 shows AADT and linear growth rates recorded at RMS' permanent automatic traffic count (ATC) site 7.800 on the Princes Highway north of Rose Valley Road. Between 1990 and 2010, AADT on the highway increased by an average of over 400 vehicles per year; equating to a linear growth rate of around 3.2 per cent per annum. More recently, between 2007 and 2010, daily traffic volumes increased by 2097 vehicles; which equates to an average linear growth rate of around 3.6 per cent per annum.

Table 2.5: AADT traffic growth summary (1990–2010)

Location:	**Site 7.800: Princes Highway, north of Rose Valley Road**		
Year	**AADT**	**Growth rate**	
		Period	**Average annual growth (%)**
1990	12,944	-	-
1994	14,791	1990 – 1994	3.6%
1997	15,711	1994 – 1997	2.1%
2000	17,753	1997 – 2000	4.3%
2002	18,960	2000 – 2002	3.4%
2004	19,371	2002 – 2004	1.1%
2006	18,731	2004 – 2006	-1.7%
2008	19,675	2006 – 2008	2.5%
2010	21,300	2008 - 2010	4.1%
-	**-**	**1990 - 2010**	**3.2%**

(Source: AECOM, based on RMS Southern Region Traffic Survey Data)

Although this location is north of the project, it is indicative of the continuous level of traffic growth on the Princes Highway corridor through the project area.

2.4.3 Seasonal variation in traffic volumes

The RMS' permanent ATC site 7.800 has also been used to perform seasonal traffic variation analysis. The changes in annual traffic volumes over two historical years (2009-2010) are shown in **Figure 2.3.**

Figure 2.3. shows that traffic flows are highest during major holiday periods, including the school holidays at Christmas, Easter, and Labour Day in October. Traffic volumes peak to over 26,000 vehicles per day during the Christmas holidays, which equates to around 20 per cent more vehicles in comparison to the AADT at this location.

Seasonality factors have been used to scale surveyed traffic volumes in order to estimate annual traffic volumes from temporary traffic surveys. The objective is to factor the average daily traffic (ADT) flow from a given survey period to the annual average daily traffic (AADT) flow for the corresponding year, resulting in a seasonality factor. A seasonality factor of 1.126 has been calculated to convert the May/June 2009 survey data and 1.138 to convert April/May 2011 survey data; to reflect the AADT for each year.

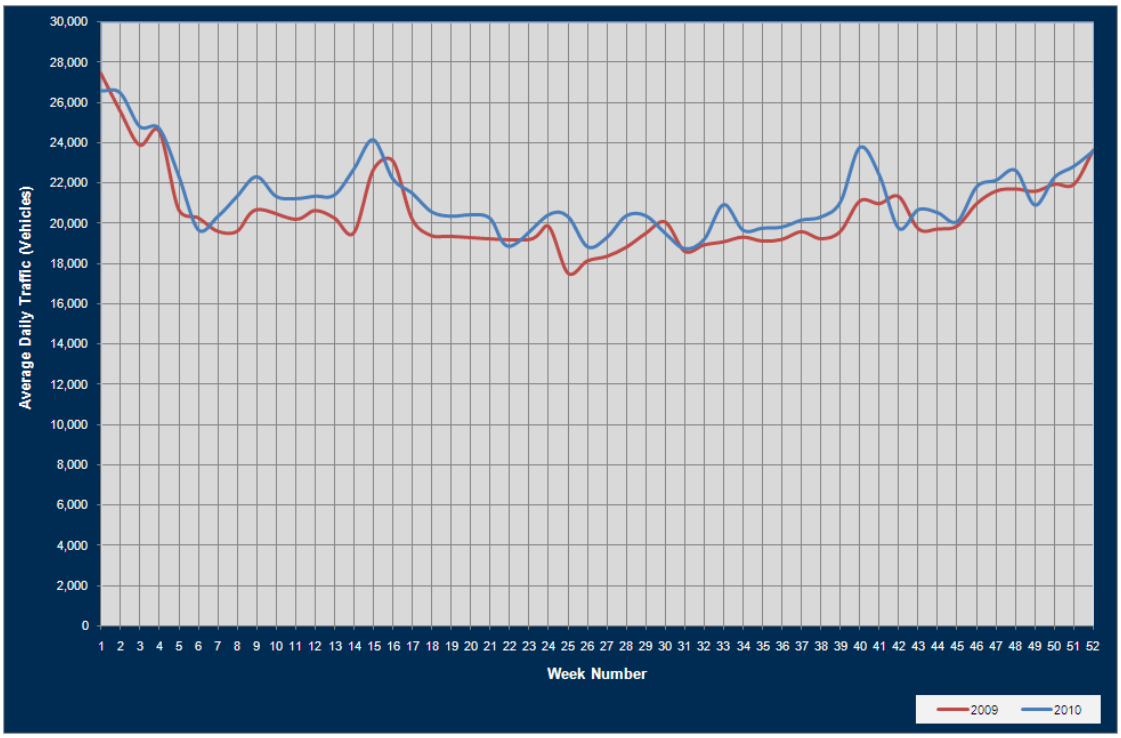


Figure 2.3: Seasonal variations in average daily traffic (2009-2010)

(Source: AECOM, based on RMS Southern Region Traffic Survey Data)

2.4.4 Daily and peak period traffic volumes

RMS commissioned traffic surveys in May/June 2009 and April/May 2011 to measure traffic volumes at other key locations on the Princes Highway and the adjacent 'Sandtrack' route in the traffic impact footprint.

A series of ATC tubes were located on the Princes Highway north of Tannery Road and south of Victoria Street and on the 'Sandtrack' south of Belinda Street and south of the Beach Road intersection, as shown in **Figure 2.4**. A summary of the average peak and daily traffic volumes (seasonally adjusted) are displayed in **Table 2.6**.

Table 2.6 shows that the highest daily volume of traffic in the traffic impact footprint is on the Princes Highway north of Rose Valley Road with an AADT of 21,300 vehicles. South of Gerringong, the combined AADT on the Princes Highway (north of Tannery Road) and on the 'Sandtrack' (south of Belinda Street) is 18,850 vehicles suggesting a net loss of traffic of around 2450 vehicles to Gerringong and villages adjacent to the highway between Gerringong and Berry, via local roads and accesses.

North of Berry, surveys showed traffic on the Princes Highway to be around 10,150 vehicles per day, with 8700 vehicles using the alternative 'Sandtrack' route. This equates to a 54 per cent / 46 per cent split of traffic using the Princes Highway / 'Sandtrack'. South of Berry, the AADT is 12,575 vehicles on the Princes Highway compared to 6650 using the 'Sandtrack'. At these locations, the bias of traffic is more heavily weighted towards the Princes Highway, with 65 per cent of the total, compared to 35 per cent using the 'Sandtrack'.

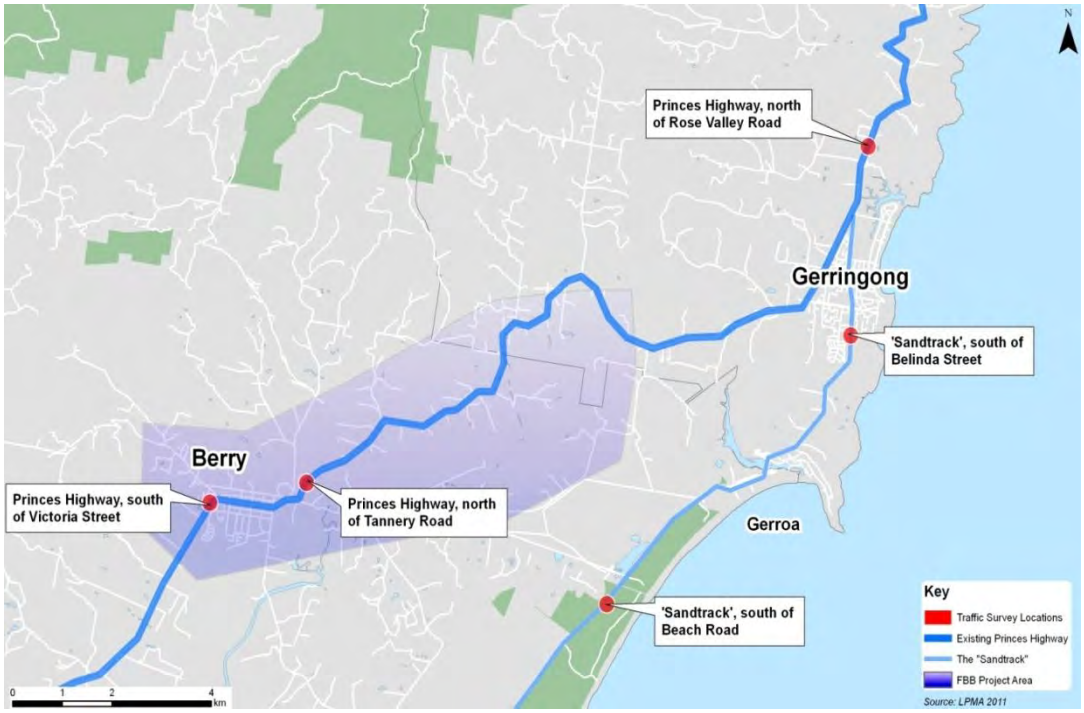


Figure 2.4: Traffic survey locations
(Source: AECOM)

The higher traffic volumes on the Princes Highway to the south of Berry compared to the north indicates that a higher proportion of traffic arriving or departing from Berry travels to or from the south of the town. The volumes also highlight the difference in heavy vehicle traffic between the two competing routes. Heavy vehicles constitute eight per cent of the AADT on the Princes Highway north of Gerringong, increasing to around 12 per cent and 13 per cent to the south and north of Berry respectively. In comparison, heavy vehicles on the 'Sandtrack' represent between three and four per cent of the AADT along the length of this alternative route due to the five tonne vehicle load limit in place.

The 100th highest hour factors of 12.6 per cent and 11.6 per cent recorded on the Princes Highway north and south of Berry were applied to the AADT for the other count locations to synthesise respective 100 northbound (NB) hour and 100 southbound (SB) hour traffic flows for the two 'Sandtrack' locations and the Princes Highway north of Rose Valley Road. The resultant traffic volumes are provided in **Table 2.6**, showing that each location has a substantial increase in 100th highest hour traffic volumes when compared to the corresponding AM peak and PM peak periods.

Table 2.6: Daily and peak period traffic volume summary (2009-2011)

Location	Year	Two-way traffic flows					
		AM peak (veh/h)	PM peak (veh/h)	100NB* peak (veh/h)	100SB* peak (veh/h)	AADT	
						Flow (veh/day)	% heavy veh
Princes Highway, north of Rose Valley Road	2010	1525	1800	2470	2680	21,300	8 %
Princes Highway, north of Tannery Road	2011	730	875	1185	1275	10,755	13 %
Princes Highway, south of Victoria Street	2011	930	1090	1250	1475	13,400	12 %
'Sandtrack', south of Belinda Street	2009	620	760	1010	1100	8700	3 %
'Sandtrack', south of Beach Road	2009	450	590	770	840	6650	4 %
Victoria Street, east of Princes Highway	2012	215	190	170	245	2170	4%
Kangaroo Valley Road, north of North Street	2011	115	140	155	140	1485	5%
Tannery Road, east of Pulman Street	2011	130	165	125	95	1680	5%
Prince Alfred Street, south of Queen Street	2011	-	-	155	220	-	-
Woodhill Mt. Road, north of North Street	2011	80	100	90	110	970	6%

NB – northbound, SB - Southbound
(Source: AECOM, based on RMS Southern Region Traffic Survey Data)

Surveys were also conducted on other roads of regional and local significance within the project area, with the results included in **Table 2.6**. ATC tube surveys undertaken during 2011 and 2012 were used to capture AM peak, PM peak and AADT traffic volumes on Victoria Street, Kangaroo Valley Road, Tannery Road, and Woodhill Mountain Road; these surveys augmented the 100NB and 100SB hour volumes captured during the Easter 2011 origin-destination (O-D) surveys.

Kangaroo Valley Road, Tannery Road and Prince Alfred Street provide both local and regional connectivity within and around the project area. The results in **Table 2.6** indicate that both local and regional traffic demand using these routes is low when compared to the Princes Highway and the 'Sandtrack'. As an example, the recorded AADT of 1485 on Kangaroo Valley Road is equivalent to around 12 per cent of the 13,400 daily vehicles recorded on the intersecting section of the Princes Highway. Although these roads provide important links for residents and businesses within and surrounding the project area, they are only used by a small proportion of vehicles travelling to, from, and within the project area.

2.4.5 Weekday and daily traffic profiles

The 2010 average weekly directional and combined traffic profiles recorded at RMS' permanent ATC site 7.800 are shown in **Figure 2.5**. The profile clearly shows a significant increase in southbound traffic on Friday afternoons and Saturday mornings, and an increase in northbound traffic on Sunday afternoons. This illustrates the significant amount of recreational travel present in the area, with many road users making weekend trips to the south coast of NSW from Sydney and Wollongong.
As a result, the probability of congestion and delays is typically higher during weekend peak hours than AM peak and PM peak hours through the week.

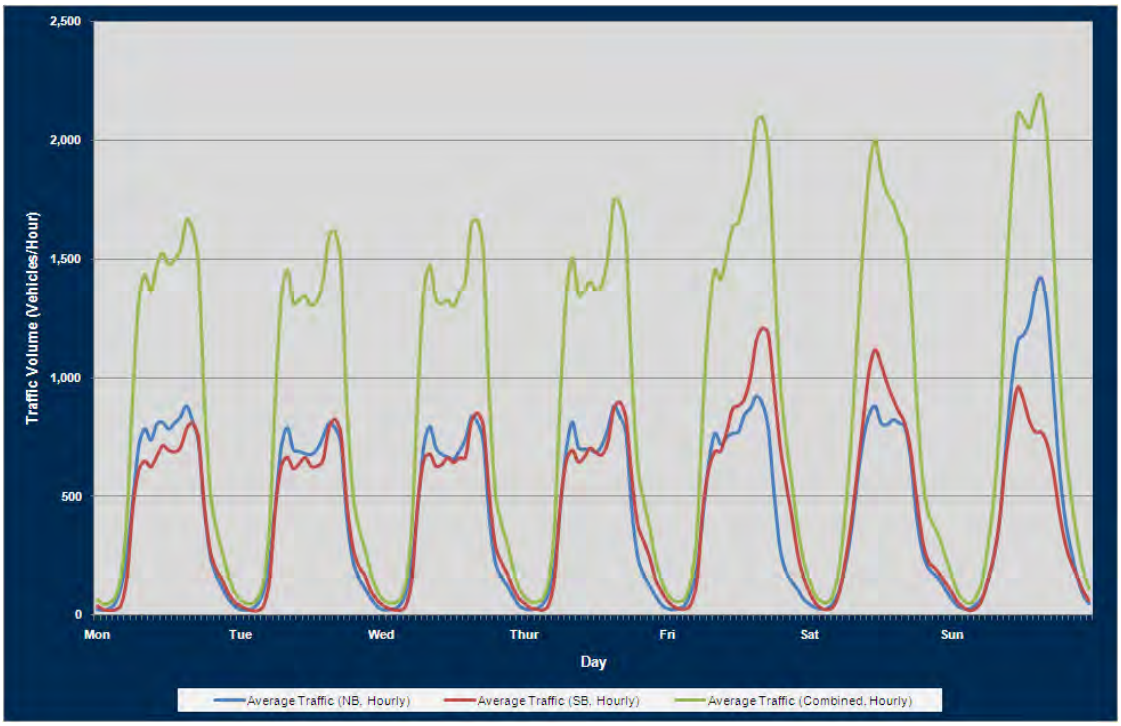


Figure 2.5: Average weekly traffic profile: Site 7.800, Princes Highway north of Rose Valley Road (2010)

(Source: AECOM, based on RMS Southern Region Traffic Survey Data)

Daily traffic volume profiles for the surveyed Princes Highway and 'Sandtrack' locations listed in **Table 2.6** are shown in **Figure 2.6** to **Figure 2.10**.

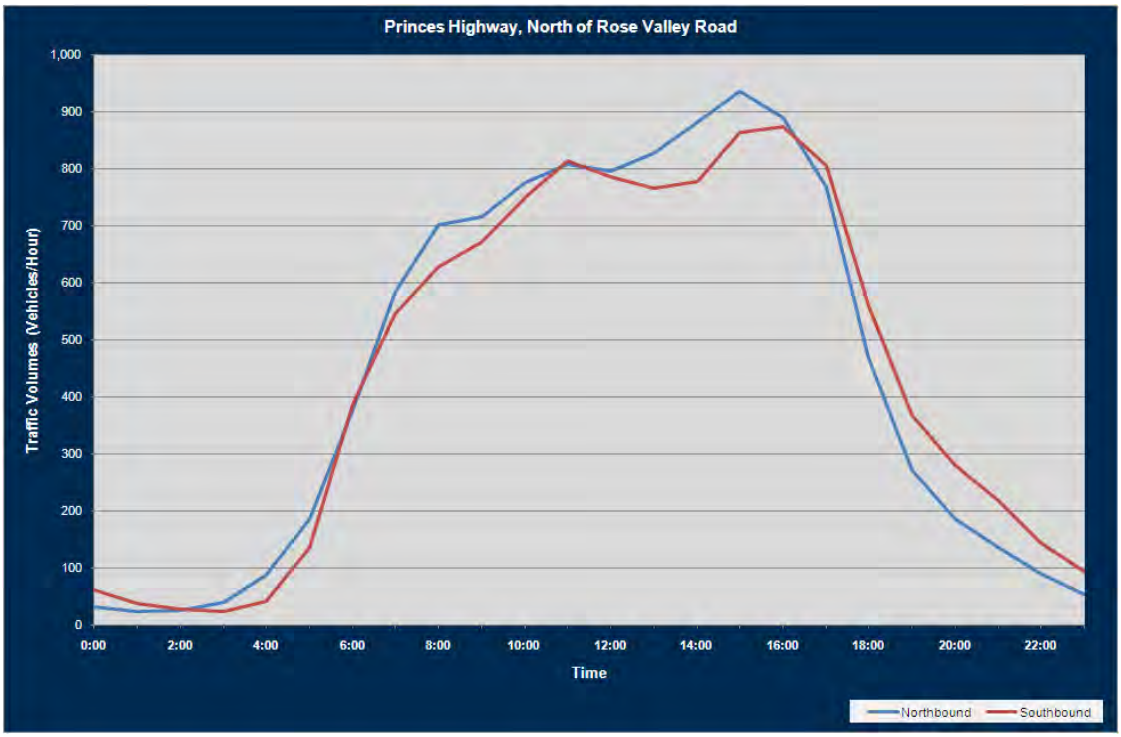


Figure 2.6: Average daily traffic profile: Princes highway north of Rose Valley Road (2010)
(Source: AECOM, based on RMS Southern Region Traffic Survey Data)

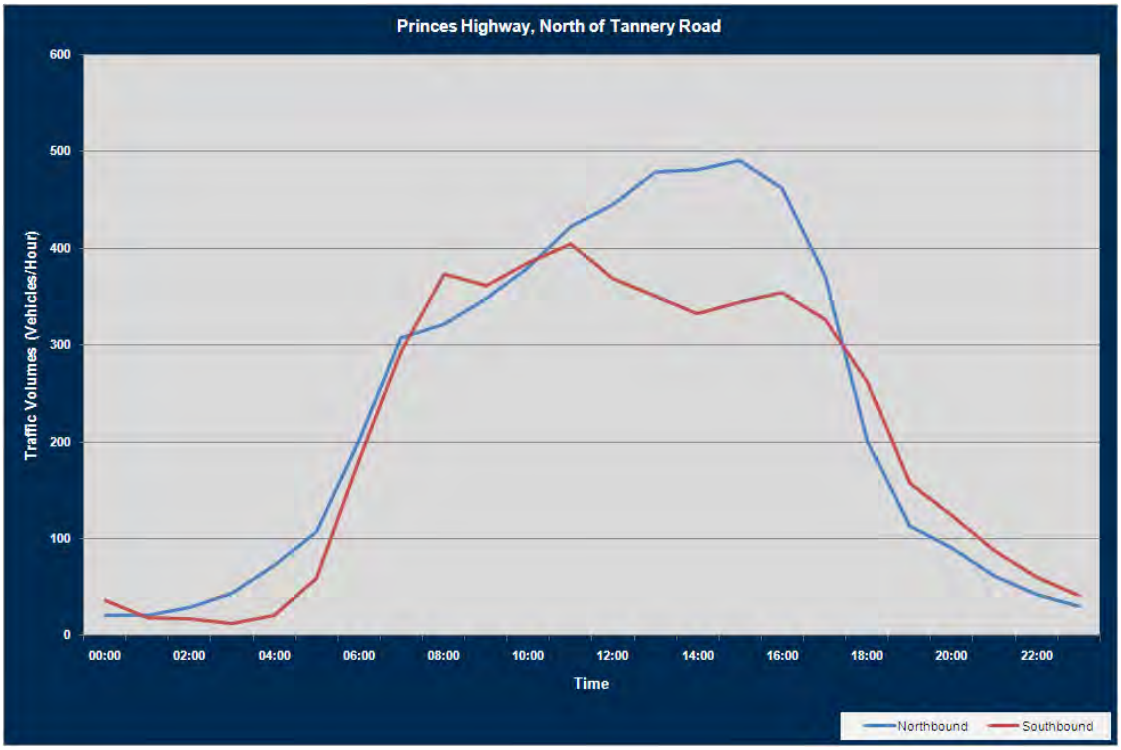


Figure 2.7: Average daily traffic profile: Princes Highway north of Tannery Road (2011)
(Source: AECOM, based on RMS Southern Region Traffic Survey Data)

Figure 2.8: Average daily traffic profile: Princes Highway south of Victoria Street (2011)
(Source: AECOM, based on RMS Southern Region Traffic Survey Data)

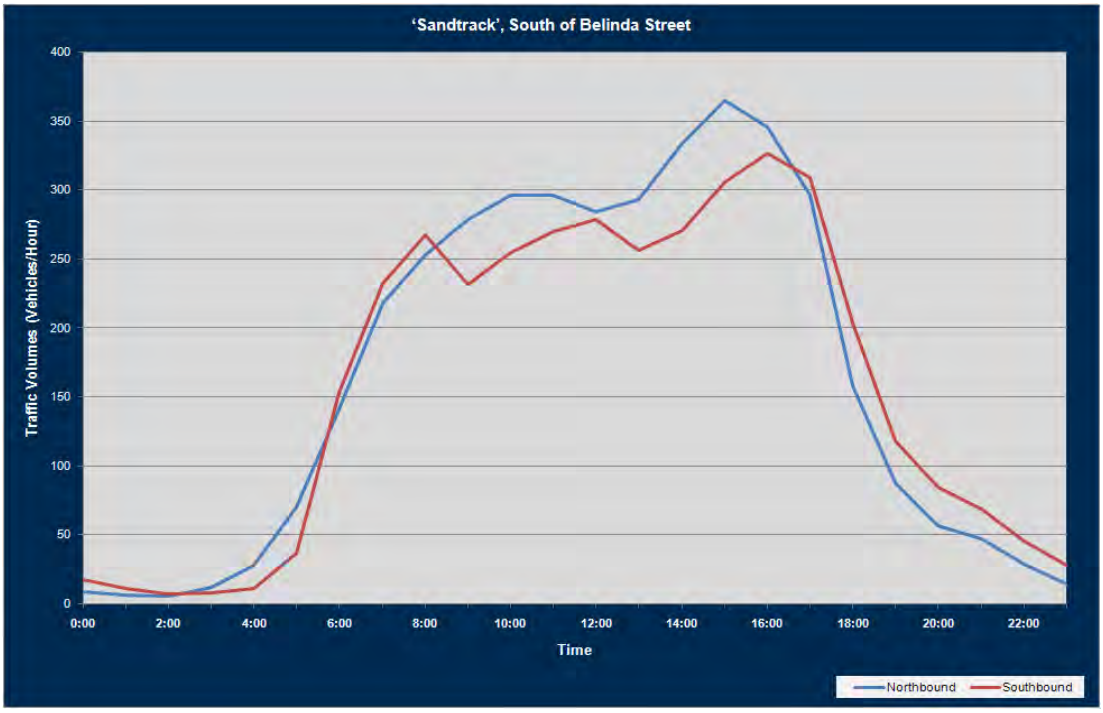


Figure 2.9: Average daily traffic profile: 'Sandtrack', south of Belinda Street (2009)
(Source: AECOM, based on RMS Southern Region Traffic Survey Data)

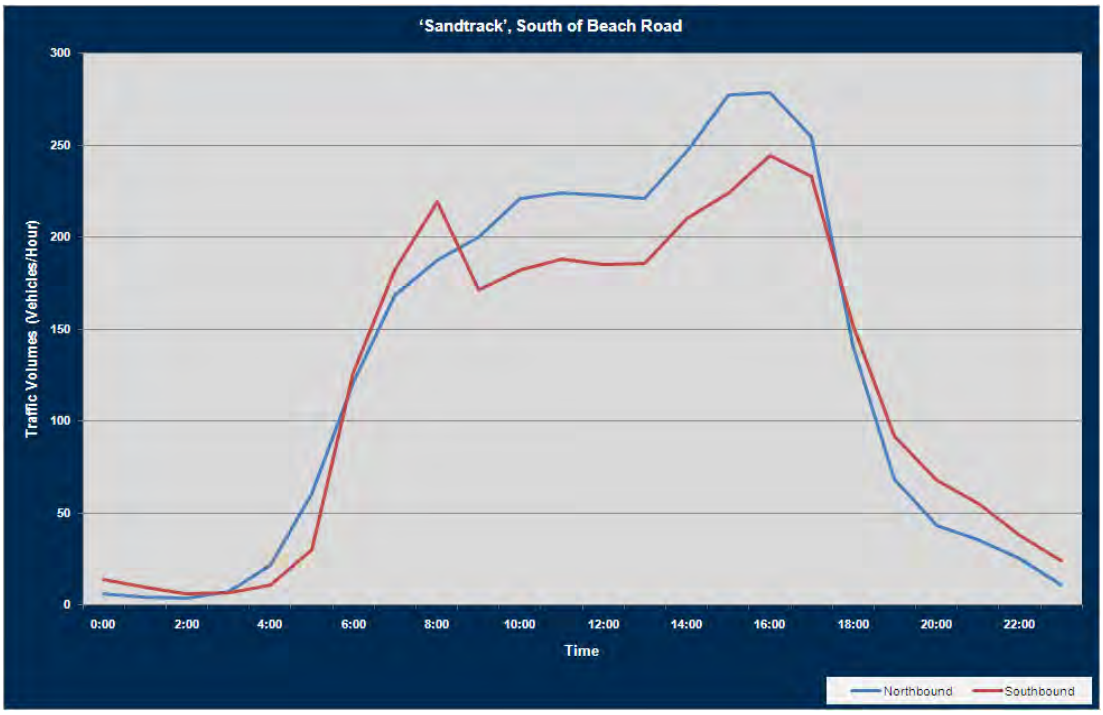


Figure 2.10: Average daily traffic profile: 'Sandtrack', south of Beach Road (2009)

(Source: AECOM, based on RMS Southern Region Traffic Survey Data)

The profiles for all of the survey sites (shown in **Figure 2.6**, **Figure 2.7**, **Figure 2.8**, **Figure 2.9** and **Figure 2.10**) show a steady increase in traffic throughout the day, peaking at around 3pm–4pm before subsiding in the early evening. Traffic volumes tend to grow gradually throughout the morning and into the afternoon; there is however a small peak in morning southbound traffic north of Berry on the Princes Highway, and south of Berry on both the Princes Highway (south of Victoria Street) and the 'Sandtrack' (south of Beach Road).

The general traffic patterns in the project area are dissimilar to denser urban areas, which generally peak early in the morning with commuter traffic, subsiding in the inter-peak period, before growing again to a peak in the afternoon. The early afternoon peak (3pm) suggests a significant level of after school pickup and resultant social and commercial activity in the area.

2.4.6 Berry traffic patterns

One of the key objectives of the project is to provide significant beneficial environmental effects for Berry town centre. At present, large volumes of through traffic, including heavy vehicles, are required to travel through the town increasing congestion, reducing road safety, and diminishing general amenity.

The project would offer substantial benefit to Berry town centre with the construction of the Berry bypass. Through traffic would use the bypass, avoiding potential delays and traffic conflicts in the town. Stopping traffic and traffic accessing local roads would enter Berry via grade-separated interchanges to the north and south of town, and would benefit from significantly reduced traffic conflicts and congestion in the town centre, especially during peak hours.

Surveys were undertaken to assess current traffic patterns within and surrounding Berry. The O-D surveys were used to help analyse the potential benefits and impacts of the Berry bypass. It also represents a key component of the traffic data required to complete traffic modelling (see Chapter 4).

Preliminary strategic O-D survey (2007)

During preliminary planning of the project in 2007, a strategic O-D survey was undertaken between Gerringong and Bomaderry within the traffic impact footprint to record traffic movements, and in particular gauge the proportions of through and stopping traffic. The survey was undertaken between 7am-9am and 2pm-6pm on Thursday 15 February 2007, at survey stations shown in **Figure 2.11**.

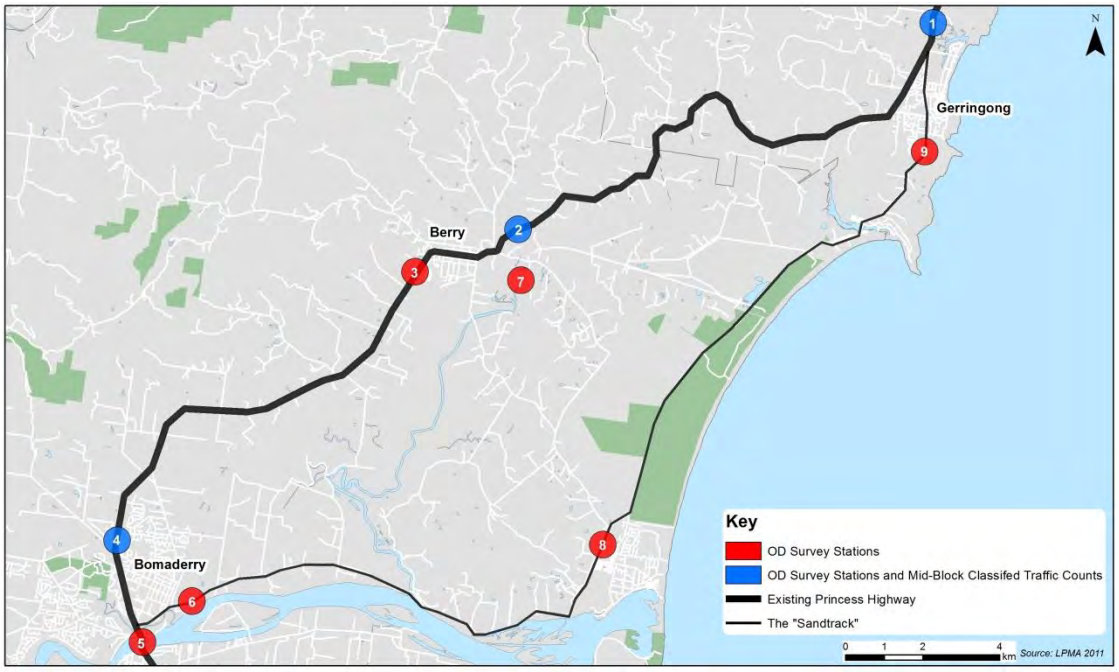


Figure 2.11: 2007 O-D survey station locations

(Source: Gerringong to Bomaderry Princes Highway upgrade–Preliminary Traffic Assessment Report, AECOM 2007)

A summary of the data collected, indicating the proportions of through and stopping traffic within the traffic impact footprint is shown in **Table 2.7**. The survey data indicates that through traffic comprised over 80 per cent of vehicles travelling between the extents of the traffic impact footprint on a typical weekday.

Table 2.7: Through and stopping traffic proportions (7am-9am and 2pm-6pm, average weekday)

Origin	Destination	Route	Sample size (all vehicles)	Through traffic (%)	Stopping traffic (%)
Station 5: South of Bomaderry	Station 1: North of Gerringong	Princes Highway (Northbound)	914	82 %	18 %
		The 'Sandtrack' (Northbound)	544	83 %	17 %
Station 1: North of Gerringong	Station 5: South of Bomaderry	Princes Highway (Southbound)	889	82 %	18 %
		The 'Sandtrack' (Southbound)	613	85 %	15 %

(Source: Gerringong to Bomaderry Princes Highway Upgrade – Preliminary Traffic Assessment Report, AECOM 2007)

Table 2.7 indicates the proportions of through and stopping traffic travelling within the traffic impact footprint from the north of Gerringong, south of Bomaderry, or between both points. Within the traffic impact footprint, local trips with origins and / or destinations in Bomaderry, Berry, and Gerringong would also influence the proportion of through traffic travelling on the Princes Highway through Berry. Although the 2007 survey suggests that over 80 per cent of traffic travels through the traffic impact footprint without stopping on a typical weekday, it is noted that the equivalent proportion travelling through Berry would also be influenced by the trip patterns of local traffic generated within the project area and traffic impact footprint.

Gerringong to Bomaderry sub-area TRACKS modelling (2010)

Outputs of the Gerringong to Bomaderry sub-area TRACKS model, developed by Gabites Porter Consultants (see Section 4.2.2) provided a representation of trip patterns in the project area. The model forecasts average daily traffic which was used to estimate daily through and stopping traffic proportions on the Princes Highway in Berry. The results estimate that presently around 70 per cent of total northbound traffic and 75 per cent of total southbound traffic on the Princes Highway travels through Berry without stopping. This indicates that local traffic generated and travelling within the traffic impact footprint lowers the proportion of through traffic in Berry, when compared to the proportion of through traffic travelling between the extents of the traffic impact footprint indicated by the 2007 O-D survey.

100th highest hour O-D surveys (Easter & Anzac Day 2011)

As noted in Section 2.4.4, traffic in Berry town centre is highest during holiday and other recreational peak periods, with the volume and distribution of traffic varying significantly from a typical weekday. For this reason, a comprehensive set of surveys, including O-D surveys, were undertaken during the Easter and Anzac Day 2011 public holiday weekend (Thursday 21 April – Tuesday 26 April 2011). The data collected during this period was used to develop detailed O-D matrices used as input to the Paramics microsimulation modelling (see Section 4.3) and also to develop and validate other forecast data used during the analysis of 100th highest hour traffic impacts and road network performance.

Within the project area, southbound traffic significantly increases at the start of a holiday period (100th southbound peak period) while northbound traffic experiences a similar peak at the end of a holiday period (100th northbound peak period). Therefore, O-D surveys were undertaken during both peak periods during the Easter and Anzac Day 2011 public holiday weekend; 3pm-7pm on Thursday 21 April and 10am-2pm on Tuesday 26 April. These surveys captured vehicle classified movements between the following locations:

- Princes Highway, south of Victoria Street.
- Queen Street (Princes Highway), west of Alexandra Street.
- Princes Highway, north of Tannery Road.
- Kangaroo Valley Road, north of North Street.
- Tannery Road, east of Pulman Street.
- Prince Alfred Street, south of Station Road.
- Woodhill Mountain Road, north of North Street.

The following additional surveys were also undertaken to develop further understanding of traffic movements within Berry and validate O-D survey data:

- Intersection turning counts (vehicle classified) at three key locations:
  - Queen Street (Princes Highway) and Kangaroo Valley Road.
  - Queen Street (Princes Highway) and Albert Street.
  - Queen Street (Princes Highway) and Woodhill Mountain Road.
- Midblock tube counts (vehicle classified) at two key locations (used to validate the integrity of the O-D survey):
  - Princes Highway, south of Victoria Street.
  - Princes Highway, north of Tannery Road.

Table 2.8 shows the travel times recorded during the 100th highest hour peak period O-D surveys for the dominant movements through Berry on the Princes Highway (Queen Street). As an example, during the 100th northbound peak period, traffic travelling southbound on the Princes Highway between Tannery Road and Victoria Street took an average of 8:31 minutes, with the quickest trip between these points recorded at 2:24 minutes. The 85th percentile bracket however shows that 85 per cent of all trips recorded between these locations took less than 6:30 minutes; the average of 8:31 minutes is skewed by travel times in excess of one hour (stopping traffic).

Because of this, 85th percentile values have been used to differentiate stopping and non-stopping traffic. Both movement combinations and travel times have been used to estimate potential bypass traffic. In this example, traffic travelling southbound on the Princes Highway between Tannery Road and Victoria Street in less than 6:30 minutes is assumed to be through traffic and potential bypass users. It is assumed that traffic with longer travel times than this would stop in Berry.

The travel time results also highlight that during the 100th northbound peak period, average northbound travel times between the locations shown were close to 15:00 minutes; the 85th percentile value between 20:00-22:00 minutes. This indicates that during this period heavy congestion and delays were experienced on the road network through Berry, exemplifying the current impact of traffic in the town during the busiest peak periods. **Figure 2.12** and **Figure 2.13** illustrate the distribution of recorded travel times through Berry during the 100th northbound and 100th southbound peak periods respectively.

Table 2.8: Princes Highway travel times through Berry (100th highest hour peak periods)

Origin	Destination	Direction	Minimum (mm:ss)	Average (mm:ss)	85th percentile (mm:ss)
100th northbound peak period					
Princes Highway, north of Tannery Road	Princes Highway, south of Victoria Street	Southbound	02:24	08:31	06:00-06:30
Princes Highway, south of Victoria Street	Princes Highway, north of Tannery Road	Northbound	03:02	14:44	20:00-22:00
100th southbound peak period					
Princes Highway, north of Tannery Road	Princes Highway, south of Victoria Street	Southbound	02:48	06:08	05:30-06:00
Princes Highway, south of Victoria Street	Princes Highway, north of Tannery Road	Northbound	02:40	05:44	04:00-04:30

(Source: AECOM)

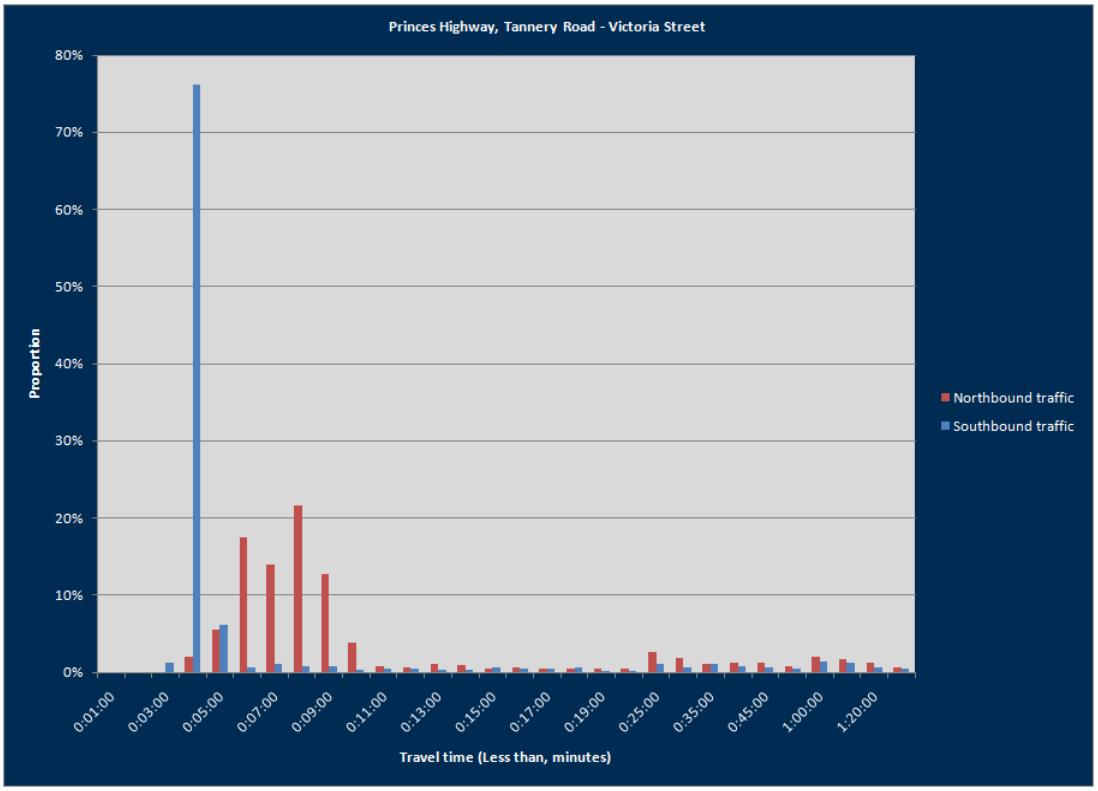


Figure 2.12: Princes Highway travel times through Berry (Distribution, 100th northbound peak period)

(Source: AECOM)

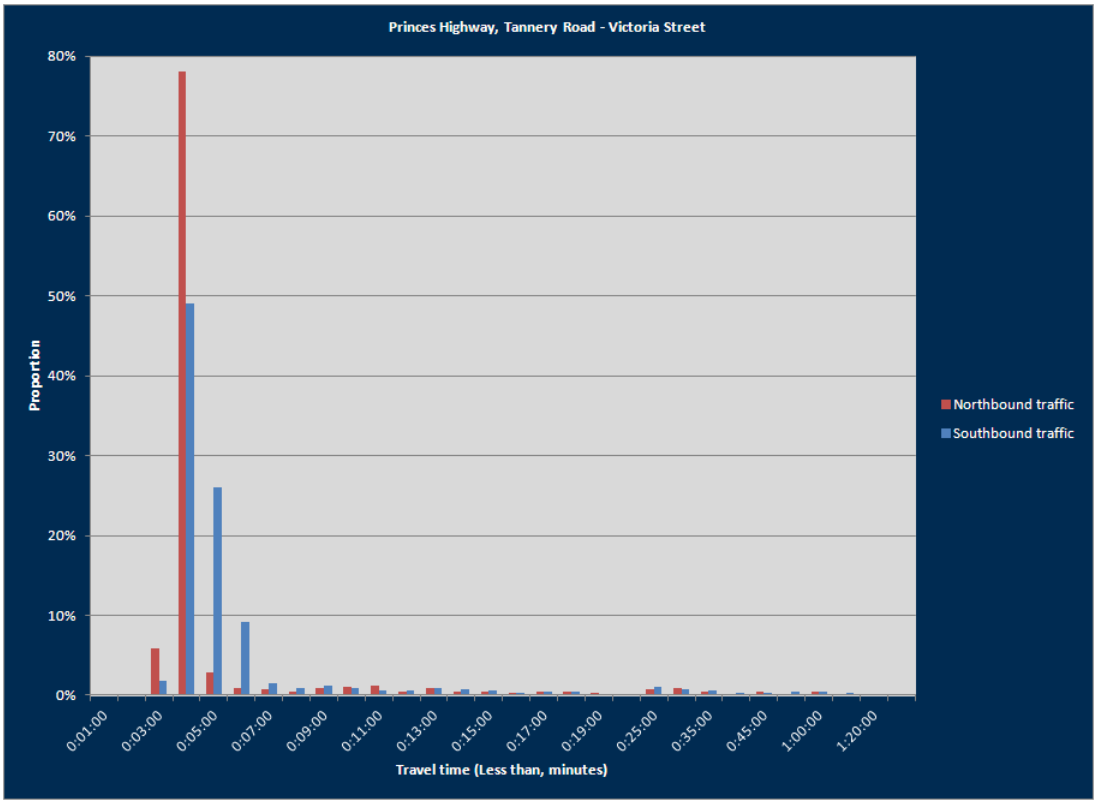


Figure 2.13: Princes Highway travel times through Berry (Distribution, 100th southbound peak period)

(Source: AECOM)

Through traffic proportions derived from the O-D surveys are summarised in **Table 2.9**, showing the proportion of traffic on the Princes Highway that currently travels non-stop through Berry during 100th highest hour peak periods. As discussed, non-stopping through traffic has been estimated based on the traffic movement recorded, as well as the time taken to complete the movement.

Table 2.9: Berry through traffic proportions (100th highest hour peak periods)

Location	Direction	100NB* peak			100SB* peak		
		Sample size (veh)	Potential bypass traffic		Sample size (veh)	Potential bypass traffic	
			Veh	%		Veh	%
Princes Highway, north of Tannery Road	Southbound	1097	753	69 %	2569	1988	77 %
Princes Highway, south of Victoria Street	Northbound	3453	2206	64 %	1800	951	53 %

*NB – northbound, SB - southbound
(Source: AECOM)

The results show that non-stopping through traffic varies significantly by direction and time period during the 100th highest hour peak periods. During both peak periods, a greater proportion of through traffic was present in the southbound direction; around 70 per cent of total traffic during the 100th northbound peak period, and closer to 80 per cent of total traffic during the 100th southbound peak period. In the northbound direction through traffic was estimated at between 50-65 per cent for the 100th southbound and 100th northbound peak periods respectively.

Overall, the O-D surveys indicate that during a typical day, non-stopping through traffic contributes around 80 per cent of total traffic travelling through Berry on the Princes Highway. During the 100th highest hour periods traffic volumes are higher and travel patterns vary. As a result, through traffic fluctuates considerably between 50-75 per cent of total traffic. The variations of both traffic volumes and patterns during varying peak periods have been considered in this traffic and transport assessment.

Victoria Street O-D surveys (2012)

Victoria Street provides access to and from local areas in the south of Berry, and is also used as a 'through' route providing a connection between the Princes Highway in the west and Prince Alfred Street in the east. Recent traffic surveys indicate that at its western end, Victoria Street currently carries around 2200 vehicles per day on average throughout the year (see Section 2.4.4).

To determine existing traffic patterns and volumes during typical weekday and weekend peak hours, O-D surveys were undertaken on Thursday 3 May, Friday 4 May, and Sunday 6 May 2012.

The O-D surveys captured the time, registration, and movements of all vehicles turning into and out of Victoria Street at both the eastern and western ends. The raw data was then processed and analysed: through movements involved a matching number plate recorded at both ends of Victoria Street within a specified travel time; non-through movements involved a number plate recorded at only one end of Victoria Street, or matched number plates but with an extended time period between them.

A summary of the results captured by these surveys is shown in **Table 2.10**. During typical weekday peak times, approximately 20 per cent of total vehicles at the western end of Victoria Street were generated by 'through' movements, with vehicles travelling to or from Prince Alfred Street at its eastern end. Sunday 6 May was the day of Berry Country Fair; as a result the proportion of 'through' traffic using Victoria Street dropped to 9 per cent, with significantly higher volumes of traffic using Victoria Street to access the Berry Showground and surrounding areas.

Table 2.10: Victoria Street O-D survey results

Movement	Victoria Street western end, all vehicles (2-way)				
	Thu 3 May 2012:		Fri 4 May 2012:		Sun 6 May 2012:
	8am-10am	3pm-6pm	8am-10am	3pm-6pm	10am-1pm
Total (Vehicles)	263	500	313	495	1342
Through (Vehicles)	59	97	62	94	116
Through (% Total)	**22 %**	**19 %**	**20 %**	**19 %**	**9 %**

(Source: AECOM, based on RTA (now RMS) Southern Region Traffic Survey Data)

3 Existing road network performance

Chapter 2 described the magnitude and patterns of existing traffic and transport demand in the traffic impact footprint. In this chapter, peak period demands are combined with the road and intersection capacity to assess the operational performance of the existing Princes Highway and the surrounding local road network.

The assessment uses the following performance indicators:

- Average travel speeds and times.
- Road safety and incidence of traffic crashes.
- Operational assessment of roadways (midblocks) and intersections based on average delay and level of service (LoS), which is described further in Section 3.3.

3.1 Traffic crashes

The Princes Highway between Toolijooa Road and Schofields Lane has a poor crash record in comparison to connecting sections of the Princes Highway and other major highways in NSW. In the northern-most part of the project area between Toolijooa Road and Austral Park Road, where the existing Princes Highway has a substandard horizontal and vertical road alignment, the crash history is particularly poor; as two of the three fatal crashes, and almost half of all crashes in the project area occurred on this section. Between 1 July 2003 and 30 September 2010 a total of 118 crashes were recorded on the Princes Highway, including three fatal and 61 injury crashes. On the alternative 'Sandtrack' route five fatal and 81 injury crashes occurred during the same period. **Table 3.1** shows the crash history for this period, detailing the section where they occurred.

Table 3.1: Crash history (1 July 2003 to 30 September 2010)

Section from	Section to	Section length (km)	Total crashes	Fatal crashes	Injury crashes	Tow-away crashes
Project area						
Toolijooa Road	Austral Park Road	5.7	50	2	25	23
Austral Park Road	Woodhill Mountain Road, Berry	4.3	34	1	16	17
Woodhill Mountain Road, Berry	Schofields Lane	2.6	34	0	20	14
Traffic impact footprint						
Princes Highway: Toolijooa Road - Schofields Lane		12.6	118	3	61	54
The 'Sandtrack': Gerringong - Bomaderry		28.9	203	5	81	117

(Source: AECOM, based on RMS Southern Region Crash Data)

Crash severity indices provide an assessment of road safety based on the type and number of crashes occurring on a route. Fatal, injury and tow-away crashes carry different weightings; they are determined independently of absolute traffic volumes, and calculated to establish the average level of severity of crashes that occur. **Table 3.2** shows crash severity indices and **Figure 3.1** illustrates the formula used to calculate these indices.

Crash Severity Index =
*[(No. of fatal crashes * 3.0) + (No. of injury crashes * 1.5) + (No. of non-injury crashes)] / Total no. of crashes*

Figure 3.1: Crash severity index calculation
(Source: RMS Southern Region)

The average crash severity index on the Princes Highway in the project area is 1.31, with the section between Toolijooa Road and Austral Park Road the highest at 1.33. By comparison the average crash severity index of all crashes reported on all roads open to the public across NSW between 2003 – 2010 was 1.24[1], indicating the Princes Highway historically has a higher than average proportion of fatal and injury crashes in the project area.

Table 3.2: Crash severity indices (1 July 2003 to 30 September 2010)

Section from	Section to	Crash severity index
Project area		
Toolijooa Road	Austral Park Road	1.33
Austral Park Road	Woodhill Mountain Road, Berry	1.29
Woodhill Mountain Road, Berry	Schofields Lane	1.29
Traffic impact footprint		
Princes Highway: Toolijooa Road - Schofields Lane		1.31
The 'Sandtrack': Gerringong - Bomaderry		1.25
New South Wales average (2003 – 2010)		1.24

(Source: AECOM, based on RMS Southern Region Crash Data)

Crash rates per 100 million vehicle kilometres travelled (100MVKM) are shown in **Table 3.3**. These crash rates are calculated using the volume of traffic and distance travelled along a route, therefore offering a measure of risk per kilometre travelled. The formula used to calculate this rate is shown in **Figure 3.2**.

Crash rate per 100 MVKM =
*(Total no. of crashes * 100,000,000) / (No. of years * 365 * Length (km) * AADT)*

Figure 3.2: Crash rate per 100 million vehicle kilometres calculation
(Source: RMS Southern Region)

[1] Calculated using crash data provided by *Road traffic crashes in New South Wales 2009*, RTA, and the Crash Severity Index formula presented in Figure 3.3.

Table 3.3 shows the average fatality rate on the Princes Highway (Toolijooa Road – Schofields Lane) is 0.8 per 100MVKM in the project area. The latest available RMS data (for the 12-month period ending June 2012) shows an average fatality rate across NSW of 0.6 per 100MVKM, indicating that this section of the existing highway historically has over 30 per cent more fatalities per kilometre travelled than the NSW average for reported crashes on all roads open to the public. The alternative 'Sandtrack' route between Gerringong and Bomaderry has a fatality rate of 0.7 per 100MVKM.

Table 3.3: Crash rates per 100MVKM (2011)

Section from	Section to	Section length (km)	2011 ADT (veh)	Crash rate per 100MVKM			
				Total	Fatal	Injury	Tow-away
Project area							
Toolijooa Road	Austral Park Road	5.7	10,755	30.8	1.2	15.4	14.2
Austral Park Road	Woodhill Mountain Road, Berry	4.3	10,755	27.8	0.8	13.1	13.9
Woodhill Mountain Road, Berry	Schofields Lane	2.6	12,077	40.9	0.0	24.1	16.8
Traffic impact footprint							
Princes Highway: Toolijooa Road - Schofields Lane		12.6	-	32.1	0.8	16.6	14.7
The 'Sandtrack': Gerringong - Bomaderry		28.9	-	29.9	0.7	12.0	17.3
New South Wales average (July 2011 – June 2012)		-	-	-	0.6	31.0	-

(Source: AECOM, based on RMS Southern Region Crash Data, NSW Crash Data Monthly Bulletin, June 2012)

Table 3.4 provides details of the crash costs for sections of the Princes Highway and the 'Sandtrack' within the traffic impact footprint. Average crash costs based on definitions for coding accidents (DCA), have been provided by RMS*' Economic Analysis Manual (Economic Parameters for 2009),* and can be used in conjunction with crash frequency data to estimate the overall cost of crashes over a period. The crash costs presented in this report are based on a 'willingness to pay' approach; willingness to pay values for road safety reflect the accumulated value the NSW community is willing to pay or forgo in exchange for a reduction in the probability of crash related injuries and road accident deaths on NSW roads.

Table 3.4: Total and average annual crash costs (1 July 2003 to 30 September 2010)

Section from	Section to	Section length (km)	Total cost (July 2003 - Sept 2010)		Average annual cost (July 2003 - Sept 2010)	
			Total cost ($M)	Cost per km ($M)	Total cost ($M)	Cost per km ($M)
Project area						
Toolijooa Road	Austral Park Road	5.7	26.71	4.69	3.68	0.65
Austral Park Road	Woodhill Mountain Road, Berry	4.3	15.40	3.58	2.12	0.49
Woodhill Mountain Road, Berry	Schofields Lane	2.6	11.53	4.44	1.59	0.61
Traffic impact footprint						
Princes Highway: Toolijooa Road - Schofields Lane		12.6	53.64	4.26	7.40	0.59
The 'Sandtrack': Gerringong - Bomaderry		28.9	77.82	2.69	10.73	0.37

(Source: AECOM, based on RMS Southern Region Crash Data and RMS Economic Analysis Manual (Economic parameters for 2009))

Crashes on the Princes Highway in the project area between 1 July 2003 and 30 September 2010 cost an estimated total of $53.6 million, based on 2009 willingness to pay rates. The relatively short section of the Princes Highway beginning at Woodhill Mountain Road at the east of Berry, travelling through the town to Schofields Lane, incurred a total cost per kilometre of $4.4 million during this period. It is noted that the project would significantly reduce this rate by providing a bypass to re-route this section of highway to the north of the town. Around half of the total crash costs were created on the section from Toolijooa Road to Austral Park Road through the 'Foxground bends', where the proposed realignment provided by the project is anticipated to significantly improve the safety record. The total cost of crashes per kilometre on the alternative 'Sandtrack' route during this period was $2.7 million.

3.2 Travel speeds and travel times

Vehicle travel times and speeds in the traffic impact footprint have been estimated using the 2006 Gerringong to Bomaderry Sub-area TRACKS model (see Section 4.2.2) for the following two key route options within the traffic impact footprint, as shown in **Figure 3.3**:

- The Princes Highway between Toolijooa Road and Schofields Lane.
- The 'Sandtrack' between Dooley Road and Shoalhaven Heads Road.

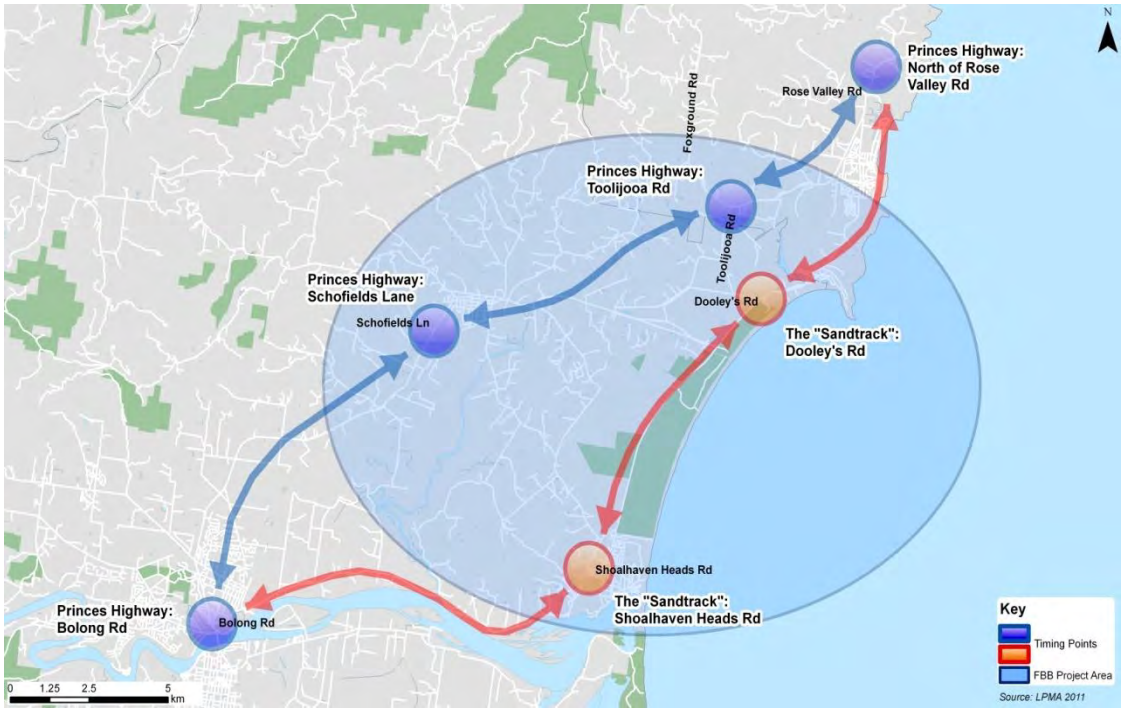


Figure 3.3: Travel time analysis routes and timing points

(Source: AECOM)

The timing points used are relevant to the boundaries of the project area and also strategic movements in the traffic impact footprint between Gerringong and Bomaderry. The results of the travel time analysis (presented in **Table 3.5**), indicates that the Princes Highway currently has an average travel time of around 14-15 minutes within the project area between Toolijooa Road and Schofields Lane. The equivalent route via the 'Sandtrack' is shorter in length and operates at a higher average speed, taking less than eight minutes on average. The longer travel time on the Princes Highway is due to a number of factors including:

- The additional distance covered when compared to the alternative 'Sandtrack' route.
- A higher proportion of slow-moving heavy vehicles than the 'Sandtrack' route.
- Steep grades and sharp bends in the project area, particularly through the 'Foxground bends'.
- Varying (lower) posted speed limits along the route.
- Delays caused by traffic conflicts when travelling through Berry.

Table 3.5: 2006 base year TRACKS modelled travel times

Route	Direction	Distance (km)	Average speed (km/h)	Average travel time (mins)
North of project area Princes Highway: North of Rose Valley Road to Toolijooa Road The 'Sandtrack': Princes Highway north of Rose Valley Road to the 'Sandtrack' at Dooley Road (via Fern Street)				
Princes Highway	Northbound	7.0	75.3	5.5
	Southbound		80.2	5.2
The 'Sandtrack'	Northbound	8.7	50.0	10.5
	Southbound		50.5	10.4
Project area Princes Highway: Toolijooa Road to Schofields Lane The 'Sandtrack': Dooley Road to Shoalhaven Heads Road				
Princes Highway	Northbound	12.6	52.6	14.4
	Southbound		51.2	14.8
'Sandtrack'	Northbound	9.9	78.4	7.5
	Southbound		77.9	7.6
South of project area Princes Highway: Schofields Lane to Bolong Road The 'Sandtrack': Shoalhaven Heads Road to the Princes Highway, Bomaderry				
Princes Highway	Northbound	13.6	63.2	12.9
	Southbound		64.8	12.6
The 'Sandtrack'	Northbound	13.8	72.4	11.5
	Southbound		70.0	11.8
Traffic impact footprint Princes Highway: North of Rose Valley Road to Bolong Road The 'Sandtrack': Princes Highway north of Rose Valley Road to the Princes Highway, Bomaderry (via Fern Street)				
Princes Highway	Northbound	33.2	60.6	32.8
	Southbound		61.1	32.6
The 'Sandtrack'	Northbound	32.4	66.0	29.5
	Southbound		65.2	29.8

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

Although the 'Sandtrack' is significantly quicker in terms of travel time within the project area, the modelling shows that within the traffic impact footprint (between Gerringong and Bomaderry) the routes are comparable in both length and travel time. Between these towns the Princes Highway is around 33.2 kilometres long and takes around 32-33 minutes, while the 'Sandtrack' which is around 32.4 kilometres long takes a little under 30 minutes.

The analysis shows that the alternative routes are similar in length south of the project area; however the higher average speed of the 'Sandtrack' results in a shorter travel time. North of the project area, the 'Sandtrack' route is considerably slower, with a longer length and lower average speed than the Princes Highway. The additional travel time is created by intersection delays through Gerringong as well as lower speed limits (50 kilometres per hour and 60 kilometres per hour) through the town and along sections of the 'Sandtrack' route through Gerroa.

3.3 Definition of level of service

LoS is a measure to determine the operational conditions and efficiency of a roadway or intersection. The definition of LoS generally outlines the operating conditions in terms of speed and travel time, freedom to manoeuvre, traffic interruptions, comfort and convenience, and road safety. There are six levels of service for midblock carriageway locations, LoS A to LoS F, with LoS A representing optimum operating conditions (free flow) and LoS F the poorest (forced or breakdown in flow). Common RMS practice suggests that when a roadway falls to LoS D, investigations should be initiated to provide suitable remediation prior to the link falling to LoS E or LoS F.

A customised midblock LoS model has been developed based on the updated *Austroads, Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009*. An example of the model, which has been developed specifically for two lane undivided road conditions, is included in Appendix A.

Average delay is commonly used to assess the operational performance of intersections, with LoS used as an index. A summary of the LoS index (including specific colour coding to highlight/group the performance of each service level) is shown in **Table 3.6**.

Table 3.6: Level of service criteria for intersections

LoS	Average delay/ vehicle (secs/veh)	Traffic signals | roundabout	Give way | stop signs
A	Less than 14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity; at signals incidents would cause excessive delays	At capacity; requires other control mode
F	>70	Roundabouts require other control mode	At capacity; requires other control mode

(Source: Guide to Traffic Generating Developments, RMS 2002)

Similar to the midblock performance measures, common RMS practice suggests that when the level of service of an intersection falls to LoS D, investigations should be initiated to provide suitable remediation prior to the approach roads falling to LoS E or LoS F. It should also be noted that capacity constraint can be used as a demand management technique and that over-provision of capacity can encourage more car use.

3.4 Roadway level of service

The current midblock LoS for the Princes Highway and the 'Sandtrack' within the traffic impact footprint, based on 2011 AM peak, PM peak and 100th highest hour (northbound and southbound peak directional) two-way traffic volumes, are summarised in **Table 3.7**. The table indicates that the Princes Highway both north and south of Berry currently operates at LoS D in both the AM peak and PM peak, while the alternative 'Sandtrack' route is currently operating at LoS C. The analysis indicates that during 100th highest hour periods, the operational performance of the Princes Highway deteriorates to an unacceptable LoS E at most locations and the 'Sandtrack' operates at LoS D.

Table 3.7: 2011 midblock level of service summary

Location	AM peak hour (veh/h)		PM peak hour (veh/h)		100NB (veh/h)		100SB (veh/h)	
	Traffic volume	LoS	Traffic volume	LoS	Traffic volume	LoS	Traffic volume	LoS
Princes Highway: Toolijooa Road – Tannery Road	730	D	875	D	1187	D	1275	E
Princes Highway: Victoria Street – South of Schofields Lane	927	D	1090	D	1248	E	1477	E
'Sandtrack': Dooley Road – Shoalhaven Heads Road	681	C	814	C	977	D	1144	D

(Source: AECOM, based on AUSTROADS Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009)

3.5 Intersection level of service

For most of the project area, the Princes Highway intersects with minor roads and property accesses; only relatively small levels of traffic demand are generated from locations that are connected by these intersections. Where the Princes Highway passes through the town of Berry, the highway intersects with numerous roads of local and regional importance, which generate significant levels of conflicting traffic demand.

The current LoS and delay at the following six key intersections in and around Berry (shown in **Figure 3.4**) has been assessed using Paramics microsimulation modelling software (see Section 4.3 for details of traffic modelling and forecasting processes):

- Princes Highway / Victoria Street.
- Queen Street (Princes Highway) / Kangaroo Valley Road.
- Queen Street (Princes Highway) / Alexandra Street.
- Queen Street (Princes Highway) / Prince Alfred Street.
- Queen Street (Princes Highway) / Albert Street.
- Princes Highway / Tannery Road.

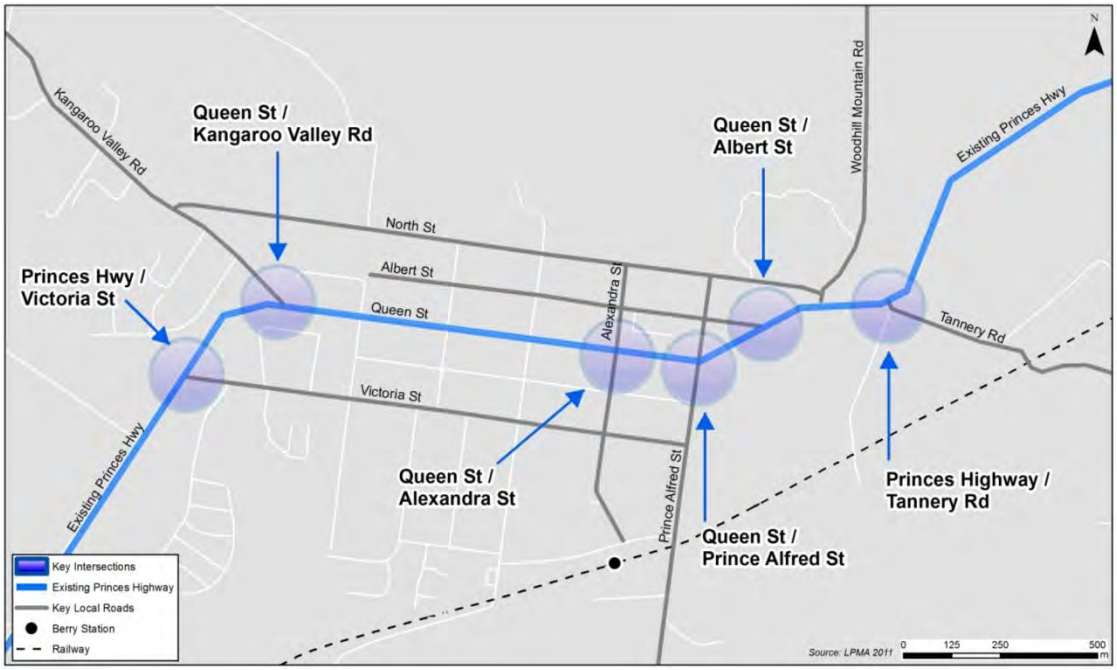


Figure 3.4: Key intersection locations in the project area
(Source: AECOM)

Table 3.8 provides a summary of intersection performance during peak hours during a 100th highest hour northbound (NB) and southbound (SB) peak period; which represents a Public Holiday weekend or equivalent traffic flow. During these periods, the intersections in Berry are subjected to the highest levels of traffic demand; it should therefore be noted that the results indicated in the table represent the poorest performance of the road network.

The LoS calculated by the Paramics modelling is based on the capacity and efficiency of the local road network and intersections within and around Berry. In comparison, the midblock LoS presented in Section 3.4 represents the operational performance of rural highway locations in the project area, based on the travel speeds and the time spent following other vehicles. For this reason, the methods produce contrasting LoS results which vary along the length of the Princes Highway within the project area. The performance of particular sections or locations should be examined and interpreted in isolation, specific to the assessment criteria.

The results of the Paramics modelling indicate that intersections in and around Berry currently have sufficient capacity to accommodate the high levels of demand associated with 100th highest hour traffic (both northbound and southbound peaks). The intersections of the Princes Highway and Victoria Street, Queen Street (Princes Highway) and Kangaroo Valley Road, Queen Street (Princes Highway) and Albert Street, and the Princes Highway and Tannery Road have three approach roads, with relatively low levels of traffic demand from their minor approaches (Kangaroo Valley Road, Albert Street and Tannery Road respectively). With little conflicting traffic demand, all of these intersections operate with minimal delay at LoS A.

In the centre of Berry, there are two significant crossroads; Queen Street (Princes Highway) and Alexandra Street, and Queen Street (Princes Highway) and Prince Alfred Street. The intersection of Queen Street and Alexandra Street provides local access to car parks, retail and recreational facilities in Berry. To the south of Berry, Prince Alfred Street leads to Coolangatta Road, a road of regional significance as it links to the 'Sandtrack' and Shoalhaven Heads. The analysis shows that the minor approach roads to these intersections are subjected to delays during peak holiday periods. For example, during the 100th highest hour northbound peak period, high volumes of through traffic on Queen Street limits the opportunity for vehicles to turn onto or cross the highway from minor approach roads, resulting in delays at these intersections. Right turn and through movements from the minor approach roads are the main cause of this delay, as vehicles have to wait for a gap in traffic on both the eastbound and westbound directions of Queen Street before they can proceed.

Nevertheless, during a typical 100th highest hour northbound peak, all approach roads at both of these intersections perform at LoS A, with a maximum average delay of less than 13 seconds.

Two-way traffic demand during the 100th highest hour southbound peak period on the Princes Highway is typically greater than the 100th highest hour northbound peak. The additional traffic volumes result in longer delays to traffic entering from the minor approach roads at intersections in the town. At the intersection of Queen Street and Prince Alfred Street, vehicles approaching from the minor approach road (Prince Alfred Street) experience an average delay of around 23 seconds, resulting in LoS B; however this is still within acceptable limits in terms of operational performance.

The operational performance of the Queen Street and Alexandra Street intersection also deteriorates during this period to LoS B on the minor Alexandra Street approach roads; where traffic encounters average delays of up to 22 seconds. During the 100th highest hour southbound peak scenario, it is increasingly difficult for vehicles on the minor approach roads to find gaps in the traffic flow on Queen Street, particularly for vehicles proceeding straight ahead or turning right which require a break in traffic in both directions. While the minor approach roads do experience delays, the bulk of traffic passes through the intersections on the major Queen Street approach roads and experiences very little delay regardless of the peak period scenario.

Table 3.8: 2011 intersection level of service summary

Intersection / approach road	100NB			100SB		
	Approach volume (veh/h)	Average delay (s)	LoS	Approach volume (veh/h)	Average delay (s)	LoS
Princes Highway / Victoria Street						
Princes Highway northbound	893	0.0	A	542	0.0	A
Victoria Street westbound	51	0.0	A	158	0.5	A
Princes Highway southbound	280	0.0	A	776	0.0	A
Total	1224	0.0	A	1476	0.1	A
Queen Street (Princes Highway) / Kangaroo Valley Road						
Queen Street eastbound	751	0.0	A	457	0.0	A
Kangaroo Valley Road	92	3.7	A	97	3.0	A
Queen Street westbound	353	0.1	A	846	0.0	A
Total	1196	0.3	A	1400	0.2	A
Queen Street (Princes Highway) / Alexandra Street						
Queen Street eastbound	819	0.0	A	543	0.0	A
Alexandra Street southbound	79	12.5	A	118	22.2	B
Queen Street westbound	318	0.1	A	812	0.0	A
Alexandra Street northbound	92	8.6	A	65	16.8	B
Total	1308	1.4	A	1538	2.4	A
Queen Street (Princes Highway) / Prince Alfred Street						
Queen Street eastbound	816	0.0	A	517	0.1	A
Queen Street westbound	329	1.6	A	797	2.3	A
Prince Alfred Street northbound	151	9.2	A	139	22.7	B
Total	1296	1.5	A	1453	3.5	A
Queen Street (Princes Highway) / Albert Street						
Queen Street eastbound	859	4.1	A	528	4.1	A
Albert Street	58	2.6	A	62	1.4	A
Queen Street westbound	367	2.7	A	865	2.4	A
Total	1284	3.6	A	1455	3.0	A
Princes Highway / Tannery Road						
Princes Highway eastbound	914	1.5	A	550	1.9	A
Princes Highway westbound	292	1.1	A	790	1.1	A
Tannery Road	66	1.2	A	79	2.4	A
Total	1272	1.4	A	1419	1.5	A

(Source: AECOM)

4 Traffic modelling and forecasting process

This chapter provides details of the integrated traffic modelling and forecasting approach that was adopted for the traffic and transport assessment; as shown in **Figure 4.1**. The objective was to make best use of strategic (TRACKS), spreadsheet (Microsoft Excel) and microsimulation (Paramics) traffic models to determine existing and future conditions on the Princes Highway and surrounding local roads; in terms of generating traffic volumes (including the predicted transfer of traffic to the project from the alternative 'Sandtrack' route) and assessing the operational performance of the project.

Figure 4.1: Overview of the traffic modelling approach
(Source: AECOM)

4.1 Introduction to traffic modelling

Traffic modelling is generally considered as a sequence of steps relating to the supply and demand of transport systems. The general structure of these steps is known as the classic four-stage transport model, which is illustrated within the project specific TRACKS model framework in **Figure 4.2**.

Traffic modelling is an important step in the transportation planning process because decisions and investments are often influenced by predicted travel demand. Models are used to estimate the number of trips that would be made on a transportation system at some future date as a result of change in supply (for example, the introduction of the project) or a change in travel demand (for instance, the impact of a local development such as Huntingdale Park).

However, traffic models would only provide forecasts for those factors that are explicitly accounted for in the modelling approach. For instance, traffic models generally exclude pedestrian and bicycle trips, expressing demand only as vehicular traffic, and cannot therefore be used to assess a bicycle improvement scheme. It is critical that model assumptions, simplifications and limitations are understood before a modelling exercise is begun.

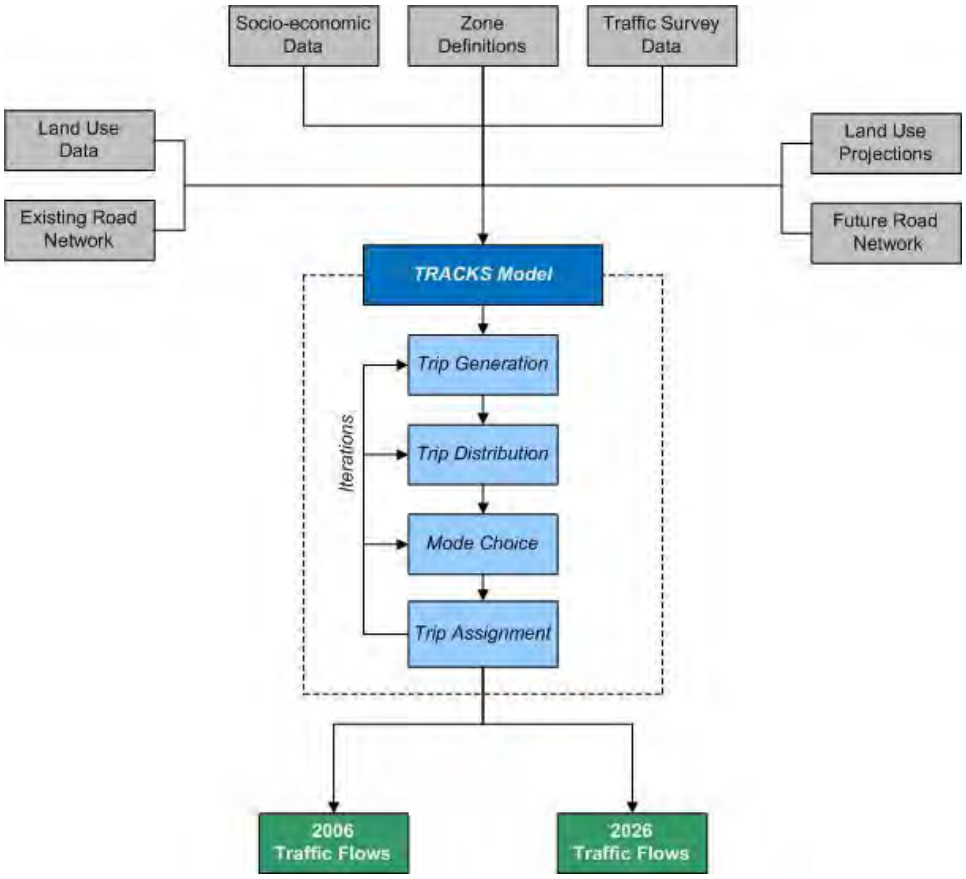


Figure 4.2: Four-stage TRACKS modelling process
(Source: AECOM)

4.2 Traffic forecasting methodology

There are four remaining sections of the Princes Highway to be upgraded as part of the RMS' overall upgrade of the Princes Highway between Waterfall and the Jervis Bay Road junction. The remaining sections include the recently approved Gerringong upgrade project, the project, the proposed Berry to Bomaderry upgrade project to the south which is currently in the planning phase and the South Nowra upgrade project for which construction tenders have been awarded. The modelling methodology used to forecast traffic volumes for the project, incorporated the following three key stages and sub-tasks, which are described in more detail in subsequent sections:

1) Derivation of base year traffic patterns

- Detailed analysis of average peak and daily traffic volumes using 2009 May/June and 2011 April/May survey data collected at key locations within the project area (see Section 2.4).
- Local area seasonality factor calculated using annual 2008-2010 traffic count data from the now RMS permanent site on the Princes Highway north of Rose Valley Road.
- 2009 and 2011 traffic count data updated using the calculated seasonality factor (May/June and April/May to average annual respectively).

2) Base and future year TRACKS model development

- Developed a Gerringong to Bomaderry sub-area model from the Illawarra regional TRACKS model.
- Internal zones disaggregated and updated to reflect local land use data.
- 2006 base year model calibrated to surveyed traffic counts.
- Updated base network with the project road network upgrades, including:
  - Re-coding the new chainage/alignment of the complete Princes Highway upgrade.
  - Addition of Berry bypass.
  - Addition of grade-separated access ramps.
  - Improvement of road classification – number of lanes, capacity, posted speed limit etc.
- Developed 2026 future year demand.
- Assigned flows at key locations extracted from the TRACKS model for the 2006 base year and 2026 future year.
- 2006 – 2026 linear traffic growth rates calculated for each location on the Princes Highway (this includes 'natural' background traffic growth as well as growth due to the switch of traffic from the 'Sandtrack' to Princes Highway).

3) Application of traffic forecasting spreadsheet model

- Developed a traffic forecasting spreadsheet model, which included the following tasks:
  - Linear growth rates (from TRACKS modelling) applied to 2009 and 2011 traffic volume survey data taken at corresponding mainline locations, producing future year forecast traffic volumes on an annual basis to 2026.
  - Linear extrapolation used to calculate forecast traffic volumes beyond 2026.
  - Existing traffic patterns used to develop classified - peak period traffic volumes for each location.
- Carriageway to ramp factors derived from the TRACKS model and origin-destination (O-D) surveys, and applied to forecast traffic volumes.
- Developed a Matrix Furness process to re-balance ramp volumes against mainline traffic volumes.
- Preliminary project traffic volumes calculated – without construction impacts.
- Updated traffic forecasts to reflect the travel time impacts and resultant redistribution of traffic to the 'Sandtrack' during construction of the project and the other upgrades to the Princes Highway.
- Final project traffic volumes calculated – with construction impacts.

4.2.1 Derivation of base year traffic patterns

The first stage in the modelling process was to collect up-to-date traffic count data at key strategic locations on both the Princes Highway and the 'Sandtrack':

- Site 7.800: Princes Highway, north of Rose Valley Road.
- Site 7.045: Princes Highway, west of Belinda Street.
- Site 7.816: Princes Highway, south of Victoria Street.
- Site 7.101: 'Sandtrack', south of Belinda Street.
- Site 78.200:'Sandtrack', south of Beach Road.

Section 2.4 provides details of the traffic data collected at each location, including an overview of the classified traffic volumes, daily profiles, peak and 100th highest hour factors and the seasonality factor calculated to convert temporary counts to an annual average.

4.2.2 Base and future year TRACKS model development

TRACKS model overview

Traffic volumes for the project have been forecast using base to future year linear growth rates from a project area specific version of the RMS' Illawarra Regional TRACKS Transport Model, which is developed and maintained by Gabites Porter Consultants.

The TRACKS software is a strategic modelling package designed to assist in decision making related to:

- The location and intensity of land use activity.
- The connections and capacity of the road system.
- The type of intersection which is appropriate for the network.

Gabites Porter Consultants has developed a 2006 base year and 2026 future year TRACKS model that covers the entire Illawarra Region. The 2026 model incorporates local area road network upgrades including North Kiama Bypass, Oak Flats to Dunmore, and other upgrades to the Princes Highway including the project.

Gerringong to Bomaderry sub-area TRACKS model

A Gerringong to Bomaderry sub-area TRACKS model was developed by Gabites Porter Consultants from the regional model, subsequently re-calibrating this model to a 2006 base year and further developing a 2026 future year model to provide forecast growth rates for the key road links within the traffic impact footprint.

Appendix B shows the extent of the sub-area TRACKS model in comparison to the wider area network coverage included in the regional model. The figure also shows the project alignment within the sub-area model.

During the course of this work, AECOM completed a peer review of the model development and calibration process and its subsequent performance. As well as working with Gabites Porter Consultants on refining the sub-area model to ensure that it was fit for purpose, AECOM also collaborated with Gabites Porter Consultants on other model inputs including updating internal zones to reflect local land use data.

Base year model calibration

In order to have confidence in the model as a basis for producing robust and reliable future year traffic forecasts, the base year model was calibrated to daily traffic volumes at key screenline locations in the sub-area network. Model calibration is an essential stage in the modelling process to demonstrate that the modelled network reasonably reflects existing traffic conditions across the corresponding road network, particularly on the Princes Highway and the adjacent 'Sandtrack' route.

Figure 4.3 shows the screenline locations, which were designed to ensure that the base year model was calibrated to accurately represent the north-south travel demand through the corridor and also the subsequent split of traffic between the Princes Highway and the 'Sandtrack' route options.

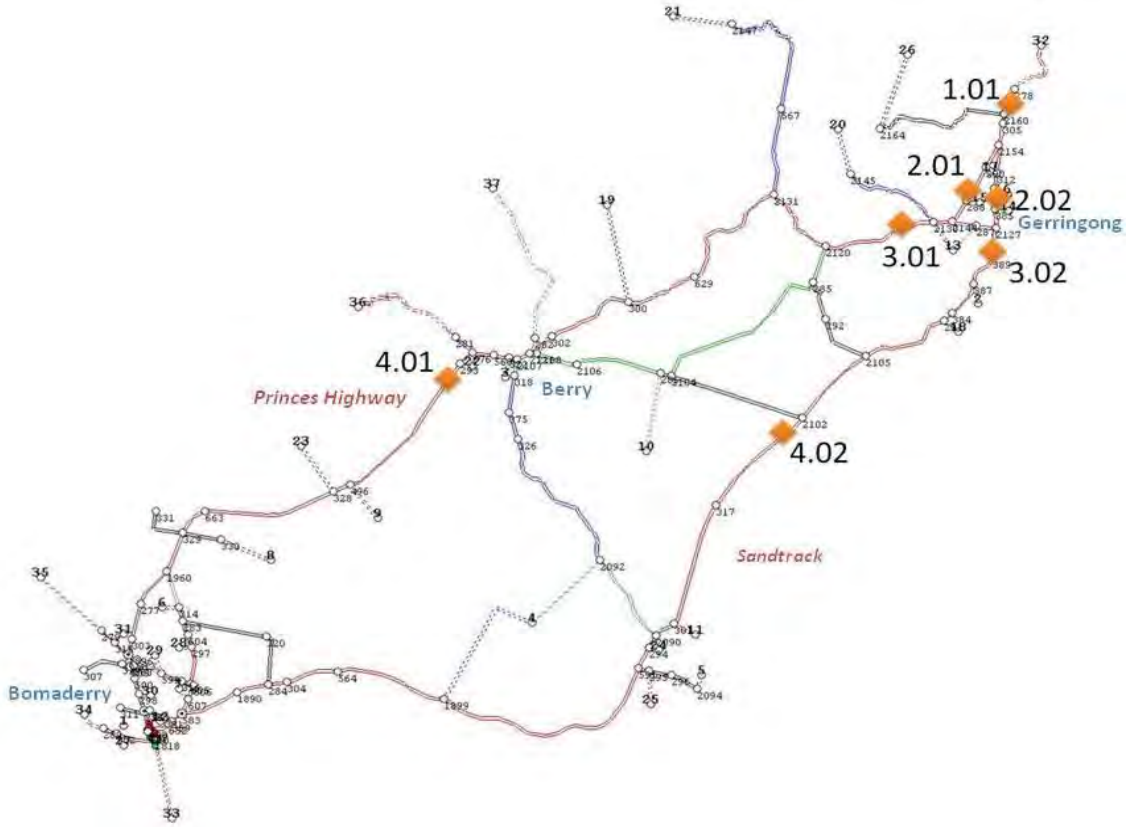


Figure 4.3: Sub-area TRACKS model screenline locations

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

For each screenline location, the model calibration process included a comparison of observed against modelled traffic flows and calculating the GEH value, which is a commonly used performance measure based on a chi-squared statistic as shown in **Figure 4.4**. An acceptable level of calibration is that all (or nearly all) screenline totals are within five per cent of observed flows and have a GEH <4.

$$GEH = \sqrt{\frac{2(M-C)^2}{M+C}}$$

Where:
M is the modelled flow; and
C is the observed flow

Figure 4.4: GEH statistic
(Source: AECOM)

Table 4.1**Table 4.1** provides details of the base year model calibration results for individual and grouped screenlines by direction of travel. The table shows that the base year model is calibrated as nearly all of the screenline totals are within five per cent of observed flows and have a GEH <4, with only Screenline 4 northbound falling just short of the desired range for the two calibration measures.

Table 4.1: 24hr base year sub-area TRACKS model calibration results

Screenline			NB (to Wollongong)				SB (from Wollongong)			
No	ID	Location	Obs	Mod	Diff	GEH	Obs	Mod	Diff	GEH
1.	1.01	Princes Highway north of Rose Valley Road	9449	9350	-1%	1.0	9449	9350	-1%	1.3
Screenline 1- north of Gerringong total			9449	9350	-1%	1.0	9449	9350	-1%	1.3
2.	2.01	Princes Highway south of Fern Street	5403	5164	-4%	3.3	5036	5763	14%	9.9
	2.02	Fern Street south of Princes Highway	3979	4549	14%	8.7	4405	3950	-10%	7.0
Screenline 2 - Gerringong total			9382	9713	4%	3.4	9440	9713	3%	2.8
3.	3.01	Princes Highway west of Belinda Street	4510	4386	-3%	1.9	4767	5239	10%	6.7
	3.02	Fern Street south of Belinda Street	3923	4345	11%	6.6	3795	3401	-10%	6.6
Screenline 3 - south of Gerringong total			8433	8731	4%	3.2	8562	8640	1%	0.8
4.	4.01	Princes Highway south of Victoria Street	5690	4634	-19%	14.7	5503	5487	0%	0.2
	4.02	The 'Sandtrack' south of Beach Road	3048	3556	17%	8.8	2856	2703	-5%	2.9
Screenline 4 - south of Berry total			8737	8190	-6%	6.0	8359	8190	-2%	1.9

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

Future year model development

As the future year modelled in TRACKS is 2026, the calibrated base year network was updated to include potential upgrades of the Princes Highway between Gerringong and Bomaderry, including the project.

More specifically, the future year network included the following updates as shown in **Figure 4.5**:

- Re-coding the new chainage of the complete Princes Highway upgrade, including the realignment of the highway through the Foxground and Broughton Village areas.
- Addition of grade-separated access ramps at Gerringong and Berry, including interchanges for Berry east of Tannery Road and at Kangaroo Valley Road.
- Bypass of Berry.
- Improvement of road classification – number of lanes, capacity, posted speed limit etc.

In addition to the potential road network upgrades, 2026 land use projections for the Illawarra Region underpin the travel demand included in the 2026 sub-area model. **Table 4.2** shows annual growth rates calculated from existing and projected household and employment data for key areas in the region. The local area is forecast to experience growth in households including an additional 332 dwellings in Berry (eg Huntingdale Park residential development) and 282 dwellings in Shoalhaven Heads, which equates to annual growth rates of 2.4 per cent and 2.1 per cent respectively.

Employment in the region is also expected to increase with an additional 743 jobs in Gerringong and 915 jobs in Bomaderry projected over the 20 year period. The population growth in Berry and Shoalhaven Heads and employment growth in Bomaderry and Gerringong would generate an increase in local travel demand along the Princes Highway corridor.

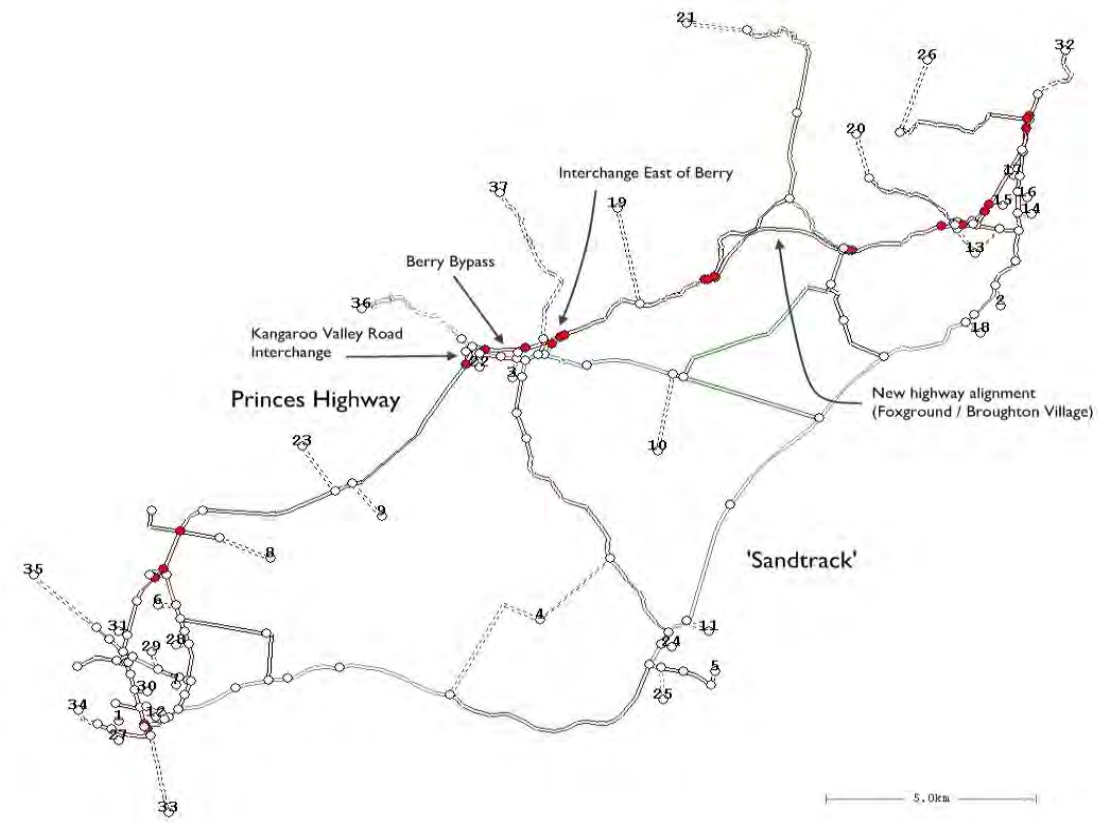


Figure 4.5: 2026 sub-area TRACKS network

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

Table 4.2: Summary of household and employment data for 2006 and 2026

Area	Household			Employment		
	2006	2026	% growth (p.a)	2006	2026	% growth (p.a)
Gerringong	1454	1921	1.4 %	1023	1766	2.8 %
Berry	541	873	2.4 %	552	682	1.1 %
Shoalhaven Heads	543	825	2.1 %	265	327	1.1 %
Bomaderry	2103	2486	0.8 %	2579	3494	1.5 %

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

2026 modelled link volumes: background growth rates and traffic transfer

Table 4.3 shows the 2026 link volumes output from the subarea TRACKS models by direction for key locations in the project area and wider traffic impact footprint. The table shows corresponding base year volumes and the resultant annual growth rates between 2006 and 2026, assuming no further upgrades (Gerringong upgrade, the project and Berry to Bomaderry upgrade) of the Princes Highway within the traffic impact footprint. **Table 4.4** shows the link volumes for the 2026 subarea TRACKS models both with and without the Princes Highway upgrades, in order to illustrate the likely magnitude of additional traffic transferred from the 'Sandtrack' following their construction.

Table 4.3: 2006 and 2026 TRACKS modelled background traffic growth (without upgrade)

Location	Background growth (without upgrade)				
	Modelled traffic volumes		Modelled growth		
	2006 (veh)	2026 (veh)	Growth (veh)	Per annum (%)	Total (%)
Princes Highway, north of Rose Valley Road	18,700	30,476	11,776	3.1 %	63.0 %
Princes Highway, west of Belinda Street	9634	15,824	6190	3.2 %	64.3 %
Princes Highway, east of Tannery Road	8993	14,807	5814	3.2 %	64.7 %
Princes Highway, south of Victoria Street	10,121	16,504	6383	3.2 %	63.1 %
The 'Sandtrack', south of Belinda Street	7746	12,323	4577	3.0 %	59.1 %
The 'Sandtrack', south of Beach Road	6259	9862	3603	2.9 %	57.6 %

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

Table 4.4: 2006 and 2026 TRACKS modelled traffic transfer (with/without upgrade)

Location	Background growth and traffic transfer (with upgrade)			
	Modelled traffic volumes		Modelled transfer	
	2026 – without upgrade (veh)	2026 – with upgrade (veh)	Total transfer (veh)	Total transfer (%)
Princes Highway, north of Rose Valley Road	30,476	30,476	0	0 %
Princes Highway, west of Belinda Street	15,824	24,144	8320	53 %
Princes Highway, east of Tannery Road	14,807	23,144	8337	56 %
Princes Highway, south of Victoria Street	16,504	23,253	6749	41 %
The 'Sandtrack', south of Belinda Street	12,323	4050	-8273	-67 %
The 'Sandtrack', south of Beach Road	9862	2507	-7355	-75 %

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

Key observations from **Table 4.3** and **Table 4.4** include:

- The total growth rate on the Princes Highway north of Rose Valley Road is 3.1 per cent per annum for both scenarios (as this location is not impacted by traffic transferring from the 'Sandtrack').
- At the Princes Highway east of Berry (Tannery Road), the transfer of traffic from the 'Sandtrack' following the upgrade would result in over 8000 (>50 per cent) more vehicles than as a result of background growth alone. Traffic on the corresponding section of the 'Sandtrack' would decrease by a similar amount.
- Once the Princes Highway is upgraded, a significant proportion of traffic would have diverted from the 'Sandtrack' onto the highway. The split of total traffic between the two routes with the upgrade would increase to around 85 per cent /15 per cent.
- Under a do-nothing approach (without upgrade), the split of total traffic between the Princes Highway and the 'Sandtrack' would remain around 55 per cent/45 per cent respectively.

It should be noted that 2026 two-way traffic volumes included in **Table 4.3** and **Table 4.4** are direct outputs from the TRACKS model and not the final traffic forecasts for the project. The key deliverable from the modelling exercise was the annual background linear traffic growth and reduction rates highlighted in **Table 4.3** and the anticipated traffic transfer percentages following the upgrade shown in **Table 4.4**. These outputs have been used to re-forecast traffic volumes based on 2009 and 2011 traffic patterns for key locations within and surrounding the project area.

4.2.3 Application of growth rates and traffic transfer proportions /traffic forecasting spreadsheet model

Forecasting model overview

Having completed the TRACKS models, the final stage in the modelling approach was to develop a traffic forecasting spreadsheet model, which included the following key tasks:

- Calculated linear growth rates and traffic transfer proportions (from TRACKS modelling) applied to 2009 and 2011 traffic surveys collected at corresponding carriageway locations, producing future year forecast traffic volumes on an annual basis to 2026.
- Linear extrapolation used to calculate forecast traffic volumes beyond 2026.
- Existing traffic patterns used to develop classified peak period traffic volumes for the key Princes Highway and 'Sandtrack' locations within and surrounding the project area.
- Carriageway to ramp factors derived from the TRACKS model and O-D surveys, which were linked to forecast traffic volumes to develop updated ramp volumes.
- As carriageway and ramp volume forecasts for the project were developed independently, a Matrix Furness process was included in the spreadsheet model to re-balance ramp volumes against carriageway traffic volumes.
- The Matrix Furness process was the penultimate task in the overall modelling procedure, which resulted in preliminary traffic volumes – without construction impacts for intermediate years.
- The final task was to update the preliminary traffic forecasts to reflect the travel time impacts and resultant redistribution of traffic to the 'Sandtrack' during the intermediate construction periods for the project.
- Preliminary traffic volumes were updated for the construction impact years, producing the final set of traffic forecasts for the project.

An example of the traffic forecasting spreadsheet model is included in Appendix C.

Carriageway to ramp factors and re-balancing process

Importantly, the application of growth rates to individual counts raised the issue of compatibility with ramps and carriageway sections upstream and downstream. To overcome this challenge, the TRACKS model and O-D surveys were used to calculate carriageway to ramp factors for each of the ramps onto and off the Princes Highway within the project area.

Using the preliminary forecast traffic volumes and these calculated factors; traffic forecasts for each ramp movement were estimated. The collected forecasts were then input into a Matrix Furness process to refine the initial forecasts. The forecasts calculated from this process were now consistent upstream and downstream along the entire corridor.

4.2.4 Final forecast traffic volumes

Traffic modelling scenario

Table 4.5 provides details of the modelling scenarios that were developed to forecast traffic volumes for three different road network configurations. The 2009 'Do nothing' scenario was required to calibrate the base year spreadsheet model and the 2037 'Do nothing' modelling was developed to assess the impacts of forecast traffic volumes on the existing road network, to determine the consequence of no action in the study area. The 2037 modelled future year corresponds to the design year of the project, which is 20 years after the estimated completion of the upgrade (2017).

Table 4.5: Traffic modelling scenarios

Modelling scenario	EA measure	Network description	Modelled year		
			2009	2017	2037
'Do nothing'	Consequence of no action	Existing road network	√	-	√
'Do minimum'	Operational impacts	Foxground and Berry bypass and Gerringong upgrade	-	√	√
'Do something'		Full Gerringong to Bomaderry upgrade	-	-	√

(Source: AECOM)

The combined operational impacts of the project and Gerringong upgrade (north of the project) were assessed, in addition to RMS' overall upgrade of the Princes Highway to four lanes from Waterfall to the Jervis Bay Road junction; developed as 'Do minimum' and 'Do something' scenarios respectively.

The 2037 'Do minimum' scenario, which includes both the project and Gerringong upgrade road network improvements, was developed to review the traffic impacts and operational performance of this upgrade combination. In addition, the 'Do something' scenario was developed to assess the traffic impacts and operational performance of the project as a result of the completion of the Gerringong upgrade, the project and the Berry to Bomaderry upgrade.

'Do minimum' scenario – forecast traffic volumes

In summary, forecast traffic volumes for the Princes Highway and the 'Sandtrack' routes were developed by applying growth rates to 2009 and 2011 observed traffic volumes and rebalancing for consistency.

Table 4.6 provides a summary of the forecast AADT at key locations for the base year and the following modelled future years:

- 2017 'Do minimum' upgrade opening year.
- 2037 'Do minimum' upgrade opening +20 design year.

Table 4.6: Final forecast traffic volumes (key locations) – 'Do minimum' scenario

Location	Annual average daily traffic (AADT)				
	2009 (All veh)	2017 (All veh)	Diff (2009-17)	2037 (All veh)	Diff (2017-37)
Princes Highway, north of Rose Valley Road	20,902	26,167	5265	39,330	13,163
Princes Highway, west of Belinda Street	10,447	14,978	4531	31,391	16,413
Princes Highway, east of Tannery Road	10,105	14,406	4301	30,191	15,785
Princes Highway, Berry bypass	-	13,331	-	26,767	13,436
Princes Highway, south of Victoria Street	12,605	16,789	4184	30,349	13,560
The 'Sandtrack', south of Belinda Street	8692	8797	105	7363	-1434
The 'Sandtrack', south of Beach Road	8271	7616	-655	7119	-497

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

Figure 4.6 provides a complete set of forecast traffic volumes at key locations in the project area including carriageway and on-ramp/off-ramp AADT for the Princes Highway upgrade 'Do minimum' scenario in 2037.

The project is planned to be completed by 2017. During the period 2009 to 2017 it is expected that:

- The Gerringong upgrade to the north of the project area would be completed, providing two lanes per direction on the Princes Highway between Mount Pleasant Lookout and Toolijooa Road.
- AADT volumes on the Princes Highway north of Rose Valley Road are expected to have increased by 5265 vehicles; equating to an average increase of about 600 vehicles per annum.
- North of Berry, AADT is expected to increase by about 4300 vehicles and 100 vehicles over the eight year period on the Princes Highway and the 'Sandtrack' respectively, including the transfer of traffic to the former from the latter following construction.
- In 2017, the bypass of Berry would accommodate around 13,000 vehicles per day, which equates to 79 per cent of the AADT on the highway south of Victoria Street.
- South of Berry, traffic on the Princes Highway is expected to increase by over 4100 vehicles and the corresponding 'Sandtrack' traffic is expected to decrease by about 650 vehicles between 2009 and 2017.
- Prior to the project, traffic is expected to follow current patterns and distributions, with a 55 per cent / 45 per cent split of total traffic between the Princes Highway and the 'Sandtrack' north of Berry, and a 60 per cent / 40 per cent split south of Berry in 2017.

Based on the predicted traffic growth from 2017 to 2037:

- AADT volumes on the Princes Highway north of Rose Valley Road are estimated to increase by about 13,000 vehicles over the 20 year post construction period (from 26,167 to 39,330 vehicles per day).
- Further south on the Princes Highway east of Tannery Road, AADT volumes are expected to grow by about 800 per annum. This increase includes a predicted transfer of traffic from the 'Sandtrack' due to improved traffic efficiency, road safety and travel time savings on the realigned and upgraded Princes Highway.
- In 2037, the bypass of Berry would accommodate around 27,000 vehicles per day, which equates to an annual growth rate of five per cent from 2017 and constitutes 88 per cent of the AADT on the highway south of Victoria Street.
- The split between the Princes Highway and the 'Sandtrack' traffic is estimated to change from 55 per cent / 45 per cent north of Berry, and 60 per cent/40 per cent south of Berry in 2009 to around 81 per cent / 19 per cent at both locations in 2037.

'Do something' scenario – forecast traffic volumes

Table 4.7 provides a summary of the forecast AADT at key locations for the modelled base year and the following two design year scenarios:

- 2017 'Do something' upgrade opening year (same road network assumptions as the 'Do minimum' scenario.
- 2037 'Do something' upgrade opening +20 design year.

Table 4.7: Final forecast traffic volumes (key locations) – 'Do something' scenario

Location	Annual average daily traffic (AADT)				
	2009 (All veh)	2017 (All veh)	Diff (2009-17)	2037 (All veh)	Diff (2017-37)
Princes Highway, north of Rose Valley Road	20,902	26,167	5265	39,330	13,163
Princes Highway, west of Belinda Street	10,447	14,978	4531	32,738	17,760
Princes Highway, east of Tannery Road	10,105	14,406	4301	31,487	17,081
Princes Highway, Berry bypass	N/A	13,331	-	28,184	14,853
Princes Highway, south of Victoria Street	12,605	16,789	4184	32,746	15,957
The 'Sandtrack', south of Belinda Street	8692	8797	105	6015	-2782
The 'Sandtrack', south of Beach Road	8271	7616	-655	4722	-2894

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

Figure 4.7 provides a complete set of forecast traffic volumes at all locations in the project area including carriageway, on-ramp and off-ramp AADT for the project. Based on the predicted traffic growth from 2017 to 2037:

- AADT volumes on the Princes Highway west of Belinda Street are expected to have increased by 17,760 vehicles; equating to an average increase of about 900 vehicles per annum over the 20 year period.
- On the Princes Highway south of Berry (Victoria Street), AADT is expected to grow by around 16,000 vehicles between 2017 and 2037. This increase includes a predicted transfer of traffic from the 'Sandtrack' due to improved traffic efficiency, road safety and travel time savings on the upgraded highway.
- In 2037, the bypass of Berry would accommodate around 28,000 vehicles per day, which equates to an average annual growth of around 750 vehicles from 2017 and constitutes 86 per cent of the AADT on the highway south of Victoria Street.
- The split between the Princes Highway and the 'Sandtrack' traffic is estimated to change from 55 per cent / 45 per cent to the north of Berry (60 per cent / 40 per cent to the south) in 2009 to 84 per cent / 16 per cent in 2037 (87 per cent / 13 per cent to the south), with the majority of traffic switching from the 'Sandtrack' in favour of the Princes Highway by 2037.

Table 4.8 displays the final AADT forecasts for the project carriageway, on-ramps and off-ramps throughout the project area, by vehicle classification and direction for the key modelled scenarios. The AADT forecasts for the 'Sandtrack' are also included for completeness.

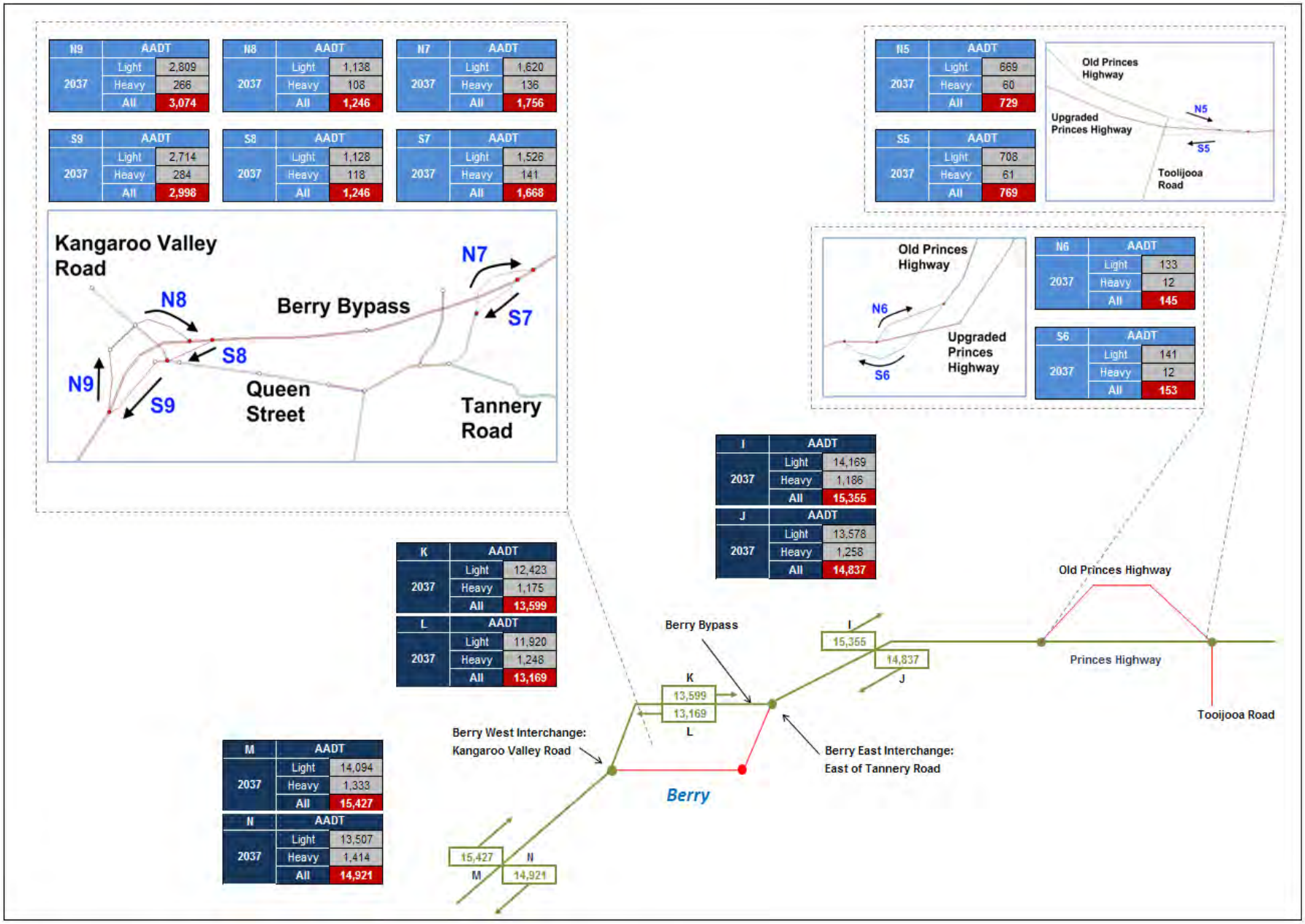


Figure 4.6: 2037 project carriageway and ramp AADT – 'Do minimum' scenario

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

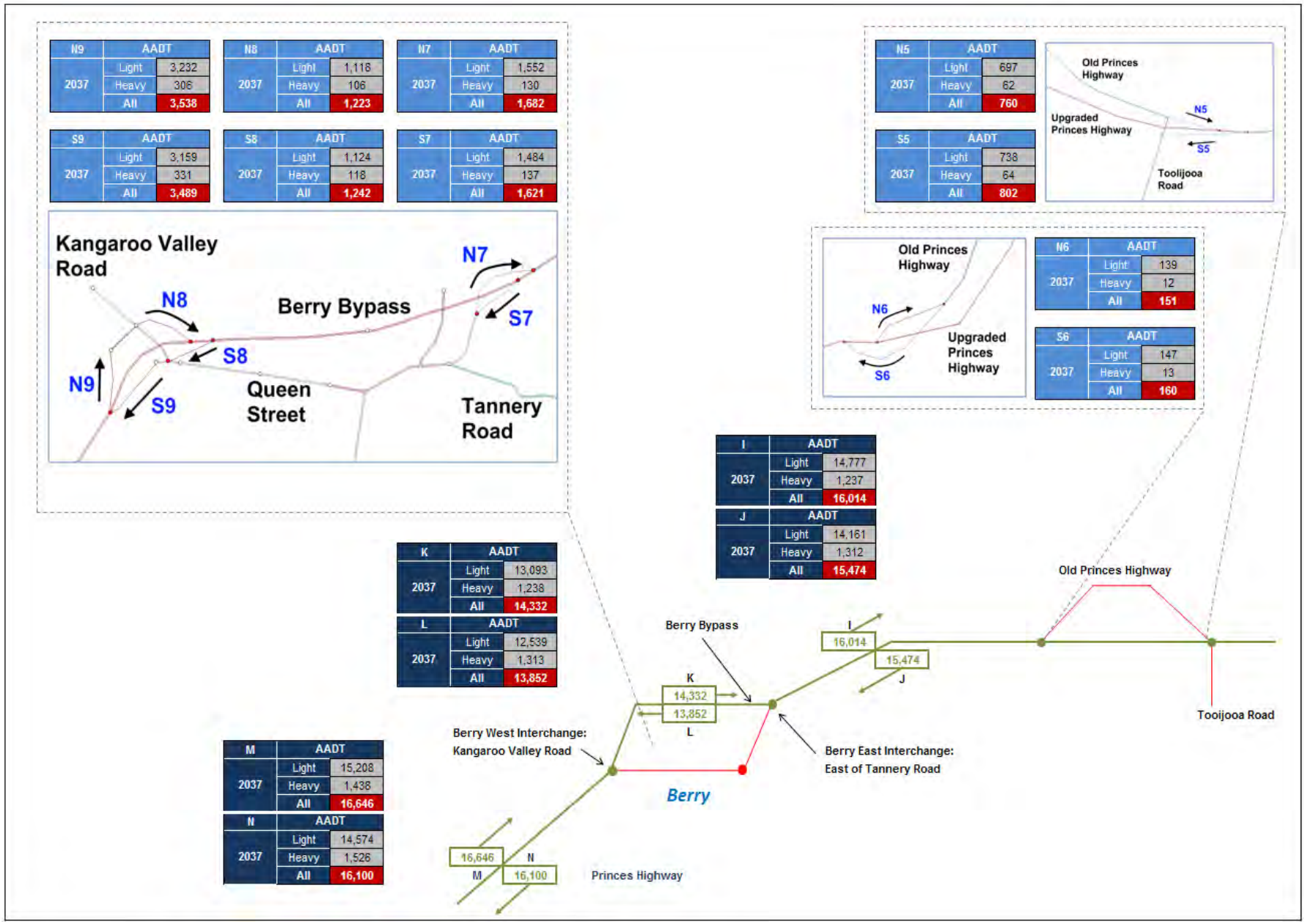


Figure 4.7: 2037 project carriageway and ramp AADT – 'Do something' scenario
(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

Table 4.8: Final forecast AADT volumes (all locations)

Ref.	Route/Direction	Location	AADT																	
			2009			2010			2011			2017 (Do minimum)			2037 (Do minimum)			2037 (Do something)		
			LV	HV	All	LV	HV	All	LV	HV	All	LV	HV	All	LV	HV	All	LV	HV	All
Foxground and Berry Bypass (FBB)																				
G	Sandtrack NB	South of Belinda Street	4,276	142	4,418	4,402	146	4,549	4,529	151	4,679	4,158	176	4,334	3,399	344	3,743	2,777	281	3,058
H	Sandtrack SB	South of Belinda Street	4,136	137	4,274	4,258	142	4,400	4,381	146	4,526	4,293	170	4,463	3,288	333	3,620	2,686	272	2,958
	Two-Way		***8,412***	***280***	***8,692***	***8,661***	***288***	***8,949***	***8,909***	***296***	***9,206***	***8,451***	***346***	***8,797***	***6,687***	***676***	***7,363***	***5,463***	***553***	***6,015***
N5	Princes Hwy NB On	Toolijooa Road										315	38	352	669	60	729	697	62	760
S5	Princes Hwy SB Off	Toolijooa Road										324	39	362	708	61	769	738	64	802
N6	Princes Hwy NB Off	Austral Park Road										63	8	70	133	12	145	139	12	151
S6	Princes Hwy SB On	Austral Park Road										65	8	72	141	12	153	147	13	160
I	Princes Hwy NB	North of Berry	4,280	606	4,887	4,681	618	5,300	4,827	638	5,465	6,604	749	7,353	14,169	1,186	15,355	14,777	1,237	16,014
J	Princes Hwy SB	North of Berry	4,590	628	5,219	4,474	656	5,130	4,613	676	5,290	6,258	795	7,053	13,578	1,258	14,837	14,161	1,312	15,474
	Two-Way		***8,871***	***1,235***	***10,105***	***9,156***	***1,274***	***10,430***	***9,441***	***1,314***	***10,755***	***12,862***	***1,543***	***14,406***	***27,747***	***2,444***	***30,191***	***28,938***	***2,549***	***31,487***
N7	Princes Hwy NB On	Northern Interchange										475	54	529	1,620	136	1,756	1,552	130	1,682
S7	Princes Hwy SB Off	Northern Interchange										484	61	546	1,526	141	1,668	1,484	137	1,621
K	Princes Hwy NB	Berry Bypass										6,125	699	6,824	12,423	1,175	13,599	13,093	1,238	14,332
L	Princes Hwy SB	Berry Bypass										5,770	737	6,507	11,920	1,248	13,169	12,539	1,313	13,852
	Two-Way											***11,895***	***1,436***	***13,331***	***24,344***	***2,423***	***26,767***	***25,632***	***2,552***	***28,184***
N8	Princes Hwy NB On	Southern Interchange										387	44	431	1,138	108	1,246	1,118	106	1,223
S8	Princes Hwy SB Off	Southern Interchange										413	53	465	1,128	118	1,246	1,124	118	1,242
N9	Princes Hwy NB Off	Southern Interchange										1,953	223	2,176	2,809	266	3,074	3,232	306	3,538
S9	Princes Hwy SB On	Southern Interchange										1,932	247	2,178	2,714	284	2,998	3,159	331	3,489
M	Princes Hwy NB	South of Berry	5,707	701	6,407	5,887	723	6,609	6,067	745	6,812	7,692	877	8,569	14,094	1,333	15,427	15,208	1,438	16,646
N	Princes Hwy SB	South of Berry	5,454	743	6,197	5,626	767	6,393	5,798	790	6,588	7,289	931	8,220	13,507	1,414	14,921	14,574	1,526	16,100
	Two-Way		***11,161***	***1,444***	***12,605***	***11,513***	***1,490***	***13,002***	***11,865***	***1,535***	***13,400***	***14,981***	***1,808***	***16,789***	***27,601***	***2,748***	***30,349***	***29,781***	***2,965***	***32,746***
O	Sandtrack NB	South of Beach Road	4,093	177	4,270	4,210	182	4,393	4,328	187	4,516	3,669	218	3,887	3,155	520	3,675	2,093	345	2,437
P	Sandtrack SB	South of Beach Road	3,836	165	4,001	3,946	170	4,116	4,057	175	4,232	3,525	203	3,729	2,959	485	3,444	1,962	322	2,284
	Two-Way		***7,929***	***342***	***8,271***	***8,157***	***352***	***8,509***	***8,385***	***362***	***8,747***	***7,195***	***421***	***7,616***	***6,114***	***1,005***	***7,119***	***4,055***	***667***	***4,722***

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

4.3 Operational traffic modelling methodology

4.3.1 Introduction

The strategic TRACKS models were utilised to generate 2006 base and forecast 2026 future year traffic demand matrices for the average daily 24 hour period. As previously discussed, the key objective of the TRACKS modelling was to derive expected traffic growth rates on the Princes Highway and other key roads in the project area, based on expected land use changes as well as proposed road network improvements including the project. In turn these growth rates were used to create traffic forecasts on key regional and local roads in the project area based on these developments.

Whereas the TRACKS model provides an aggregated representation of traffic demand, Paramics microsimulation models have the ability to focus on the individual vehicles and movements at key times in a project area specific road network. By simulating driver behaviour, traffic interaction and operation, detailed engineering design such as the Berry bypass and access arrangements can be evaluated far more comprehensively, including:

- A determination of the anticipated operational performance of the project. More specifically, to assess the feasibility of the project concept design and confirm the functional capability and benefits in terms of:
  - Mobility: efficient movement of people and goods on the upgraded highway, including the operational benefits of the Berry bypass.
  - Access: the ability to enter/exit Berry via the respective off-ramps/on-ramps without delays and congestion; particularly during the periods of peak period travel demand (100th highest hour).
- To confirm that the project (carriageway and ramps) would accommodate future growth, population and freight needs or identify locations where the proposed concept design may not perform at acceptable service levels.
- Quantification and visualisation of local and regional traffic flows, including a comparison of pre and post-upgrade scenarios.

Therefore, using traffic growth rates from the TRACKS models as input, Paramics microsimulation models were developed to assess the operational performance of the road network during peak periods, with a particular focus on the two grade-separated interchanges, intersections within Berry and the surrounding local road network.

This section outlines and discusses the approach used to create Paramics microsimulation models to replicate current and future traffic conditions in Berry for a number of scenarios both with and without the construction of the project.

4.3.2 Data collection

As summarised and discussed in Section 2.4 traffic data has been collected to provide an in-depth understanding of traffic volumes and patterns in and around Berry to ensure the development of models which can accurately replicate current operating conditions. During the development of the base year model traffic data was collected on typical weekdays (Tuesday, Wednesday, and Thursday, outside of school holidays). These days are deemed to have the most stable and therefore most typical traffic volumes and patterns, as they are less likely to be influenced by weekend and holiday activities.

The following vehicle classified turning counts were collected during these times to enable the development of the models:

- Princes Highway and Victoria Street.
- Queen Street (Princes Highway) and Albany Street.
- Kangaroo Valley Road and North Street.
- Queen Street (Princes Highway) and Alexandra Street.
- Albert Street and Alexandra Street.
- Queen Street (Princes Highway) and Prince Alfred Street.
- Prince Alfred Street and Victoria Street.
- Princes Highway and Woodhill Mountain Road.
- Princes Highway and Tannery Road.

This weekday survey data was supplemented with additional traffic data (both current and historic) including tube counts and turning counts from the RMS' and local Council surveys. All data used in the development of the base year models was scrutinised to ensure it contained no errors or inconsistencies.

Historical data has shown that Berry's road network is subjected to the highest levels of demand during public holidays and other peak recreational times (100th highest hour). The distribution and volume of traffic during these times varies significantly from weekday traffic; for this reason a comprehensive suite of additional surveys were undertaken during the Easter and Anzac Day 2011 public holiday weekend (Thursday 21 April – Tuesday 26 April 2011), one of the busiest holiday peak periods of the year. The data collected was used to develop detailed O-D demand matrices for the northbound and southbound 100th highest hour models (see Section 2.4.6).

Site visits and observations were also undertaken to collect additional information regarding the layout and operation of the road network during the development of the base year model. The site visits were used to develop an understanding of the existing road network and traffic behaviour in Berry, including:

- Posted speed limits.
- Intersection configuration.
- Lane usage.
- Location of on- and off- street parking.
- Bus stop locations.
- Bottlenecks and pinch-points within and surrounding Berry.

All of the above data in conjunction with forecasting model outputs, including traffic volumes and growth rates, were used to develop the Paramics demand matrices used during the modelling process.

4.3.3 Traffic demand – base year model

Paramics traffic simulation modelling uses O-D assignment via O-D demand matrices; vehicles enter and leave the road network via model zones, with zones representing either a key location within a modelled area, or a road that leads into or out of the modelled area. O-D demand matrices list the number of trips that travel between specific zone combinations during the modelled period. Separate O-D matrices have been defined for light and heavy vehicles for all models due to the differences in trip patterns between these vehicle types.

Demand matrices detailing the movements of vehicles between zone combinations were created for the base year models using a combination of the traffic data sources listed in Section 4.3.2. Key O-D combinations were provided directly by surveyed data (see Section 2.4.6); some smaller O-D movements which were not captured directly by the surveys were calculated using an O-D matrix estimation process. This is a standard industry process which produces a representation of traffic patterns and volumes in a modelled area.

The models developed during this study represent peak-hour periods; O-D matrices have been developed with one hour demand volumes accordingly. Although the analysed model period covers only a single peak hour, a minimum 30 minute warm-up period has been used prior to the analysis period to ensure that the road network is populated at the time the analysis starts (analysed vehicles are not released into an empty model network as this would result in an inaccurate performance analysis).

In addition, the distribution of traffic over a modelled peak hour has been further refined using a peak hour profile, created from surveyed data. This allows the specific distribution of hourly traffic into 15 minute intervals, increasing the accuracy of modelling and allowing a finer level of detail during the assessment.

4.3.4 Base year model development

It is standard microsimulation practice to create a base model to replicate existing traffic conditions before developing any future options scenarios. This process, known as model calibration, is undertaken to ensure that vehicles in the modelled road network behave as expected; this includes ensuring typical routes are used, movements at intersections are representative and accurate, and modelled traffic volumes match surveyed data.

The Berry Paramics model was calibrated against the criteria outlined in the *Highways Agency's (UK) Volume 12 of the Design Manual for Roads and Bridges (DMRB)* and audited following the *RTA's Audit Schedule* defined by the *RTA NSW Manual for Modellers, Stage 4 Auditing*, as part of the *Gerringong to Bomaderry Princes Highway Upgrade Preliminary Traffic Assessment*, creating a calibrated base year model for 2008 weekday AM peak and PM peak hours. **Figure 4.8** shows the modelled area and the correlation between key locations in and around Berry and zones within the Paramics models. **Figure 4.9** shows the base year road network and zones in the Paramics model.

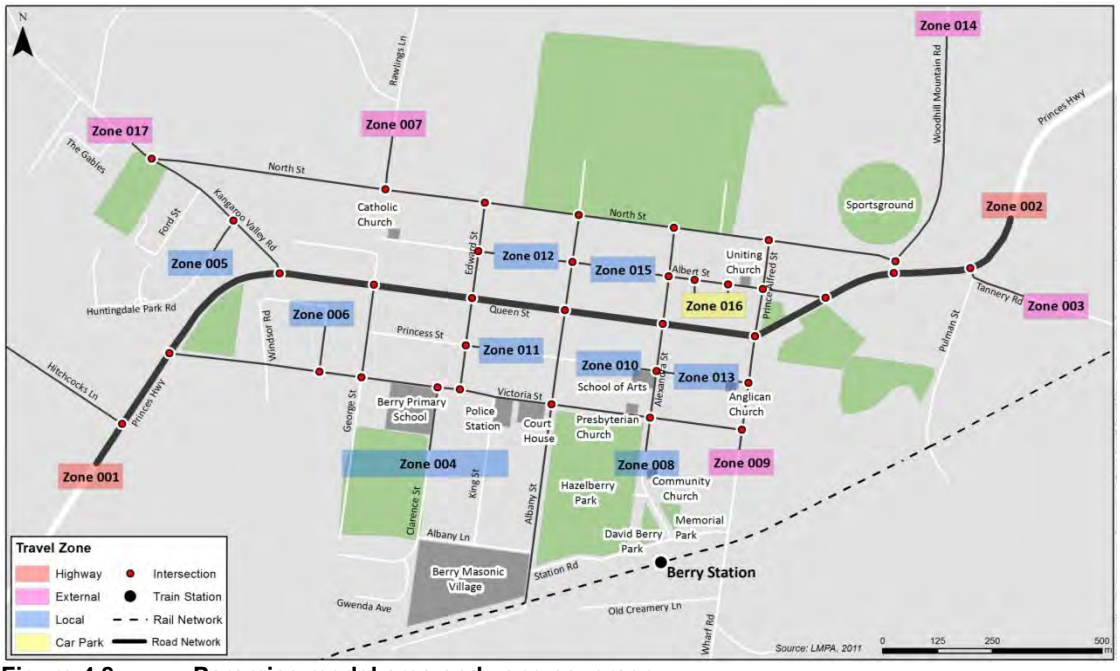


Figure 4.8: Paramics model area and zone coverage

(Source: AECOM)

Figure 4.9: Paramics base year road network and zone system

(Source: AECOM)

4.3.5 Future year model development

Following the calibration of the base model, forecast traffic growth has been applied to model a 'Do nothing' scenario, including the anticipated future performance in 2037 – the design year of the project – should the project not be constructed. Modelling of the 'Do nothing' scenario therefore used the existing road network, shown in **Figure 4.9**.

The 'Do nothing' scenario incorporates forecast traffic demand using the corresponding future year TRACKS model growth rates; in broad terms this assumes that traffic distribution patterns in and around Berry remain roughly unchanged, and that traffic would continue to grow at the current rate of over three per cent per annum.

Following the development of a ‘Do nothing’ model, ‘Do minimum’ and ‘Do something’ models were created to assess the performance of Berry’s road network including the Berry bypass and access arrangements proposed by the project. **Figure 4.10** indicates the modifications made to the base year road network in these models.

Figure 4.10: Paramics ‘Do minimum’ and ‘Do something’ road network and zone system

(Source: AECOM)

As well as changes to the road network the 'Do minimum' and 'Do something' scenarios also assume variations to the 'Do nothing' models in terms of traffic patterns and volumes in and around Berry, largely caused by the anticipated transfer of traffic from the 'Sandtrack' to the Princes Highway following the upgrade. Corresponding TRACKS models for these scenarios were used to predict growth rates to be applied to the base year Paramics model demand, including this transfer of traffic. In this scenario, traffic on the Princes Highway would be expected to grow at a higher rate than the three per cent per annum used in the 'Do nothing' models. Traffic demand on local roads and other regional routes including Kangaroo Valley Road, Tannery Road and Prince Alfred Street also used route-specific growth rates based on the expected re-routing of traffic following construction.

A further scenario was developed to determine the performance of the road network during construction for a worst-case situation. This model was used to analyse the effects of traffic transferring from the 'Sandtrack' in advance of construction being completed. In this case an increase in traffic demand and change in traffic distribution based on the 'Do something' scenario, including high growth on the Princes Highway due to the transfer of traffic from the 'Sandtrack', was paired with the 'Do nothing' road network.

As discussed in Section 2.4 and Section 4.3.2, traffic in and around Berry is highest during public holiday and other recreational peak times (100th highest hour); it is at these times when the road network would be subjected to the highest demand, and therefore at its lowest levels of performance. Paramics modelling has therefore been used to analyse the performance of Berry's road network for the 'Do nothing', 'Do minimum', 'Do something', and construction scenarios, when subjected to 100th highest hour levels of demand.

The 2011 northbound and southbound 100th highest hour demand O-D matrices were developed (as discussed in Section 4.3.3) using a comprehensive suite of traffic data collected during the Easter 2011 period. The 2011 matrices were then developed using scenario-specific growth factors from the TRACKS model and anticipated changes to trip patterns to create 2037 100th highest hour northbound (NB) and 2037 100th highest hour southbound (SB) peak period O-D demand matrices.

The 100th highest hour demand matrices have been used to analyse the 'Do nothing' models, assessing the performance of the current road network both now and in the future during traffic peaks of this magnitude. In addition, corresponding 100th highest hour models for all scenarios including the construction of the project have also been created, analysing the performance of the proposed upgrade including an assessment of highway, ramp and interchange performance, as well as the elements and intersections within Berry that would remain unchanged.

The results of the future year Paramics microsimulation modelling are included in Chapter 5 and Chapter 7.

5 Future conditions without the project

This chapter focuses on the anticipated performance of the road network in the project area should the highway not be upgraded, which is referred to as the 'Do nothing' scenario. The forecast roadway LoS, based on the operational speed and time spent following vehicles on extra-urban sections of the highway has been assessed using forecast AM peak, PM peak and 100th highest hour (northbound and southbound peak directional) traffic volumes for the project design year of 2037. Intersection LoS, based on the capacity and efficiency of the local road network and intersections in the urban area of Berry, has also been assessed using Paramics models that have been specifically developed for this scenario.

5.1 Roadway level of service

Table 5.1 indicates that midblock locations on the Princes Highway in the project area would operate at an unacceptable LoS E or LoS F for all peak periods in the absence of the project, should traffic continue to grow at current rates. This compares to LoS D during AM and PM peak hours and LoS E during 100th peak hours at present, as discussed in Section 3.4.

During the 100th highest hour northbound (NB) and southbound (SB) peak hours, the Princes Highway is anticipated to operate at LoS F, indicating that the traffic volumes forecast would exceed the existing capacity of the highway, resulting in traffic flow breakdown and major delays. The alternative 'Sandtrack' route would also be expected to deteriorate to LoS D during typical AM peak and PM peak hours and LoS E during the 100th highest hour (southbound) peak period. Overall, the results show that the provision of additional road capacity throughout the project area is necessary to ensure acceptable highway performance.

Table 5.1: 2037 midblock level of service summary ('Do nothing' scenario)

Location	AM peak hour (veh/h)		PM peak hour (veh/h)		100NB (veh/h)		100SB (veh/h)	
	2-way volume	LoS	2-way volume	LoS	2-way volume	LoS	2-way volume	LoS
Princes Highway: Toolijooa Road – Tannery Road	1381	E	1658	E	2172	F	2372	F
Princes Highway: Victoria Street – South of Schofields Lane	1749	E	2062	E	2286	F	2714	F
'Sandtrack': Dooley Road – Shoalhaven Heads Road	1108	D	1324	D	1539	D	1789	E

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model and AUSTROADS Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009)

5.2 Intersection level of service

Paramics microsimulation modelling software has been used to assess the road network within and around Berry for the project design year of 2037, assuming that the road network is not upgraded. The results, which are included in **Table 5.2**, illustrate that the existing performance of key intersections in the town would deteriorate when subjected to the expected traffic demand from both local traffic and through movements, particularly during the 100th highest hour southbound peak period.

Table 5.2: 2037 intersection level of service summary ('Do nothing' scenario)

Intersection / approach road	100NB			100SB		
	Approach volume (veh/h)	Average delay(s)	LoS	Approach volume (veh/h)	Average delay(s)	LoS
Princes Highway / Victoria Street						
Princes Highway northbound	1681	0.0	A	870	94.7	A
Victoria Street westbound	83	0.2	A	173	3.9	A
Princes Highway southbound	486	0.0	A	918	0.0	A
Total	2250	0.0	A	1961	42.4	D
Queen Street (Princes Highway) / Kangaroo Valley Road						
Queen Street eastbound	1469	0.2	A	733	104.4	F
Kangaroo Valley Road	270	276	F	106	773.9	F
Queen Street westbound	663	19.5	B	1056	15.4	B
Total	2402	36.5	C	1895	92.3	F
Queen Street (Princes Highway) / Alexandra Street						
Queen Street eastbound	1637	0.6	A	789	86.2	F
Alexandra Street southbound	130	276	F	106	426.6	F
Queen Street westbound	634	1.0	A	1011	3.3	A
Alexandra Street northbound	136	329	F	98	438.9	F
Total	2537	32.4	C	2004	79.6	F
Queen Street (Princes Highway) / Prince Alfred Street						
Queen Street eastbound	1589	2.0	A	766	90.2	F
Queen Street westbound	659	3.9	A	1002	5.3	A
Prince Alfred Street northbound	222	197	F	156	296.9	F
Total	2470	20.0	B	1924	62.7	E
Queen Street (Princes Highway) / Albert Street						
Queen Street eastbound	1595	4.6	A	766	72.6	F
Albert Street	83	20.5	B	42	137.7	F
Queen Street westbound	855	16.8	B	1100	41.6	C
Princes Highway / Tannery Road	2533	8.9	A	1908	56.2	E
Princes Highway / Tannery Road						
Princes Highway northbound	1656	4.0	A	776	72.7	F
Princes Highway southbound	583	1.2	A	996	25.6	B
Tannery Road	166	5.4	A	81	696.7	F
Total	2405	3.4	A	1853	74.7	F

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model and AUSTROADS Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009)

It should be noted that the LoS calculated by the Paramics modelling is based on the capacity and efficiency of the local road network and intersections within and around Berry. In comparison, the midblock LoS presented in Section 5.1 represents the operational performance of rural highway locations in the traffic impact footprint, based on the travel speeds and the time spent following other vehicles. For this reason, the methods produce contrasting LoS results which vary along the length of the Princes Highway within the project area. The performance of particular sections or locations should be examined and interpreted in isolation; specific to the assessment criteria.

Large volumes of traffic demand on Queen Street (Princes Highway) would leave few gaps in the traffic flow and would therefore create significant delays to vehicles proceeding via the minor approach roads of intersections. In addition to this, some major intersection approach roads on Queen Street would also begin to incur delays (for example at Kangaroo Valley Road, Prince Alfred Street, Albert Street and Tannery Road), resulting in widespread congestion across the town.

Paramics modelling shows that as well as significant traffic delays at intersections, traffic queuing back to adjacent intersections could also become an issue, further diminishing the performance of the local road network in Berry. The results of the modelling undertaken illustrate that some local roads and intersections in Berry would operate at unacceptable performance levels based on the predicted increase in traffic if the current road network remains unchanged.

5.3 Travel speeds and travel times

Travel times throughout the project area would increase as the level of traffic and congestion grows on the existing road network. In the west of the project area, intersection delays in Berry would significantly increase especially during the peak periods, as shown in Section 5.2. This would be caused by local traffic conflicting with major through movements in the town at key intersections. The analysis shows that during peak holiday periods the average delay to vehicles approaching intersections from key local roads such as Tannery Road and Alexandra Street would be in the order of four to five minutes; Prince Alfred Street three minutes; and Kangaroo Valley Road two minutes. Through movements on the Princes Highway would also experience delays of up to one minute per intersection during the busiest holiday peak periods.

To the north of Berry where the Princes Highway passes through rural areas, an increase in traffic on the existing highway would result in lower operating speeds and therefore longer travel times. Midblock LoS analysis (documented in Section 5.1) indicates that in 2037 average travel speeds in the AM peak hour would fall to around 55 kilometres per hour at locations with an 80 kilometres per hour or 90 kilometres per hour posted speed; this is significantly lower than the existing average operating speed. Average travel speeds in the PM peak hour would fall further still, with higher traffic volumes than the AM peak. During the busiest holiday peaks traffic would not be expected to exceed an average speed of 45 kilometres per hour.

In addition, an increase in traffic on the existing highway would increase the likelihood of crashes and other incidents that lead to travel delays and congestion (see Section 5.4). As an example, following construction of the recently approved Gerringong upgrade, the highway immediately to the north of the project area would be upgraded to four lanes with a central median and safety barrier separating opposing traffic. This would require southbound highway traffic to merge into a single lane immediately east of Toolijooa Road should the Foxground and Berry bypass project not be constructed, creating potential performance and safety issues at this location.

Increased travel times due to these factors would result in negative economic impacts to freight, commuter and tourist traffic travelling both within the project area and longer distance regional destinations. Increases in travel times on the highway would reduce the attractiveness of the local area to commercial business and industry; new businesses may choose to locate outside the area to gain adequate freight access, while increased commuting

times in the project area would hinder employment growth in the region. The significant tourism industry in the region would also suffer with recreational travellers becoming less willing to accept the time and cost associated with travelling through the area.

5.4 Traffic crashes

The frequency of crashes on both the Princes Highway and the 'Sandtrack' would be expected to increase should traffic continue to grow while the road network within the traffic impact footprint remains unchanged. The same potential for crashes, indicated by the crash rates per vehicle kilometre travelled in Section 3.1, would remain. On the Princes Highway, crashes due to the substandard horizontal and vertical alignment in the northern section of the project area would continue to be a particular concern. Continued traffic growth on the 'Sandtrack' would also be expected to increase the frequency of crashes on this alternative route, where a number of fatalities have occurred in recent years.

Traffic on the road network within the traffic impact footprint is expected to continue to grow at current rates of around three per cent per annum in the 'Do nothing' scenario; this would result in total linear growth of 78 per cent by the design year of 2037. Assuming current crash trends remain constant in the future; this increase in traffic would create a directly proportional increase in crash frequency and costs. Annual crashes on the Princes Highway would be expected to increase from an average of over 16 to around 29. The total annual cost of crashes would rise from $7.4 million to $13.2 million. The total annual cost of crashes on the 'Sandtrack' would be expected to increase from $10.7 million to over $19.1 million.

These estimates assume that the likelihood and severity of crashes would remain constant despite a significant increase in traffic. It is likely however that continued traffic growth would increase the probability of crashes per kilometre travelled.

As an example, growth in intersection throughput in the project area would increase the frequency of conflicting at-grade turning movements and consequently the potential for crashes, particularly in and around Berry. In addition, an increase in demand on rural sections of the highway would result in lower operating speeds and more time spent following other vehicles. This often results in vehicles travelling closer together, increasing the likelihood of rear-end crashes. In these conditions drivers can also become frustrated as their ability to travel their desired speed is impaired; often more risks are taken and crashes occur as a result. Similarly a reduction in the gap between vehicles would also increase the difficulty for vehicles joining and leaving the highway via local roads and property accesses; motorists may take greater risks when entering and leaving the highway as the opportunities to do so become less frequent.

Although the frequency of crashes typically increases in proportion to traffic growth, it is also known that increases in traffic can lead to a decrease in the severity of crashes that occur. For example this could be as a result of lower operating speeds, or changes in commonly occurring crash types. In the 'Do nothing' scenario it has been assumed that crash costs per kilometre travelled would remain constant in the future, and that the additional costs associated with increased crash frequency would be balanced by a reduction in the average crash cost based due to a decrease in the typical severity of crashes that occur.

In summary, the forecast growth in traffic on the existing road network within the traffic impact footprint would result in a considerable increase in the total number and cost of crashes occurring. Assuming current crash rates and costs remain constant the total number and cost of crashes would increase by 78 per cent by the design year of 2037.

5.5 Public transport

Current public transport options in the project area comprise buses, trains, walking and cycling, described in Section 2.3.

An increase in vehicles on the existing road network within the project area would result in lower travel speeds on the Princes Highway in rural areas, and increased delays at intersections within Berry. Higher traffic volumes in Berry would also reduce the amenity of the town for pedestrians and increase walking and cycling travel times in the town. If the project was not constructed, the following impacts to public transport services in the project area would potentially be experienced:

- Buses:
  - An increase in bus service travel times due to slower travel speeds and increased intersection delays.
  - More frequent delays to services caused by traffic incidents and congestion in the project area.
  - The potential for crashes caused by buses stopping on the Princes Highway and local roads to pick-up and drop-off passengers would increase in proportion to the expected growth in traffic.
  - Longer travel times to and from bus stops by supplementary travel modes (e.g. car passenger, walking to/from bus stop, etc) due to an increase in traffic volumes, slower travel speeds and increased intersection delays.
  - Reduced amenity for bus users waiting at stops; an increase in traffic would result in impacts including a reduction in air quality, increase in noise, and reduction in pedestrian roadside safety.
- Rail services:
  - Longer travel times for rail passengers travelling to and from Berry train station by car, bus, walking and cycling, due to an increase in traffic volumes, slower travel speeds and increased intersection delays.
- Walking:
  - Increased delays when crossing roads at uncontrolled points without pedestrian facilities in the project area (particularly Berry), caused by heavier traffic flows.
  - Reduced overall amenity throughout the project area including a reduction in air quality, increase in noise, and reduction in pedestrian safety.
- Cycling:
  - Increased delays at intersections in Berry due to an increase in conflicting traffic volumes travelling through the town.
  - Reduced cyclist road safety; increased potential for accidents with other road users throughout the project area caused by an increase in traffic on the existing road network.
  - Reduced overall amenity throughout the project area including a reduction in air quality and increase in noise.

6 The Foxground and Berry bypass project

6.1 Description of the project

The project would involve widening and realigning of 11.6 kilometres of the Princes Highway, located within the Kiama and Shoalhaven LGAs. The project would achieve a four lane divided highway (two lanes in each direction) with median separation between Toolijooa Road north of Foxground and Schofields Lane, south of Berry (the project). The project would include bypasses of Foxground and Berry.

The project would comprise the following key features:

- Construction of a four lane divided highway (two lanes in each direction) with median separation (wire rope barriers or concrete barriers where space is constrained, such as at bridge locations).
- Bypasses of the Foxground bends and the Berry township.
- Construction of around 6.6 kilometres of new highway where the project deviates from the existing highway alignment at Toolijooa Ridge, the Foxground bends and the Berry township.
- Provision for the possible widening of the highway (if required in the future) to six lanes within the road corridor and, in some areas, construction of the road formation to accommodate future additional lanes where safety considerations, traffic disruption and sub-optimal construction practices are to be avoided.
- Grade-separated interchanges at:
  - Toolijooa Road.
  - Austral Park Road.
  - Tindalls Lane.
  - East of Berry at the existing Princes Highway, referred to as the northern interchange for Berry.
  - West of Berry at Kangaroo Valley Road referred to as the southern interchange for Berry.
- A major cutting at Toolijooa Ridge (around 900 metres long and up to 26 metres deep).
- Six lanes (two lanes plus a climbing lane in each direction) through the cutting at Toolijooa Ridge for a distance of 1.5 kilometres.
- Four new highway bridges:
  - Broughton Creek bridge 1, a four span concrete structure around 170 metres in length and nine metres in height.
  - Broughton Creek bridge 2, a three span concrete structure around 75 metres in length and eight metres in height.
  - Broughton Creek bridge 3, a six span concrete structure around 190 metres long and 13 metres in height.
  - A bridge at Berry, an 18 span concrete structure around 600 metres long and up to 12 metres in height.

- Three highway overbridges:
  - Austral Park Road interchange, providing southbound access to the highway.
  - Tindalls Lane interchange, providing southbound access to and from the highway.
  - Southern interchange for Berry, providing connectivity over the highway for Kangaroo Valley Road along its existing alignment.
- Eight underpasses including roads, drainage structures and fauna underpasses:
  - Toolijooa Road interchange, linking Toolijooa Road to the existing highway and providing northbound access to the upgrade.
  - Property access and fauna underpass in the vicinity of Toolijooa Ridge at chainage 8400.
  - Dedicated fauna underpass in the vicinity of Toolijooa Ridge at chainage 8450.
  - Property access underpass between Toolijooa Ridge and Broughton Creek at chainage 9475.
  - Combined drainage and fauna underpass in the vicinity of Austral Park Road at chainage 12770.
  - Combined drainage and fauna underpass in the vicinity of Tindalls Lane at chainage 13320.
  - Dedicated fauna underpass in the vicinity of Tindalls Lane at chainage 13700.
  - Property access underpass between the Tindalls Lane interchange and the northern interchange for Berry in the vicinity of at chainage 15100.
- Modifications to local roads, including Toolijooa Road, Austral Park Road, Gembrook Lane, Tindalls Lane, North Street, Queen Street, Kangaroo Valley Road, Hitchcocks Lane and Schofields Lane.
- Diversion of Town Creek into Bundewallah Creek upstream of its confluence with Connollys Creek and to the north of the project at Berry.
- Modification to about 47 existing property accesses.
- Provision of a bus stop at Toolijooa Road and retention of the existing bus stop at Tindalls Lane.
- Dedicated u-turn facilities at Mullers Lane, the existing highway at the Austral Park Road interchange, the extension to Austral Park Road and Rawlings Lane.
- Roundabouts at the southern interchange for Berry and the Woodhill Mountain Road junction with the exiting Princes Highway.
- Two culs-de-sac on North Street and the western end of Victoria Street in Berry.
- Tie-in with the existing highway about 75 metres north of Toolijooa Road and about 440 metres south of Schofields Lane.
- Left in/left out only provisions for property accesses to the upgraded highway.
- Dedicated public space with shared pedestrian/cycle facilities along the southern side of the upgraded highway from the playing fields on North Street to Kangaroo Valley Road.
- Ancillary operational facilities, including permanent detention basins, stormwater treatment facilities and a permanent stockpiling site for general road maintenance.

Construction activities as part of the project would include the following:

- Site preparation and establishment works.
- Temporary construction facilities, including construction compounds, stockpile sites, creek crossings, sediment control basins and haulage roads.
- Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks.
- Earthworks and bridge construction.
- Pavement construction.
- Drainage construction.
- Road furniture installation.
- Site restoration.

The project and the key features of the project are shown in **Figure 6.1** and **Figure 6.2**.

During detailed design, refinements could be made to the design features and construction methods (refer to Chapter 4 of the environmental assessment).

6.2 Project objectives

The project objectives are to:

- Improve road safety.
- Improve efficiency of the Princes Highway between Toolijooa Road (north of Foxground) and Schofields Lane (south of Berry).
- Support regional and local economic development.
- Provide value for money.
- Provide significant beneficial environmental effects for Berry town centre and manage potential adverse environmental impacts elsewhere.
- Optimise the benefits and minimise adverse impacts on the local social environment.

Supporting the project objectives are the following six sub-objectives and design principles that make up the urban and regional design framework:

- Provide a flowing highway alignment that is responsive and integrated with the natural landscape.
- Protect the natural systems and ecology of the corridor.
- Protect and enhance the heritage and cultural values of the corridor.
- Respect the communities and towns along the highway.
- Provide an enjoyable, interesting highway with strong visual connections to the immediate hinterland and the mountains to the west.
- Develop a simple and unified palette of elements and details that are easily maintained.

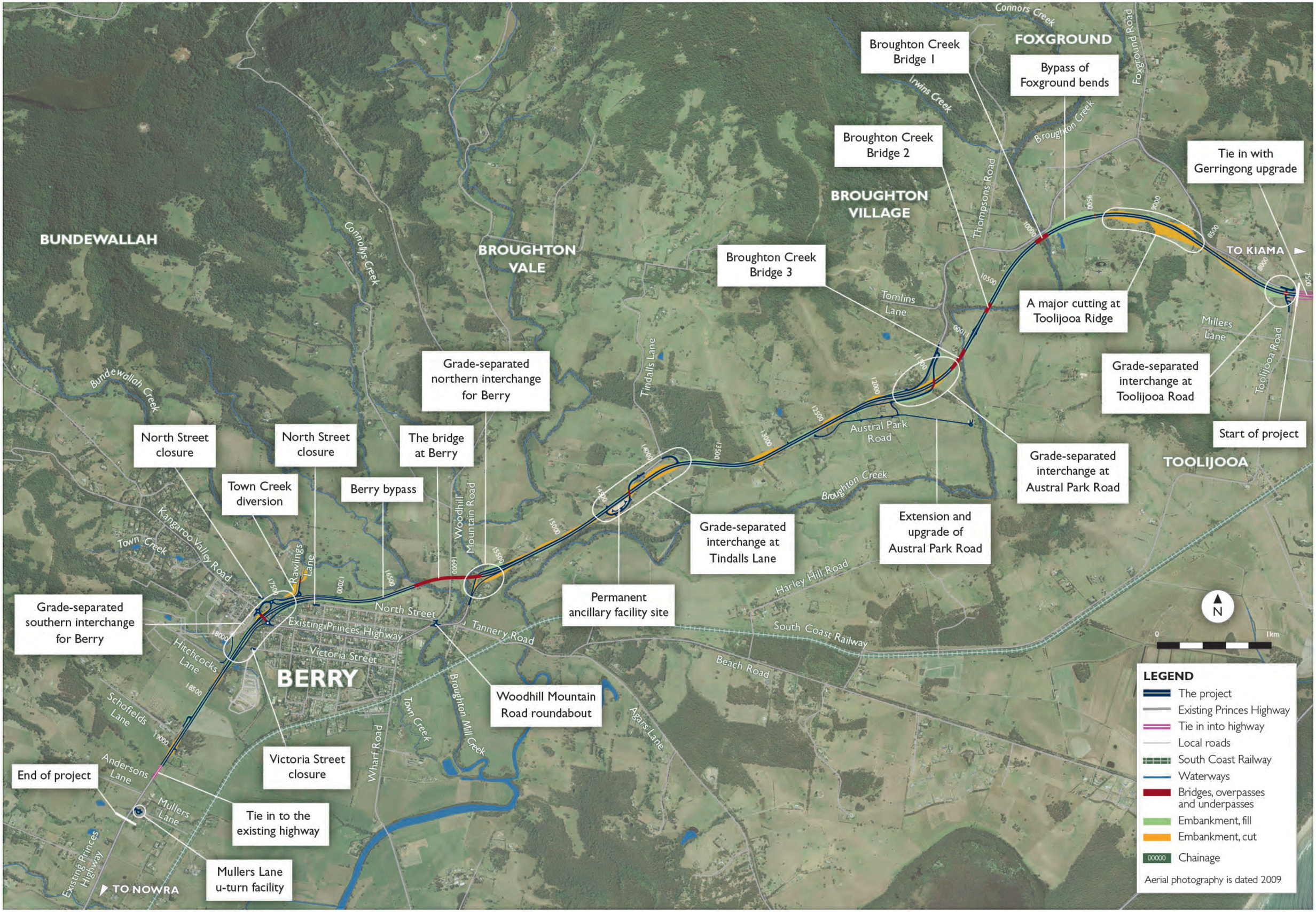


Figure 6-1: Project concept design (Source: AECOM)

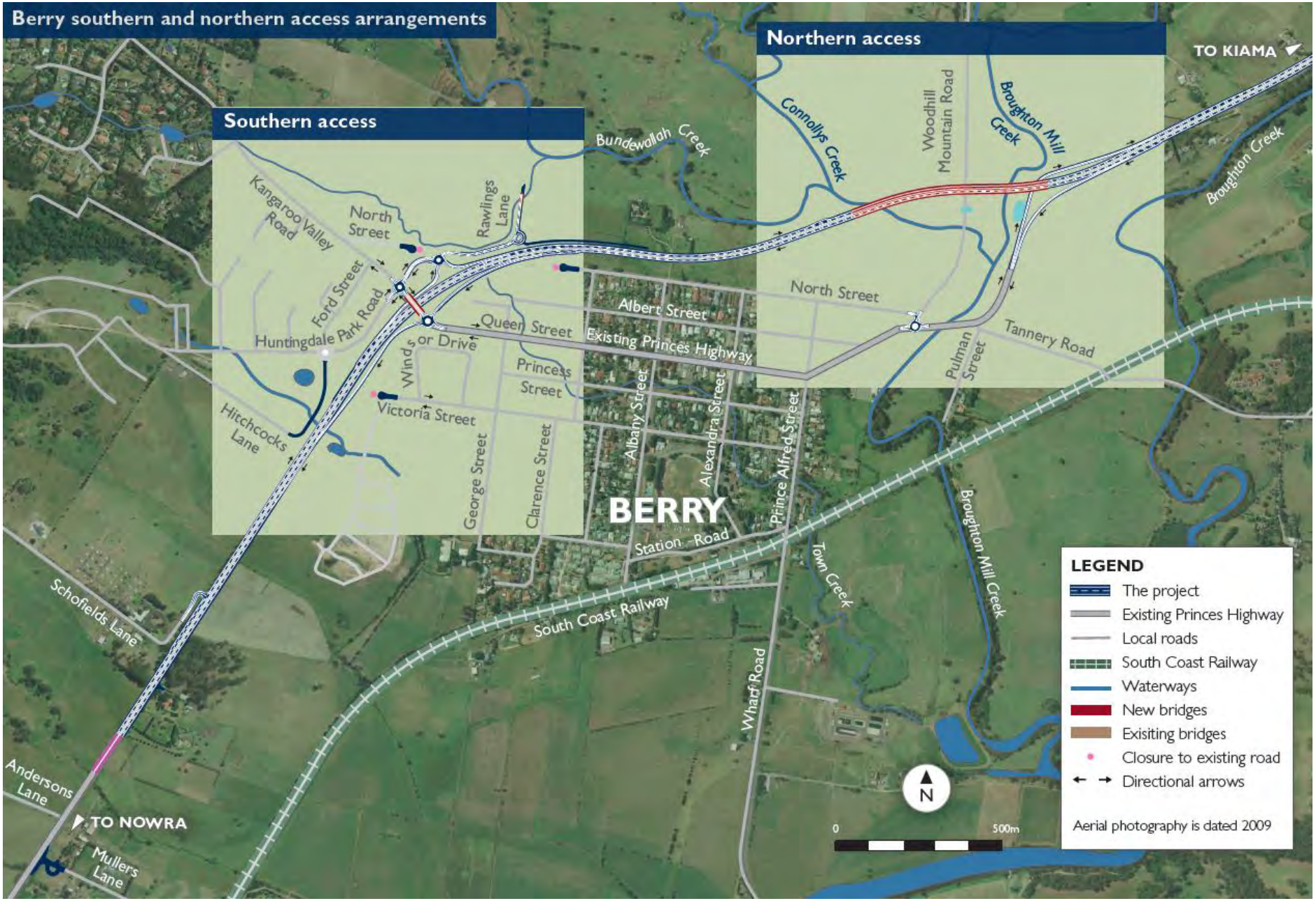


Figure 6.2: Berry southern and northern access arrangements

7 Traffic impact assessment

This chapter provides details of the traffic impact assessment that was completed for different stages and scenarios, including the construction and operational impacts of the project for both 'Do minimum' and 'Do something' traffic modelling scenarios (see Section 4.2.4).

7.1 Construction impacts

7.1.1 Constructability and staging

The construction activities required for the project would pose a number of staging challenges. Sections involving the widening or duplication of the existing highway pose greater construction and road user management challenges. They would require the widening of road shoulders, temporary ramps and traffic switches to enable the highway to remain open during construction.

Other than the partial use of completed sections of the highway during construction, it is not intended that completed sections of the project would be opened prior to the completion of the full project.

As a result of these challenges, a number of staging options have been developed. There are currently three potential staging options for the construction of the project which differ in the sequence of construction events but would ultimately deliver the project in the same manner.

The first option would be to deliver the project in four stages based on whether construction would occur on line or off line. The four stages would be based around the following geographical areas:

- Toolijooa Road to Austral Park Road (off line).
- Austral Park Road to the bridge at Berry (on line).
- The bridge at Berry to Kangaroo Valley Road (off line).
- Kangaroo Valley Road to Schofields Lane (on line).

The second option would be to deliver the project in two stages with discrete construction zones within each stage. The zones would be developed with the aim to achieve an earthworks balance based on balancing the earthworks (cut equal to and fill) required across each stage. The two stages would be:

- Toolijooa Road to the northern end of the bridge at Berry.
- The bridge at Berry to Schofields Lane.

The third option would be to deliver the project through a series of early works packages as an early works stage followed by a remaining road works stage package. The road works package would be delivered in a similar way to option two, with stages and construction zones developed to achieve balanced earthworks: areas and the sequence would be based on the balanced earthworks zones described in option two. The stages would include:

- Construction of the Toolijooa Road interchange.
- Construction of all bridges.
- Remaining road works:
  - Toolijooa Road interchange to the northern end of the bridge at Berry.
  - The bridge at Berry to Schofields Lane.

Further details of each staging option are provided in the concept design report which is available on the project website (www.rms.nsw.gov.au/fbb). The final staging strategy would be determined during detailed design and would be dependent on the construction contractor.

7.1.2 Construction traffic

The construction of the project would inevitably generate construction vehicles travelling to, from, and within the project area on the existing Princes Highway and local roads which provide site access. Traffic generation and control details are currently limited as these would depend on the final detailed design and the contractor's work methods. Additional traffic demand would be expected to be generated by sources including:

- Construction workers travelling to and from worksites.
- The delivery of heavy vehicles and machinery, and other equipment required for highway construction.
- The delivery of construction materials including dry bulk such as cement and aggregates, significant quantities of steel, as well as pre-fabricated structures.
- The movement of spoil generated by earthworks, including the movement of materials within the site, transferral to stockpile sites and/or removal from the project area.

It is anticipated that most construction-related heavy traffic would travel to and from the project area from the north, particularly the Wollongong area. Here, the Princes Highway would be a four-lane highway, mostly with a central median and safety barrier separating opposing traffic. The Gerringong upgrade between Mount Pleasant and Toolijooa Road is expected to be largely complete prior to construction of this project. The Princes Highway would therefore provide a suitable route for construction-related vehicles to travel safely and efficiently to and from work sites in the project area.

Of the total 11.6 kilometre project length, 6.6 kilometres would be completed offline from the existing alignment. In addition, a significant proportion of the online upgrade would involve construction on either side of the existing Princes Highway, maximising efficiency and safety of construction, while minimising delays to highway traffic. Wherever practicable, offline construction would be completed first, with the aim of removing construction-related vehicles from the existing highway. Construction traffic would use the cleared project footprint where possible, to transport materials either adjacent to the highway or via a haul route as appropriate. Construction traffic entry and exit points would be minimised and controlled and the use of the existing highway would be restricted at peak hours, especially during holiday periods. Once offline sections are completed, traffic can be rerouted onto new highway sections, enabling the safe and efficient renewal of the existing roadway.

During construction of the bypass at Berry, heavy construction vehicles would be present in the northern end of the town to source and transport material to/from the project footprint to the proposed stockpile site and compound/office adjacent to Woodhill Mountain Road and also to the compound/office south of North Street; accessed via Kangaroo Valley Road. All other compound stockpile sites and construction compound/offices would be accessed directly from the existing highway or vehicles would be required to travel a short distance on a local road after turning off the highway (eg Toolijooa Road).

Heavy traffic volumes generated by construction would be significantly influenced by the volume of material requiring transportation to, from, and within the project area. Estimates of construction resources including bulk earthworks volumes, a discussion of pavement materials, and material sources are included in the project Concept Design Report (Chapter 15). Preliminary estimates forecast total earthworks of about 1,000,000 cubic metres and in the region of 160,000 cubic metres excess material. Total pavement area of the current design is about 240,000 square metres.

Detailed quantities of earthworks, construction material quantities, and person hours required to construct the project would be confirmed during detailed design; for this reason earthworks, material quantities and person hours, and traffic generated by the haulage of materials and personnel, has been estimated for the concept design of the project.

Table 7.1 indicates forecast traffic generated by the construction of the project. Assumptions including typical vehicle capacities and operating hours have been used to estimate total and average daily vehicle generation.

It is estimated that around 45,000 heavy vehicles would be required to travel to and from the project area during construction, generating a total of about 90,000 vehicle movements. Earthworks haulage and the delivery of dry bulk materials is expected to generate the vast majority of heavy vehicle movements, with small volumes of heavy traffic required to deliver steel and pre-fabricated units. Assuming a three year construction period and an even spread of total vehicles over this period, the project would generate around 50 heavy vehicles, or 100 vehicle movements per day.

Assuming construction workforce hours of around 105,000 per kilometre, a total of over 1.2 million workforce hours would be required to construct the 11.6 kilometre project. Construction is estimated to be completed in three years (9440 hours based on the construction period assumptions in **Table 7.1**). Completion of the project within this timeframe would require 130 person hours (130 personnel on site) on average during every construction hour. Assuming an average of two construction personnel per vehicle travelling to and from the project area, 65 light vehicles per day would be generated by construction personnel.

Previous upgrades to sections of the Princes Highway north and south of the project area have been used to validate the construction traffic forecasts in this section. The upgrade of the Princes Highway between Kinghorne Street and Warra Warra Road, south of Nowra, anticipated that construction activities were expected to generate on average 60 truck movements per day (*Princes Highway Upgrade Kinghorne Street to Warra Warra Road, south of Nowra – Review of Environmental Factors, Nov 2009*); the construction of additional access ramps for Kiama bypass anticipated 50 trucks per day would be generated by construction activities (*Kiama Bypass Additional access ramps – Review of Environmental Factors, July 2006*). Anticipated heavy traffic generated by both of these projects is therefore in line with the forecast of around 50 heavy vehicles per day created by the project.

As with any increase in traffic, construction traffic on the Princes Highway would be expected to decrease road network performance. It would also be expected that traffic generated by construction, and in particular heavy vehicles, would increase noise, reduce air quality, and decrease general amenity, especially if required to travel through Berry. It is not however expected that this increase in traffic would reduce road safety, provided adequate traffic management measures are employed.

Although the numbers included in **Table 7.1** are indicative of the likely magnitude of construction traffic generated by the project, key features including the location and size of stockpile sites, the need for and location of mobile batching plants, and material suppliers selected would all influence construction traffic volumes and movement patterns at both a local and regional level. These key features, and consequently detailed forecasts of traffic volumes and trip patterns, would need to be developed from the final detailed design.

Following the finalisation of the detailed design and construction staging planning, periods of key activity relating to construction traffic generation and movements would be identified. During these periods information and advice would be issued to affected residents, businesses and road users through channels including community updates and other material distributed via project mailing lists, announcements through local and regional media channels, and updates on the project website. The communication process would be managed to ensure relevant and concise information is provided to affected parties as appropriate.

Table 7.1: Estimated construction traffic generation, based on example project construction material and workforce requirements

Project details:					
Project name:	Foxground and Berry bypass				
Project length:	11.6 km				
Construction period:	Three years (52 weeks per year; 5.5 days per week; 11 hours per day)				
Road type:	Four lane divided carriageway				
Project features:	– Bypass of Berry and 'Foxground bends'. – Grade separated interchanges to north and south of Berry and 'Foxground bends'. – At-grade intersections with 'left-in left-out' only arrangements providing direct access between the upgraded highway and local roads and properties. – Design capable of widening to 6 lanes. – 600-metre-long Berry divided four lane bridge spanning Broughton Mill Creek, Woodhill Mountain Road and Bundewallah Creek. – Additional single lane bridges at interchanges and local roads. – Two 3.5 metre traffic lanes and 2.5 metre (minimum) paved outer shoulder per direction.				
Estimated construction traffic generation – heavy vehicles:					
Source	**Estimate (average, per km)**	**Estimate (total)**	**Vehicle capacity (average)**	**Estimated vehicle generation**	
				Total	**Daily (average)**
Earthworks	-	1,000,000 m^3	30 m^3	33,333	39
Dry bulk materials	28,450 m^3	330,000 m^3	30 m^3	11,000	13
Reinforcing steel	460 tonnes	5320 tonnes	10 tonnes	532	1
Pre-fabricated units	18 units	205 units	1 unit	205	<1
Total – heavy vehicles	-	-	-	45,000	53
Estimated construction traffic generation – light vehicles:					
Source	**Estimated person hours (average, per km)**	**Estimated person hours (total)**	**Construction hours (total)**	**Person hours per construction hour (average)**	**Estimated vehicle generation (daily, average)**
Construction personnel	105,880	1,230,000	9440	130	65

(Source: AECOM)

7.1.3 Traffic delays and disruptions

Large sections of the project (6.6 kilometres of the total 11.6 kilometre project length) would be completed offline from the existing alignment, including significant construction operations during the realignment through Foxground such as the cutting at Toolijooa Ridge and the three bridges over Broughton Creek, and the Berry bypass which includes a bridge 600 metres in length. The offline location of these major works, as well as a large proportion of construction occurring on either side of the existing alignment, should ensure that construction can be carried out at these sites with minimal impacts to traffic efficiency on the current road network.

During construction, traffic management measures are employed to maintain road safety for all users. Although it is RMS' goal to maintain an 80 kilometres per hour construction speed zone (where normal posted speeds are higher than 80 kilometres per hour), additional delays for traffic using the Princes Highway would be expected during the construction phase in those periods when the project requires online works and/or ties in with the existing highway. Some temporary disruptions and delays to local and highway traffic would be experienced during construction of the project due to the narrowing of lanes and temporary speed reductions. There would also be delays to local traffic during periods when other local or private roads are being bridged or tied in with the project.

Local roads that would potentially experience some delays during construction include Toolijooa Road, Austral Park Road, and Tindalls Lane. The north and south interchanges accessing Berry may also incur specific delays during the tie-in with the Berry bypass. It is also likely that roads directly linked to, or serviced by, the new grade-separated interchanges would experience detours at some stages during construction. This includes residents in the Foxground and Broughton Village areas who would use the new interchanges at Toolijooa Road and Austral Park Road. Moreover, construction of the new Kangaroo Valley Road overpass at the southern interchange to Berry would require a temporary road closure. It is anticipated that traffic would be diverted along North Street and as a result, the overpass would need to be operational before construction of the bypass section that severs North Street begins.

It is expected that approximately three per cent of through traffic in the traffic impact footprint (ie combined traffic on both the Princes Highway and the 'Sandtrack') would divert to the 'Sandtrack' during construction. Although heavy vehicles (over five tonnes) are restricted from using the 'Sandtrack', vehicles within this limit are free to use this route. It is anticipated that some vehicles may opt to use the 'Sandtrack' to travel between Gerringong, Berry and Bomaderry to avoid actual or perceived delays through construction zones associated with the project. The proportion of vehicles has been estimated based on 80 kilometres per hour construction zone speed limits and passing constraints, with the effects included in traffic forecasting figures and performance analyses. The roadway level of service impacts of vehicles using the 'Sandtrack' in favour of the Princes Highway during construction are discussed in Section 7.1.4.

Toolijooa Road is a local road that currently carries very low traffic volumes (less than 500 vehicles per day), with the majority of vehicles using it to access properties along its length between the Princes Highway and Beach Road. It could potentially offer an alternative route to the Princes Highway during construction, as the intersection between Toolijooa Road and the Princes Highway is located at the extent of the project area to the east. However, it is anticipated that Toolijooa Road would continue to be primarily used by local residents during construction, based on the following factors:

- It is signposted as a local road and most motorists are unaware that it ultimately connects to Beach Road (and on to Berry).
- The road is of a much lower standard than both the Princes Highway and the 'Sandtrack'; it offers a lower quality road surface, narrow lanes and poor road alignment at a number of locations.
- The posted speed limit is 60 kilometres per hour.
- There is an unsealed section at the western end of Toolijooa Road, which is particularly narrow and undesirable for through traffic.

The use of local roads by heavy vehicles associated with construction would be limited to where these roads provide access to construction ancillary sites, or where local road modifications are proposed. Two construction ancillary sites are located off the Princes Highway which would require travel along local roads, being the site located off Woodhill Mountain Road and the site located adjacent to North Street (and accessed via Kangaroo Valley Road).

The existing AADT on Woodhill Mountain Road and Kangaroo Valley Road is 970 and 1485 vehicles respectively. Assuming a maximum of 53 heavy vehicles per day, the impacts on both local roads is likely to be between a three per cent and five per cent increase on existing traffic volumes. Although the presence of heavy vehicles close to the town would be a temporary inconvenience to the community during construction of the bypass, the additional trucks would have a negligible impact on the operational performance of both roads with minimal delay and congestion. This is due to the low volume of daily and peak period local traffic flows that currently travel on Woodhill Mountain Road and Kangaroo Valley Road, the close proximity of the stockpile/ compound sites and direct access to the Princes Highway to transport residual material to other sites/locations external to the town.

7.1.4 Roadway level of service

Both most-likely and worst-case scenarios have been developed to assess roadway and intersection LoS during construction. The most-likely scenario represents a typical day during construction of the project. Forecast construction traffic would increase overall daily traffic on the Princes Highway, while a proportion of traffic currently using the highway would transfer to the 'Sandtrack' to avoid delays through construction zones.

The worst-case construction scenario assesses the local and regional road network performance when traffic is at 100th highest hour levels during holiday peaks. The project would be planned and managed to avoid construction work (and the additional impacts created by construction traffic) during these times. Despite this, overall traffic volumes would be much higher than during the most-likely scenario due to the large proportions of recreational traffic at these times. These traffic volumes, combined with traffic management measures through construction zones including speed restrictions and passing constraints, would result in the poorest performance of the road network during construction.

Most-likely construction scenario

The most-likely construction scenario has been developed to assess roadway and intersection LoS on a typical day during construction. Traffic forecasts for this scenario have been developed based on assumptions including:

- 2017 AM peak and PM peak 'Do something' traffic volumes prior to project completion. This assumes no transfer of traffic from the 'Sandtrack' to the Princes Highway (expected following completion of the project).
- Temporary transfer of light vehicles from the Princes Highway to the 'Sandtrack', based on vehicles avoiding estimated delays associated with construction on the Princes Highway.
- Construction traffic generated by material and equipment deliveries, earthworks haulage and construction personnel travelling on the Princes Highway (see Section 7.1.12).
- An 80 kilometres per hour construction zone speed limit throughout the project area (at locations where current posted speed is currently >80 kilometres per hour).
- Existing highway layout (two-lane, two-way; no upgraded sections open to highway traffic).
- Passing constrained throughout the project area due to construction zones.

As referenced in previous sections, customised midblock LoS models have been developed based on the updated *AUSTROADS, Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009*. An example of the model, which is designed to assess the operational performance of the project, is included in Appendix D.

Table 7.2 provides a summary of the anticipated midblock LoS on both the Princes Highway and the 'Sandtrack' for the most likely construction scenario. The analysis examines the AM and PM peak hours of a typical day during construction.

The results show that the Princes Highway is expected to operate at LoS E both north and south of Berry in 2017, the final year of construction; this indicates a deterioration from 2011 levels (LoS D). The analysis undertaken indicates that average travel speeds on the Princes Highway would be around 50-60 kilometres per hour, with passing constrained by traffic management measures through construction zones.

Table 7.2: 2017 midblock level of service summary (most-likely construction scenario)

Location	AM peak hour (veh/hr)		PM peak hour (veh/hr)	
	2-way volume	LoS	2-way volume	LoS
Princes Highway: Toolijooa Road – Tannery Road	972	E	1150	E
Princes Highway: Victoria Street – South of Schofields Lane	1160	E	1348	E
'Sandtrack': Dooley Road – Shoalhaven Heads Road	728	C	870	C

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model and AUSTROADS Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009)

The volume of construction traffic when compared to total traffic on the Princes Highway is expected to be relatively small. Construction personnel travelling in light vehicles would be expected to mainly travel at the beginning and end of the day; it has been assumed that a maximum of 65 light vehicles used by construction personnel would travel in the AM and PM peaks of a typical day. Heavy vehicles associated with construction have been assumed to follow a more even distribution throughout a typical day; a maximum of 10 (of around 50 daily) heavy vehicles have been assumed to travel during AM and PM peak hours.

Construction traffic would comprise no more than eight per cent of total traffic on the Princes Highway during peak hours based on these estimates; further analysis of the most-likely construction scenario indicates that the Princes Highway would operate at LoS E without the introduction of estimated construction traffic (although travel speeds would be expected to decrease marginally when it is included). Provided that access to and from construction sites is planned and managed correctly, the introduction of construction traffic on the Princes Highway would not decrease current levels of road safety.

Traffic on the 'Sandtrack' is expected to increase from current levels, including annual growth as well as the effects of light vehicles using this alternative route to avoid construction zones on the Princes Highway. Despite this the 'Sandtrack' is expected to continue to operate at LoS C up to and including the final year of construction during typical AM and PM peak hours. The relatively small increase in traffic is not expected to decrease the safety of this route.

Worst-case construction scenario

In order to estimate the potential LoS of a worst-case construction scenario, the following assumptions have been used to model the operational impacts:

- 2017 100th highest hour 'Do something' traffic volumes.
- The completion and opening of some sections of the project, resulting in a transfer of traffic from the 'Sandtrack' to the Princes Highway.
- No construction traffic travelling on the Princes Highway (construction would not occur during 100th highest hour traffic peaks).
- An 80 kilometres per hour construction zone speed limit through construction zones project area (at locations where current posted speed is currently >80 kilometres per hour).
- Existing highway layout (two-lane, two-way) on some sections of the Princes Highway north and south of Berry; combination of upgraded and non-upgraded highway conditions throughout the project area.
- At least one construction zone on the Princes Highway both north and south of Berry.
- Passing constrained in construction zones.

The worst-case construction scenario includes a three per cent transfer of traffic from the 'Sandtrack' to the Princes Highway prior to the completion of the project. This assumption is based on the scenario that the Gerringong upgrade has been completed and a section of the highway, such as the realignment through Toolijooa Ridge, is completed and opened to traffic prior to the completion of other sections within the project area. In this scenario 'Sandtrack' traffic would potentially transfer to the Princes Highway to benefit from travel time savings and improved road safety on upgraded sections of the project area, while construction would still be continuing on others. In the 100th highest hour peak period this is more likely than during a typical day as large proportions of recreational, non-local traffic would be travelling through the area, with less knowledge of potential delays caused by traffic management in the project area.

The performance analysis using the above conditions and summarised in **Table 7.3**, indicates that the two midblock locations on the Princes Highway would operate at LoS E during both the 100th highest hour northbound and southbound scenarios. This analysis assumes the presence of at least one construction zone on the Princes Highway both north and south of Berry. Average travel speeds on the Princes Highway would be expected to drop to around 50 kilometres per hour or less; key factors contributing to this deterioration include the expected increase in traffic, and speed restrictions and the prevention of overtaking through construction zones in the project area. The analysis indicates that despite a poor LoS and low travel speeds during peak hours, the Princes Highway does have the capacity to accommodate worst-case traffic volumes during construction.

Table 7.3: 2017 midblock level of service summary (worst-case construction scenario)

Location	100NB (veh/hr)		100SB (veh/hr)	
	2-way volume	LoS	2-way volume	LoS
Princes Highway: Toolijooa Road – Tannery Road	1666	E	1793	E
Princes Highway: Victoria Street – South of Schofields Lane	1674	E	1967	E
'Sandtrack': Dooley Road – Shoalhaven Heads Road	792	C	924	D

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model and AUSTROADS Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009)

The results show the roadway LoS on the 'Sandtrack' would remain relatively unchanged despite a reduction in traffic (with traffic expected to transfer to the Princes Highway), operating at LoS C during the 100th highest hour northbound period, and deteriorating to LoS D during the busier 100th highest hour southbound period.

7.1.5 Intersection level of service

Construction of the project does not include any major works within the centre of Berry. The most significant modification to the town's local road network would occur at the new Kangaroo Valley Road interchange, which would require a temporary road closure with an alternative route available via North Street. The online construction of a new roundabout at the intersection of the Princes Highway and Woodhill Mountain Road would also create minor traffic delays at this location. The majority of works in the vicinity of Berry would be constructed offline and although it is likely there would be some adverse effects during the tie-in of offline to online sections, these occurrences would only last for short periods of time.

Intersection LoS for both the most-likely and worst-case construction scenarios has been estimated using the assumption that the road network throughout Berry has not been upgraded, and that all traffic travelling on the Princes Highway travels through the town (the Berry bypass and grade-separated interchanges are not operational). Traffic volumes used for this analysis have been developed based on the assumptions listed in Section 7.1.4.

The posted speed limit on Queen Street (Princes Highway) through Berry is currently 50 kilometres per hour; it is assumed this would remain unchanged during construction. The major factors influencing the performance of the road network and intersections in Berry include traffic management during road closures and natural traffic growth.

Most-likely construction scenario

Table 7.4 provides a summary of the expected intersection LoS in Berry during the most-likely construction period, described in Section 7.1.4.

The results of the modelling included in **Table 7.4** indicates that the local road network would be expected to accommodate forecast traffic, including light and heavy construction vehicles, with minimal delay. Only the intersection approaches from Alexandra Street and Prince Alfred Street would be expected to drop to LoS B during typical 2017 AM and PM peak hours, with a maximum average delay of around 24 seconds.

Table 7.4: 2017 intersection level of service summary (most-likely construction scenario)

Intersection / approach road	AM peak hour			PM peak hour		
	Approach volume (veh/hr)	Average delay (s)	LoS	Approach volume (veh/hr)	Average delay (s)	LoS
Princes Highway / Victoria Street						
Princes Highway northbound	609	0.0	A	695	0.0	A
Victoria Street westbound	33	0.4	A	37	0.3	A
Princes Highway southbound	565	0.0	A	597	0.0	A
Total	1207	0.0	A	1329	0.0	A
Queen Street (Princes Highway) / Kangaroo Valley Road						
Queen Street eastbound	569	0.0	A	685	0.0	A
Kangaroo Valley Road	282	4.4	A	191	5.7	A
Queen Street westbound	614	0.0	A	796	0.7	A
Total	1465	0.8	A	1672	1.0	A
Queen Street (Princes Highway) / Alexandra Street						
Queen Street eastbound	714	0.2	A	750	0.0	A
Alexandra Street southbound	48	19.1	B	98	23.6	B
Queen Street westbound	620	0.2	A	684	0.1	A
Alexandra Street northbound	33	10.6	A	52	13.9	A
Total	1415	1.1	A	1584	2.0	A
Queen Street (Princes Highway) / Prince Alfred Street						
Queen Street eastbound	612	0.2	A	682	0.2	A
Queen Street westbound	650	2.4	A	622	2.1	A
Prince Alfred Street northbound	137	13.4	A	210	17.6	B
Total	1399	2.5	A	1514	3.4	A
Queen Street (Princes Highway) / Albert Street						
Queen Street eastbound	609	4.2	A	660	4.2	A
Albert Street	18	2.4	A	18	1.9	A
Queen Street westbound	667	2.7	A	637	2.3	A
Total	1294	3.4	A	1315	3.2	A
Princes Highway / Tannery Road						
Princes Highway northbound	601	2.8	A	683	2.1	A
Princes Highway southbound	503	1.2	A	530	1.2	A
Tannery Road	130	1.4	A	112	0.7	A
Total	1234	2.0	A	1325	1.6	A

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model and AUSTROADS Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009)

Worst-case construction scenario

Table 7.5 shows the performance of key intersections in Berry for the 2017 worst-case construction scenario, described in Section 7.1.4.

Table 7.5 2017 intersection level of service summary (worst-case construction scenario)

Intersection / approach road	100NB			100SB		
	Approach volume (veh/hr)	Average delay (s)	LoS	Approach volume (veh/hr)	Average delay (s)	LoS
Princes Highway / Victoria Street						
Princes Highway northbound	1182	0.0	A	743	0.0	A
Victoria Street westbound	73	0.0	A	159	3.7	A
Princes Highway southbound	371	0.0	A	996	0.0	A
Total	1626	0.0	A	1898	0.3	A
Queen Street (Princes Highway) / Kangaroo Valley Road						
Queen Street eastbound	1037	0.0	A	650	0.0	A
Kangaroo Valley Road	286	32.7	C	281	8.2	A
Queen Street westbound	483	2.9	A	1084	0.3	A
Total	1806	6.0	A	2015	1.3	A
Queen Street (Princes Highway) / Alexandra Street						
Queen Street eastbound	1178	0.0	A	796	0.3	A
Alexandra Street southbound	76	40.2	C	142	90.3	F
Queen Street westbound	445	0.0	A	1040	0.3	A
Alexandra Street northbound	119	21.7	B	93	41.5	C
Total	1818	3.1	A	2071	8.3	A
Queen Street (Princes Highway) / Prince Alfred Street						
Queen Street eastbound	1163	0.3	A	772	3.6	A
Queen Street westbound	447	2.2	A	1054	3.0	A
Prince Alfred Street northbound	198	23.2	B	214	65.2	E
Total	1808	3.3	A	2040	9.8	A
Queen Street (Princes Highway) / Albert Street						
Queen Street eastbound	1173	4.1	A	764	4.3	A
Albert Street	57	8.4	A	56	2.5	A
Queen Street westbound	495	4.0	A	1124	3.5	A
Total	1725	4.2	A	1944	3.8	A
Princes Highway / Tannery Road						
Princes Highway northbound	1221	1.8	A	798	3.2	A
Princes Highway southbound	401	0.9	A	1034	1.3	A
Tannery Road	74	2.0	A	101	3.5	A
Total	1696	1.6	A	1933	2.2	A

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model and AUSTROADS Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009)

The results in **Table 7.5** show that the road network in Berry would continue to operate at acceptable performance levels during peak periods; as the majority of intersection approach roads would continue to operate at LoS A. However, the increase in traffic demand on the Princes Highway (Queen Street) would result in additional delays for some of the minor intersection approach roads, notably at Kangaroo Valley Road, Alexandra Street and Prince Alfred Street.

With the majority of traffic demand on the Queen Street approach roads (priority through movements), vehicles using the minor approach roads would find gaps in traffic less frequent and subsequently incur additional delays. The 100th highest hour southbound period modelling scenario indicates that vehicles travelling southbound on Alexandra Street would experience an average delay of about 90 seconds, resulting in LoS F. In addition, vehicles travelling on the Prince Alfred Street northbound approach would experience an average delay of 65 seconds. All other intersection approach roads in Berry would operate at LoS C or better.

In summary, it can be concluded that due largely to the offline construction of the Berry bypass, the local road network and intersections in Berry would still perform adequately during both the most-likely and worst-case construction scenarios; without the provision of additional temporary traffic management measures.

7.2 Operational impacts

7.2.1 Roadway level of service

The midblock LoS of the Princes Highway and the 'Sandtrack' at key locations on the regional road network have been assessed for the 2037 design year, 20 years after the 2017 year of opening. Both the 'Do minimum' and 'Do something' scenarios, described in Section 4.2.4, include the construction of the project and the operational performance of the highway for both scenarios is summarised in **Table 7.6** and **Table 7.7** respectively.

Table 7.6: 2037 midblock level of service summary ('Do minimum' scenario)

Location	Dir	AM peak hour (veh/h)		PM peak hour (veh/h)		100NB (veh/h)		100SB (veh/h)	
		Traffic volume	LoS	Traffic volume	LoS	Traffic volume	LoS	Traffic volume	LoS
Princes Highway: Toolijooa Road – Berry east interchange	NB	1050	A	1420	B	2295	C	1298	B
	SB	1114	B	1228	B	795	A	2036	C
Princes Highway: Berry bypass	NB	990	A	1233	B	1894	C	1031	B
	SB	989	A	1086	A	575	A	1691	C
Princes Highway: Kangaroo Valley Road interchange – South of Schofields Lane	NB	1123	B	1399	B	2179	C	1299	B
	SB	1110	B	1260	B	742	A	2103	C
'Sandtrack': Dooley Road – Shoalhaven Heads Road	Two-way	532	C	627	C	660	C	774	C

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model and AUSTROADS Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009)

The results indicate that the upgraded highway would operate at LoS A or LoS B throughout the project area during typical AM peak or PM peak periods, for both the 'Do minimum' and 'Do something' scenarios. During the 100th highest hour northbound (NB) and southbound (SB) periods, the highway would be expected to operate at LoS C or better based on forecast traffic volumes. In addition, the alternative 'Sandtrack' route is expected to operate at LoS C during all peak periods, as traffic is anticipated to reduce from current levels due to the significant proportion of vehicles expected to transfer to the Princes Highway following its upgrade. The reduction in traffic on the 'Sandtrack' would improve its safety and efficiency, which would enhance the characteristic of this scenic coastal route.

Table 7.7: 2037 midblock level of service summary ('Do something' scenario)

Location	Dir	AM peak hour (veh/h)		PM peak hour (veh/h)		100NB (veh/h)		100SB (veh/h)	
		Traffic volume	LoS	Traffic volume	LoS	Traffic volume	LoS	Traffic volume	LoS
Princes Highway: Toolijooa Road – Berry east interchange	NB	1096	B	1481	B	2419	C	1366	B
	SB	1162	B	1280	B	838	A	2146	C
Princes Highway: Berry bypass	NB	1043	A	1299	B	2007	C	1092	B
	SB	1041	B	1142	B	611	A	1791	C
Princes Highway: Kangaroo Valley Road interchange – South of Schofields Lane	NB	1211	B	1509	B	2297	C	1369	B
	SB	1198	B	1359	B	782	A	2215	C
'Sandtrack': Dooley Road – Shoalhaven Heads Road	Two-way	353	C	416	C	428	C	501	C

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model and AUSTROADS Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009)

The project would provide two lanes in each direction, which when coupled with the improved alignment would increase the safe operating speed of the Princes Highway in the project area. These features contribute to the modelled improvement in performance from the current LoS. In addition, the provision of a central median and safety barrier enables the directional flows on the highway to operate independently; a heavy flow of traffic resulting in a decrease in the LoS in one direction does not reduce the LoS in the other. This is particularly relevant during 100th highest hour northbound (NB) and southbound (SB) periods, when highway traffic volume splits increase by up to 80:20 in favour of the peak direction. The following example illustrates this: during the 100th highest hour NB peak period for the 'Do something' scenario, the northbound carriageway north of Berry is expected to operate at LoS C, carrying over 2400 vehicles per hour as recreational travellers travel towards Wollongong and Sydney; however the southbound carriageway at this time is forecast to carry only around 840 vehicles and operate at LoS A.

The results indicate that the Princes Highway in the project area would perform at an acceptable LoS during peak hours for the 2037 design year in both scenarios. In addition, further sensitivity testing for post 2037 scenarios has been conducted, and the results show that the highway would have sufficient capacity to accommodate a significant amount of additional traffic demand before deteriorating to an unacceptable LoS.

In summary, the predicted midblock LoS for all highway locations and scenarios falls within the Concept Design Criteria set out for the project, which states that the project must perform at LoS C (represents optimum free flow conditions) or better for the 100th highest hour (holiday peak hour) in its design year of 2037.

Although roadway LoS is expected to improve within the project area, the increase in traffic on the Princes Highway following construction of the project could put pressure on unimproved sections of the highway to the south. For example, the Princes Highway between Schofields Lane and Cambewarra Road would still be awaiting upgrade and likely to experience additional traffic growth as a result of motorists switching from the 'Sandtrack' to the Princes Highway.

7.2.2 Intersection level of service

As discussed in Section 4.3. Paramics microsimulation models have been developed to assess the performance of the local road network and intersections in and around Berry following the construction of the project. Models have been constructed for the design year of 2037 for both the 'Do minimum' and 'Do something' scenarios using traffic demand matrices for both the 100th highest hour northbound (100NB) and southbound (100SB) holiday peak periods.

The project proposes grade separated interchanges at the northern and southern ends of Berry as shown in **Figure 6.2**. At the northern end, an interchange would be provided for vehicles to join the highway in the northbound direction and exit the highway in the southbound direction. These ramps would connect to the existing Princes Highway. Intersections with the existing Princes Highway in the east and centre of the town would remain unchanged in their layout and operation, with the exception of the Queen Street and Woodhill Mountain Road intersection which would be reconfigured as a roundabout.

At the southern end of town, a full grade separated interchange would be provided at Kangaroo Valley Road, providing on-ramps and off-ramps to and from the highway both northbound and southbound. The construction of this interchange would include two new roundabouts on Kangaroo Valley Road to the southeast and northwest of the bypass, at the approximate locations of the existing priority intersections of Kangaroo Valley Road and Huntingdale Park Road, and Queen Street (Princes Highway) and Kangaroo Valley Road respectively. In addition, a new road connection and roundabout would be constructed to the northeast of Kangaroo Valley Road, linking the northbound off ramps and on-ramps and Rawlings Lane to Kangaroo Valley Road.

Key intersections in Berry following the construction of the project and therefore included in the Paramics models and subsequent analysis are shown in **Figure 7.1**.

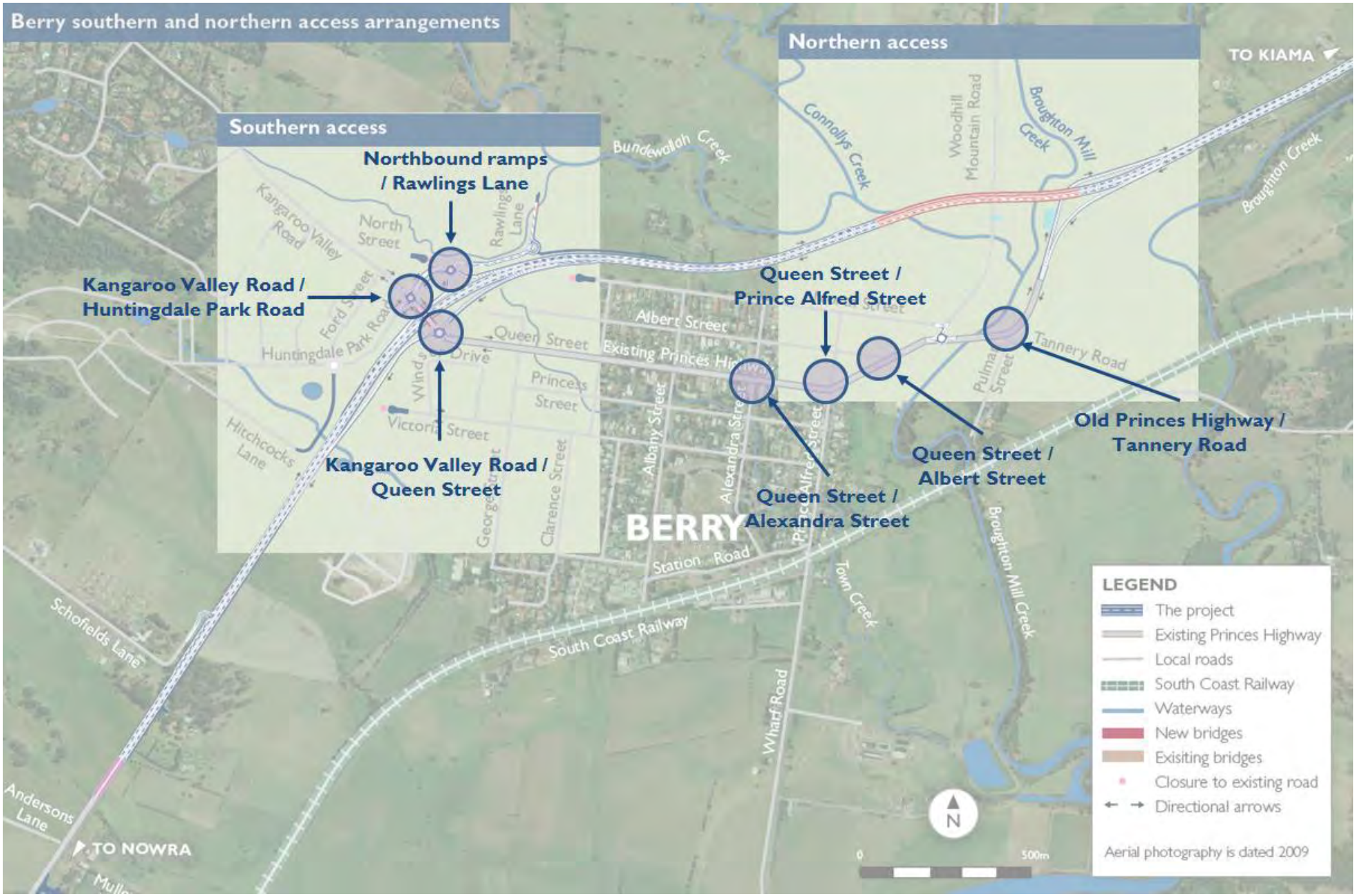


Figure 7.1: Key intersection locations in project area (post-construction) (Source: AECOM)

Table 7.8 and **Table 7.9** provide details of the operational performance of key intersections in Berry (for the southern and central/eastern intersections respectively) for the 2037 design year 'Do something' scenario. Paramics models have been developed using both 100th highest hour NB and SB holiday peak period forecast travel demand; at these times the local and regional road network would be subjected to the highest traffic volumes.

As discussed in previous chapters, the LoS calculated by the Paramics modelling is based on the capacity and efficiency of the local road network and intersections within and around Berry. In comparison, the midblock LoS presented in Section 7.2.1 represents the operational performance of rural highway locations in the project area, based on the travel speeds and the time spent following other vehicles. For this reason, the methods produce contrasting LoS results which vary along the length of the Princes Highway within the project area. The performance of particular sections or locations should be examined and interpreted in isolation, specific to the assessment criteria.

For both 100th highest hour scenarios, Paramics modelling of the proposed intersection arrangements at Kangaroo Valley Road at the southern end of Berry, indicates that all approach roads to the three intersections are expected to operate at LoS A, with minimal delays incurred as shown in **Table 7.8**.

Table 7.8: 2037 southern intersections level of service summary ('Do something' scenario)

Intersection / approach road	100NB			100SB		
	Approach volume (veh/h)	Average delay (s)	LoS	Approach volume (veh/h)	Average delay(s)	LoS
Kangaroo Valley Road / Huntingdale Park Road						
Huntingdale Park Rd	252	0.5	A	244	0.5	A
Kangaroo Valley Rd southbound	141	0.9	A	164	0.9	A
New road connection westbound	603	0.9	A	547	1.1	A
Kangaroo Valley Road northbound	379	0.7	A	259	0.7	A
Total	1375	0.8	A	1214	0.9	A
Northbound highway ramps / Rawlings Lane						
Rawlings Lane	33	0.2	A	18	0.4	A
Northbound off-ramp	585	1.3	A	541	1.8	A
New road connection eastbound	172	0.3	A	141	0.3	A
Total	790	1.0	A	700	1.5	A
Kangaroo Valley Road / Queen Street						
Kangaroo Valley Road	790	0.9	A	664	0.7	A
Southbound off-ramp	166	6.1	A	135	2.4	A
Queen Street	501	0.9	A	701	1.0	A
Total	1457	1.5	A	1500	1.0	A

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model and AUSTROADS Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009)

The Kangaroo Valley Road and Queen Street intersection would be subjected to the highest volumes of traffic levels during the 100SB peak period, with an hourly throughput of around 1500 vehicles per hour. During the 100NB peak period, maximum hourly throughput would be expected to reach around 1450 vehicles per hour. Traffic modelling indicates that the intersection would operate well within its limits and traffic would experience little congestion or delay.

The proposed access arrangements would create a new roundabout to the northeast of Kangaroo Valley Road, linking the northbound off-ramps and on-ramps and Rawlings Lane to Kangaroo Valley Road via a new road connection, as shown in **Figure 7.1**. It is estimated that during the 100th highest hour southbound (100SB) peak period, traffic exiting the highway via this off-ramp would reach 585 vehicles per hour. Traffic modelling indicates that the roundabout provided at this intersection would operate efficiently, with very little delay to traffic on all approaches during both modelled peak periods.

The proposed roundabout between Kangaroo Valley Road and Huntingdale Park Road would replace the existing priority t-intersection, including a new road connection to the northbound highway off-ramps and on-ramps and Rawlings Lane. Traffic modelling indicates that during peak holiday periods hourly throughput is expected to reach around 1375 vehicles; incorporating this volume of traffic, this arrangement would operate effectively with minimal delay.

Table 7.9: 2037 central/eastern intersections level of service summary ('Do something' scenario)

Intersection / approach road	100NB			100SB		
	Approach volume (veh/h)	Average delay (s)	LoS	Approach volume (veh/h)	Average delay(s)	LoS
Queen Street / Alexandra Street						
Queen Street eastbound	799	0.2	A	543	0.1	A
Alexandra Street southbound	124	8.9	A	216	15.9	B
Queen Street westbound	231	0.0	A	330	0.0	A
Alexandra Street northbound	248	7.3	A	220	11.7	A
Total	1402	2.2	A	1309	4.6	A
Queen Street / Prince Alfred Street						
Queen Street eastbound	448	0.0	A	403	0.0	A
Queen Street westbound	322	0.0	A	411	0.0	A
Prince Alfred Street northbound	356	4.5	A	344	3.8	A
Total	1126	1.4	A	1158	1.1	A
Queen Street / Albert Street						
Queen Street eastbound	492	0.0	A	429	0.0	A
Albert Street	123	2.4	A	103	0.2	A
Queen Street westbound	377	0.0	A	526	0.1	A
Total	992	0.3	A	1058	0.1	A
Old Princes Highway / Tannery Road						
Old Princes Highway northbound	580	0.0	A	487	0.2	A
Old Princes Highway southbound	245	0.4	A	402	0.6	A
Tannery Road	99	1.0	A	125	1.0	A
Total	924	0.2	A	1014	0.5	A

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model and AUSTROADS Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009)

Table 7.9 shows the performance of intersections located in the centre and to the east of Berry. Modelling results indicate that delays would be expected to decrease from existing levels at these locations. The project would result in a change in traffic distribution and patterns at key intersections in the future. While major through movements would be reduced, demand generated by the town and its local surroundings is expected to continue to grow. This would result in a significant increase in the proportion of demand generated by the minor approach roads at these intersections.

Peak period traffic demand at Prince Alfred Street is forecast to grow from currently around 150 vehicles per hour to around 360 vehicles per hour by 2037; with traffic at Alexandra Street northbound expected to increase from about 100 vehicles per hour to over 250 vehicles. Conversely, traffic on the major Queen Street (Princes Highway) intersection approaches is expected to reduce following the provision of the Berry bypass, removing through traffic from the town centre. In 2011, eastbound traffic on Queen Street at the intersection with Alexandra Street peaked at over 900 vehicles per hour; westbound traffic peaked at over 860 vehicles per hour. However, 2037 future year traffic modelling indicates that on completion of the upgrade, eastbound traffic would reduce during peak periods to around 550 vehicles per hour, and westbound traffic to around 330 vehicles per hour. The modelled westbound flow is considerably lower than the eastbound flow. This is partially due to the provision of a second southbound off-ramp at Kangaroo Valley Road; this allows traffic travelling southbound on the Princes Highway to access areas in the west of Berry and Kangaroo Valley Road without travelling through the town centre.

Despite the growth in locally generated traffic increasing demand from minor approaches, the reduction in traffic on Queen Street would see an overall improvement in LoS and reduced average delay. During the busiest peak periods all intersection approach roads would operate at LoS A and experience minimal congestion or delay (with the exception of Alexandra Street southbound, which would operate at LoS B, with an average delay of around 16 seconds), as the bypass of Berry would remove large volumes of through-traffic from the centre of town.

Further analysis of the Princes Highway/Kangaroo Valley Road NB off-ramp

The Paramics modelling for the 2037 'Do something' 100th highest hour holiday peak period scenarios showed that proposed access arrangements including a single northbound off-ramp would accommodate projected traffic demand to Berry from the south with minimal delay and LoS A. In addition, further sensitivity analysis was completed to determine the volume of traffic that would be required to reduce the performance of this arrangement to an unacceptable LoS and the year that traffic is expected to reach this level.

Table 7.10: Northbound off-ramp intersection performance - sensitivity analysis

Intersection / approach road	2037 100NB		2037 100NB x 2		2037 100NB x 3		2037 100NB x 4	
	Approach volume (veh/h)	LoS	Approach volume (veh/h)	LoS	Approach volume (veh/h)	LoS	Approach volume (veh/h)	LoS
Kangaroo Valley Road / Huntingdale Park Road: New road connection westbound	603	A	951	A	1135	C	1172	F

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model and AUSTROADS Guide to Traffic Management, Part 3: Traffic Studies and Analysis, 2009)

The total demand matrix used in the 2037 'Do something' 100th highest hour NB Paramics model was factored by multiples of two, three and four, and the resulting matrices were assigned to the modelled network to assess the performance of the northbound off-ramp arrangement at Berry when subjected to large increases in future year traffic volumes. **Table 7.10** provides details of the traffic volumes and corresponding LoS for the intersection sensitivity modelling.

Modelling indicates the new road connection approach to the Kangaroo Valley Road and Huntingdale Park Road intersection, which links the northbound off-ramp to Kangaroo Valley Road[2], would still operate at LoS A when northbound off-ramp traffic is increased to double the expected volume during the busiest peak periods in 2037. Intersection performance would deteriorate to LoS C when subjected to three times the volume of off-ramp traffic expected in 2037. More critically at this point however, qualitative analysis of this scenario indicated that the capacity of the approach roads (ie the capacity of the single lane new road connection and off-ramp) to this intersection would be exceeded by an increase in demand of this magnitude. This would lead to a significant deterioration in overall network performance. Extrapolation of future year forecast traffic volumes for the off-ramp shows that this level of traffic demand would not be expected to be reached until around 2070, or around 35 years after the project design year.

Assuming the capacity constraints of the approach roads were mitigated, the modelling indicates that intersection performance would fall to an unacceptable LoS F with four times the peak period demand forecast in 2037.

Performance analysis of the other intersections at the Kangaroo Valley Road interchange and local roads within Berry has shown that the access arrangements proposed as part of the project are suitable for the forecast traffic flows. Despite this, concept design work has included an investigation of suitable locations where an additional northbound off-ramp could be located to access Berry from the south. This analysis identified the only feasible connection for a second northbound off-ramp would be at Woodhill Mountain Road, although unfavourable geographical and geological conditions would result in significant impacts to the current environment both during construction and operation.

In summary, Paramics modelling shows that the proposed northbound off-ramp arrangement at the southern interchange would have sufficient operating capacity to adequately accommodate traffic volumes much higher than those predicted at the time of the design year in 2037. Further to this, it is anticipated that other environmental impacts (for example noise and air quality impacts created by traffic) would be within relevant thresholds based on the proposed design, without the provision of a second northbound off-ramp.

Due to this, the social and environmental impacts that would be created by the construction of a second northbound off-ramp would not be justifiable when considering the project objectives; this is especially true when considering the proposed site for an additional off-ramp to Woodhill Mountain Road. Hence, a second northbound off-ramp in Berry is not required to accommodate projected traffic volumes or mitigate other environmental impacts and is not being provided as part of this project.

Despite this, the concept design does not preclude the future addition of a second northbound off-ramp for Berry at Woodhill Mountain Road should it become warranted in the future. The construction of this facility would be subject to a separate environmental assessment.

[2] The performance of the Kangaroo Valley Road / Huntingdale Park Road intersection was assessed as it is at this location that conflicting traffic demand generated by the northbound off-ramp, Kangaroo Valley and Huntingdale Park would be greatest, and intersection performance poorest.

7.2.3 Travel speeds and travel times

The 2006 Gerringong to Bomaderry sub-area TRACKS traffic model, produced by Gabites Porter Consultants, has been developed with inputs including surveyed traffic volumes and travel times, plus land use and demographic data. Using these inputs, the model has been calibrated to ensure an accurate representation of current highway conditions in the project area. The results of current travel time modelling and analysis are discussed in Section 3.2.

Following the development of this model to represent current traffic conditions, a future year (2026) model has been developed by Gabites Porter Consultants to estimate the effects the project would have on future travel times and speeds. The results of this modelling are included in **Table 7.11**, with the routes and timing points used shown in **Figure 7.2**.

Table 7.11: 2006 pre-upgrade and 2026 post-upgrade TRACKS modelled travel times

Route	Direction	Pre-upgrade (2006)			Post-upgrade (2026)		
		Distance (km)	Average speed (km/h)	Average travel time (mins)	Distance (km)	Average speed (km/h)	Average travel time (mins)
North of project area Princes Highway: North of Rose Valley Road to Toolijooa Road The 'Sandtrack': Princes Highway north of Rose Valley Road to 'Sandtrack' at Dooley Road (via Fern St)							
Princes Highway	Northbound	7.0	75.3	5.5	6.8	97.5	4.2
	Southbound		80.2	5.2		97.5	4.2
The 'Sandtrack'	Northbound	8.7	50.0	10.5	8.7	49.9	10.5
	Southbound		50.5	10.4		51.1	10.3
Project area Princes Highway: Toolijooa Road to Schofields Lane The 'Sandtrack': Dooley Road to Shoalhaven Heads Road							
Princes Highway	Northbound	12.6	52.6	14.4	11.2	98.5	6.8
	Southbound		51.2	14.8		98.5	6.8
'Sandtrack'	Northbound	9.9	78.4	7.5	9.9	78.9	7.5
	Southbound		77.9	7.6		79.0	7.5
South of project area Princes Highway: Schofields Lane to Bolong Road The 'Sandtrack': Shoalhaven Heads Road to the Princes Highway, Bomaderry							
Princes Highway	Northbound	13.6	63.2	12.9	13.6	69.0	11.8
	Southbound		64.8	12.6		68.8	11.9
The 'Sandtrack'	Northbound	13.8	72.4	11.5	13.8	72.3	11.5
	Southbound		70.0	11.8		72.5	11.4
Traffic impact footprint Princes Highway: North of Rose Valley Road to Bolong Road The 'Sandtrack': Princes Highway north of Rose Valley Road to the Princes Highway, Bomaderry (via Fern Street)							
Princes Highway	Northbound	33.2	60.6	32.8	31.6	83.0	22.8
	Southbound		61.1	32.6		82.9	22.9
The 'Sandtrack'	Northbound	32.4	66.0	29.5	32.4	66.0	29.5
	Southbound		65.2	29.8		66.6	29.2

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

The project shortens the length of the Princes Highway through the major realignment of the existing carriageway. Bypassing the 'Foxground bends' in the east of the project area, the upgraded highway would provide a shortened route and also benefit from significantly improved horizontal and vertical alignment, resulting in increased safe travel speeds in the area. In the project area the existing Princes Highway is longer, and has an average travel time close to double that of the equivalent 'Sandtrack' route to the south.

The project would create a shorter travel time on the Princes Highway than the 'Sandtrack' in the project area in the future, with estimated travel time savings of over seven minutes on the Princes Highway between Toolijooa Road and Schofields Lane. It is estimated that average travel times along the 'Sandtrack' would remain roughly constant at around 7.5 minutes.

Without the project, the 'Sandtrack' has a substantially shorter average travel time in the project area than the Princes Highway (although travel times between within the traffic impact footprint between Gerringong and Bomaderry are similar overall). The significant travel time savings that would be created by the project are anticipated to result in a large amount of traffic transferring from the 'Sandtrack' in favour of the upgraded highway following construction. Similar upgrades to the north and south of the project area are likely to improve travel times further on the Princes Highway within the traffic impact footprint, adding to the proportion of overall traffic using the highway rather than the alternative 'Sandtrack' route.

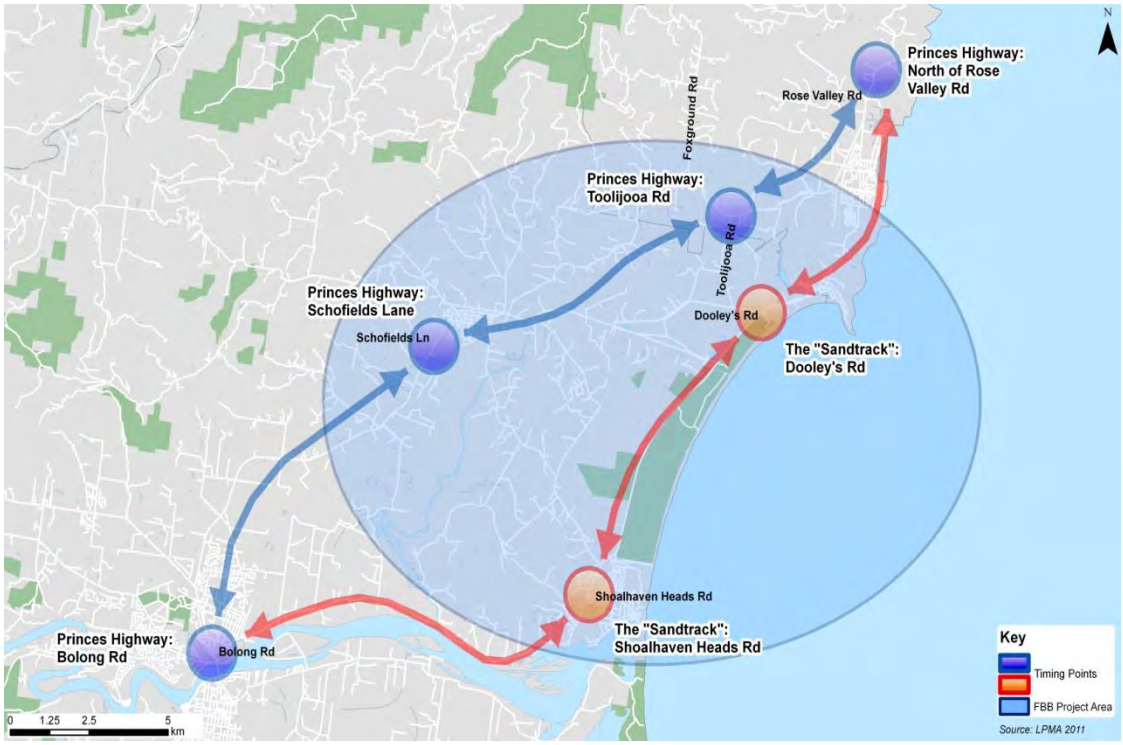


Figure 7.2: Travel time analysis routes and timing points

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

7.2.4 Climbing lane assessment

Significant and/or sustained uphill gradients can reduce heavy vehicle travel speeds to a point where the efficiency of the four lane divided carriageway would be considerably reduced, impacting the ability of the proposed upgrade to meet the project objectives. Consequently, the need for climbing lanes has been assessed due to the variations in vertical alignment (as a result of the natural geography) of the project in the project area.

For divided, multi-lane highways climbing lanes are warranted if the following criteria are both met (*Austroads Guide to Road Design Part 3 – Geometric Design; Chapter 9 – Auxiliary Lanes*):

- Heavy vehicle speed drops below 40 kilometres per hour.
- Traffic volumes equal or exceed those in **Table 7.12**.

In addition, climbing lanes should also be considered in the following cases:

- Long grades over eight per cent occur.
- Accidents attributable to the effects of slow moving trucks are significant.
- The highway operates at LoS E or worse, (or the LoS falls two levels from the LoS on approach to the incline).

Heavy vehicle speed calculations are available both in the RMS *Road Design Guide (Section 9)* as well as various Austroads publications. The following sources have been used for calculations in this analysis:

- Heavy Vehicle Speed Calculations: *Austroads Guide to Road Design Part 3 - Geometric Design (Chapter 9 – Auxiliary Lanes, Table 9.5 and Figure 9.4*).
- LoS Calculations: *Austroads Guide to Traffic Management Part 3 – Traffic Studies and Analysis (Chapter 4)*.

Table 7.12: Volume guidelines for partial climbing lanes

Overtaking opportunities over the preceding 5 km[3]		Current year design volume (AADT)		
Description	Per cent length providing overtaking	Percentage of slow vehicles[4]		
		5 %	10 %	20 %
Excellent	70 – 100	4500	4000	3500
Good	30 – 70	3500	3000	2600
Moderate	10 – 30	2500	2200	2000
Occasional	5 – 10	1800	1600	1400
Restricted	0 – 5	1200	1000	900
Very restricted[5]	0	700	600	500

(Source: Austroads Guide to Road Design Part 3 - Geometric Design, 2010)

[3] Depending on road length being considered, this distance can range from 3 to 10 kilometres.
[4] Including light trucks and cars towing trailers, caravans and boats.
[5] No overtaking for 3 kilometres in either direction.

A total of six locations in the project area have been identified with the potential to warrant a climbing lane based on the grade, and the length of grade associated with the proposed highway upgrade. These locations are listed below (drawings of these sections are provided in Appendix E):

- A: CH6920-8800 (beginning 800 metres east of Toolijooa Road), southbound.
- B: CH11040-8800 (beginning 1 kilometre east of Austral Park Road), northbound.
- C: CH11040-11700 (beginning 1 kilometre east of Austral Park Road), southbound.
- D: CH12780-11700 (beginning 500 metres west of Austral Park Road), northbound.
- E: CH13540-14160 (beginning 400 metres east of Tindalls Lane), southbound.
- F: CH16400-14160 (beginning 400 metres west of Woodhill Mountain Road), northbound.

The locations include significant inclines for sustained periods, which could result in heavy vehicle speeds dropping below the 40 kilometres per hour threshold and/or significant decreases in LoS. The current project concept design includes climbing lanes in the vicinity of Toolijooa Ridge in the southbound direction at location A and in the northbound direction at location B.

Table 7.13 indicates the lengths on constant individual grades that are required to reduce heavy vehicle speeds to 40 kilometres per hour. The table shows the relationship between the approach design speed, grade and length of the incline. For example, **Table 7.13** shows that a climbing lane would likely be required on a road link with an approach speed of 100 kilometres per hour and a constant seven per cent grade over a distance greater than 800 metres as this would cause truck speeds to drop below 40 kilometres per hour.

Table 7.13: Grade/distance relationship (lengths to reduce truck vehicle speed to 40 km/h)

Approach speed (km/h)	Uphill gradient (%) / length (m)						
	4 %	5 %	6 %	7 %	8 %	9 %	10 %
100	-	-	1050	800	650	550	450
80	630	460	360	300	270	230	200
60	320	210	160	120	110	90	80

(Source: Austroads Guide to Road Design Part 3 - Geometric Design, 2010)

For each location, the total length and elevation has been extracted from the concept design; these values in turn can be used to calculate the average grade. However, because relatively small differences in highway grade have a significant effect on truck speed (as shown in **Figure 7.3**), it is necessary to divide each location into smaller subsections for the assessment. This allows for analysis that takes into account the grades of individual subsections at each location, with the speed at the end of one subsection carried through as the speed at the start of the next, based on the speed curves shown in **Figure 7.3**.

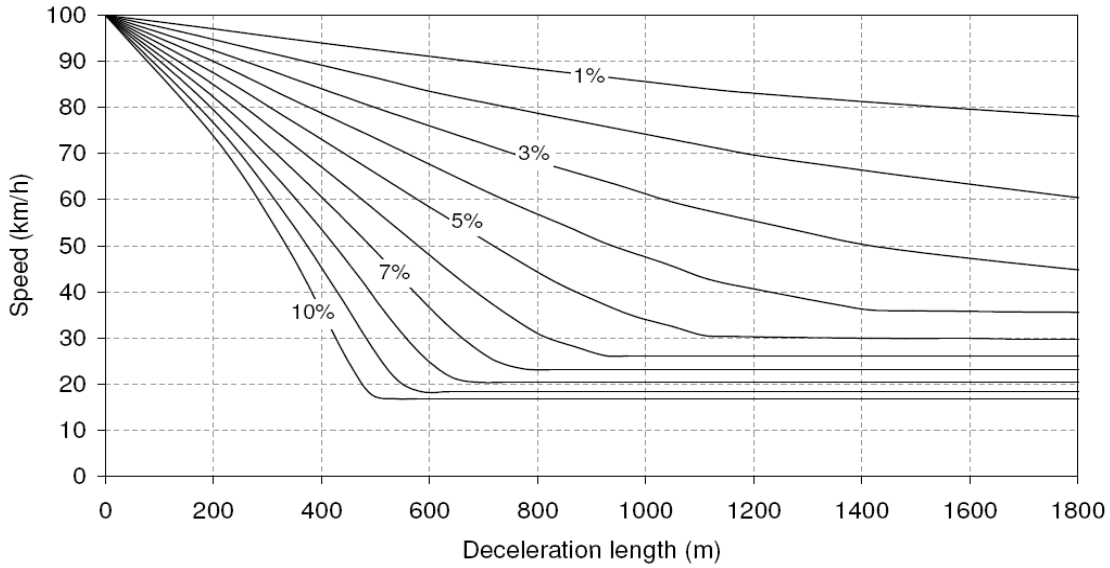


Figure 7.3: Determination of truck speeds on grade, B-double (62.4t) carrying a maximum load

(Source: Austroads Guide to Road Design Part 3 - Geometric Design, 2010)

The climbing lane assessment, which is summarised in **Table 7.14** (full analysis is included in **Appendix E**), indicates that truck speeds would drop below 40 kilometres per hour at location A southbound, and location B northbound as heavy vehicles traverse Toolijooa Ridge. In this area traffic volumes on the Princes Highway are forecast to exceed 30,000 vehicles per day by the design year of 2037; this is in excess of the volume guidelines shown in **Table 7.12**, and confirms that locations A and B both satisfy the criteria that warrant climbing lanes.

For the remaining four locations, truck speeds are expected to drop to no lower than approximately 70 kilometres per hour, indicating there is no requirement for climbing lanes to maintain an adequate LoS.

Table 7.14: Truck speed analysis summary

Location	Direction	Posted speed (km/h)	Length (m)	Elevation (m)	Maximum grade (%)	Minimum truck speed (km/h)
A	Southbound	100	1880	72	6.0 %	**26.0**
B	Northbound	100	2240	54	4.9 %	**36.0**
C	Southbound	100	660	17	4.8 %	75.0
D	Northbound	100	1080	23	2.5 %	70.0
E	Southbound	100	620	16	4.0 %	75.0
F	Northbound	100	2240	26	2.9 %	68.0

(Source: AECOM, based on AUSTROADS Guide to Road Design Part 3 – Geometric Design, 2010)

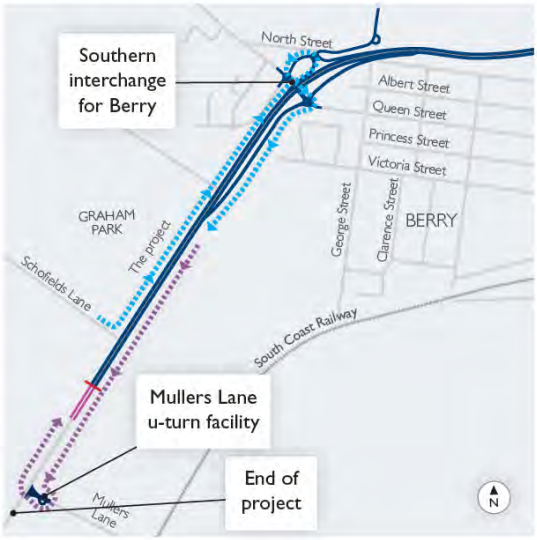
7.2.5 Highway access constraints

The introduction of a central median and safety barrier would provide significant improvements in road safety, including the separation of opposing traffic flows, and elimination of right turn movements between the Princes Highway and minor roads and property accesses across fast-moving two-way traffic (at locations where right turns can currently be made prior to the introduction of a central median and safety barrier). The crash data analysis shown in Section 7.2.7 shows that around 20 per cent of crashes in the project area occurred either at intersections or between vehicles travelling in opposite directions. Minor roads which join the Princes Highway currently have the ability to turn either left or right to or from the highway. Once a central median and safety barriers are installed local roads and accesses in rural areas would be provided with left in and left out only turning facilities. Low daily volumes of traffic, which would previously have turned right from, or into a minor road, would be required to travel to the nearest u-turn facility to make a safe right hand turn to proceed in the desired direction. Although this would inconvenience a small proportion of local traffic as it would require additional travel when compared to existing arrangements.

Current access arrangements would be restricted for the following key sections of the Princes Highway in the project area:

- Schofields Lane to Berry (south) interchange.
- Berry (north) interchange to Tindalls Lane.
- Tindalls Lane to Austral Park Road.

Figure 7.4 shows the access constraints between Schofields Lane and the southern half of the interchange at Kangaroo Valley Road following the construction of the project. Due to left-in-left-out only arrangements for access points along this length including Schofields Lane, traffic desiring to turn right across opposing traffic flows into or out of these accesses, would have to travel to either the highway interchange at Kangaroo Valley Road, or Mullers Lane to turn around before proceeding in the desired direction.



From	Properties in and north of Schofields Lane to the southern interchange for Berry accessed via northbound carriageway.
To	Princes Highway southbound.
Traffic circulation	Requires northbound travel on the Princes Highway and u-turn at the southern interchange for Berry.
Maximum additional travel (typical conditions)	2.8 km (2.3 minutes).

From	Properties south of Victoria Street accessed via southbound carriageway.
To	Princes Highway northbound.
Traffic circulation	Requires southbound travel on the Princes Highway and u-turn at Mullers Lane.
Maximum additional travel (typical conditions)	2.8 km (2.4 minutes).

Figure 7.4: Access constraints - Schofields Lane to southern interchange for Berry

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

Similarly:

- **Figure 7.5** shows the access constraints between the Berry (north) interchange and Tindalls Lane interchange following construction of the project; and
- **Figure 7.6** shows the access constraints between the Tindalls Lane and the Austral Park Road interchanges following construction of the project.

Again due to access restrictions at these locations on the upgraded Princes Highway, traffic desiring to turn right across opposing traffic flows into or out of these accesses, would have to travel in the opposite direction to the adjacent interchange to turn around before proceeding in the desired direction.

From	Properties north of the northern interchange for Berry to Tindalls Lane accessed via northbound carriageway.
To	Princes Highway southbound.
Traffic circulation	Requires northbound travel on the Princes Highway and u-turn at Tindalls Lane interchange or via underpass/Queen Street.
Maximum additional travel (typical conditions)	3.1 km (2.9 minutes).

From	Properties south of Tindalls Lane to the northern interchange for Berry accessed via southbound carriageway.
To	Princes Highway northbound.
Traffic circulation	Requires southbound travel on the Princes Highway and u-turn at Woodhill Mountain Road.
Maximum additional travel (typical conditions)	2.6 km (2.9 minutes).

Figure 7.5: Access constraints – northern interchange for Berry to Tindalls Lane

(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

From	Properties north of Tindalls Lane to Austral Park Road interchange accessed via northbound carriageway.
To	Princes Highway southbound.
Traffic circulation	Requires northbound travel on the Princes Highway and u-turn at Austral Park Road interchange.
Maximum additional travel (typical conditions)	3.2 km (2.9 minutes).

From	Properties south of Austral Park Road to Tindalls Lane accessed via southbound carriageway.
To	Princes Highway northbound
Traffic circulation	Requires southbound travel on the Princes Highway and u-turn at Tindalls Lane interchange or via Austral Park Road interchange.
Maximum additional travel (typical conditions)	2.9 km (2.8 minutes).

Figure 7.6: Access constraints - Tindalls Lane to Austral Park Road
(Source: AECOM, based on data from Gabites Porter Consultants sub-area TRACKS model)

7.2.6 Local access constraints

In addition to the constraint of right turns imposed by the provision of a central median and safety barrier, the proposed concept design would sever the current road link provided by North Street between Rawlings Lane and Edward Street. North Street currently provides an alternative route to the Princes Highway between Kangaroo Valley Road and Woodhill Mountain Road to the north of Berry. Although only a small proportion of through traffic currently uses this route, the construction of the Berry bypass would require vehicles to use either the Berry bypass (vehicles travelling between Kangaroo Valley Road and areas east of Berry) or Queen Street as an alternative to North Street in the future.

Local properties whose connection to the local road network is affected would be provided with an alternative means of access. Properties to the north of North Street, which currently gain access to the local road network via Rawlings Lane, would be provided with a link via a new road connection to Kangaroo Valley Road. All local properties to the south of the bypass travelling to and from Kangaroo Valley Road would do so via Queen Street.

The severance of North Street would also impact local services. Garbage trucks servicing properties on North Street would encounter cul-de-sacs on both sides of the bypass. Turning provision would be provided on the residual sections of North Street to allow trucks to turn, while travel between these sections would be via Kangaroo Valley Road, Queen Street and Edward Street.

7.2.7 Victoria Street design options

Introduction

Victoria Street currently intersects with the Princes Highway at the southern extent of Berry adjacent to Mark Radium Park; allowing for all turning movements between the two roads. Under the project, various treatments could occur at this intersection, which would change the volume and distribution of traffic on local roads; particularly along and between Victoria Street and Queen Street.

The project team identified three design options that could 'work' with the overall project from the point of view of road safety, traffic efficiency and general operational performance. The details of each option are listed below and shown in **Figure 7.7**.to **Figure 7.9**.

Option 1 - Victoria Street closed and one-way southbound on-ramp

- Direct access to the upgraded highway from Queen Street via a southbound on-ramp and the closure of Victoria Street (via creation of a cul-de-sac or turnaround area) west of the current BUPA/Arbour developments' access point.
- This would have very limited (although not zero) impact on Mark Radium Park, as shown in **Figure 7.7**.

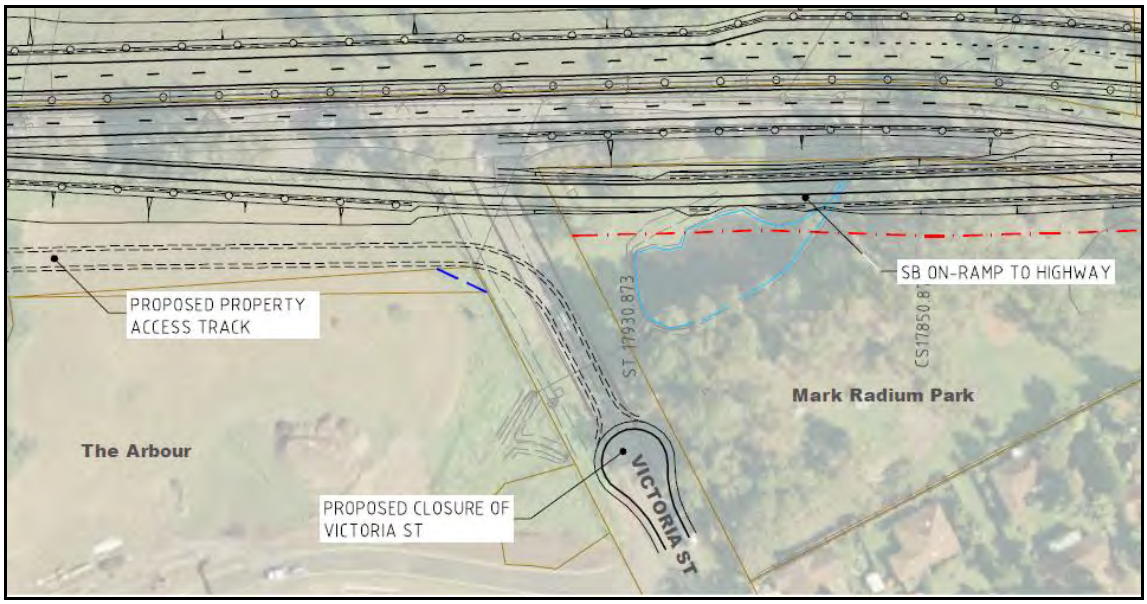


Figure 7.7: Victoria Street design option 1

(Source: AECOM)

Option 2 - Victoria Street open and one-way southbound on-ramp

- Maintaining a one-way link between Queen Street and Victoria Street for southbound traffic only.
- Traffic heading southbound from Berry onto the upgraded highway would also be able to access the on-ramp from Victoria Street.
- This option would require utilisation of a portion of Mark Radium Park, however to a lesser extent than the two-way option 3, as shown in **Figure 7.8**.

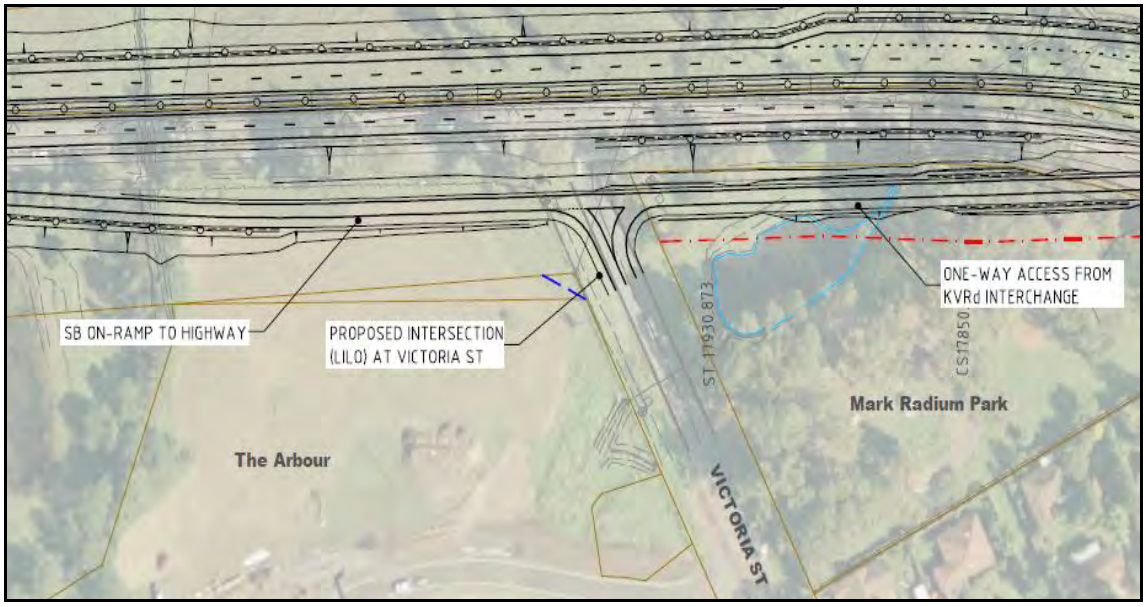


Figure 7.8: Victoria Street design option 2
(Source: AECOM)

Option 3 - Victoria Street open and two-way southbound on-ramp

- Maintaining a two-way link between Queen Street and Victoria Street through the construction of a local road between the upgraded highway and Mark Radium Park.
- Traffic heading southbound from Berry onto the upgraded highway would also be able to access the on-ramp from Victoria Street.
- This option would require utilising a portion of Mark Radium Park, extending to and including part of the 'duck pond' water feature, as shown in **Figure 7.9**.

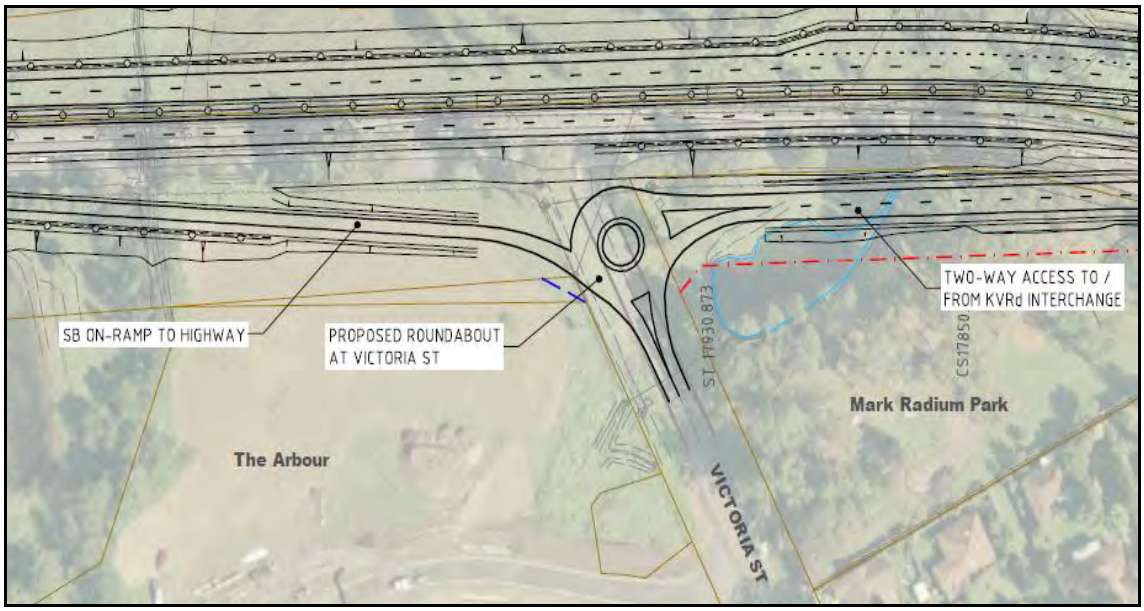


Figure 7.9: Victoria Street design option 3
(Source: AECOM)

Existing year (2012) traffic volumes and patterns

In order to assess the local road traffic impacts of the three options identified, RMS and Shoalhaven City Council commissioned the following traffic surveys; which were undertaken during April / May 2012 to measure traffic volumes and patterns on Victoria Street and other key adjacent local roads:

- Automatic Traffic Counts - ATC 'tubes' were put down on 13 local roads in Berry for several weeks to record daily traffic volumes.
- Intersection Turning Counts - surveyors manually recorded the number of vehicles turning at the Victoria Street intersections with the Princes Highway and Prince Alfred Street during the AM peak and PM peak periods on an average weekday.
- Origin-destination (O-D) Surveys - surveyors manually recorded number plates of vehicles entering and exiting Victoria Street to/from the highway and Prince Alfred Street; to determine the proportion of 'through' traffic on average weekdays and during the May 2012 Berry Country Fair. Further details of these surveys are provided in Section 2.4.6.

Figure 7.10 summarises 2012 AADT volumes on Victoria Street, Queen Street and the five local north-south roads. AADT on Victoria Street is currently highest at the western end, near the Princes Highway intersection with around 2200 vehicles per day in comparison to around 1200 vehicles per day at the eastern end between Prince Alfred Street and Alexandra Street. The figure also shows the AADT on the four key north-south roads between these two locations on Victoria Street, which peaks at 750 vehicles per day on Albany Street, with an average AADT of around 350-450 vehicles on the other roads. In addition, the figure highlights the existing spread of combined AADT across the four north-south roads, ranging from 18 per cent of combined north-south daily traffic travelling on Edward Street to 39 per cent on Albany Street.

Existing turning volumes at the Princes Highway and Victoria Street intersection were recorded to gain an understanding of the amount of traffic that would be re-distributed to other local roads, which would vary depending on the option selected.

Figure 7.10: 2012 AADT and traffic patterns
(Source: AECOM)

Figure 7.11 displays the 2012 AADT turning volumes at the intersection, and shows the movement from Victoria Street to the Princes Highway southbound as the most heavily trafficked at around 1100 vehicles per day. The opposite movement from the Princes Highway northbound into Victoria Street has a similar level of daily traffic with an AADT of 925 vehicles.

The other two turning movements accommodate a small amount of daily traffic ranging from 30 to 110 vehicles. This suggests that a one-way or two-way link between Queen Street and Victoria Street (Option 2 and Option 3) may not be warranted based on the potential levels of traffic that would utilise the road.

The project would provide an access to the southbound Princes Highway on-ramp via Victoria Street or Queen Street and in terms of accessibility this would not be a significant change from existing conditions. However, the existing access from the Princes Highway northbound into Victoria Street would be removed for all options and traffic currently travelling along this route would need to utilise the Kangaroo Valley Road interchange to access Berry.

As previously discussed, the existing AADT for this movement is 925 vehicles per day, and the AADT on Victoria Street east of the highway intersection is 2200 vehicles per day. Therefore, there would be around a 43 per cent reduction (925/2170) in traffic on Victoria Street regardless of the design option selected.

O-D Surveys were conducted during typical weekday and weekend peak periods in May 2012 established the proportion of through traffic that currently travels (without stopping) along the entire length of Victoria Street, between the Princes Highway and Prince Alfred Street intersections.

Findings from the O-D surveys (see Section 2.4.6) showed that around 20 per cent of vehicles travel through the entire length of Victoria Street during typical weekday AM peak and PM peak periods, with the remaining 80 per cent of vehicles either stopping or turning off to a side street before the other end of Victoria Street. The proportion of through traffic reduced to around nine per cent during the busy four hour peak period of the Berry Country Fair, due to increased levels of traffic travelling along Victoria Street to access the Berry Showground and surrounding areas.

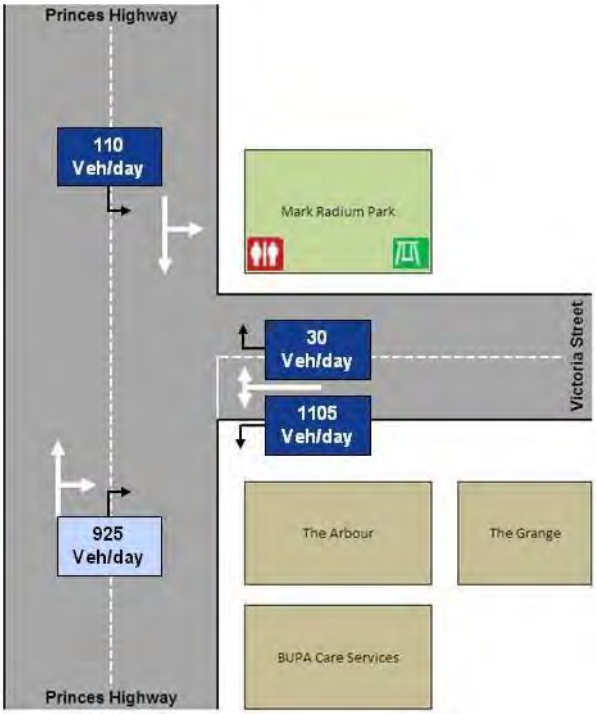


Figure 7.11: 2012 AADT at the Princes Highway and Victoria Street intersection
(Source: AECOM)

Traffic distribution model development

ATC, intersection and O-D survey data was used as inputs to a Berry local road distribution model (see **Appendix F**), which was developed to assess the traffic impacts in the town as a result of each Victoria Street design option. The modelling methodology was aligned with and included traffic projections from, the main traffic modelling and forecasting process and involved a series of steps and assumptions, as summarised below:

- A future design year of 2037, which is 20 years after the 2017 year of opening, was selected as required for the traffic assessment of the project.
- Daily traffic volumes on local roads are predicted to increase by two per cent per annum due to population and employment growth projections; as advised by Shoalhaven City Council.
- The projected increase in traffic volumes generated from Huntingdale Park were derived from separate assumptions, as this is the main development area in the town and growth rates will be higher compared to other areas of Berry.
- The predicted transfer or re-distribution of traffic for the closure, or part closure, of Victoria Street options was based on:
  - Projected Princes Highway mainline and ramp traffic volumes as discussed in Section 4.2.4.
  - Existing volumes and proportions of total AADT across George Street, Edward Street, Albany Street and Alexandra Street.
  - 80 per cent local and 20 per cent through traffic split on Victoria Street to / from the Princes Highway and Prince Alfred Street.

Forecast year (2037) traffic volumes and patterns for each option

Detailed illustrations of the four distribution models, showing traffic volumes and patterns, are included in **Appendix F.** In addition, **Table 7.15** (and **Figure 7.12**) provides a summary of the forecast traffic volumes and calculated level of service (LoS) at key local road locations for the 2012 modelled base year and 2037 design year for the three Victoria Street design options. In addition, the percentage difference in AADT is also included; showing the predicted change on each road compared to existing traffic volumes.

Option 1, which would provide access to the main alignment from Queen Street via a southbound on-ramp and the closure of Victoria Street via creation of a cul-de-sac or turnaround area, would result in the following key local road impacts, based on predicted traffic growth from 2012 to 2037, and traffic rerouting following construction of the project:

- In 2037, daily traffic volumes on Queen Street would be potentially 47 per cent less than existing levels due to construction of the bypass; and would be expected to operate at LoS C during the 100th highest hour southbound (100SB) peak period.
- Victoria Street would have a six per cent reduction in AADT at the eastern end near Prince Alfred Street.
- Traffic volumes on George Street, Edward Street and Alexandra Street would grow by around 185 per cent over the next 25 years, resulting in similar daily traffic volumes to existing levels on Victoria Street (east).
- Albany Street traffic volumes are also expected to grow by around 185 per cent to an AADT of 2140 vehicles per day in 2037, resulting in similar daily traffic volumes to existing levels on Victoria Street (west).
- AADT on Prince Alfred Street is expected to grow by 53 per cent over the next 25 years.
- Peak hourly traffic volumes for the 100SB scenario would be less than 200 vehicles per direction for all local roads (excluding Queen Street), resulting in LoS B or better.

Option 2, which would maintain a one-way link between Queen Street and Victoria Street, is predicted to result in the following key local road impacts, based on predicted traffic growth from 2012 to 2037, and traffic rerouting following construction of the project:

- In 2037, daily traffic volumes on Queen Street are expected to be 62 per cent lower than existing levels with the bypass constructed and Victoria Street open with a left-turn to the southbound on-ramp. It is predicted that Queen Street would operate at LoS B during the 100SB peak period for this scenario.
- Victoria Street is expected to have a 16 per cent reduction and 26 per cent increase in AADT at its western and eastern ends respectively.
- Traffic volumes on George Street, Edward Street and Alexandra Street would grow by 110 per cent over the next 25 years, resulting in similar daily traffic volumes to existing levels on Albany Street.
- Albany Street traffic volumes are also expected to grow by 110 per cent to an AADT of 1575 vehicles per day in 2037.
- AADT on Prince Alfred Street is predicted to grow by 52 per cent over the next 25 years, which is consistent across all options.
- Peak hourly traffic volumes for the 100SB scenario would be less than 200 vehicles per direction for all local roads (excluding Queen Street), resulting in LoS B or better.

Option 3, which would maintain a two-way link between Queen Street and Victoria Street, is predicted to result in the following key local road impacts, based on predicted traffic growth from 2012 to 2037, and traffic rerouting following construction of the project:

- In 2037, daily traffic volumes on Queen Street are expected to be 62 per cent lower than existing levels with the bypass constructed and Victoria Street open with a left and right turn to the southbound on-ramp. It is predicted that Queen Street would operate at LoS B during the 100SB peak period for this scenario.
- Victoria Street is expected to have a 14 per cent reduction and 26 per cent increase in AADT at its western and eastern ends respectively.
- Traffic volumes on George Street, Edward Street and Alexandra Street are expected to grow by 107 per cent over the next 25 years, resulting in similar daily traffic volumes to existing levels on Albany Street.
- Albany Street traffic volumes would also grow by 107 per cent to an AADT of 1560 vehicles per day in 2037.
- AADT on Prince Alfred Street is predicted to grow by 52 per cent over the next 25 years, which is consistent across all options.
- Peak hourly traffic volumes for the 100SB scenario would be less than 200 vehicles per direction for all local roads (excluding Queen Street), resulting in LoS B or better.

In summary, for all three Victoria Street design options, the four local north-south roads between George Street and Alexandra Street are expected to experience the largest increase in daily traffic volumes, ranging between 107 per cent and 185 per cent over the next 25 years. These figures appear relatively high, however AADT would be around or less than 2000 vehicles per day in 2037, which equates to:

- Approximately 100 vehicles per hour in each direction during the busiest 100SB peak period, or less than 2 vehicles per minute.
- The existing daily traffic volumes on Victoria Street near Mark Radium Park.

Table 7.15: Final forecast traffic volumes and LoS – local roads

Location	Measurement	Existing 2012 Road Network	Option 1 - 2037 Victoria St closed | one-way ramp	Option 2 - 2037 Victoria St open | one-way ramp	Option 2 - 2037 Victoria St open | two-way ramp
Queen St	AADT	12,285	6510	4690	4645
	% Difference (vs. 2012)	-	-47%	-62%	-62%
	100SB 1hr Flow (2-way)	1548	820	591	585
	100SB 1hr Flow (1-way)	774	410	295	293
	LoS	D	C	B	B
Victoria St (west)	AADT	2,170	-	1820	1865
	% Difference (vs. 2012)	-	-	-16%	-14%
	100SB 1hr Flow (2-way)	273	-	229	235
	100SB 1hr Flow (1-way)	137	-	115	117
	LoS	A	-	A	A
Victoria St (east)	AADT	1,140	1070	1430	1430
	% Difference (vs. 2012)	-	-6%	26%	26%
	100SB 1hr Flow (2-way)	144	135	180	180
	100SB 1hr Flow (1-way)	72	67	90	90
	LoS	A	A	A	A
George St	AADT	410	1165	860	850
	% Difference (vs. 2012)	-	185%	110%	107%
	100SB 1hr Flow (2-way)	52	147	108	107
	100SB 1hr Flow (1-way)	26	73	54	54
	LoS	A	A	A	A
Edward St	AADT	350	990	725	720
	% Difference (vs. 2012)	-	185%	110%	107%
	100SB 1hr Flow (2-way)	44	125	91	91
	100SB 1hr Flow (1-way)	22	62	46	45
	LoS	A	A	A	A
Albany St	AADT	750	2140	1575	1560
	% Difference (vs. 2012)	-	185%	110%	107%
	100SB 1hr Flow (2-way)	95	270	198	197
	100SB 1hr Flow (1-way)	47	135	99	98
	LoS	A	A	A	A
Alexandra St	AADT	435	1235	910	900
	% Difference (vs. 2012)	-	185%	110%	107%
	100SB 1hr Flow (2-way)	55	156	115	113
	100SB 1hr Flow (1-way)	27	78	57	57
	LoS	A	A	A	A
Prince Alfred St	AADT	1,925	2940	2925	2925
	% Difference (vs. 2012)	-	53%	52%	52%
	100SB 1hr Flow (2-way)	243	370	369	369
	100SB 1hr Flow (1-way)	121	185	184	184
	LoS	A	B	B	B

(Source: AECOM)

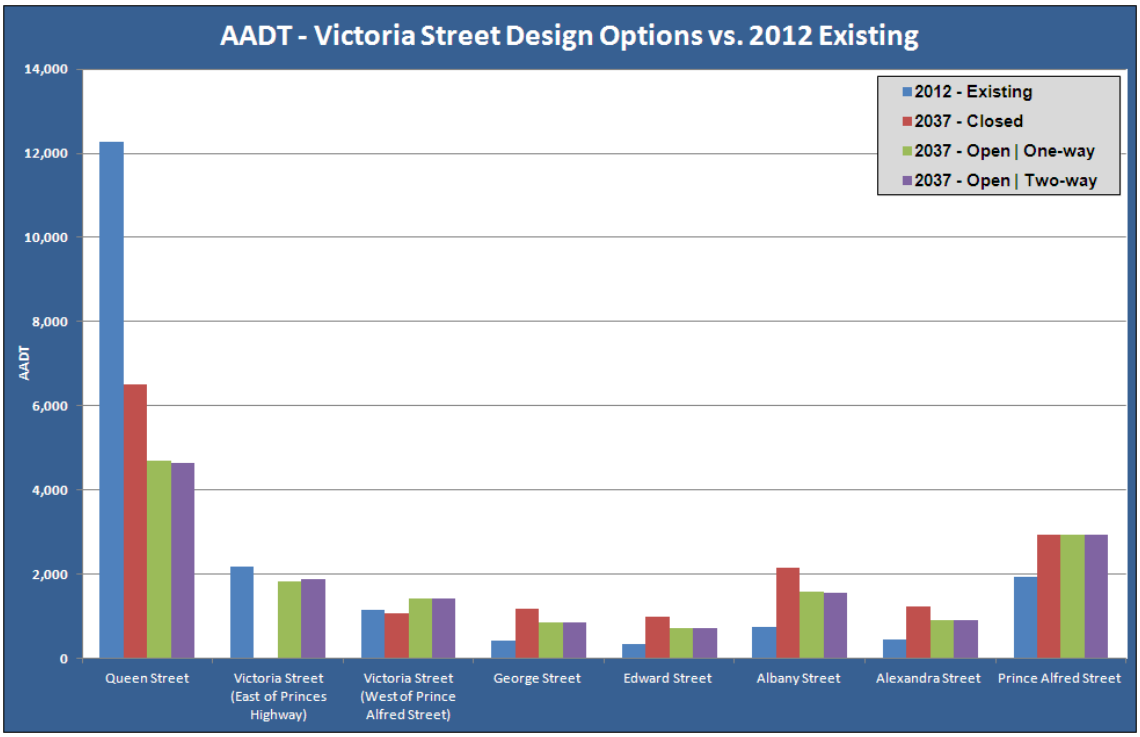


Figure 7.12: 2037 Victoria Street design options vs. 2012 existing AADT
(Source: AECOM)

Key findings and summary

Table 7.16 provides a summary of both the positive and negative traffic related impacts for the three Victoria Street design options. The table shows that each Victoria Street option would either result in less or more daily traffic in comparison to existing levels depending on location, with the magnitude varying for each option. For example, option 1 would re-distribute the largest amount of traffic from Victoria Street to other local roads, resulting in a 35 per cent increase on George Street, Edward Street, Albany Street and Alexandra Street when compared to the other two options. Inversely, option 1 would also remove 2000 vehicles per day from the western end of Victoria Street and a 45 per cent reduction at the eastern end.

Although traffic growth is predicted to be large when compared to existing levels, the resulting daily volumes, which include a two per cent per annum increase due to population and employment growth projections, are relatively low; with local roads accommodating between 700 and 2000 vehicles per day in 2037.Moreover, the resulting level of service (LoS) for all local roads is predicted to be LoS A or LoS B in 2037, which represents optimum operating conditions (free flow).

Therefore, for all options, predicted traffic volumes 25 years from now would not significantly change the residential nature of the local road network in Berry, particularly as AADT on Queen Street in 2037 is expected to be at least 50 per cent less than existing daily traffic volumes.

RMS is required to present one option for the purpose of the environmental assessment and has moved forward with Option 1, with Victoria Street closed in the concept design. Nonetheless, RMS is able to deliver any of the Victoria Street design options through the project.

RMS will continue discussions and encourage feedback and submissions through the environmental assessment display period and traffic impacts along with other environmental impacts will contribute to the selection of a final solution for Victoria Street.

Table 7.16: Victoria Street design options – summary of traffic and transport impacts

Traffic related impacts	Option 1 - Victoria St closed | one-way ramp	Option 2 - Victoria St open | one-way ramp	Option 3 - Victoria St open | two-way ramp
Positive	• In 2037, daily traffic volumes on Queen Street would be around 50 per cent less than today. • Around 2000 vehicles removed from the western end of Victoria Street. • Reduces traffic volumes on the eastern end of Victoria Street by around 45 per cent in 2037 when compared to the other options. • All local roads would perform at LoS A or LoS B in 2037, with only Queen Street operating at LoS C. • Least impact and land-take of Mark Radium Park and the closure of Victoria Street would allow for safer pedestrian connectivity to the park. • Provides a turning circle at the eastern end of Victoria Street (adjacent to Mark Radium Park) that could be used as a u-turn for larger vehicles (buses, garbage trucks etc.)	• In 2037, daily traffic volumes on Queen Street would be around 60 per cent less than today. • Reduces traffic volumes on the local north-south roads between Victoria Street and Queen Street by around 35 per cent in 2037 when compared to option 1. • Maintains most of the existing traffic movements and patterns on the local road network, including direct access from Victoria Street to the Princes Highway southbound. • All local roads would perform at LoS A or LoS B in 2037.	• In 2037, daily traffic volumes on Queen Street would be around 60 per cent less than today. • Reduces traffic volumes on the local north-south roads between Victoria Street and Queen Street by around 35 per cent in 2037 when compared to option 1. • Maintains the majority of existing traffic movements and patterns on the local road network, including direct access from Victoria Street to the Princes Highway southbound. • All local roads would perform at LoS A or LoS B in 2037. • Provides a roundabout at the Victoria Street and southbound on ramp intersection that could be used as a u-turn for larger vehicles (buses, garbage trucks etc.).
Negative	• In 2037, daily traffic volumes on local north-south are predicted to be three times greater when compared to existing levels. • Largest impacts on the local road network due to additional traffic volumes (around 35 per cent more than the other two options) on the north-south roads between Victoria Street and Queen Street. • Additional travel time to/from residential areas along and adjacent to Victoria Street to/from the south.	• In 2037, daily traffic volumes on local north-south are predicted to double when compared to existing levels. • Additional travel time to residential areas along and adjacent to Victoria Street from the south. • Potential safety issues due to slow moving traffic turning left from Victoria Street merging with vehicles accelerating on the southbound on ramp.	• In 2037, daily traffic volumes on local north-south are predicted to double when compared to existing levels. • Only 45 vehicles per day would travel northbound on Queen St (the southbound on ramp) between the Victoria Street and Kangaroo Valley Road intersections. This low volume of traffic shows that the two-way ramp option would provide a negligible benefit when compared to the other two options – particularly option 2. • Additional travel time to residential areas along and adjacent to Victoria Street from the south.

(Source: AECOM)

7.2.8 Traffic crashes

As listed in Section 6.2, one of the key objectives of the project is to improve road safety in the project area. An analysis of crashes that have recently occurred on the Princes Highway in the project area is shown in Section 3.1. The crash severity index in the project area is 1.31, significantly higher than the NSW average of 1.23 for all public roads, indicating a higher than average proportion of injury and fatal crashes on this section of the Princes Highway. Significantly, **Table 3.7** shows that the Princes Highway in the project area currently has a fatality rate of 0.8 per 100MVKM; this indicates that fatal crashes are 50 per cent more likely per kilometre travelled than the NSW average for all roads open to the public. Historical data also shows five fatal crashes on the 'Sandtrack' between 1 July 2003 and 30 September 2010, at a rate of 0.7 per 100MVKM.

The proposed highway upgrades are expected to significantly improve road safety, along and adjacent to the project. Crash analysis has been undertaken by comparing existing and proposed conditions to determine estimated crash reduction statistics based on historical data between 1 July 2003 and 30 September 2010, using the RMS' *Crash Reduction Guide*. Average crash costs based on a 'Willingness to pay' approach, have been provided by the RMS *Economic Analysis Manual (Economic Parameters for 2009)*, as discussed in Section 3.1.

The analysis assumed the following road safety improvements are implemented on the Princes Highway:

- Central median and safety barrier separating opposing traffic flows along the length of the project.
- Improved road alignment.
- Provision of additional and wider lanes and shoulders.
- Grade separated interchanges.
- Improved alignment and/or sight distances, and acceleration and deceleration provision at retained at-grade intersections on the Princes Highway.
- New alignment of the Princes Highway via the cutting at Toolijooa Ridge, bypassing the Foxground bends.
- Bypass of Berry.
- Central safety barrier resulting in median closure at all intersections (left in and left out turns only at local accesses)[6].

An estimate of the improvement in road safety created by these measures has been calculated using RMS' *Crash Reduction Guide;* this guide includes typical percentage reductions in crashes by definitions for coding accidents (DCA) codes based on highway and intersection treatments, which have been applied in this analysis. In addition, existing crash data in the area has been further analysed to determine if any crashes could have been prevented, or consequences minimised as a result of the construction of the project.

[6] The median safety barrier would be discontinued at the intersection of the Princes Highway and Mullers Lane at the southern extent of the project. Vehicles travelling southbound on the Princes Highway would be provided with a facility to turn into Mullers Lane, perform a safe u-turn and re-join the Princes Highway in the northbound direction.

The results shown in **Table 7.17** indicate crashes between vehicles travelling in opposing directions would see the greatest reduction (100 per cent) based on the proposed conditions, following the introduction of a central median and safety barrier. Crashes at intersections are estimated to reduce by 83 per cent as current at-grade intersections would be upgraded to grade separated interchanges or constrained to left in left out only access with acceleration and deceleration provision. It is also expected that highway improvements would reduce the frequency of crashes between vehicles travelling in the same direction (50 per cent reduction). Off path, on curve crashes, currently the most frequently occurring crash type in the project area, are estimated to be reduced by 74 per cent due to improvements in the horizontal and vertical alignment of the highway. It is estimated that total crashes on the Princes Highway in the project area would be reduced by 64 per cent under the upgraded conditions.

Upgrades of existing heavy vehicle rest areas north and south of the project area are currently being planned and are proposed by RMS within the scope of other projects. The Princes Highway in the project area is part of a key regional route for heavy vehicles travelling long distances between Sydney and Wollongong to the NSW south coast to Victoria. Fatigue is often a factor involved in traffic crashes, particularly for heavy vehicles making long distance journeys. The upgrading of existing rest areas for drivers would be expected to help reduce the risk of crashes of this type occurring in and around the project area.

In the section between Toolijooa Road and Austral Park Road, off path, on curve crashes currently account for over half of all crashes. In this area crashes of this type would reduce by around 75 per cent, primarily as a result of the realignment of the highway through Toolijooa Ridge, bypassing the 'Foxground bends'. The next most frequent crash type involves vehicles from opposing directions. The provision of a central median and safety barrier would eliminate the possibility of crashes of this type.

Between Austral Park Road and Woodhill Mountain Road, off path, on curve crashes are also the most commonly occurring crash type at present, accounting for over half of all crashes. Half of the crashes of this type that occurred in the analysis period also listed a steep grade or crest as a contributing factor to the crash. The combinations of curves at locations with poor vertical alignment is a significant road safety issue at present. The project would include significant improvements to the horizontal and vertical alignment of the highway which is expected to reduce the occurrence of crashes of this type by over 70 per cent in this section.

Between Woodhill Mountain Road and Schofields Lane the highway currently bisects Berry. Through this section the road environment changes significantly; the posted speed is reduced to 50 kilometres per hour through Berry and numerous urban roads intersect with the Princes Highway. Crashes involving vehicles travelling in the same direction were most common; seven of the ten of this type that occurred were rear end crashes. Crashes occurring at intersections were the next most frequent crash type; traffic travelling straight across or turning right at intersections caused all crashes of this type. The project would not remove the possibility of these crashes occurring; however the construction of the Berry bypass would remove a significant proportion of traffic currently travelling through Berry on the existing Princes Highway (Queen Street). This would in turn reduce the amount of conflicting movements occurring in the town and therefore decrease the potential for crashes to occur.

Table 7.18 shows that following construction of the project, total crashes occurring between Toolijooa Road and Austral Park Road would be expected to reduce by between 4 and 5 per year, with the potential to substantially reduce the occurrence of fatal and injury crashes. The frequency of crashes (indicated by the crash rate per 100 MVKM) would be expected to fall from 30.8 to 12.4, indicating less than half as many crashes would occur per vehicle kilometre travelled. Although the crash severity index shows a similar rating for the proposed conditions, the reduced frequency of crashes means that crash costs per kilometre following the upgrade would drop from $0.65 million to $0.29 million, a saving of around 55 per cent.

Between Austral Park Road and Woodhill Mountain Road, total crashes would be reduced by nearly 70 per cent based on the proposed conditions of the project. The analysis shows that the fatal crash that occurred over this period could potentially have been avoided, as could around two-thirds of all injury crashes. The crash rate per 100 MVKM travelled would potentially reduce by over 60 per cent from 27.8 to 10.0. With a reduced crash severity index and crash frequency following construction, crash costs per kilometre would drop to $0.1 million, a reduction of nearly 80 per cent.

Between Woodhill Mountain Road and Schofields Lane, construction of the Berry bypass would potentially see total crashes reduce by around 55 per cent and injury crashes by 65 per cent. A reduction in the frequency of crashes from 40.9 to 16.5 per 100 MVKM travelled, and reduction in crash severity index from 1.29 to 1.23, would see crash costs drop from $0.61 million per kilometre at present to $0.2 million in the future, a reduction of close to 70 per cent.

In addition to the road safety improvements on the Princes Highway, by drawing traffic from the alternative 'Sandtrack' route the project would be expected to further reduce the overall cost and frequency of crashes within the traffic impact footprint. Historical crash statistics for the 'Sandtrack' are provided in Section 3.1; this data shows that between Gerringong and Bomaderry crashes occurred at an average rate of 29.9 per 100 MVKM, with 0.7 fatal crashes per 100 MVKM. The average annual cost of crashes on the 'Sandtrack' is currently about $10.7 million.

Vehicles currently using the 'Sandtrack' would be expected to switch to the Princes Highway following the completion of the project to benefit from improved road safety, as well as travel time savings. It is estimated that without the project (the 'Do nothing' scenario) annual vehicle kilometres travelled on the 'Sandtrack' between Gerringong and Bomaderry would increase from around 90 MVKM at present to 160 MVKM by the design year of 2037. This would be expected to increase crash occurrences by a similar proportion, and in turn increase the total annual cost of crashes on this route from $10.7 million to $18.4 million, assuming current crash rates remain unchanged.

Conversely the 'Do something' scenario, which assumes the project is constructed, estimates that in 2037 significantly less traffic would use the 'Sandtrack' on a daily basis than at present. Forecasts indicate that in 2037 vehicle kilometres travelled on the 'Sandtrack' between Gerringong and Bomaderry would have decreased to 53 MVKM, a 57 per cent reduction from existing levels. Assuming current crash rates remain constant, the reduction in vehicle kilometres travelled on this route would result in a directly proportional drop in crash occurrences and costs. The vehicles switching to the upgraded Princes Highway from the 'Sandtrack' would benefit from a much higher level of safety, and hence lower potential for crashes.

In summary, the project could be expected to significantly reduce the frequency and severity of crashes occurring on the Princes Highway in the project area for existing users, as well as provide an alternative with a much higher level of safety than experienced by current users of the 'Sandtrack'. This would both increase the level of road safety to highway users, and reduce the cost attributable to crashes that occur across the traffic impact footprint.

Table 7.17: Existing and proposed crash statistics based on proposed safety improvements (1 July 2003 – 30 September 2010)

Section	Scenario	Length (km)	Accident type (From DCA code)						
			Intersection (adjacent approaches)	Vehicles from opposing directions	Vehicles from same direction	Off path, on straight	Off path, on curve	Other	Total
Toolijooa Road to Austral Park Road	Existing conditions	5.7	0	10	8	4	28	0	50
	Proposed conditions	4.6	0	0	5	4	7	0	16
Austral Park Road to Woodhill Mountain Road	Existing conditions	4.3	0	6	6	3	18	1	34
	Proposed conditions	3.9	0	0	3	3	5	0	11
Woodhill Mountain Road to Schofields Lane	Existing conditions	2.6	6	3	10	6	0	9	34
	Proposed conditions	2.9	1	0	4	5	0	5	15
Project area	Existing conditions	12.6	6	14	24	13	46	10	118
	Proposed conditions	11.3	1	0	12	12	12	5	42
	Crash reduction (%)	-	83%	100%	50%	8%	74%	50%	64%

(Source: AECOM, based on RMS' 'Southern Region Crash Data and RMS Crash Reduction Guide')

Table 7.18: Existing and proposed crash statistics based on proposed safety improvements (Annual average, 1 July 2003 – 30 September 2010)

Section	Scenario	Length (km)	Total crashes	Fatal crashes	Injury crashes	Tow-away crashes	Crash rate per 100MVKM (Total)	Crash severity index	Cost per km ($M)	Total cost ($M)
Toolijooa Road to Austral Park Road	Existing conditions	5.7	6.9	0.3	3.4	3.2	30.8	1.33	0.65	3.68
	Proposed conditions	4.6	2.2	0.1	0.8	1.2	12.4	1.31	0.29	1.33
	Change in conditions	-1.1	-4.7	-0.2	-2.6	-2.0	-18.4	-0.02	-0.35	-2.36
Austral Park Road to Woodhill Mountain Road	Existing conditions	4.3	4.7	0.1	2.2	2.3	27.8	1.29	0.49	2.12
	Proposed conditions	3.9	1.5	0.0	0.7	0.8	10.0	1.23	0.10	0.40
	Change in conditions	-0.4	-3.2	-0.1	-1.5	-1.5	-17.8	-0.07	-0.39	-1.72
Woodhill Mountain Road to Schofields Lane	Existing conditions	2.6	4.7	0.0	2.8	1.9	40.9	1.29	0.61	1.59
	Proposed conditions	2.9	2.1	0.0	1.0	1.1	16.5	1.23	0.20	0.56
	Change in conditions	0.3	-2.6	0.0	-1.8	-0.8	-24.4	-0.06	-0.42	-1.03
Project area	**Existing conditions**	**12.6**	**16.3**	**0.4**	**8.4**	**7.4**	**32.1**	**1.31**	**0.59**	**7.40**
	Proposed conditions	**11.3**	**5.8**	**0.1**	**2.5**	**3.2**	**12.7**	**1.26**	**0.20**	**2.29**
	Change in conditions	**-1.3**	**-10.5**	**-0.3**	**-5.9**	**-4.3**	**-19.4**	**-0.05**	**-0.38**	**-5.11**

(Source: AECOM, based on RMSs 'Southern Region Crash Data, RMS Crash Reduction Guide' and RMS' 'Economic Analysis Manual' (Economic parameters for 2009)

7.2.9 Emergency u-turns, cross over facilities and public u-turn facilities

The project would include emergency u-turn facilities which provide an opportunity for emergency service vehicles to execute a u-turn manoeuvre on the highway rather than travelling to the next grade-separated interchange, which are provided at Austral Park Road, Tindalls Lane, and the southern and northern ends of Berry to access the town. The median safety barrier would be discontinued and a permanent gap provided. In addition, signposting would denote that the facility is for use by emergency vehicles only, and a lay-by with an emergency telephone would be incorporated with this facility. One such facility is provided in the concept design.

Unlike emergency u-turn facilities, emergency cross over facilities are intended to enable contra-flow arrangements to be put in place by emergency services in the case of a significant traffic incident blocking one direction of flow. These facilities operate in tandem, with one facility directing traffic into the contra-flow arrangement, and another directing traffic back to the normal arrangement. The emergency u-turn facilities provided by the project could also be used to facilitate contra-flow arrangements in the event of an emergency. There is also the potential for the proposed bypass sections of the highway at both Berry and Foxground, and the alternative 'Sandtrack' route to be utilised as part of the current incident management plan for the area.

Emergency u-turn and cross over facilities are not intended to be used to facilitate routine maintenance activities or vehicle movements. It is likely that the median safety barrier would be continuous with provision for the barrier to be 'dropped' at key locations when the facility was needed.

The regular spacing of grade-separated interchanges minimises the need for dedicated at-grade public u-turn facilities. Two are to be provided; one on a section of the residual highway just north of the Austral Park Road interchange, and the other at Mullers Lane south of Berry.

7.2.10 Public transport

In addition to the impacts associated with specific vehicular traffic discussed in previous sections, the following operational impacts to public transport created by the construction of the project have been identified:

- Buses:
  - Bus travel times would be improved; the project would enable higher safe travel speeds on the Princes Highway, while intersection delays in Berry would reduce as a result of fewer vehicles travelling through the town. A reduction of traffic on the 'Sandtrack' would also benefit travel times for buses using this alternative route.
  - Delays to services caused by traffic incidents and congestion would reduce: the construction of the project is expected to lessen the frequency of traffic crashes (see Section 7.2.6), reducing the occurrence of incidents that would cause delays. The provision of two lanes per direction on the Princes Highway would significantly ease congestion and improve the LoS during peak times, as discussed in Section 7.2.1.
  - Reduced potential for crashes caused by buses stopping on the Princes Highway. Following construction the practice of buses stopping at intersections with local roads and property accesses would be discouraged. This would remove the risk of crashes caused by buses speeding up from or slowing down to a stop in high-speed traffic.
  - Travel times to and from bus stops in Berry by supplementary travel modes would be shortened. Travel to and from bus stops by car, walking and cycling would be quicker in Berry, due to a reduction in traffic throughout the town, as shown in the intersection analysis in Section 7.2.2.

  - Improved amenity for bus users waiting at stops within Berry and on the 'Sandtrack'; a reduction in traffic within Berry and on the 'Sandtrack' would result in improved air quality, decreased noise levels and enhanced pedestrian safety.

- Rail services:
  - Shorter travel times for rail passengers travelling to and from Berry train station as a result of a decrease in traffic volumes (and associated travel delays) in Berry as well as improved travel speeds throughout the project area, as discussed in Section 7.2.2 and Section 7.2.3.
- Walking:
  - Improved travel times in Berry; less traffic in the town would reduce the delays incurred when crossing roads within the town.
  - Improved amenity in the project area; lower volumes of traffic within Berry and on the alternative 'Sandtrack' route would improve air quality, reduce noise and enhance pedestrian safety.
- Cycling:
  - Reduced delays for cyclists at intersections in Berry; this would follow a reduction of traffic in the town as a result of the bypass.
  - Improved cyclist safety; within Berry lower traffic volumes would reduce the potential for crashes with other road users. In rural areas, cyclists would utilise the 2.5 metre shoulder provided on the upgraded highway, allowing greater separation between bicycles and high speed traffic than existing conditions. A reduction in traffic on the 'Sandtrack' would also improve safety on this alternative route.
  - Improved amenity in Berry and the 'Sandtrack'; cyclists would benefit from a reduction of traffic in Berry and on the 'Sandtrack', resulting in an improvement in air quality levels and reduced noise.
  - Provision for a shared cycleway/pedestrian footpath facility connecting the northern side of Berry to Kangaroo Valley Road, North Street and Queen Street is part of the project concept design and would be determined in consultation with the community.
  - The project would generally support and complement the Berry Pedestrian Access and Mobility Plan (PAMP) developed by Shoalhaven City Council.

In addition to the positive impacts generated by the project, there are also some potential negative impacts to bus services, pedestrians and cyclists.

School bus services currently stop at numerous intersections in rural areas between the Princes Highway and local roads and accesses in the project area, as described in Section 2.3.1. It is proposed that to improve road safety following the construction of the project this practice would be discouraged; public and school buses would only stop at dedicated facilities built for this purpose at the grade separated interchanges at Tindalls Lane and Toolijooa Road. This would effectively result in a reduction in the number of bus stops on the Princes Highway in the project area, inconveniencing users of the removed stop locations who would be required to travel to and from other stop locations, but improving overall safety.

Within Berry, the addition of two roundabouts on Kangaroo Valley Road to the west of the town was identified as a concern by the community, potentially reducing amenity for pedestrians and cyclists. This would include pedestrians and cyclists re-routed from North Street following its severance by the Berry bypass.

Contemporary guidelines relating to road design, specifically *Austroads Guide to Road Design Part 4B: Roundabouts (2009),* states that there is no evidence to suggest that roundabouts are less safe for pedestrians than other forms of intersection control. With most roundabouts, the installation of well-designed splitter islands of sufficient size to hold and protect pedestrians allows them to cross only one direction of traffic at a time. This should result in pedestrians being able to move more safely and freely around the intersection than was the case before installation of the roundabout.

Suitable pedestrian and cyclist arrangements would be provided according to relevant guidelines to ensure that safe pedestrian access is maintained following construction of the project.

8 Management of impacts

8.1 Construction

A traffic management plan (TMP) would be prepared as part of the construction environmental management plan (CEMP). The TMP would include the guidelines, general requirements and procedures to be used when construction activities would have a potential impact on existing traffic arrangements. It would ensure that delays and disruptions are kept to a minimum, and identify and respond to any changes in road safety (including the 'Sandtrack') as a result of highway construction works.

The TMP would be submitted in stages to reflect the progress of work and would include:

- Signage requirements (eg temporary speed restrictions, changes to the road environment, traffic management controls deployed).
- Lane possession and approval process during periods of online construction (eg linemarking and temporary barriers).
- Traffic control devices such as temporary traffic signals.
- A local and regional communications strategy. This would include methods to provide advanced notice of any major or prolonged impacts (eg leaflets and local media), and real-time information regarding current impacts (e.g. variable message signs, radio traffic news).

To minimise the impacts of construction on road network performance and safety, offline construction would be undertaken wherever possible. In addition, to further minimise the potential effects of any major sources of delay, any works which would significantly reduce the performance of the road network in the project area would be scheduled for periods of typically lower traffic volumes where possible.

Traffic would be routed from old sections to new sections through a combination of linemarking and barriers with appropriate signage as necessary.

Where offline construction is not practical, and for tie-ins between online and offline sections of the project, construction sequencing and any temporary works identified would aim to minimise user delay while providing sufficient flexibility for the selected contractor to safely and efficiently construct the project.

Signage would be used to clearly indicate the traffic controls in use; this could also include temporary speed restrictions and passing constraints if required to maintain road safety levels. In some instances road closures and clearly signed detours would be implemented to remove road traffic from construction zones altogether.

The TMP would provide details of both the general approach to be used to ensure suitable locations are chosen for access and egress points to worksites (eg minimum sight distances, maximum grade allowances, etc), and the specific controls required at selected locations (signage, barriers, signalling requirements).

The Princes Highway is currently used by emergency service vehicles for travel to and from call outs. The TMP would be developed in consultation with the local emergency services to ensure that procedures are in place to maintain an unrestricted and safe environment for vehicles to swiftly pass through the construction zones.

Local emergency services would be frequently updated on the staging and progress of construction works and communication systems would be in place with traffic controllers to provide appropriate access and routes (eg gaps in concrete barriers, side-tracks, wide verges etc) for emergency vehicles to bypass any queued traffic.

Overall, the TMP would ensure:

- Construction methods and staging would be designed to minimise road closures, subject to other project constraints, and ensure that disruptions to existing traffic are within acceptable levels.
- Where feasible, the provision of an 80 kilometres per hour construction speed zone for highway traffic.
- Continuous access to local roads and properties.
- Road occupancy licences would be obtained for all work that impacts traffic on the existing highway.
- The continuing performance of the local road network in Berry during the proposed closure of Kangaroo Valley Road.
- Suitable road network safety and performance is maintained during construction of the project.

8.2 Operation

Although the project would significantly improve the performance of the Princes Highway in the project area for the majority of road users, it is recognised that some negative impacts would be created, as noted in Section 7.2. In some cases these effects can be negated; where this is not the case any impacts would be minimised and balanced by the overall benefits provided by the upgrade.

The project is expected to significantly improve road safety in the project area. The project is being designed to current safety standards and a road safety audit has been undertaken by qualified auditors as part of the concept design to examine the design from a road safety perspective and identify potential safety issues created by the design. This process was undertaken in accordance with the RMS *Accident Reduction Guide Part 2: Road Safety Audits (2005)*. As part of this process, stage 3 (detailed design stage) and stage 4 (immediately prior to opening to traffic) road safety audits would be carried out.

Traffic levels and operational performance would be monitored six months and 12 months following construction, particularly during peak periods, to ensure that the road network performs as expected. Traffic monitoring would be undertaken on the Princes Highway and key local roads in Berry including the bypass, on- and off- ramps, Kangaroo Valley Road and Queen Street, and traffic volumes would be assessed against those predicted. The performance of climbing lanes provided by the project would be similarly monitored. A comparison of actual versus modelled performance of the road network in this way would identify any significant differences at an early stage. As a result, revised traffic forecasting would be undertaken and the adjusted traffic predictions would be input to the Paramics modelling to re-assess the future operational performance of the project and plan in advance of any major impacts occurring.

The current concept design proposes to retain the current bus interchange at Tindalls Lane, and incorporate a new interchange at Toolijooa Road to minimise the negative impacts imposed by a reduction of stops in rural sections of the project area. The project would provide turning facilities in newly created cul-de-sacs, and buses would be required to use the alternative Queen Street route. The negative impacts would be reduced to a small amount of additional travel in this area. Turning facilities for garbage trucks and buses would be provided to ensure current routes/services are maintained.

Pedestrian and cyclist arrangements would be provided according to relevant guidelines to ensure that adequate access is maintained. The project includes the following provisions for cyclists and pedestrians:

- A 2.5 metre wide shoulder that would provide adequate space for cyclist access along the main alignment of the project.
- Provision of shared pedestrian and cyclist facilities on both sides of the Kangaroo Valley Road overbridge. The shared facilities would be separated from traffic and provide a link between Berry town centre and residential development to the north-west along Kangaroo Valley Road and beyond. This is discussed in more detail in Section 7.6 and Appendix I.
- Shared pedestrian and cyclist facilities along the northern side of North Street. This facility would provide connectivity between Kangaroo Valley Road and the sports grounds and mitigate the loss of connectivity associated with the bypass and the cul-de-sac of North Street by maintaining the existing level of recreational connectivity. This is discussed in more detail in Section 7.6 and Appendix I.
- All provisions for cyclists would comply with the RMS *NSW Bicycle Guidelines and Austroads Traffic Engineering Practice - Part 14*; this includes provision for cyclists at all interchanges and intersections constructed as part of the project
- Provision for pedestrians and cyclists in and around Berry would support and complement any Berry Pedestrian Access and Mobility Plans (PAMP) and would be developed further during detailed design in consultation with Shoalhaven City Council.

Appendix A

Midblock level of service (LoS) model - two lane roads (example location)

Midblock level of service (LoS) model - two lane roads (example location)

Foxground and Berry Bypass
Project Number: 60021933
Level of Service (LOS) Calculator - Existing Highway Conditions

Friday 01 July, 2011

AECOM

Two-Lane Two-way Roads

EXHIBIT 20-2. LOS CRITERIA FOR TWO-LANE HIGHWAYS IN CLASS I

LOS	Percent Time-Spent-Following	Average Travel Speed (km/h)
A	≤ 35	> 90
B	> 35–50	> 80–90
C	> 50–65	> 70–80
D	> 65–80	> 60–70
E	> 80	≤ 60

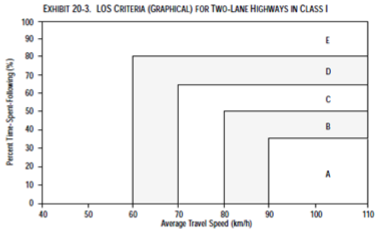
Note:
LOS F applies whenever the flow rate exceeds the segment capacity.

EXHIBIT 20-4. LOS CRITERIA FOR TWO-LANE HIGHWAYS IN CLASS II

LOS	Percent Time-Spent-Following
A	≤ 40
B	> 40–55
C	> 55–70
D	> 70–85
E	> 85

Note:
LOS F applies whenever the flow rate exceeds the segment capacity.

EXHIBIT 20-3. LOS CRITERIA (GRAPHICAL) FOR TWO-LANE HIGHWAYS IN CLASS I



General Information

Engineer:	David Bohm	ID:	I|J
Project Details:	60021933 - FBB Princes Highway Upgrade	Location:	Princes Highway: Tannery Rd - Toolijooa Rd
Date Performed:	1/07/2011	Direction:	Northbound | Southbound
Modelled Year:	2011	Time Period:	Holiday Peak (Southbound)

☐ Operational (LOS) ☐ Design (V_P) ☑ Planning (LOS) ☐ Planning (V_P)

Input Data

Shoulder Width:	1.8+	m
→ Lane Width:	3.0 to <3.3	m
← Lane Width:	3.0 to <3.3	m
Shoulder Width:	1.8+	m
Segment Length, Lt:	9.9	km

☑ Class 1 highway ☐ Class 2 highway

Terrain:	Rolling	
Surroundings Type:	Rural	
Two-way Hourly Volume:	1,275	veh/h
Directional Split:	0.60	
Peak-hour Factor:	0.88	
% Heavy:	5.1%	
% No-passing Zone:	80%	
Access points/km:	<6	/km

Average Travel Speed

Grade Adjustment Factor:	0.99	
Passenger Car Equivalent (Trucks):	1.50	
Heavy Vehicle Adjustment Factor:	0.97	
Two-way Flow Rate:	1,501	
V_P x Directional Split:	901	
Estimated Free Flow Speed:		
Base Free Flow Speed:	80	km/h
Lane | Shoulder Width Adj:	1.7	km/h
Access Points Adj:	0.0	km/h
Free Flow Speed:	78.3	km/h
No. Passing Zone Adjustment Factor:	2.1	km/h
Average Travel Speed:	**57.4**	km/h
Volume / Capacity Ratio (One-way):	0.53	
Volume / Capacity Ratio (Two-way):	0.47	

Percent Time-Spent Following

Grade Adjustment Factor:	1.00	
Passenger Car Equivalent (Trucks):	1.00	
Heavy Vehicle Adjustment Factor:	1.00	
Two-way Flow Rate:	1,449	veh/h
V_P x Directional Split:	869	veh/h
Base Percent Time-Spent Following:	72.0	%
Directional Distribution | No Passing Zone Adj:	4.0	
Percent Time-Spent Following:	**76.0**	%
Volume / Capacity Ratio (One-way):	0.51	
Volume / Capacity Ratio (Two-way):	0.45	

LOS and Performance Measures

Operational (LOS)

Average Travel Speed Range:	<=60	km/h
Percent Time-Spent Following:	>65 - 80	%
Level of Service (LOS):	**E**	

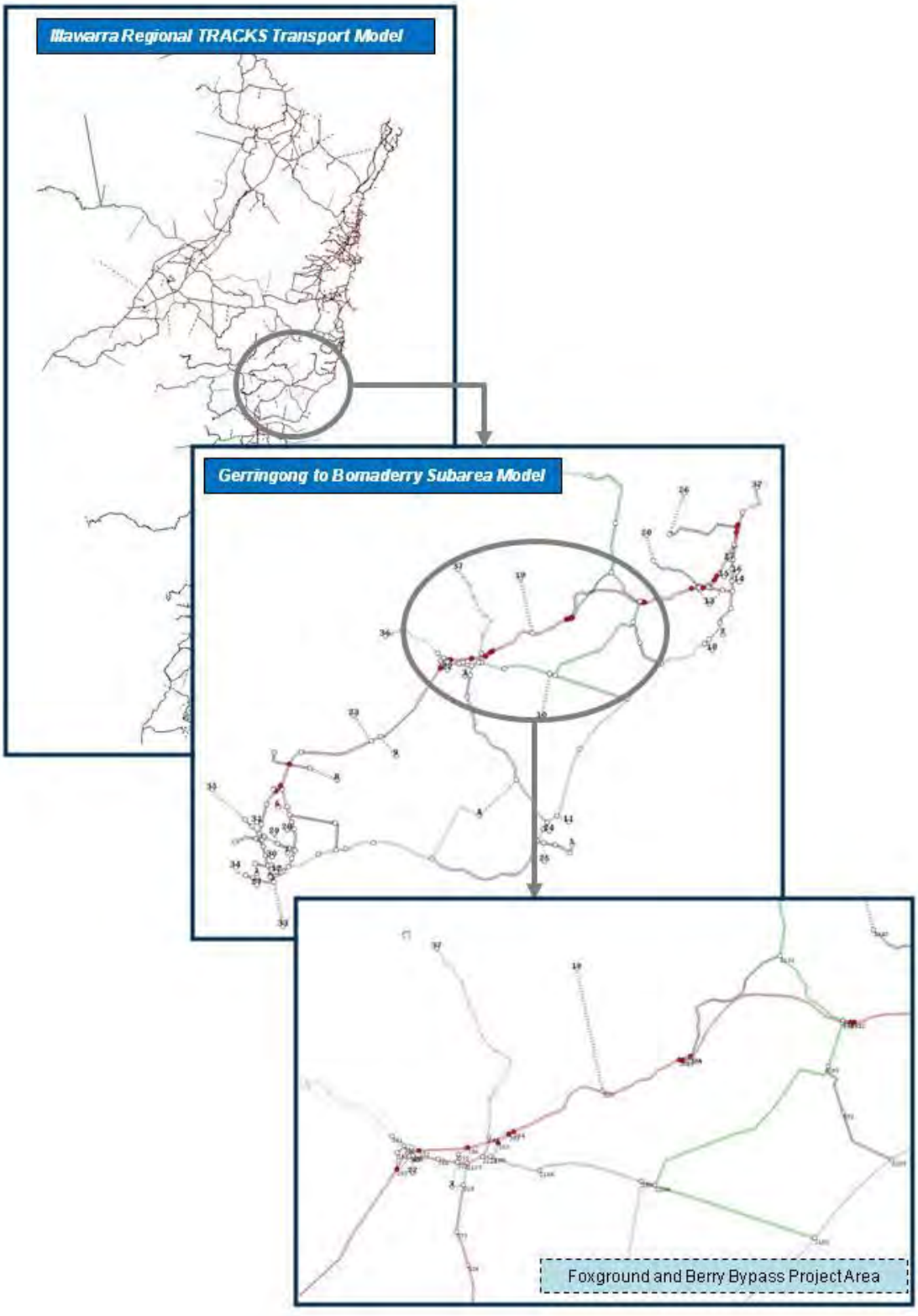
Notes

- If Vp => 3,200 pc/h, terminate analysis - the LOS is F.
- If the highest directional split Vp => 1,700 pc/h, terminate analysis - the LOS is F.

Appendix B

Regional and sub-area TRACKS model network coverage

Regional and sub-area TRACKS model network coverage



Appendix C

Traffic forecasting spreadsheet model (example location)

Traffic forecasting spreadsheet model (example location)

AECOM

Location:	Princes Hwy: Berry Bypass Between Between Berry East and West Ramps		
Site ID:	K | L		
TRACKS Modelled Data 2026	Princes Hwy South of Berry	Berry Bypass	Bypass Use (%)
Northbound	11635	10245	88.1%
Southbound	11618	10289	88.6%
Two-Way	23253	20534	88.3%
100th:	11.62%	(of AADT)	

Proposed Construction Dates	
2011	Project 1 Begins
2014	Project 1 Completed
2017	Project 2 Completed
2019	Project 3 Completed

Annual Average Daily Traffic (AADT) - Annual Forecast Summary

Year	Southbound				Northbound				Two-way			
	Light	Heavy	% Heavy	All Veh	Light	Heavy	% Heavy	All Veh	Light	Heavy	% Heavy	All Veh
2009	-	-	-	-	-	-	-	-	-	-	-	-
2010	-	-	-	-	-	-	-	-	-	-	-	-
2011	-	-	-	-	-	-	-	-	-	-	-	-
2012	-	-	-	-	-	-	-	-	-	-	-	-
2013	-	-	-	-	-	-	-	-	-	-	-	-
2014	-	-	-	-	-	-	-	-	-	-	-	-
2015	-	-	-	-	-	-	-	-	-	-	-	-
2016	-	-	-	-	-	-	-	-	-	-	-	-
2017	6,455	824	11.3%	7,280	6,773	773	10.2%	7,545	13,228	1,597	10.8%	14,825
2018	6,568	845	11.4%	7,413	6,888	792	10.3%	7,680	13,456	1,637	10.8%	15,093
2019	7,579	866	10.3%	8,445	7,870	812	9.3%	8,682	15,449	1,677	9.8%	17,127
2020	7,821	877	10.1%	8,697	8,119	822	9.2%	8,941	15,939	1,698	9.6%	17,638
2021	8,062	888	9.9%	8,949	8,368	832	9.0%	9,200	16,430	1,719	9.5%	18,149
2022	8,303	898	9.8%	9,201	8,617	842	8.9%	9,458	16,920	1,740	9.3%	18,660
2023	8,544	909	9.6%	9,453	8,866	852	8.8%	9,718	17,410	1,761	9.2%	19,171
2024	8,785	920	9.5%	9,705	9,115	862	8.6%	9,977	17,900	1,782	9.1%	19,682
2025	9,103	955	9.5%	10,056	9,444	893	8.6%	10,337	18,546	1,846	9.1%	20,393
2026	9,420	986	9.5%	10,406	9,773	924	8.6%	10,697	19,192	1,911	9.1%	21,103
2027	9,737	1,020	9.5%	10,756	10,102	955	8.6%	11,057	19,838	1,975	9.1%	21,813
2028	10,054	1,053	9.5%	11,106	10,431	987	8.6%	11,417	20,484	2,039	9.1%	22,523
2029	10,371	1,086	9.5%	11,457	10,759	1,018	8.6%	11,777	21,130	2,104	9.1%	23,234
2030	10,688	1,119	9.5%	11,807	11,088	1,049	8.6%	12,137	21,776	2,168	9.1%	23,944
2031	11,005	1,152	9.5%	12,157	11,417	1,080	8.6%	12,497	22,422	2,232	9.1%	24,654
2032	11,322	1,186	9.5%	12,507	11,746	1,111	8.6%	12,857	23,068	2,297	9.1%	25,364
2033	11,639	1,219	9.5%	12,857	12,075	1,142	8.6%	13,217	23,714	2,361	9.1%	26,075
2034	11,956	1,252	9.5%	13,208	12,404	1,173	8.6%	13,577	24,360	2,425	9.1%	26,785
2035	12,273	1,285	9.5%	13,558	12,733	1,204	8.6%	13,937	25,006	2,490	9.1%	27,495
2036	12,590	1,318	9.5%	13,908	13,062	1,235	8.6%	14,297	25,652	2,554	9.1%	28,205
2037	12,907	1,352	9.5%	14,258	13,391	1,267	8.6%	14,657	26,297	2,618	9.1%	28,916
2038	13,224	1,385	9.5%	14,609	13,720	1,298	8.6%	15,017	26,943	2,682	9.1%	29,626
2039	13,541	1,418	9.5%	14,959	14,049	1,329	8.6%	15,377	27,589	2,747	9.1%	30,336
2040	13,858	1,451	9.5%	15,309	14,377	1,360	8.6%	15,737	28,235	2,811	9.1%	31,046

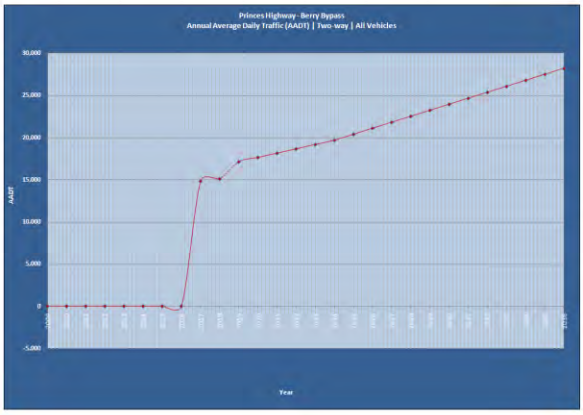
Bypass growth rate post Sandtrack transfer: 3.76%

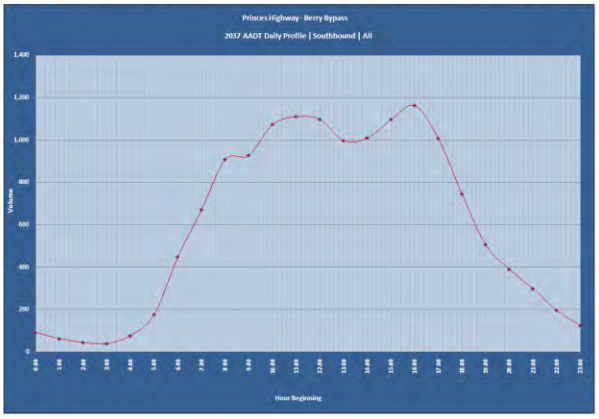
Annual Average Daily Traffic (AADT) - Daily Forecast Analysis

Direction	Year	AADT	9 Hour AADT (22:00 - 07:00) Total	9 Hour AADT (22:00 - 07:00) Peak	15 Hour AADT (07:00 - 22:00) Total	15 Hour AADT (07:00 - 22:00) Peak	AM Peak	PM Peak	100th Hour	PM Peak - 100th Hour Factor Hour	% Heavy	Expansion Factor
Light Vehicles												
Southbound	2037	12,907	928	343	11,978	1,098	964	1,098	1,500	1.37	-	13.4
Heavy Vehicles												
Southbound	2037	1,352	269	87	1,082	107	107	78	157	2.02	-	12.6
All Vehicles												
Southbound	2037	14,258	1,258	448	13,000	1,163	1,073	1,163	1,657	1.42	#N/A	13.3

Hour	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Periods:	9 Hour AADT								AM Peak								PM Peak					15 Hour AADT		
Light Vehicles																								
Profile %	0.5%	0.3%	0.2%	0.2%	0.3%	0.9%	2.7%	4.3%	6.4%	6.4%	7.5%	7.8%	7.9%	7.1%	7.2%	7.9%	8.5%	7.8%	5.5%	3.7%	2.8%	2.2%	1.4%	0.8%
Volume:	67	39	20	20	34	117	343	556	821	829	964	1,007	1,017	920	929	1,023	1,098	975	712	482	366	280	180	108
Heavy Vehicles																								
Profile %	1.5%	1.3%	1.4%	1.1%	2.4%	3.5%	6.5%	7.4%	6.4%	7.0%	7.9%	7.7%	6.4%	6.1%	6.3%	8.1%	5.7%	3.8%	3.3%	2.3%	2.1%	1.6%	1.3%	1.0%
Volume:	20	18	18	15	32	48	87	100	87	95	107	104	87	82	85	82	78	51	45	31	28	21	17	14
All Vehicles																								
Profile %	0.6%	0.4%	0.3%	0.3%	0.5%	1.1%	3.1%	4.7%	6.4%	6.5%	7.5%	7.8%	7.7%	7.0%	7.1%	7.7%	8.1%	7.1%	5.2%	3.6%	2.7%	2.1%	1.4%	0.9%
Volume:	91	62	44	39	76	177	448	670	908	928	1,073	1,110	1,057	997	1,009	1,096	1,163	1,008	746	506	390	299	197	124

Hour	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Profile %																								
Light Vehicles																								
Northbound	0.5%	0.2%	0.1%	0.2%	0.6%	1.2%	2.8%	4.4%	5.5%	6.8%	7.5%	8.0%	8.2%	7.9%	8.4%	9.3%	9.4%	8.4%	6.6%	2.5%	1.5%	1.2%	0.8%	0.4%
Southbound	0.5%	0.3%	0.2%	0.2%	0.3%	0.9%	2.7%	4.3%	6.4%	6.4%	7.5%	7.8%	7.9%	7.1%	7.2%	7.9%	8.5%	7.6%	5.5%	3.7%	2.8%	2.2%	1.4%	0.8%
Two-way	0.4%	0.2%	0.1%	0.2%	0.4%	1.1%	2.7%	4.4%	5.9%	6.6%	7.4%	7.9%	8.0%	7.5%	7.8%	8.6%	8.9%	8.0%	6.1%	3.1%	2.2%	1.7%	1.1%	0.6%
Heavy Vehicles																								
Northbound	0.7%	0.9%	1.2%	1.5%	2.9%	3.1%	5.5%	7.5%	7.5%	7.4%	6.8%	7.3%	7.2%	7.5%	7.2%	6.4%	5.9%	4.4%	2.5%	1.5%	1.5%	1.3%	1.2%	1.1%
Southbound	1.5%	1.3%	1.4%	1.1%	2.4%	3.5%	6.5%	7.4%	6.4%	7.0%	7.9%	7.7%	6.4%	6.1%	6.3%	8.1%	5.7%	3.8%	3.3%	2.3%	2.1%	1.6%	1.3%	1.0%
Two-way	1.1%	1.1%	1.3%	1.3%	2.6%	3.3%	6.0%	7.3%	7.0%	7.2%	7.4%	7.5%	6.8%	6.8%	6.8%	6.3%	5.8%	4.1%	2.9%	1.9%	1.8%	1.5%	1.3%	1.1%
All Vehicles																								
Northbound	0.5%	0.2%	0.3%	0.4%	0.8%	1.5%	3.1%	4.8%	5.8%	6.9%	7.2%	8.0%	8.1%	7.9%	8.3%	8.9%	8.9%	7.9%	4.4%	2.4%	1.5%	1.2%	0.8%	0.5%
Southbound	0.6%	0.4%	0.3%	0.3%	0.5%	1.2%	3.1%	4.7%	6.4%	6.5%	7.5%	7.8%	7.7%	7.0%	7.1%	7.7%	8.1%	7.1%	5.2%	3.6%	2.7%	2.1%	1.4%	0.9%
Two-way	0.5%	0.3%	0.3%	0.3%	0.7%	1.3%	3.1%	4.7%	6.1%	6.7%	7.4%	7.9%	7.9%	7.4%	7.7%	8.3%	8.5%	7.5%	4.8%	3.0%	2.1%	1.6%	1.1%	0.7%





Appendix D

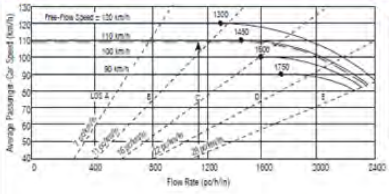
Midblock level of service (LoS) model – freeways (example location)

Foxground and Berry Bypass
Project Number: 60021933
Level of Service (LOS) Calculator - Future Highway Conditions

AECOM

Friday 01 July, 2011

Basic Freeway Segments



Application	Input	Output
Operational (LOS)	FFS, N, V_p	LOS, S, D
Design (N)	FFS, LOS, V_p	N, S, D
Design (V_p)	FFS, LOS, N	V_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (V_p)	FFS, LOS, N	V_p, S, D

LOS	Density Range (pc/km/ln)
A	0–7
B	>7–11
C	>11–16
D	>16–22
E	>22–28
F	>28

EXHIBIT 23-2: LOS CRITERIA FOR BASIC FREEWAY SEGMENTS

Criteria	LOS A	LOS B	LOS C	LOS D	LOS E
FFS = 120 km/h					
Maximum density (pc/km/ln)	7	11	16	22	28
Minimum speed (km/h)	120.0	120.0	114.6	99.6	85.7
Maximum v/c	0.35	0.55	0.77	0.92	1.00
Maximum service flow rate (pc/h/ln)	840	1320	1840	2200	2400
FFS = 110 km/h					
Maximum density (pc/km/ln)	7	11	16	22	28
Minimum speed (km/h)	110.0	110.0	108.5	97.2	83.9
Maximum v/c	0.33	0.51	0.74	0.91	1.00
Maximum service flow rate (pc/h/ln)	770	1210	1740	2135	2350
FFS = 100 km/h					
Maximum density (pc/km/ln)	7	11	16	22	28
Minimum speed (km/h)	100.0	100.0	100.0	93.8	82.1
Maximum v/c	0.30	0.48	0.70	0.90	1.00
Maximum service flow rate (pc/h/ln)	700	1100	1600	2065	2300
FFS = 90 km/h					
Maximum density (pc/km/ln)	7	11	16	22	28
Minimum speed (km/h)	90.0	90.0	90.0	89.1	80.4
Maximum v/c	0.28	0.44	0.64	0.87	1.00
Maximum service flow rate (pc/h/ln)	630	990	1440	1965	2250

General Information

Engineer:	David Bohm	ID:	K
Date Performed:	1/07/2011	Modelled Year:	2037
Location:	Princes Hwy NB (Berry Bypass):	Time Period:	Holiday Peak (NB)
Highway Segment:	Berry South - Berry North Interchange	Direction:	Northbound

☐ Operational (LOS) ☐ Design (N) ☐ Design (V_P) ☑ Planning (LOS) ☐ Planning (N) ☐ Planning (V_P)

Flow Inputs

Volume (V):	2,007	veh/h	General Terrain:	Rolling
AADT:	14,332	veh/day	Surroundings Type:	Rural
% Heavy (P_T):	2.1%			
Peak Hour % of AADT (K):				
Peak Hour Dir % (D):			Driver Type:	☐ Commuter | Weekday ☑ Recreational | Weekend
DDHV (AADT x K x D):		veh/h		
Peak Hour Factor (PHF):	0.88		Grade:	Length: 2.0 km Up | Down %

Calculate Flow Adjustments

fp:	0.95	E_R:	2.0
E_T:	2.5	f_{HV}:	0.970

Speed Inputs

Lane Width:	3.5	m	
Left Shoulder Lateral Clearance:	>=1.8	m	
Interchange Density:	0.5	I/km	
Number of Lanes (N):	2	lanes	
FFS (measured):	-	km/h	
Base Free-Flow Speed (BFFS):	100	km/h	

Calculate Speed Adjustments

f_{LW}:	1.0	km/h
f_{LC}:	0.0	km/h
f_{ID}:	2.1	km/h
f_N:	0.0	km/h
FFS = (BFFS - f_{LW} - f_{LC} - f_{ID} - f_N):	96.9	km/h
Lane Capacity:	2,400	pc/h/ln

LOS and Performance Measures

Performance Measures

$$Vp = \frac{V}{(PHF)(N)(f_{HV})(f_p)}$$ 1,238 pc/h/ln

V/C:	0.42	
S:	96.9	km/h
D = Vp/S:	12.8	pc/km/ln

Level of Service (LOS):

Density, D:	C	Vol/Capacity, V/C:	B
Speed, S:	A	Flow Rate, Vp:	C

Overall Performance: C

Glossary

N - Number of lanes
V - Hourly Volume
V_p - Flow Rate
LOS - Level of Service
DDHV - Directional Design Hour Volume
S - Speed
D - Density
FFS - Free Flow Speed
BFFS - Base Free Flow Speed

Tables | Equations - AUSTROADS 2009 Chapter 23 | Highway Capacity Manual (HCM)

E_R - Exhibits 23-8, 23-10
E_T - Exhibits 23-8, 23-9, 23-11
f_p - Page 23-12
LOS, S, FFS, v_p - Exhibits 23-2, 23-3
f_{LW} - Exhibit 23-4
f_{LC} - Exhibit 23-5
f_N - Exhibit 23-6
f_{ID} - Exhibit 23-7

Appendix E

Climbing lane assessment locations

Climbing lane assessment locations

Direction	Location	Section	Chainage (m)		Length (m)	Vertical Alignment (m)		Elevation (m)	Average Grade	Posted Speed (km/h)	Truck speed (km/h, end of section)*	Truck Speed <40km/h?
			From	To		From	To					
Southbound	A	1	6920	7420	500	12.5	22.1	10	1.9%	100	87.0	NO
		2	7420	7740	320	22.1	34.9	13	4.0%	100	68.0	NO
		3	7740	7980	240	34.9	46.9	12	5.0%	100	50.0	NO
		4	7980	8420	440	46.9	73.2	26	6.0%	100	26.0	YES
		5	8420	8800	380	73.2	84.5	11	3.0%	100	40.0	NO
		All	**6920**	**8800**	**1880**	**12.5**	**84.5**	**72**	**3.8%**	**100**	**40.0**	**YES**
Northbound	B	1	11040	10040	1000	30.8	39.7	9	0.9%	100	86.0	NO
		2	10040	9640	400	39.7	51.4	12	2.9%	100	70.0	NO
		3	9640	9120	520	51.4	77.0	26	4.9%	100	36.0	YES
		4	9120	8800	320	77.0	84.5	8	2.3%	100	45.0	NO
		All	**11040**	**8800**	**2240**	**30.8**	**84.5**	**54**	**2.4%**	**100**	**45.0**	**YES**
Southbound	C	1	11040	11240	200	30.8	35.1	4	2.2%	100	94.0	NO
		2	11240	11300	60	35.1	38.0	3	4.8%	100	91.0	NO
		3	11300	11700	400	38.0	48.2	10	2.6%	100	75.0	NO
		All	**11040**	**11700**	**660**	**30.8**	**48.2**	**17**	**2.6%**	**100**	**75.0**	**NO**
Northbound	D	1	12780	12680	100	25.2	26.6	1	1.4%	100	98.0	NO
		2	12680	11900	780	26.6	46.1	20	2.5%	100	70.0	NO
		3	11900	11700	200	46.1	48.2	2	1.1%	100	70.0	NO
		All	**12780**	**11700**	**1080**	**25.2**	**48.2**	**23**	**2.1%**	**100**	**70.0**	**NO**
Southbound	E	1	13540	13740	200	24.1	29.0	5	2.5%	100	93.0	NO
		2	13740	13760	20	29.0	29.8	1	4.0%	100	91.0	NO
		3	13760	14160	400	29.8	39.9	10	2.5%	100	75.0	NO
		All	**13540**	**14160**	**620**	**24.1**	**39.9**	**16**	**2.5%**	**100**	**75.0**	**NO**
Northbound	F	1	16400	15950	450	13.5	16.1	3	0.6%	100	93.0	NO
		2	15950	15550	400	16.1	27.6	12	2.9%	100	76.0	NO
		3	15550	15250	300	27.6	33.5	6	2.0%	100	68.0	NO
		4	15250	14160	1090	33.5	39.9	6	0.6%	100	70.0	NO
		All	**16400**	**14160**	**2240**	**13.5**	**39.9**	**26**	**1.2%**	**100**	**70.0**	**NO**

Figure E1: Detailed truck speed analysis

(Source: AECOM)

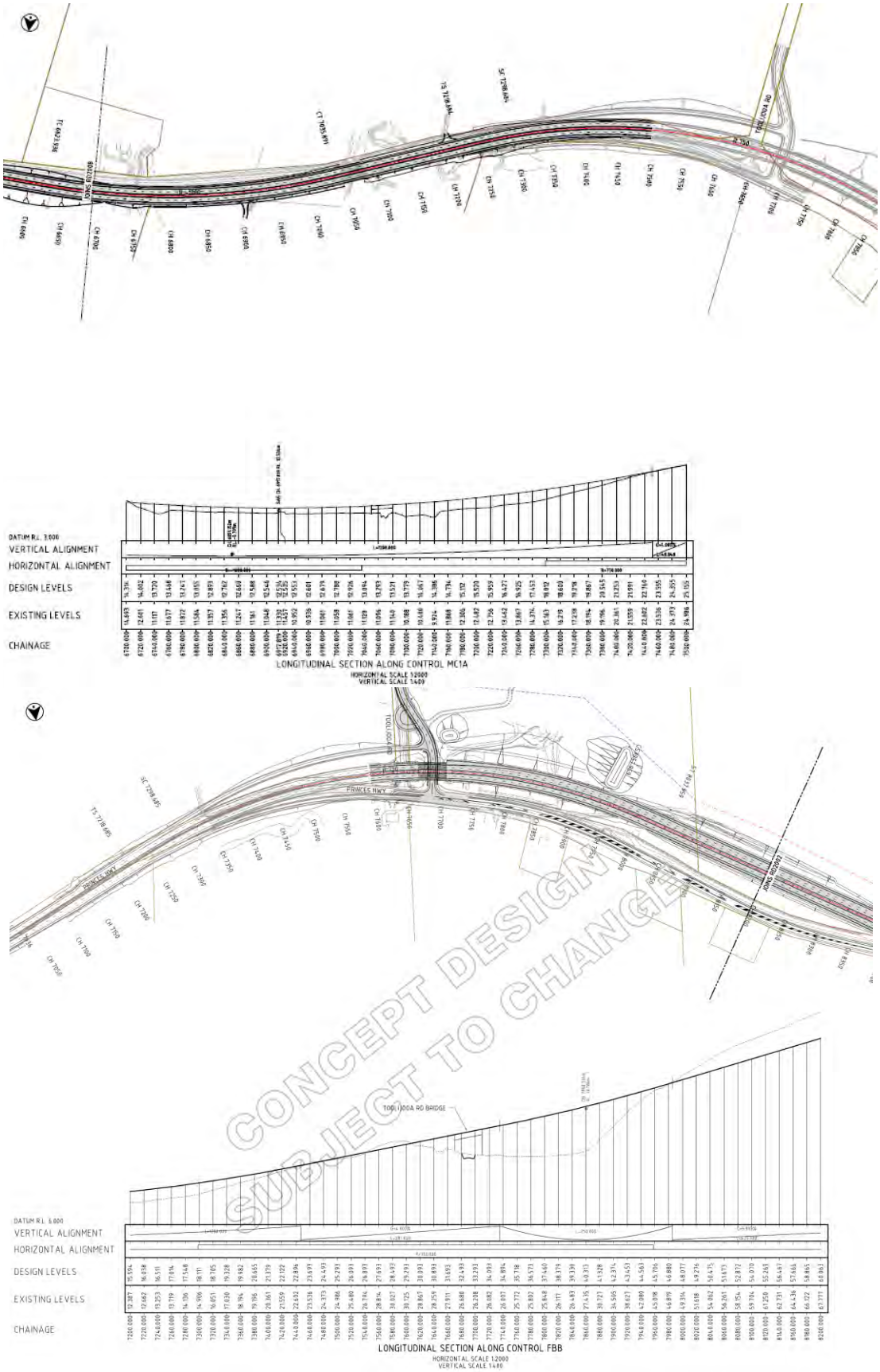


Figure E2: Location A - CH6920-8800 (beginning 800 metres east of Toolijooa Road), southbound

(Source: AECOM)

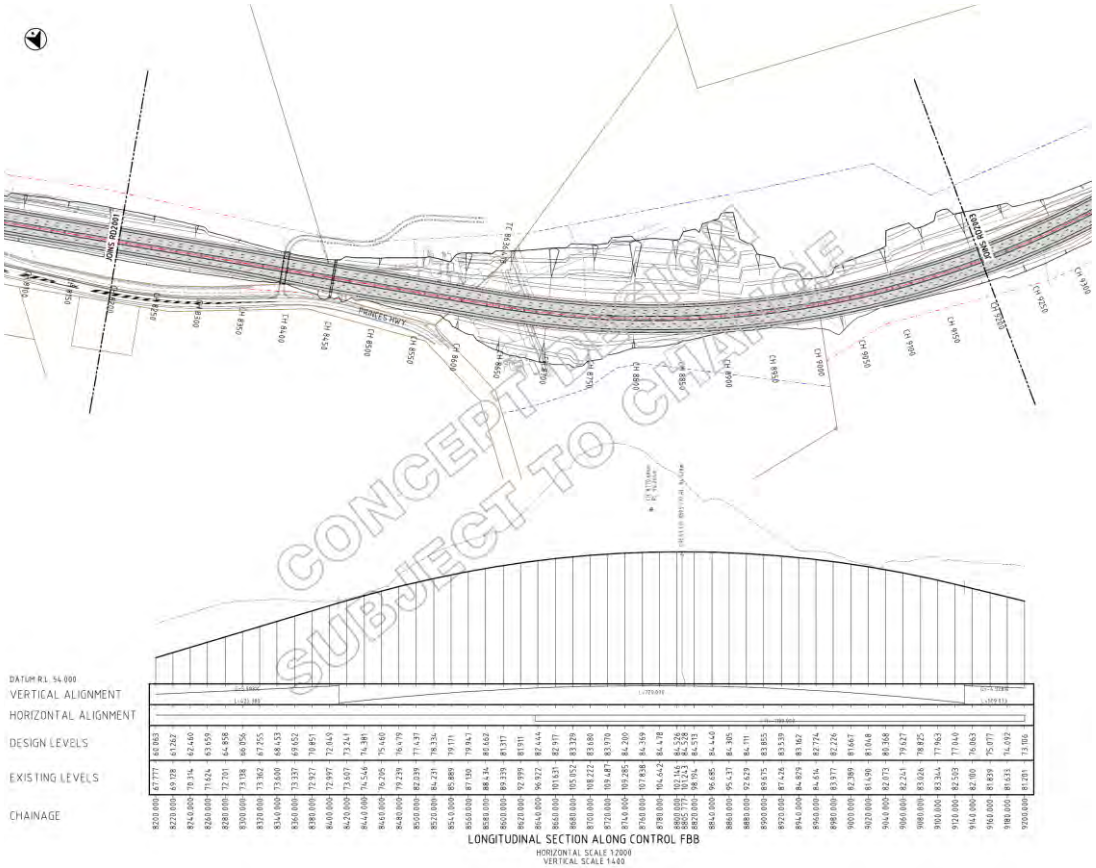


Figure E2 (con't): Location A - CH6920-8800 (beginning 800 metres east of Toolijooa Road), southbound

(Source: AECOM)

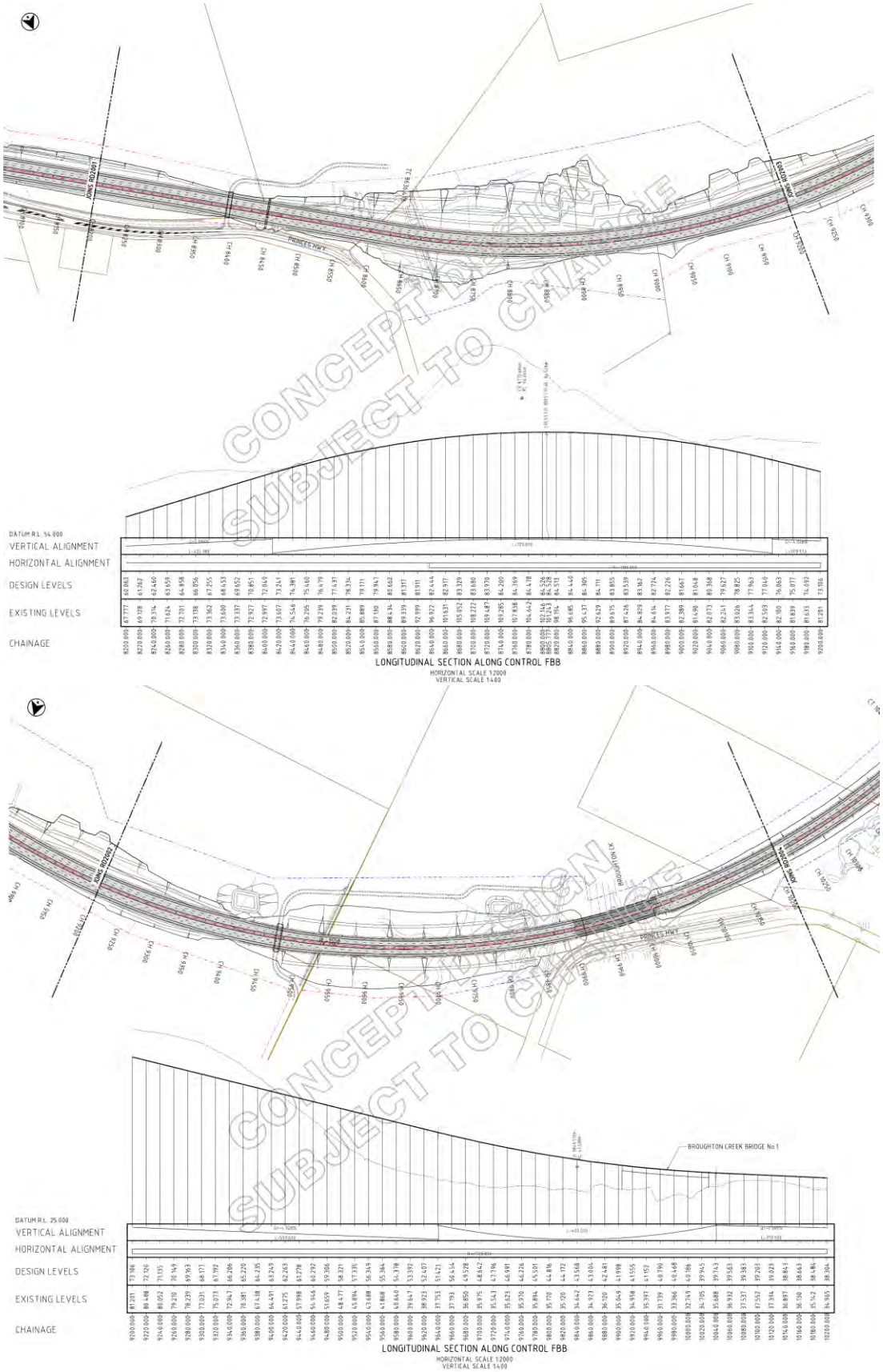


Figure E3: Location B - CH11040-8800 (beginning one kilometre east of Austral Park Road), northbound

(Source: AECOM)

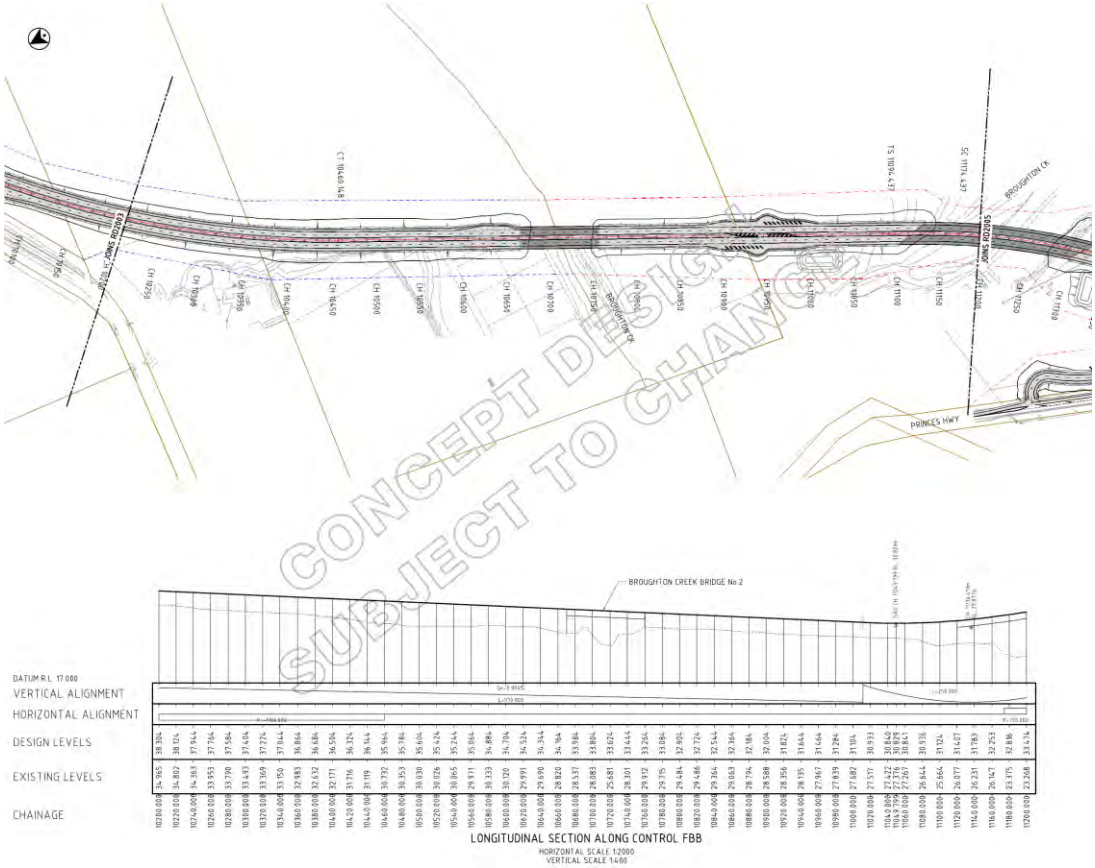


Figure E3 (con't): Location B - CH11040-8800 (beginning one kilometre east of Austral Park Road), northbound

(Source: AECOM)

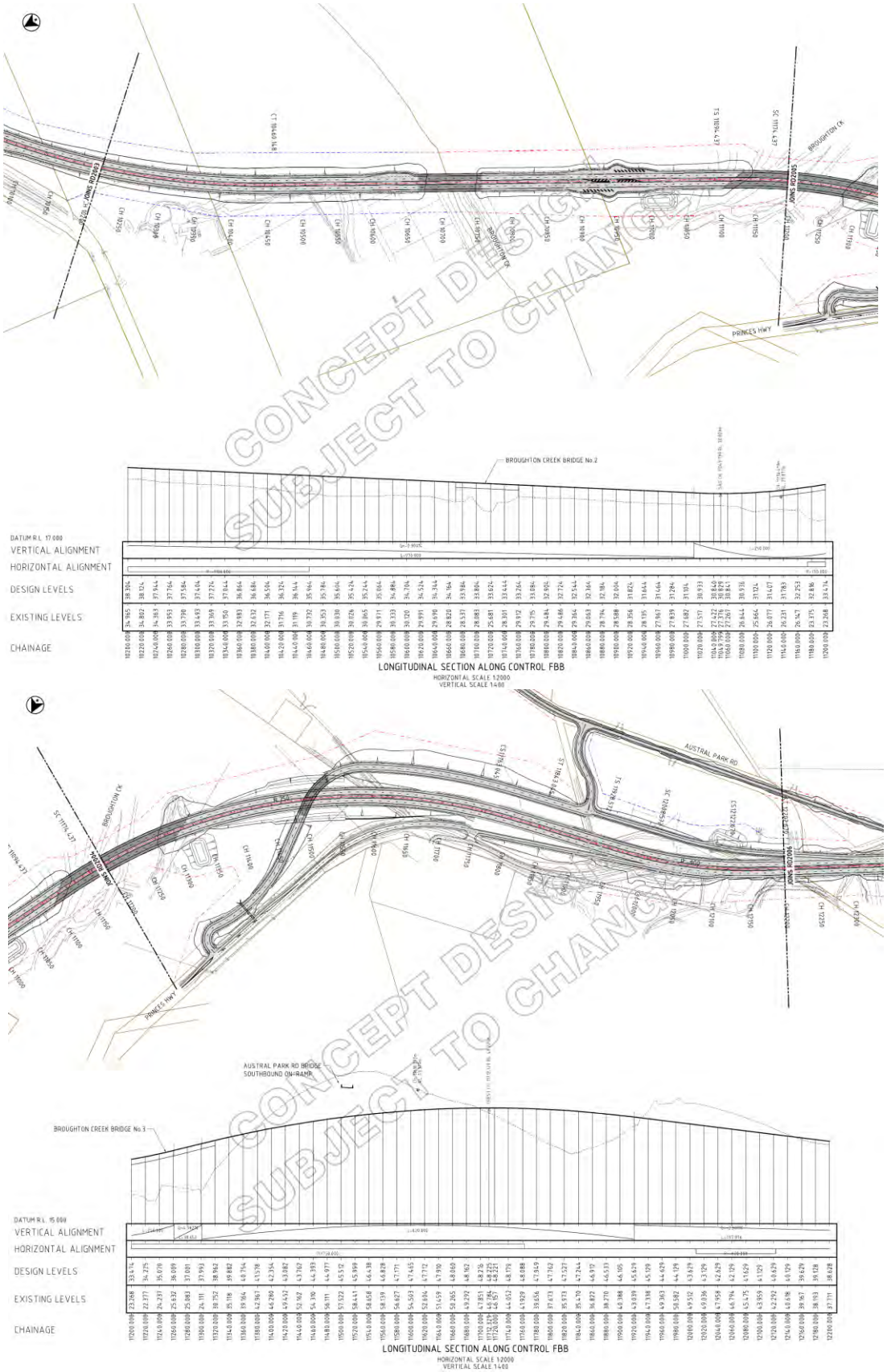


Figure E4: Location C - CH11040-11700 (beginning one kilometre east of Austral Park Road), southbound

(Source: AECOM)

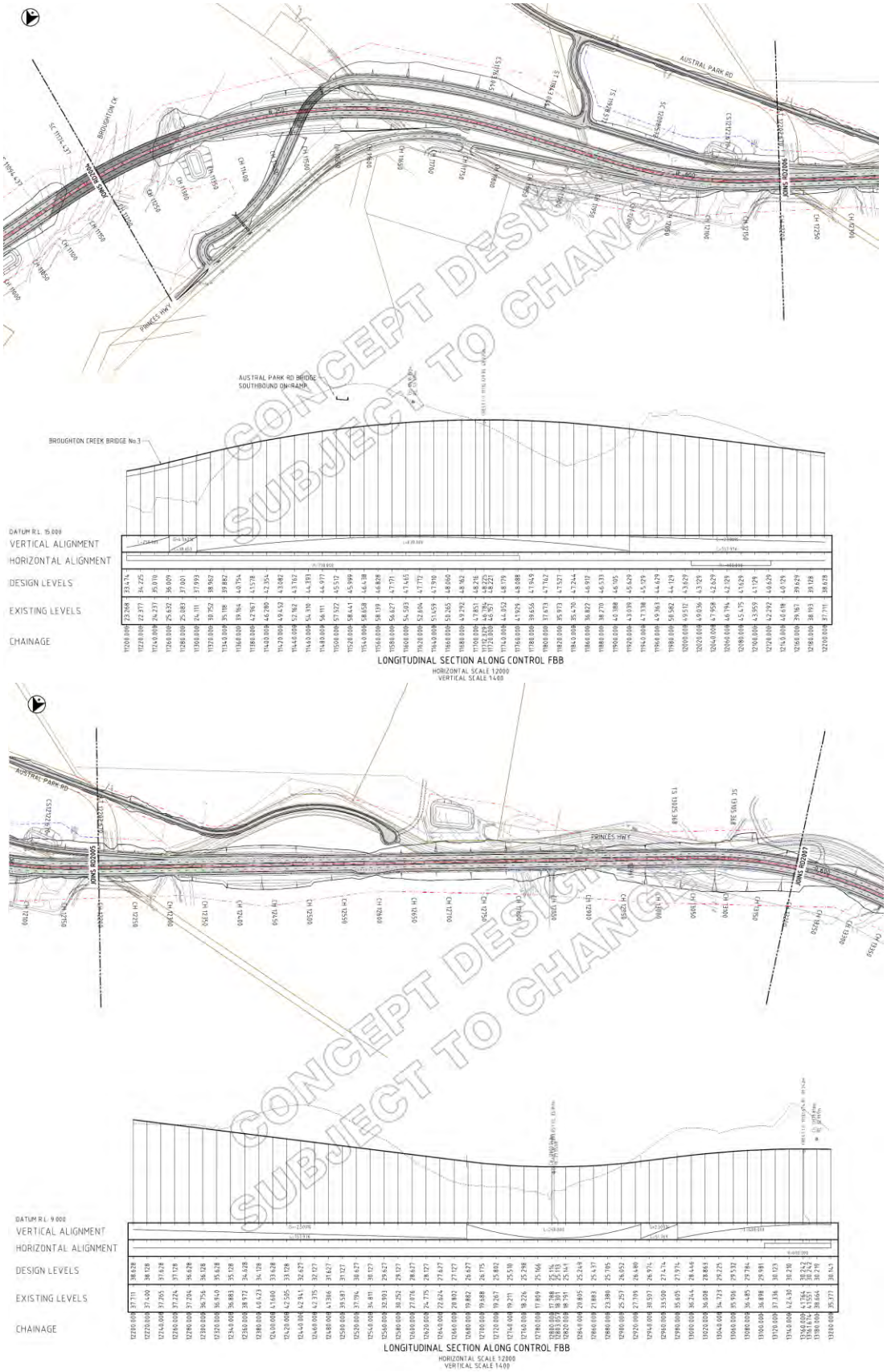


Figure E5: Location D - CH12780-11700 (beginning 500 metres west of Austral Park Road), northbound

(Source: AECOM)

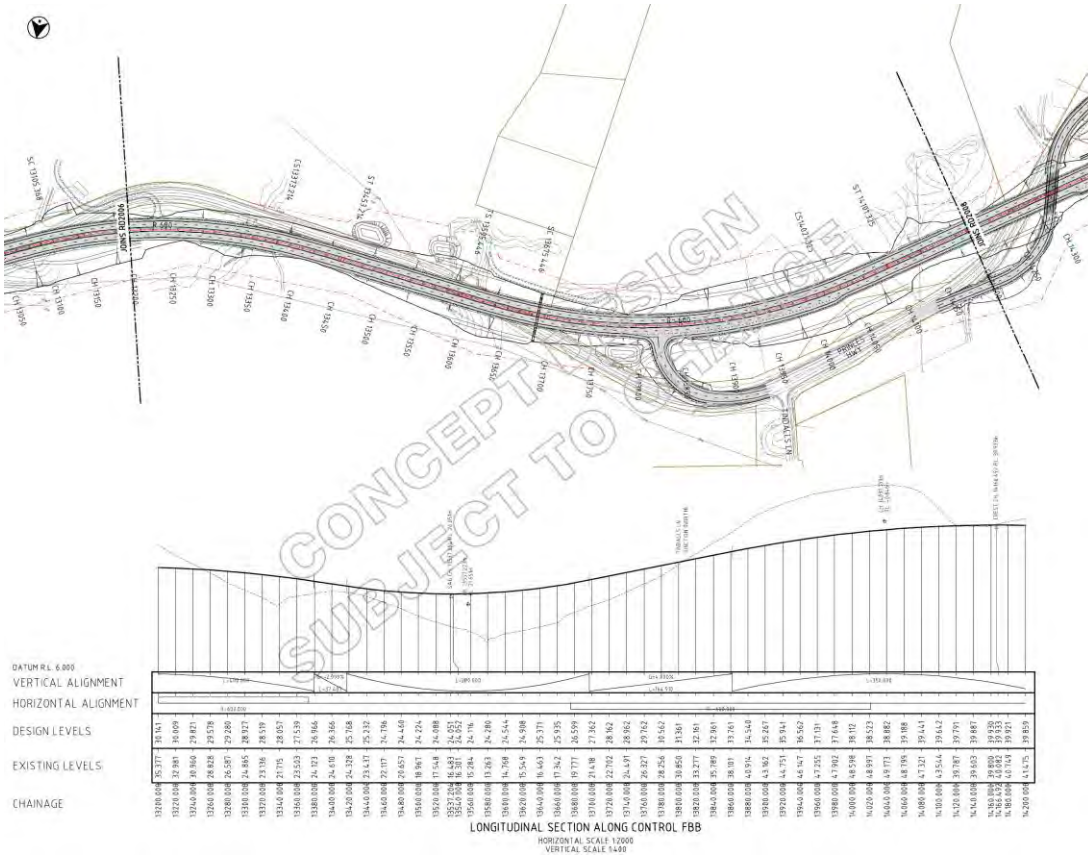


Figure E6: Location E - CH13540-14160 (beginning 400 metres east of Tindalls Lane), southbound

(Source: AECOM)

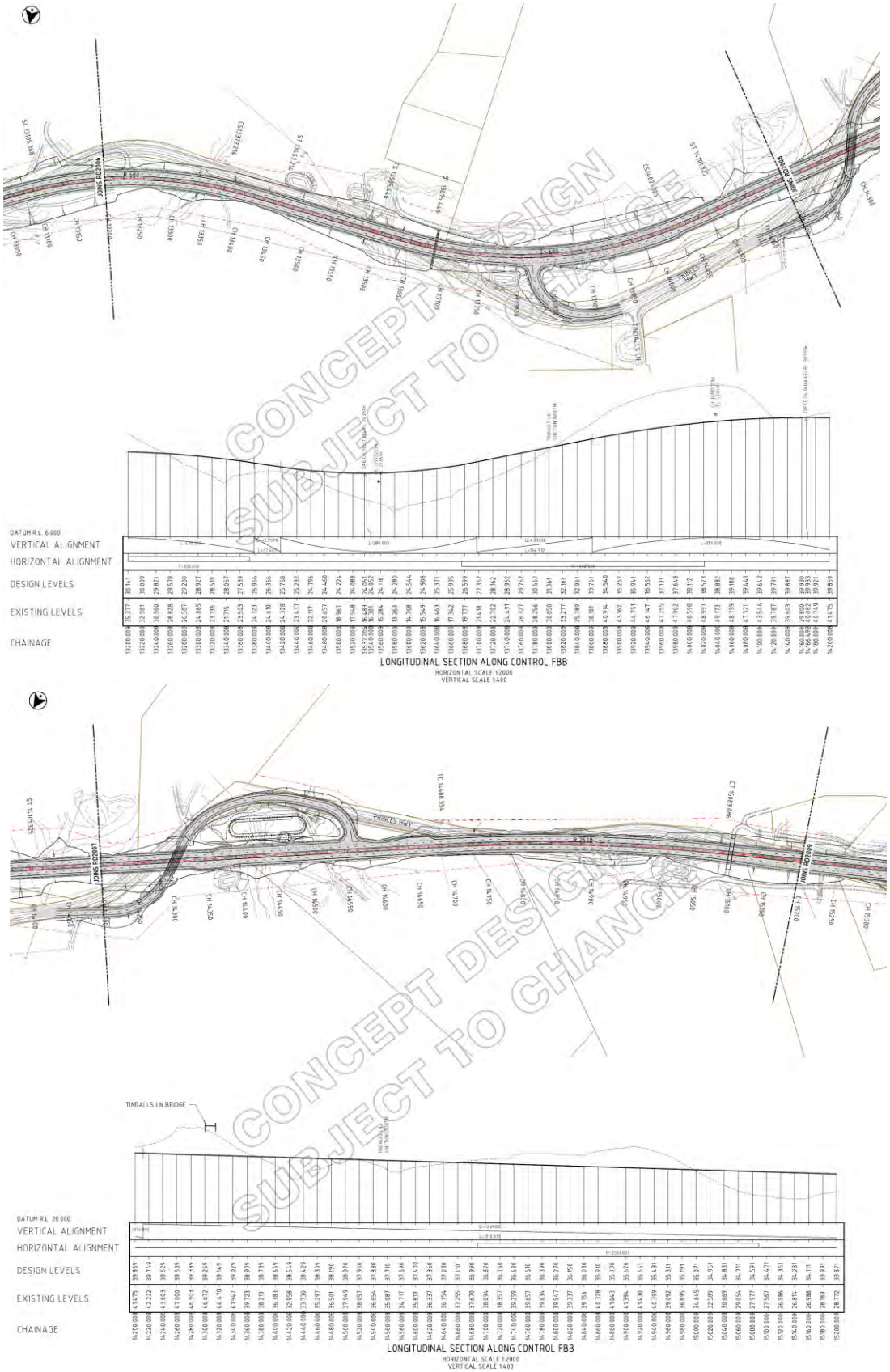


Figure E7: Location F - CH16400-14160 (beginning 400 metres west of Woodhill Mountain Road), northbound

(Source: AECOM)

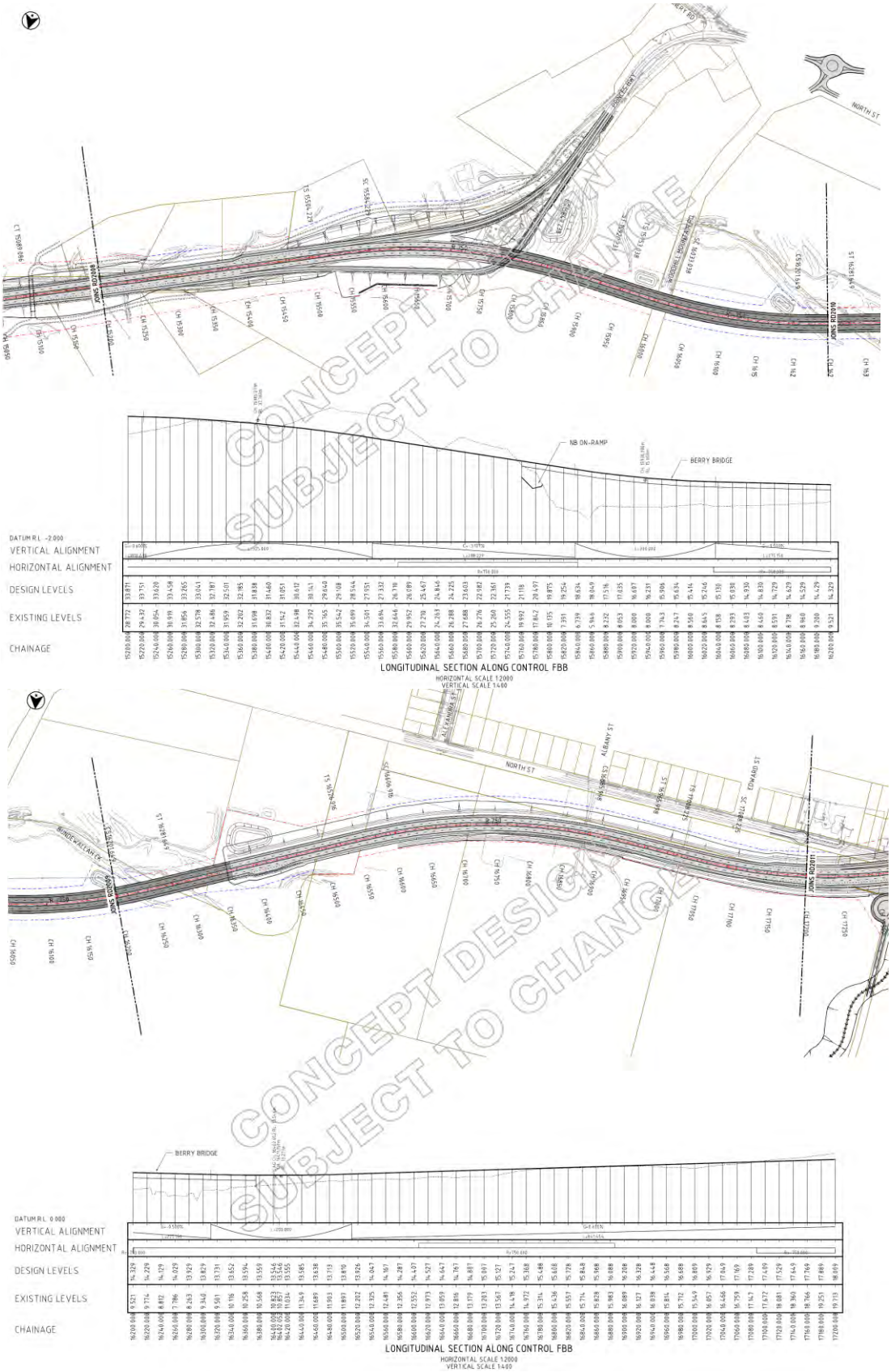
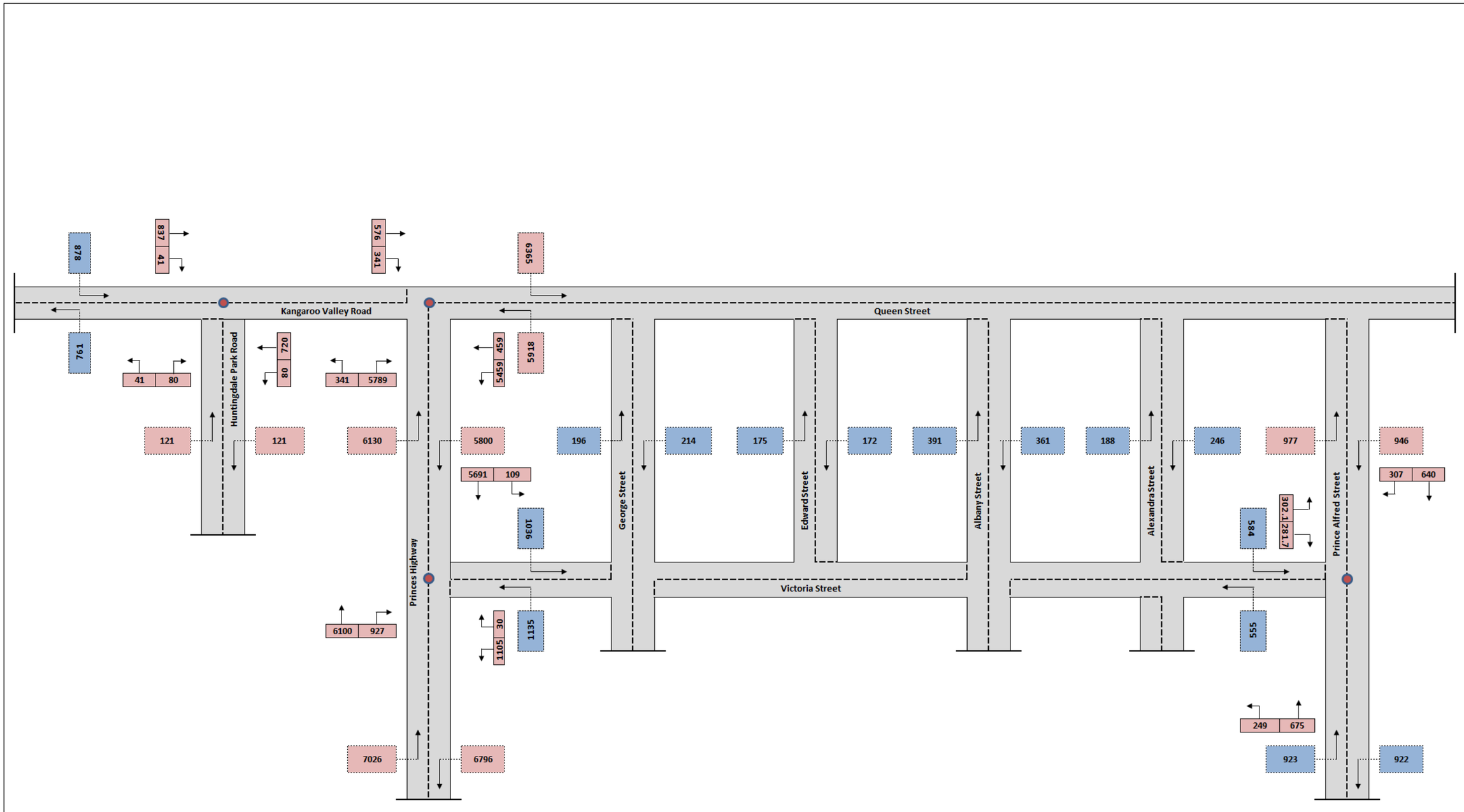


Figure E7 (con't): Location F - CH16400-14160 (beginning 400 metres west of Woodhill Mountain Road), northbound

(Source: AECOM)

Appendix F

Victoria Street design options - annual average daily traffic (AADT) flow diagrams



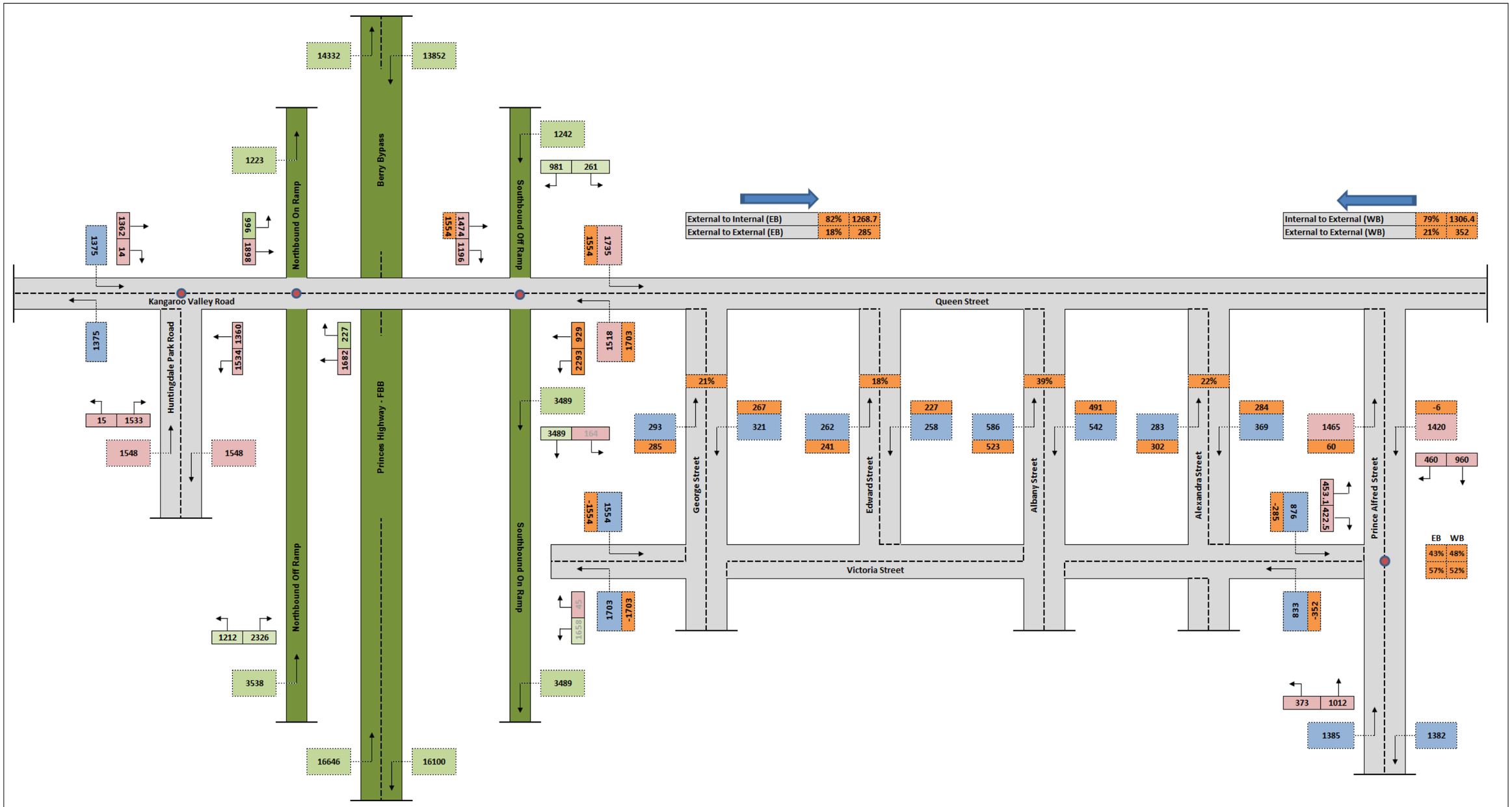
Berry Local Road Traffic Surveys	
2012 - Existing Conditions	
Annual Average Daily Traffic (AADT) Volumes	
Summary of Directional ADT Based on Shoalhaven City Council Traffic Data (2002 - 2012)	
Friday, 19 October, 2012	

Key:

- AADT from Shoalhaven Council Traffic Data
- AADT calculated from intersection counts and FBB traffic modelling
- Transfer of traffic from Victoria Street option

AECOM

Figure F1: 2012 Existing Conditions – AADT flow diagram
(Source: AECOM)



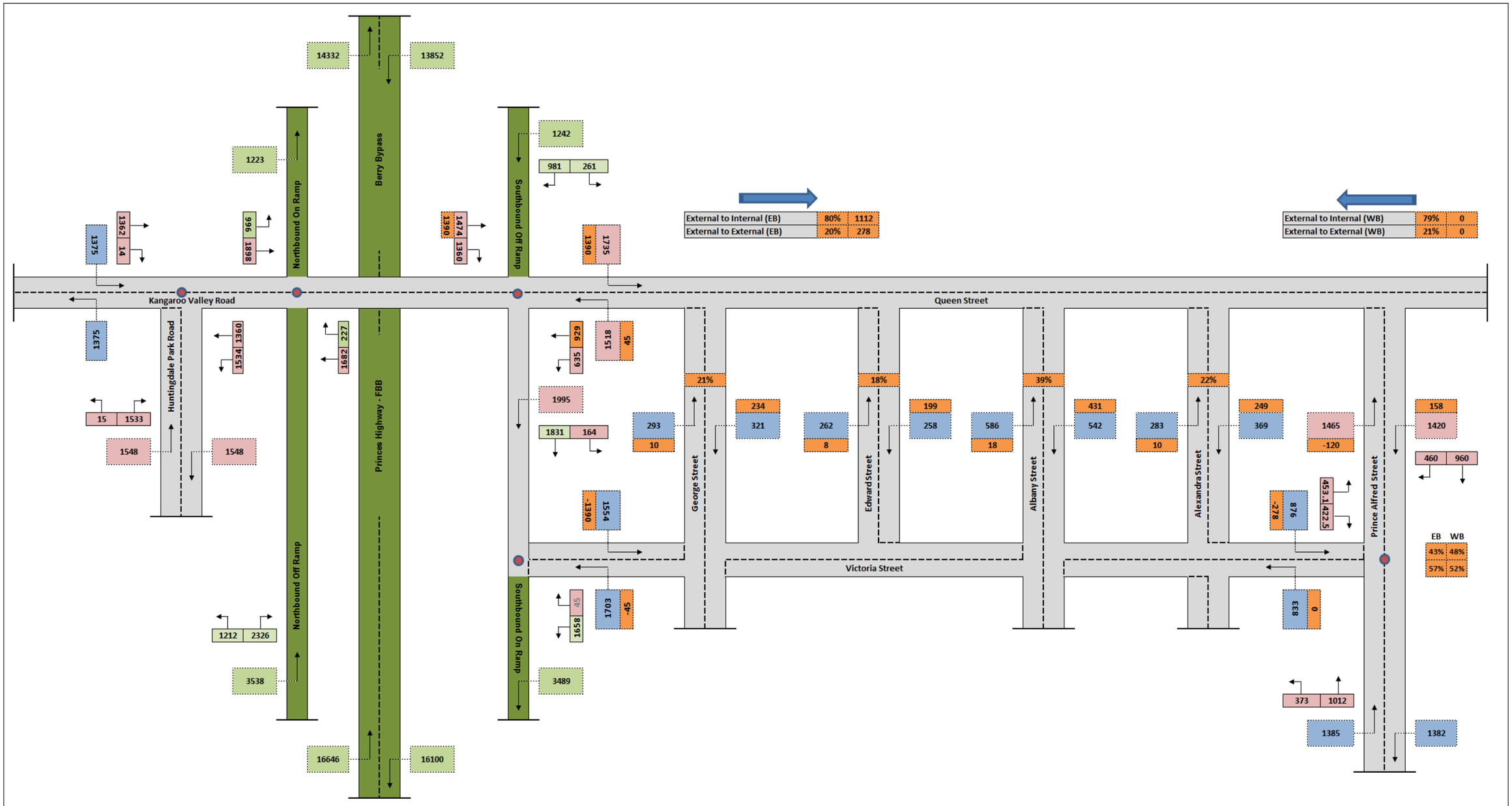
Berry Local Road Traffic Surveys	
2037 - Victoria St Closed | One-way Southbound On-Load Ramp	
Annual Average Daily Traffic (AADT) Volumes	
Summary of Directional ADT Based on Shoalhaven City Council Traffic Data (2002 - 2012)	
Friday, 19 October, 2012	

Key:

- AADT from Shoalhaven Council Traffic Data
- AADT calculated from intersection counts and FBB traffic modelling
- Transfer of traffic from Victoria Street option

AECOM

Figure F2: 2037 Option 1 Victoria Street closed and one-way southbound on ramp – AADT flow diagram
(Source: AECOM)



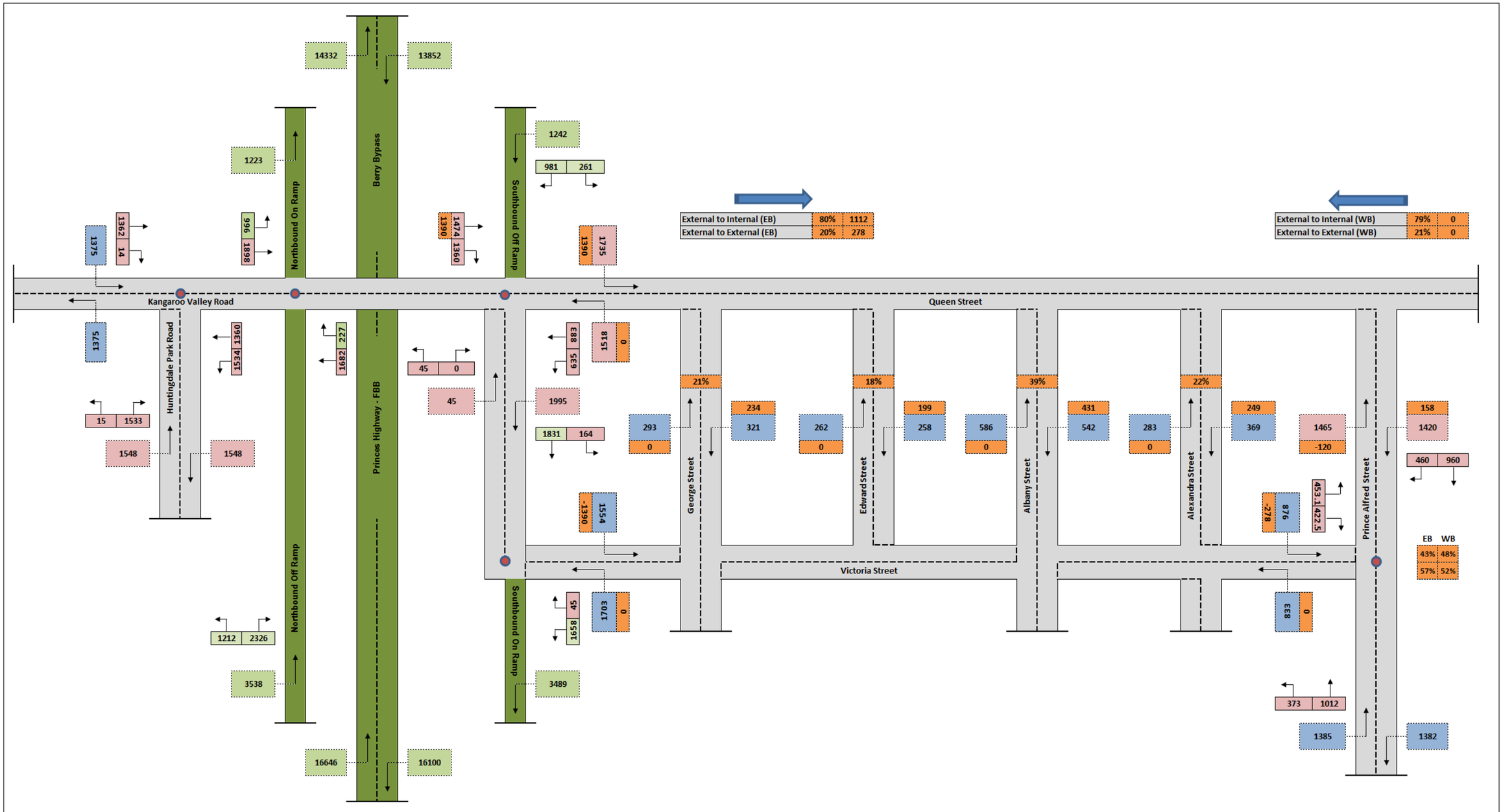
Berry Local Road Traffic Surveys	
2037 - Victoria St Open | One-way connection between Victoria Street and Queen Street	
Annual Average Daily Traffic (AADT) Volumes	
Summary of Directional ADT Based on Shoalhaven City Council Traffic Data (2002 - 2012)	
Monday, 22 October, 2012	

Key:

- AADT from Shoalhaven Council Traffic Data
- AADT calculated from intersection counts and FBB traffic modelling
- Transfer of traffic from Victoria Street option

AECOM

Figure F3: 2037 Option 2 Victoria Street open and one-way southbound on ramp – AADT flow diagram
(Source: AECOM)



Berry Local Road Traffic Surveys	
2037 - Victoria St Open | Two-way connection between Victoria Street and Queen Street	
Annual Average Daily Traffic (AADT) Volumes	
Summary of Directional ADT Based on Shoalhaven City Council Traffic Data (2002 - 2012)	
Monday, 22 October, 2012	

Key:

- AADT from Shoalhaven Council Traffic Data
- AADT calculated from intersection counts and FBB traffic modelling
- Transfer of traffic from Victoria Street option

AECOM

Figure F4: 2037 Option 3 Victoria Street open and two-way southbound on ramp – AADT flow diagram
(Source: AECOM)