MR545 Strategic Study

Pacific Highway (Ewingsdale) Interchange to the Byron/ Ballina Shire Boundary (Broken Head)

Strategic Report

February 9, 2009

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1. Introduction

Byron Shire Council engaged Opus International Consultants (Opus) to undertake a Strategic Study for Regional Road, MR545. The objectives of the engagement as noted in the project brief are as follows:

(a) Assess the current level of service offered by MR545

(b) Determine the impact of future development and traffic growth on the functioning of MR545

(c) Consider the feasibility of town centre bypass and mini-bypass

(d) Consider alternative modes and park and ride facilities for tourists and commuter use

(e) Make recommendations on measures that could be taken to improve levels of service on MR545 in the 10 year horizon, ensuring that any proposed works do not jeopardise the proposed construction of the Coastal Cycleway, from Byron Bay to Ewingsdale, and

(f) Make recommendations to Council regarding Section 94 Contributions that may be applicable to development on the Ewingsdale corridor to fund road improvements required to deal with traffic growth.

The scope of works essentially included:

- Review relevant studies to develop better understanding of the project objectives and constraints
- Identify existing level of service
- Create a traffic model of MR545 and use it
    - To predict level of service in 10 years and 20 years
    - To evaluate the feasibility of the town centre bypass and mini-bypass options with cost-benefit analysis of these projects
    - To evaluate the effectiveness of alternative transport modes for accessing the town centre and park and ride facilities for tourist and commuter use
- Prepare an implementation plan identifying priorities of recommended works and management strategies
- Explore funding options for recommended works and make recommendations regarding Section 94 contributions.

It should be noted at the outset that this and other accompanying reports are making recommendations on data modelling/analysis, and are provided to support future decision making regarding the road network. This is *not* presented as an agreed (or final) position of Council and the scenarios modelled and presented are based on the agreed project brief. Decisions regarding the matters subject to study and guidance in the report are a matter for Council.

2. Study Overview

The study progressed in stages and outputs were discussed, reviewed and documented at each stage. This helped reduce complexity, facilitated sharing of ideas and knowledge, and improved rigour in the analysis and options evaluation. Moreover, throughout the project an active communication was maintained between Opus and Council staff. The stages, key activities and outcomes, and outputs from different stages are shown below.

	Tasks	Key Activities & Outcomes	Reporting
Stage 1	Project Initiation	Site visit and Stakeholder workshop Review of earlier studies, consultation/ feedback from Council staff Improved understanding of the study objectives and constraints Future growth projections and Land use MR545 corridor & Land use patterns Acceptable level of service & design environment Available traffic data and data gaps	Scoping Report
Stage 2	Data Collection	Origin-Destination Survey Intersection Movement Counts Tube Counts Travel Time Surveys	Scoping Report & Survey Data Report
Stage 3	Model Development	Road Network Coding in SATURN Model Disaggregation of study area into zones (93) Trip Assignment Cost Function Model Calibration Development of Trip Matrix (2018 & 2028)	Modelling Report
Stage 4	Strategic Analysis	Network deficiencies in 2028 Works required for Ewingsdale Road, CBD, Broken Head & Bangalow Works needed to maintain/ improve MR545 level of service Detailed analyses of key intersections Butler Street Reserve Carpark analysis Travel Time Analysis Network Statistics	Modelling Report
Stage 5	Strategic & Economic Analyses	Economic Analyses & Staging of Works Developers Contributions Timing of Works Parking Considerations Predicting the Future Conclusions & Recommendations	This Report

3. Project Initiation

Three members of the Opus team visited Byron Shire on April 28-29, 2008. The members of the Opus team were briefed about the past traffic studies, local issues, construction and environmental constraints, possible future development sites, and the history of limits on crossings over the railway line. In the afternoon the Opus team drove through MR545 to develop a first hand knowledge of the study site, accompanied by Mr Simon Bennett (Traffic and Transport Planner). Mr Bennett indicated to the team the location of possible future development sites and briefed them on the constraints and features of different sites.

On April 29, a stake holder workshop was held at Byron Shire Council that was attended by the Opus team, Mr Simon Bennett, Mr Michael King (Manager, Infrastructure Planning), Mr Philip Holloway (Director, Asset Management Services), and Ms Lisa Wrightson (Team Leader Community Planning). The workshop was led by Mr Richard Jarvis and the areas covered included the characteristics of current and future population, current and future land use, traffic generation, traffic character and travel patterns. Discussion was held upon the definition of the level of service of the road: what is desired, satisfactory or acceptable, and future design road environment. Themes included the application of travel demand management, the consequences of congestion, and parking use and control patterns.

The available data and reports were also looked at with a view to evaluate data adequacy for model development. There was a lack of information on traffic travelling to and through town centre as the origin-destination (O-D) survey data available dated back to early 1990s. As reliable data is a key to informed decision making, it was agreed that new traffic surveys were necessary to better understand current trends.

4. Data Collection

Extensive surveys were arranged by the Council to ascertain traffic movements within Byron Bay. Four types of surveys were conducted:

- Origin-Destination (O-D) surveys
- Intersection Movement Counts
- Tube Counts
- Travel Time Surveys

The O-D surveys were conducted by recording vehicle number plates north and south of town centre. The number plates were matched for the two ends and this process showed that most of the vehicles entering town centre stay within the town centre and that as little as 7%, and no more than 20%, would actually pass through or ‘bypass’ the town centre within one or three hours, respectively. In a nutshell, the O-D data revealed that Byron Bay is the destination for most of the traffic, and the proportion of through traffic on MR545 is relatively small. The O-D data along with counts (intersection and tube) and travel time data were used to create and validate traffic simulation models used for this study.

5. Model Development

5.1. Overview

Traffic models are developed to replicate vehicle traffic generated from land use on defined road networks. They provide information on the changes in transport efficiencies based on changes to traffic flow conditions and/or road network alterations. Two levels of transportation modelling have been performed:

- Strategic network modelling using SATURN
- Detailed Intersection modelling using SIDRA

SATURN (Simulation and Assignment of Traffic to Urban Road Networks) modelling software was used for the strategic network model. SATURN is a suite of flexible network analysis programmes that utilise model algorithms for the assignment of trips onto routes throughout the road network, based upon the perceived cost of travel between zone pairs (and the relative cost of alternative routes).

Sidra Intersection was used for the detailed intersection modelling. Traffic flows from SATURN were input into Sidra Intersection with intersection layout specifications. This allowed a more detailed analysis of intersections than provided by SATURN.

Traffic models generally require two inputs:

- Road network – coding that describes the road network layout, made up of links (roads) and nodes (intersections).
- Trip matrix – coding to describe where vehicles commence and end their trips.

5.1.1. Model Extent

Figure 1 shows the extent of the transportation network model. The solid lines represent the roads whereas the dashed lines show the zone loading and connect the zones to the point(s) that the traffic is loaded on the network. In addition to the Saturn model, Sidra Intersection models were created for all the key intersections.

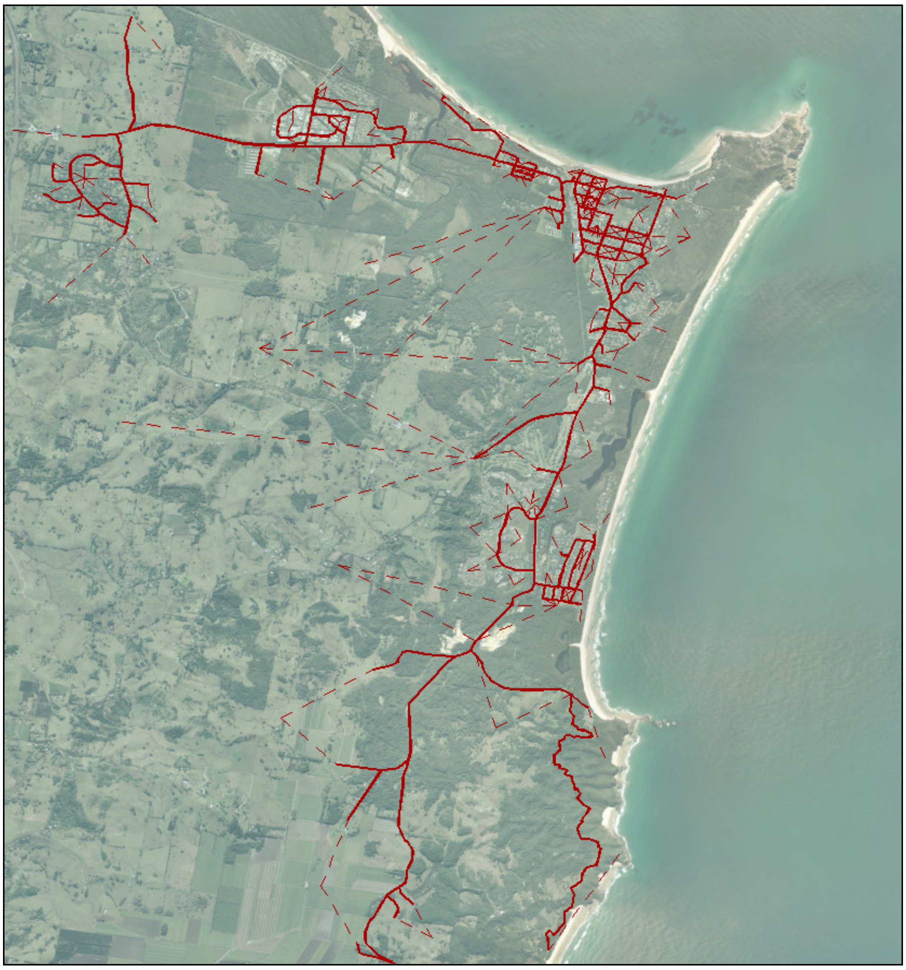


Figure 1 Saturn Model Base Network

5.1.2. Traffic Scenarios Modelled

Three years were modelled, a base year 2008, and two future years, 2018 and 2028. The details are provided in the Modelling Report.

5.2. Existing 2008 Model

5.2.1. Road Network

The road network was coded as a series of links (roads) and nodes (junctions). It was coded to include all arterial and collector roads within the study area. The existing network characteristics were used as an input to develop a representation of the base road within the SATURN software. All intersections were replicated in the model with appropriate traffic lanes, capacities, and configuration plans, identified from existing data, and on-site visits.

5.2.2. Trip Matrix

The base matrix requires disaggregation of the study area into a number of zones (93 zones). Trip generations are calculated for these zones based on land use. Trips are firstly distributed between zone pairs through a standard gravity model approach. This distribution is then adjusted using SATURN's purposely developed software (ME2), which adjusts zone pairs based on matching input intersection turning counts and tube count information. Specific limits on the amount of adjustment to be allowed are user defined.

5.2.3. Trip Assignment

Trips are assigned to a network using SATURN. This assignment is based on the perception that a driver aims to minimise its 'cost'. This generalised cost is a composite of trip distance and trip travel time. Trip routes are selected on minimising the trip cost between zone pairs.

5.2.4. Model Calibration

The base year model has been calibrated using industry recognised methods for correlation and adjustment techniques. Surveyed travel times have been compared to model output travel times. This has required some refinement to the speed-flow relationships applied to the modelled links. Links within the CBD have been adjusted to take account of the high 'side friction' within the CBD. Traffic flow on urban road links is usually interrupted by different factors within the road environment, and these factors are referred herein as 'side friction' factors and including pedestrian/parking activity, bicycles, etc.

The traffic split between those that travel through the CBD and those that stop or whose trip originated in the CBD is compared to the assigned traffic. In addition, the split between the route through the CBD is compared (Jonson Street versus Tennyson Street). To counter the increased trip length of the Tennyson route, a specific "cost" is applied to the route to provide the necessary attraction, so that the model traffic flows better match the measured flows.

In an attempt to replicate the uncertainty of how drivers perceive the least cost route, the stochastic assignment has been used in this assessment. A traditional value of 20% has been used, meaning all routes with a generalised cost within 20% of the minimum cost are assumed equal opportunity for route choice.

In summary, the developed base models for 2008 AM and PM peak periods has been determined as being fit for purpose.

6. Network Analysis

6.1. Overview

Although the existing network is already showing signs of operating close to or beyond its capacity (long queues, delays, and poor travel time reliability), it is generally confined to weekends and/ or peak periods of the day. The occurrence of these visual signs is irregular and generally confined to summer holiday period; however, they appear to be increasing in occurrence.

The trip matrices used in this assessment have been developed to represent the average typical hour rather than a specific hour period with known network deficiencies. This is a reasonable approach whereby the network generally operates at a reasonable level of service for the majority of hours during a year. There will be holiday period that continue to load the network to capacity of the route.

As traffic flow increases, the expected network deficiencies are likely to become more apparent. As such, in the initial assessment of identifying network deficiencies the trip matrix with the greatest trip numbers has been used (i.e. 2028 network). Upon establishing network deficiencies in 2028, backwards assessment has been completed to estimate when the improvements are likely to be required.

6.2. Levels of Service

The Austroads Guide to Traffic Engineering Practice describes the levels of service as follows.

- Level of Service A is a condition of free flow in which individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high, and the general level of comfort and convenience provided is excellent.

- Level of Service B is in the zone of stable flow and drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream, although the general level of comfort and convenience is a little less than with level of service A.

- Level of Service C is also in the zone of stable flow, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level.

- Level of Service D is close to the limit of stable flow and is approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor, and small increases in traffic now will generally cause operational problems.

- Level of Service E occurs when traffic volumes are at or close to capacity, and there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream. Flow is unstable and minor disturbances within the traffic stream will cause break-down.

- Level of Service F is in the zone of forced flow. With it, the amount of traffic approaching the point under consideration exceeds that which can pass it. Flow break-down occurs, and queuing and delays result.

6.3. 2028 Network Deficiencies

Based on discussions with Byron Shire Council several potential developments were considered (see Figure 3) in order to predict the future traffic matrix in addition to Pacific Highway traffic (refer to Modelling Report for details). The predicted traffic matrix is simulated using the SATURN model, and the SATURN modelling shows the network has the following deficiencies in 2028:

- Ewingsdale Road is at capacity with 2,500 vph between the new (proposed) sports complex and Banksia Drive (existing traffic volumes are approximately 1,650 vph in the peak periods). Other sections of Ewingsdale Road to the west of the new (proposed) sports complex are nearing capacity.

- Traffic volumes on the following links exceed capacity (or are at practical spare capacity of (volume/capacity) v/c = 80%):

    - Jonson Street (southern) approach to the Jonson Street / Lawson Street Roundabout

    - Lawson Street (eastern) approach to the Jonson Street / Lawson Street Roundabout

    - Lawson Street approach to the Butler Street / Shirley Street Roundabout

The above links are shaded in red in Figure 2 which shows that the intersection and links related to the existing railway crossing exceed capacity. This clearly shows the need for a 2nd railway crossing not only to improve traffic flow but also in an emergency situation.

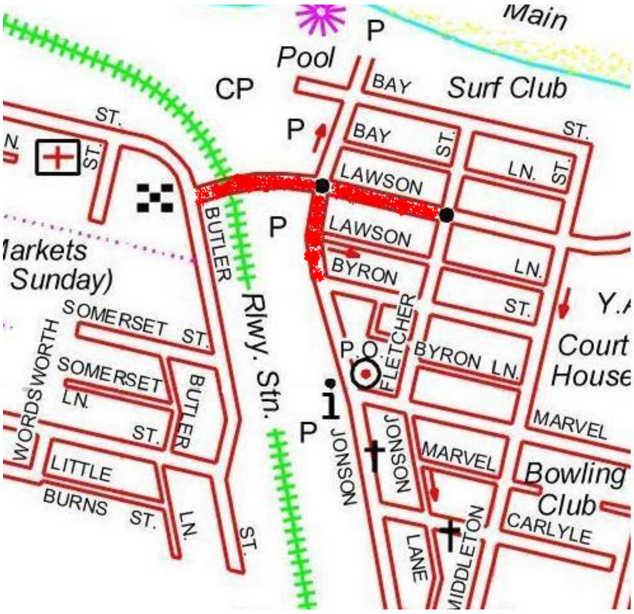
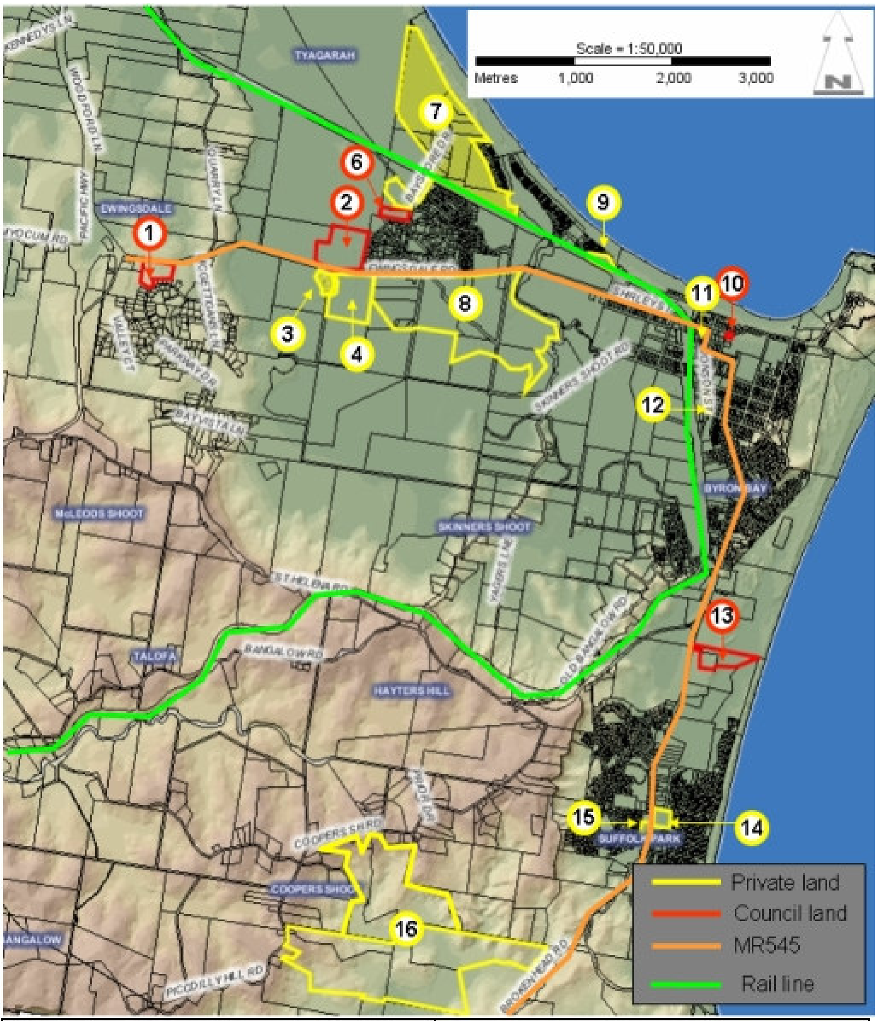


Figure 2 Links Exceeding Capacity (Marked in Red)

- Some traffic will re-route in 2028. Notable examples are:
  - Belongil (West Byron) Residential – high delays on the right turn out of Belongil Residential causes traffic travelling to the CBD to turn left out of Belongil and then u-turn rather than turn right out of Belongil.
  - Traffic from the Milton Street area will also turn left onto Ewingsdale Road and u-turn to go to the CBD.
  - Traffic favours the Tennyson – Marvell Street route over Jonson – Browning Street.
- The travel time between the Tennyson Street / Browning Street Roundabout and McGettigans Lane increases from 7 minutes in 2008 to 9 minutes in 2028 in the PM peak (this represents a 30% increase in travel time, which is considered unacceptable).



Site ID. Name (status)	Site ID. Name (status)
1. Byron Hospital (proposed)	9. Epicentre (proposed residential development)
2. Sports Fields & Centre (proposed)	10. Library (proposed)
3. Island Quarry (potential for future expansion)	11. Byron Village (proposed mixed use development)
4. Sunnybrand (potential for future expansion)	12. South Jonson Street (proposed rezoning for commercial expansion)
5. Bayshore Village (proposed mix use development)	13. Former STP Site (proposed rezoning)
6. A&I Estate expansion (proposed)	14. Broken Head Road (proposed residential development)
7. Becton (proposed tourist development)	15. Aged Care Facility (potential expansion of existing facility)
8. Byron West (proposed rezoning for residential development)	16. Natural Lane (potential rezoning for rural living development)

Figure 3 Potential Future Developments

6.4. Network Upgrades

The 2028 modelling was divided into 3 sections (see Figure 4):

- Ewingsdale Road
- CBD, and
- Broken Head Road.

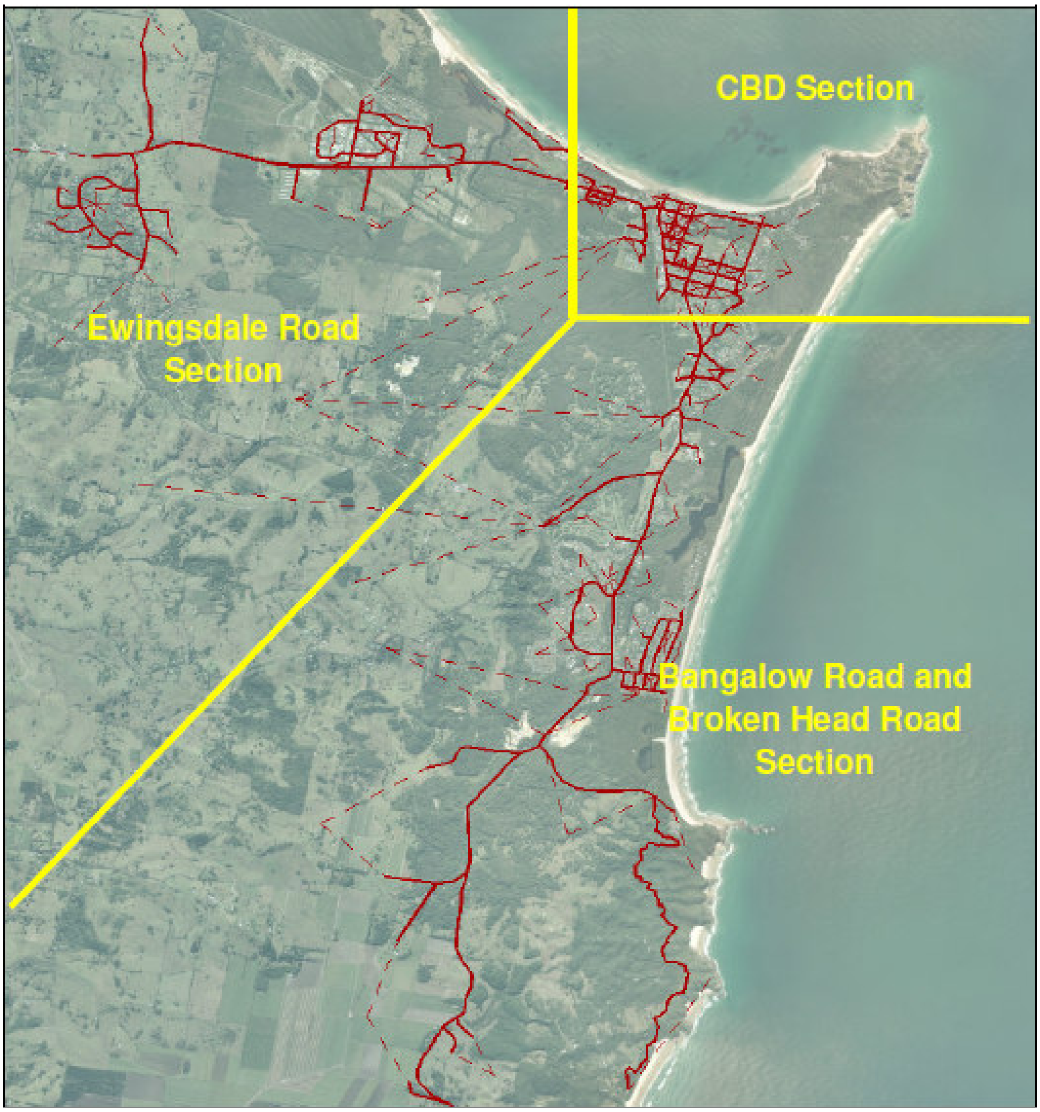


Figure 4 SATURN Modelling Sections for 2028 Option Testing

A detailed analysis was done for each section to identify the works needed to improve/ maintain the existing level of service (the network analysis is provided in the Modelling Report). Following discussion with Byron Shire Council a preferred improved 2028 road network was selected based on the 2028 modelling results (see Figure 5). It includes the following works.

- A roundabout at McGettigan Lane/ Ewingsdale Road intersection
- A 2nd rail crossing from Butler Street to the Jonson Street / Marvell Street intersection with a single lane roundabout at the Jonson Street / Marvell Street intersection
- A roundabout at the Sunrise Boulevard / Ewingsdale Road intersection with access to the proposed Belongil (West Byron) residential
- A roundabout at the Bayshore Drive / Ewingsdale Road intersection
- 4-laning of Ewingsdale Road between a roundabout at the proposed sports field and a roundabout at the Sunrise Boulevard / Ewingsdale Road intersection
- An upgrade of Shirley Street / Butler Street roundabout
- Two lanes on the Fletcher Street approach to the Fletcher Street / Lawson Street roundabout
- A slip lane on the Bangalow Road at Patterson Street, Cooper Street, Bangalow Road intersection
- A right turn bay at the Bangalow Road for the Golf Course Access
- A single lane roundabout at the Clifford Street / Broken Head Road

It is worth clarifying that the inclusion of the above works in the preferred network is predicted based upon the progression of possible land developments listed in the Modelling Report, which does not mean they are approved or will progress. They are listed as known potential future developments at the time of this report. Decisions regarding their approval or otherwise are subject to Council and other reports/process. The list is subject to change, not exhaustive nor indicates a Council preference.

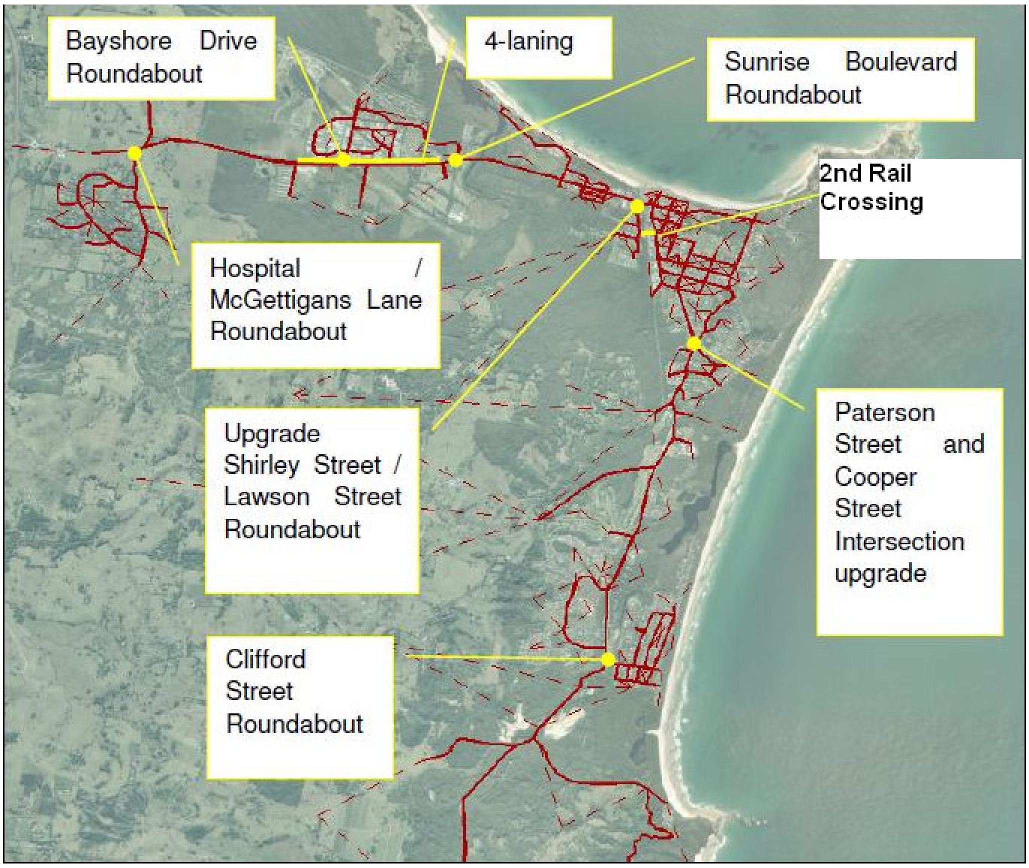


Figure 5 Preferred Improved 2028 Network

6.5. Network Statistics

Table 1 and Table 2 summarise the total travel time and total distance travelled for all trips on the existing network and the upgraded network in 2008, 2018, and 2028 for AM and PM peaks, respectively (more detailed outputs are in the Modelling Report). The 'Do Minimum' scenario in the tables entails existing network plus sports field roundabout.

It should be noted that these travel times are derived from the average trip journey time. In many instances the existing corridor at 2008 operates at/or close to capacity at times. As such, an increase in traffic in these corridors may result in increased trip re-routing (to avoid the congestion) and therefore increased journey times may not be clearly evident. In addition, where flows are close to capacity they are unstable and the reliability of regular journey times becomes low (meaning high variability around the average journey time). This variability around the average is not included in these outputs.

Table 1 AM Peak Network Statistics – Travel Time, Distance and Fuel Usage

Year	Option	Total Trips	Total Travel Time (pcu hours)	Total Distance (pcu km)	Fuel Usage (litres)
2008	Do Minimum	6630.2	460.8	24683.7	1819.3
	Full upgrade	6630.2	457.4	24599.1	1814.9
2018	Do Minimum	7619.6	529.0	27570.6	2060.3
	Full upgrade	7619.6	518.8	27410.4	2044.9
2028	Do Minimum	8553.5	689.5	31911.3	2550.6
	Full upgrade	8553.5	615.6	31360.5	2395.7

N.B.: pcu stands for passenger car units

Table 2 PM Peak Network Statistics – Travel Time, Distance and Fuel Usage

Year	Option	Total Trips	Total Travel Time (pcu hours)	Total Distance (pcu km)	Fuel Usage (litres)
2008	Do Minimum	6210.8	462.6	28008.4	1834.7
	Full upgrade	6210.8	460.7	24972.2	1836.4
2018	Do Minimum	7749.2	558.8	28854.2	2170.0
	Full upgrade	7749.2	546.4	28676.6	2153.3
2028	Do Minimum	8353.6	630.3	30928.9	2393.7
	Full upgrade	8353.6	594.0	30519.4	2327.1

N.B.: pcu stands for passenger car units

The tables above show that there are 30% more trips in 2028 compared with 2008. Without any network upgrades the travel time within Byron Bay will increase by approximately 16% per vehicle. By upgrading the network the travel time will only increase by 10 seconds per vehicle in the AM peak and will reduce by 12 seconds per vehicle in the PM peak. The upgraded network in 2028 will also have a lower travel distance per trip and fuel usage than the existing 2008 network. It is worth noting here that the travel time for the do minimum scenario in 2028 is under reporting the travel time, and the trip time could be much higher because both the AM and PM peaks are at or near breakdown point meaning small incidents on the road will cause long queuing and delays.

7. Intersection Analysis

Key intersections were tested using Sidra Intersection to provide more detailed information on intersection performance. The key intersections in the final 2028 network will operate at Level of Service A/B in the peak periods.

7.1. Ewingsdale Road Intersections

Table 3 Ewingsdale Road intersection modelling results – worst LOS & queue length

Intersection	Option	Now		2018		2028		Comments
		Queue	LOS	Queue	LOS	Queue	LOS	
McGettigans Lane/ Ewingsdale Road	Do Min	50m	F	> 500m	F	> 500m	F	Right turn operates poorly
	RAB	N/A	N/A	105m	B	130m	B	Operates well
Bayshore Drive/ Ewingsdale Road	Do Min	110m	F	> 500m	F	> 500m	F	Right turn out operates poorly
	RAB	N/A	N/A	30m	B	50m	B	Longest queue is on Ewingsdale Road
Sunrise Boulevard/ Ewingsdale Road	Do Min	10m	E	50m	F	> 500m	F	Right turn out operates poorly
	RAB	N/A	N/A	30m	B	35m	B	Operates well
Proposed Sportsfield RAB	Only tested in 2028 to show proposed layout operate works in the future					70m	B	Operates well
West Byron	Seagull	N/A	N/A	40m	F	> 500m	F	Right turn out operates poorly

N.B.: RAB stands for roundabout

7.2. CBD Intersections

Table 4 Ewingsdale Road intersection modelling results – worst LOS & queue length

Intersection	Option	Now		2018		2028		Comments
		Queue	LOS	Queue	LOS	Queue	LOS	
Butler Street/ Shirley Street	Do Min	100m	B	140m	C	280m	F	Operates poorly in 2028. Queue lengths in 2018 cause blocking back between intersections
	Upgrade	55m	B	80m	B	90m	B	Operates well
2nd Railway crossing	Jonson St T-Intersection	Only tested in 2028 to show poor operation of T junction				430m	F	Right turn operates poorly
	Jonson St RAB	Only tested in 2028 to show good operation of roundabout				40m	B	Operates well
Jonson Street/ Lawson Street	Do Min	50m	B	Not tested		20m	B*	Operates well with 2nd Railway crossing
Fletcher Street/ Lawson Street	Do Min	Only tested in 2028 to compare queue lengths				60m	B	Delay is alright, but queue length may be an issue
	Upgrade					30m	B	Extra lane reduces queue length by half

*Assuming 2nd railway crossing is built. See Table 3 for results if no 2nd crossing is built.

Table 5 Jonson St/ Lawson St with no 2nd Railway Crossing – Worst LOS & Queue Length

Intersection Option	Now		2018		2028		Comments
	Queue	LOS	Queue	LOS	Queue	LOS	
Jonson Street / Lawson Street (no 2nd rail crossing)	Not tested		140m	C	420m	F	Operates poorly in 2028. Queue lengths in 2018 cause blocking back between intersections

7.3. Bangalow Road & Broken Head Road Intersections

Table 6 Bangalow Road and Broken Head Road Intersection modelling - worst LOS and queue length

Intersection	Option	Now		2018		2028		Comments
		Queue	LOS	Queue	LOS	Queue	LOS	
Clifford Street	Do Min	20m	D	20m	D	400m	F	Right turn out operates poorly in 2028
	RAB	Testing not needed given that 2028 modelling results are good				70m	B	Operates well
Golf Course	Do Min	60m	B	75m	B	80m	C	Right turning vehicles may cause queuing on Bangalow Road
	Right turn bay	N/A		5m	B	5m	B	Operates well
Paterson Street and Cooper Street	Do Min	Not tested		100m	C	110m	C	Right turning vehicles may cause queuing on Bangalow Road
	Slip lane	N/A		5m	B	5m	B	Operates well
Beech Drive North	Do Min	Testing not needed given that 2028 modelling results are good				45m	B	Operates well
Beech Drive South	Do Min	Testing not needed given that 2028 modelling results are good				45m	B	Operates well

N.B.: RAB stands for roundabout

8. Economic Analysis

This section presents economic analyses at a network level for the projects identified through SATURN modelling as shown in Figure 5. The steps involved in a benefit cost analysis are quantification of benefits, costs, and selection of other analysis parameters.

8.1. Benefits and Costs

The benefits (travel time and fuel savings) are estimated using SATURN model as shown in Table 1 and Table 2. The cost estimates (low band) used here are based on existing projects, and construction rates are based on assumed quantities for such items as asphalt pavement, kerb and gutter and concrete. It should be noted that the project costs are treated as indicative only, as an accurate assessment of cost for the proposed works would involve detailed design, consideration of specific site conditions, environmental factors and quantification of other costs such as utility relocations and land acquisition. Such a detailed assessment of costs is beyond the scope of this study. To provide confidence in analysis, the report provides benefit-cost analyses for three cost bands i.e. low, average, and high.

Table 7 Preliminary Cost Estimates

Projects	Description	Cost Estimate ($)		
		Low	Average	High
Ewingsdale Road & McGettigans Lane Intersection	Single Lane RAB	150,000	300,000	450,000
Sportfields, Sunnybrand and Island Quarry Intersection	Four Lane RAB	1,000,000	1,500,000	2,000,000
Ewingsdale Road Four Laning	Approx length: 1.5 km	4,000,000	6,000,000	8,000,000
Ewingsdale Road & Bayshore Drive Intersection	Dual Lane RAB	1,000,000	1,500,000	2,000,000
Ewingsdale Road & Sunrise Boulevard Intersection	Dual Lane RAB	1,000,000	1,500,000	2,000,000
Shirley Street and Butler Street RAB	50m New Traffic Lane	150,000	300,000	450,000
Extra lane on Fletcher Street approach to Lawson Street RAB	30m New Traffic Lane	75,000	125,000	175,000
2nd Rail Crossing (Butler Street to Jonson/Marvel Streets)	aka mini bypass	500,000	750,000	1,000,000
Johnson Street /Marvel Street RAB with 2nd Rail Crossing	Single Lane RAB	350,000	450,000	550,000
Broken Head Road & Clifford Street RAB	Single Lane RAB	250,000	350,000	450,000
Golf Course Intersection	Right Turning Bay	50,000	100,000	150,000
Banglow Road Intersection with Patterson and Cooper Streets	New Slip Lane	75,000	150,000	225,000
Total Cost ($)		**8,600,000**	**13,025,000**	**17,450,000**

N.B.: RAB stands for roundabout

8.2. Analysis Parameters

The monetary quantification of travel time and fuel benefits requires data on time value, vehicle occupancy rate, and fuel cost. Once the benefits are quantified in dollars, the benefit-cost analysis calculation can be done for a discount rate and analysis period. The parameters used here for benefit-cost analysis are as follows.

8.2.1. Time Value

The value of time is closely related to the wage rate. The Austroads Guide to Project Evaluation Part 4: Project evaluation data recommends a value of $11.49/ person-hour for private trip and $36.76/ person-hour for business trip to be used for benefit-cost analysis in non-urban environment. These values are adopted for this study.

8.2.2. Vehicle Occupancy Rate

The value of time in combination with vehicle occupancy rate is used to quantify the travel time value in monetary terms. The Austroads Guide to Project Evaluation Part 4: Project evaluation data recommends a value of 1.7 per persons/vehicle for private trip and 1.3 per persons/vehicle for business trip to be used for benefit-cost analysis in non-urban environment. These values are adopted for this study.

8.2.3. Fuel Cost

The market price of fuel is affected by the resource cost of fuel, taxes, rebates, and subsidies. The Austroads Guide to Project Evaluation Part 4: Project evaluation data recommends a value of 131.80 cents/litre for market price, and 88.36 cents/litre for resource price of unleaded fuel in Lismore. As per standard economic analysis practice, the resource price of fuel is used to quantify the monetary value of fuel savings.

8.2.4. Discount Rate

As noted in the Austroads Guide to Project Evaluation Part 2: Project Evaluation Methodology, the discount rate is used to calculate discount factors, which can be regarded as ‘exchange rates’ for converting values at one period to values at another. For instance, the discount factor in real terms over 30 years at 7% p.a. is 0.13, which means that $1 in 30 years time ‘converts’ to about 13 cents now. Discount rates are determined by state Treasuries. The recommended annual discount rate for public transport infrastructure projects is currently 7% in real terms, which is adopted for this study.

8.2.5. Analysis Period

The influence of costs or benefits on the benefit-cost ratio diminishes the further they incur in the analysis period because of discounting. A 30 year analysis period is adopted for benefit-cost analysis in this study. This analysis period is sufficiently long to capture the project benefits.

8.3. Benefit-Cost Analysis

The network statistics for travel time and trips for 2008, 2018, and 2028 are used to estimate savings in travel time and fuel costs (see Table 1 and Table 2). A thirty year analysis period was used for benefit-cost analysis and the SATURN modelling provided network statistics for 2008, 2018, and 2028. The network statistics for other years are derived as follows:

- The network statistics (travel time and fuel usage) for years 2009-2017 are linearly interpolated using 2008 and 2018 SATURN modelling outcomes (Table 1 and Table 2).
- The network statistics (travel time and fuel usage) for years 2019-2027 are linearly interpolated using 2018 and 2028 SATURN modelling outcomes (Table 1 and Table 2).
- The network statistics (travel time and fuel usage) for years 2029-2038 are set to same as for 2028 (Table 1 and Table 2).

- A two hour peak for both AM and PM is assumed for the whole analysis period.

The above were used to calculate savings in travel time over the analysis period. Using those benefits, the benefit-cost ratios for the full network upgrade in 2008 for the three cost bands identified in section 8.1 are as shown in Figure 6.

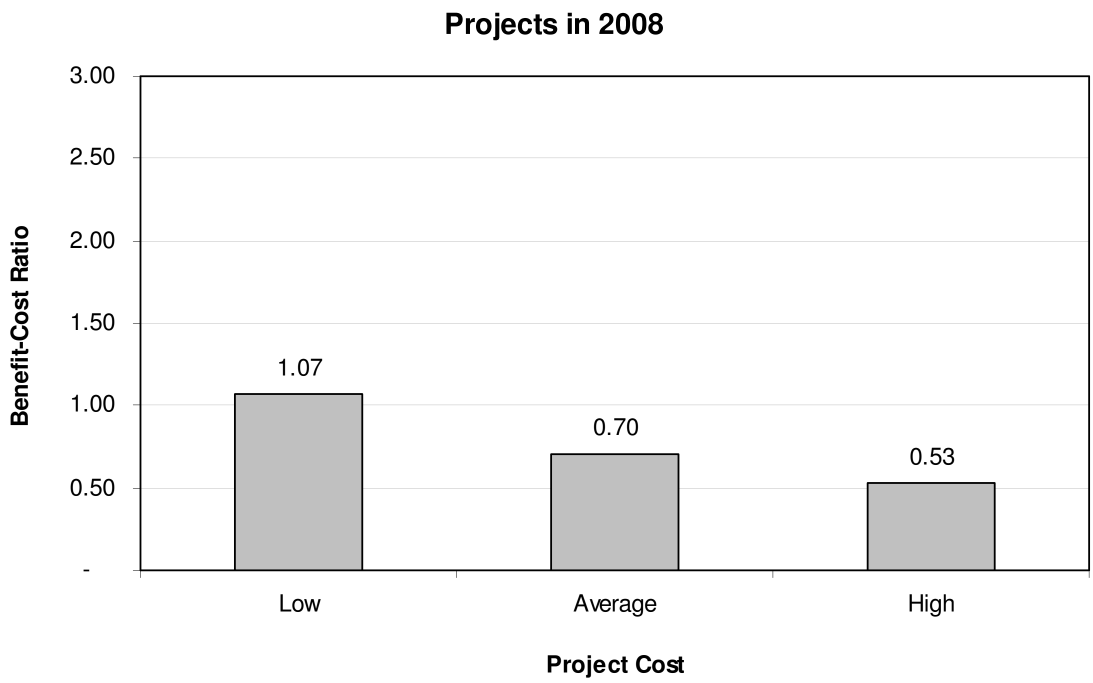


Figure 6 Benefit-Cost Ratios for the Full Network Upgrade in 2008

Given the benefit-cost ratios are low and greater than 1 for low cost band only for the full network upgrade in 2008, the benefit-cost analysis was also carried out for the full network upgrade in 2018 as shown in Figure 7. The benefit-cost ratios are greater than 1 for all cost bands for the full network upgrade in 2018.

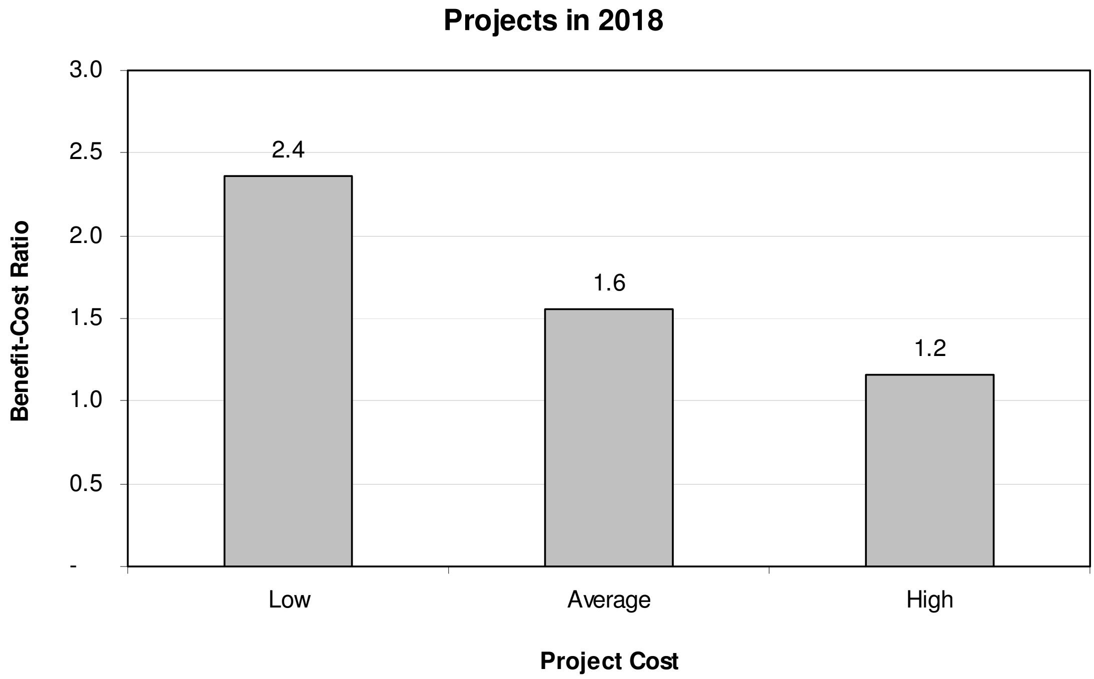


Figure 7 Benefit-Cost Ratios for the Full Network Upgrade in 2018

The benefit-cost ratios are strongly dependent on the cost of the full network upgrade and therefore it is vital that better site specific cost estimates are developed as noted in section 8.1. It should be noted that the estimated benefits over the analysis period are in general on the lower side because of following:

- A two hour peak for both AM and PM is used for the calculation of benefit-cost ratios. However, as traffic flow increases, the AM and PM peak may extend to 3-hour or even longer. This would improve benefit-cost ratio significantly.

- The savings in travel time and fuel costs for years 2029-2038 are assumed the same as for 2028. If traffic flows are greater in later years the benefits would be higher. However, the further away the benefits/costs incur in the analysis period, the smaller their affect on the benefit-cost ratio because of discounting.

- The yearly benefits are calculated based on a typical day rather than a specific hour period with known network deficiencies (for instance school holidays). The estimated benefits are therefore on the conservative side. This is, however, a reasonable approach whereby the network generally operates at a reasonable level of service for the majority of hours during a year.

9. Triggers for Works

One of the key objectives of this study has been to identify when, where, and what works would be needed to at least maintain, if not improve, the current level of service in the wake of expected future growth. The works needed and the expected level of service against a do minimum case for 2008, 2018, and 2028 are identified in Table 3 to Table 6. As noted in the tables, the works are expected to provide a level of service B even during peak period on typical days, whereas if not undertaken the expected level of service is F in most situations. However, given real life uncertainties such as the economic downturn, fuel prices, etc. which would affect private developments and the number of tourists visiting Byron Bay, the following triggers are also provided for different works.

Table 8 Triggers for Proposed Works

Intersection Option	Trigger Point	Comments
Ewingsdale Road & McGettigans Lane RAB	When hospital is built	The LOS of right turn out movements are difficult in peak periods. The improvements are needed as soon as possible, particularly as development occurs
Ewingsdale Road & Bayshore Drive RAB*	With first development in Bayshore Drive area	
Ewingsdale Road & Sunrise Boulevard RAB	With construction of Belongil (West Byron) Residential	
Ewingsdale Road Four Traffic Lanes (from the sportsfield roundabout to the Sunrise Boulevard roundabout)	When the operating speeds start falling below 65 kph and traffic volumes are near capacity	Four lanes would increase the speed on this link to 71km/hr in the AM and PM peaks (in 2028); this is approximately the same as the existing speeds thereby maintaining the current level of service.
Shirley Street and Butler Street RAB	2000-2300vph (two-way) on Lawson Street between Shirley Street and Jonson Street	The LOS of the intersection will be ok, but the queue lengths will cause blocking back to other intersections
2nd Rail Crossing (Butler Street to Jonson/Marvel Streets)	Same as above	Same as above
Additional lane on Fletcher Street approach to Lawson Street RAB	With the construction of Byron Village or when queue lengths regularly reach Byron Street in peaks	The LOS of the intersection will be ok, but the queue lengths will cause blocking back to other intersections
Sportfields, Sunnybrand and Island Quarry Intersection	With the construction of related development	The developments would generate significant traffic and improvements would be needed as development occurs
Broken Head Road & Clifford Street RAB	1400vph (2-way) on Broken Head Road	No change in right turn out in modelling
Right Turning Bay on Golf Course Intersection	When queuing causes a safety issue	These improvements are safety rather than capacity improvements
New Slip Lane for Banglow Road Intersection with Patterson and Cooper Streets	When queuing causes a safety issue	

N.B.: RAB stands for roundabout; *With either the Bayshore Village, Becton or A&I Estate land rezoning development (or their equivalent)

It is worth noting that the level of service of the right turn out movements from McGettigans Lane, Bayshore Drive, and Sunrise Boulevard are already becoming difficult in peak periods. Traffic growth on the Pacific Highway will cause an increase in traffic volumes on Ewingsdale Road. This traffic growth on Ewingsdale Road will cause the right turn out movements to become worse even without growth on the side roads.

10. Section 94 Contributions

The project brief required recommendations regarding funding contributions under Section 94 of the NSW Environmental Planning and Assessment Act. The Act requires a nexus between the type of development and the extra demand on public resources it will place. Table 9 shows the total number of trips for AM and PM peaks for 2018 and 2028 as well as the proportion of trips for various potential developments. In terms of Byron development, Belongil Residential Development has the highest proportion followed by Bayshore Village Development. It is recommended that the trip share of each development to the total trips is used as a basis for the development of Section 94 contributions plan. It is, however, worth clarifying that trip share is one factor, and the Council may consider planning, development and other relevant factors while establishing Section 94 contributions.

Table 9 AM and PM Peak Network Statistics – Total Trips and Proportion of Traffic Growth

Potential Development	AM Peak		PM Peak		Average
	2018	2028	2018	2028	
Sportsfield Development	2.5%	6.4%	1.9%	5.3%	4.0%
Bayshore Village Development	7.1%	7.0%	5.5%	5.7%	6.3%
Arts and Industrial Estate	3.6%	3.5%	2.8%	2.9%	3.2%
Becton Tourist Development	1.8%	1.8%	1.4%	1.5%	1.6%
Belongil Residential Development (West Byron)	9.7%	9.6%	15.1%	15.8%	12.6%
South Jonson Street Rezoning	4.8%	4.8%	7.5%	7.8%	6.2%
Broken Head Residential	1.0%	1.0%	0.8%	0.9%	0.9%
Natural Lane Residential	0.4%	0.4%	0.6%	0.6%	0.5%
Epicentre Site	0.4%	0.4%	0.3%	0.3%	0.4%
Decommissioned STP	0.2%	0.2%	0.4%	0.4%	0.3%
Aged Care Beech Drive	0.1%	0.1%	0.2%	0.2%	0.2%
Ewingsdale Hospital	0.4%	0.6%	0.3%	0.5%	0.5%
Highway Growth	67.9%	64.2%	63.3%	58.2%	63.4%

N.B.: Bayshore Village, Becton, Broken Head, Epicentre are already approved and that quoted rates only applicable if developments do not proceed as approved.

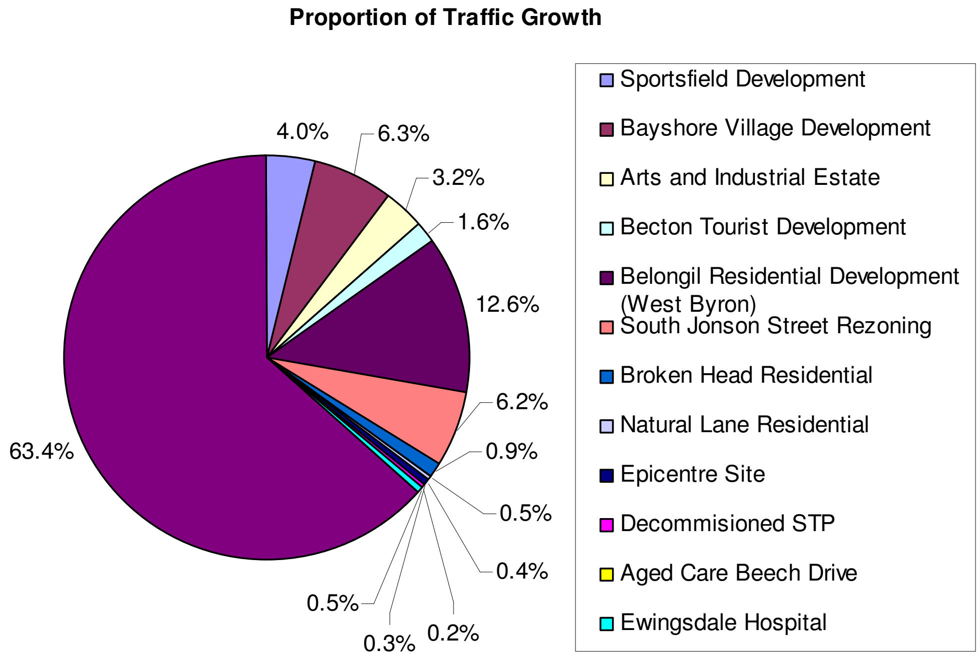


Figure 8 Average Proportion of Traffic

11. Parking Considerations

11.1. Butler Street Reserve Carpark

In addition to the network and intersection modelling, a carpark at Butler Street reserve was modelled with the objective of analysing how it would impact traffic around towncentre.

The maximum walking distance for a major centre is generally considered to be 300-500m. People are usually willing to walk further to/from car parks in major urban centres because parking is more limited. However, in smaller centres people are far more likely to try to find a car park outside their destination.

Figure 9 and Figure 10 show the potential walking capture based on a distance of 250m and 500m, respectively, from the Butler Street Reserve car park. With a 500m walking distance the entire CBD is accessible and the beach is also accessible from the car park. With a 250m walking distance the beach is not accessible and only the western edge of the CBD is included in the catchment.

Due to uncertainty of pedestrian desired trip lengths, two scenarios of walking distance have been compared:

- 250m radius from car park
- 500m radius from car park

Without a patronage survey the volume of trips using the car park (rather than going to the CBD) can not be accurately estimated. For the purposes of our modelling we have assumed that the car park will attract most of the commuter traffic accessing those parts of the CBD within the 500m radius of the car park. Specifically we have assumed 80% of trips within 250m and 50% of trips between 250-500m may be attracted to the car park. Given that our model covers the AM and PM commuter peaks we have assumed that only people travelling to the CBD will use the car park.

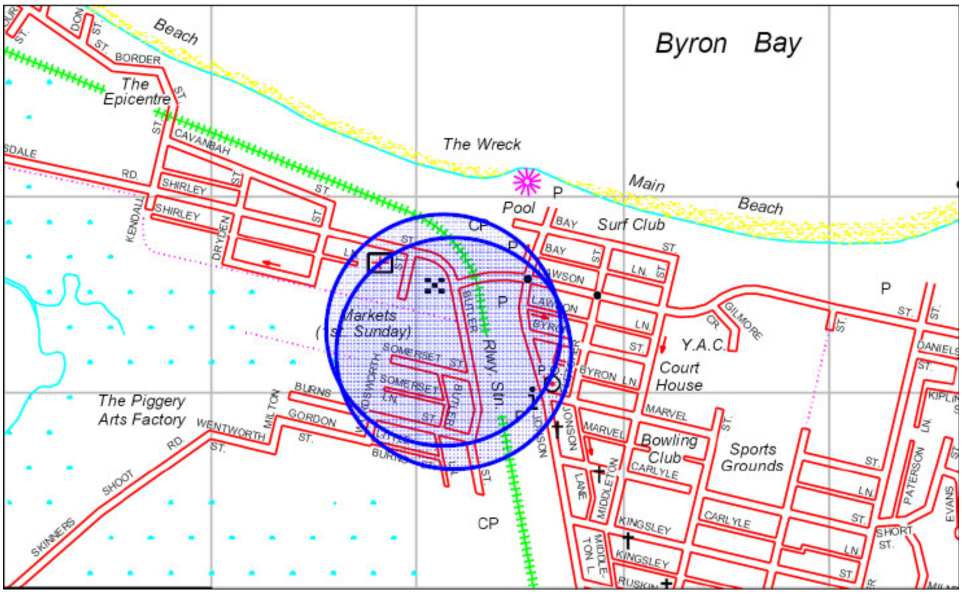


Figure 9 Car park walking distance (250m)

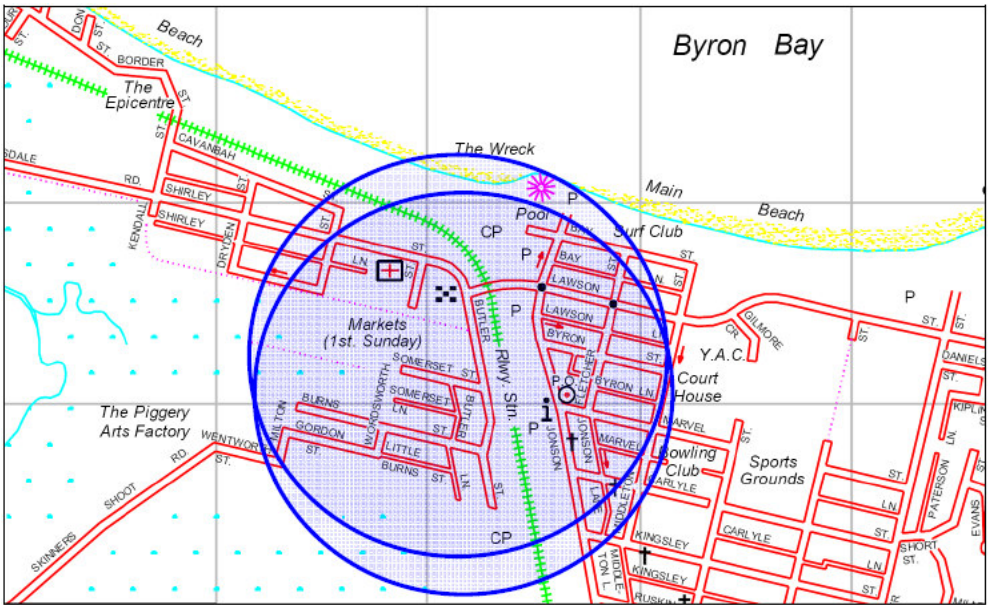


Figure 10 Car park walking distance (500m)

The effect of the car park on congestion through the CBD depends on the volume of trips attracted to the car park and the origin of those trips. The car park was tested in the 2028 model with the 2nd rail crossing and a 250m and 500m walking distance from the car park.

Two tests were run, one where the car park attracted only trips from the western zones, and the other where it attracted trips from both the west and south. Assuming people in Byron Bay are willing to walk 500m from the Butler Street Reserve car park to their destination and the car park attracts trips from the west only, then it is expected to reduce the volume of trips accessing the CBD from the west by 80 trips. The 250m walking distance will attract approximately half the trips that the 500m walking distance does (about 40 trips), so will also reduce congestion in the CBD, but not as significantly as the 500m walking distance.

In contrast, if the car park attracts trips from the south as well as the west then it is expected to attract 280 trips from the CBD. This scenario will have a substantial effect. The roads around the car park and routes to the car park from the south will become busier, and the roads within the CBD will become less congested. This drop in congestion attracts through traffic back into Jonson Street, as vehicles use Jonson Street rather than the 2nd rail crossing to travel from the south to the west. The net result is that the CBD won't become any less congested with the addition of the car park. This modelling emphasises the need for a patronage survey for the car park to establish the volume of trips attracted to the CBD and their origin. It is also worth recognising here the competing uses for Butler Street Reserve carpark as a support to the towncentre and as a venue for the markets.

11.2. Towncentre Parking

There appears to be a perception that many people would prefer front to kerb parking in the towncentre and that the current parking situation (rear to kerb) impacts on traffic flow as people stop and then reverse into the parking spaces. It was requested that this report give an outline of the impacts of rear to kerb parking on traffic flow and the advantages / disadvantages of nose to kerb. It is worth noting here that the discussion on the towncentre parking here is limited and is based on the standard guidelines.

Table 10 compares front-to-kerb parking situation to rear-to-kerb based on common issues and identify a preferred option (based on Austroads Guide to Traffic Management Part 11: Parking). The front-to-kerb is a preferred option for most of the issues except loading/unloading of vehicles and traffic and cyclist safety. In general, the loading/unloading is not expected to be major issue in the towncentre and it is recommended that any change in the existing parking situation should consider the number of cyclists and safety of pedestrians and cyclists.

Table 10 Relative merits of front-in versus tail-in parking

Issue	Front-to-kerb parking situation	Rear-to-kerb parking situation	Preferred option
Exhaust emissions	Exhaust facing away from footpath.	Vehicle's exhaust directed onto pedestrian footpath (causing discomfort and staining of footway paving), and into open doors of shops in retail precincts	Front-to-kerb
Loading/unloading vehicles	Boot/rear hatch faces away from the footpath exposing the motorist/shopper to moving traffic.	Boot/rear hatch faces towards the footpath allowing for safer loading/unloading.	Rear-to-kerb
Judgement in a reversing manoeuvre	Reversing occurs into a space relatively free of fixed obstructions (provided the motorist is able to observe approaching traffic or the approaching traffic poses no significant hazard).	Reversing occurs into a limited and obstructed space.	Front-to-kerb
Motorist confusion	Vacant spaces are clearly visible and a motorist is able to slow down and move directly into a parking space in a single movement, causing little confusion or delay to the following motorists.	It is more difficult to observe vacant spaces and a motorist needs to actually pass the parking space in order to reverse into it, potentially confusing a following motorist who may also wish to park in the same space.	Front-to-kerb
Disruption to passing traffic when reversing	Motorist reversing out from the parking bay can select a time when passing traffic will not be disrupted.	Stationary motorist about to reverse into the parking bay tends to disrupt passing traffic by trapping a vehicle behind.	Front-to-kerb
Traffic and cyclist safety	Motorist leaving a front-to-kerb space must reverse approximately 1 m or more before gaining a clear view of approaching traffic and cyclists. This is aggravated by increasing numbers of large 4WDs and vans.	Motorist about to drive forward from a rear-to-kerb space has a relatively good view of approaching traffic and cyclists without moving forward significantly.	Rear-to-kerb
Impact with kerb obstructions	Motorist can more easily view high kerbs and footpath obstructions whilst moving in the normal forward motion into the parking space.	Motorist reversing into the parking space cannot easily view the obstructions, and the rear overhang is generally greater than the front overhang which results in greater footpath intrusion.	Front-to-kerb
Pedestrian safety	Motorist reverses into a vehicle based environment.	Motorist reverses into a pedestrian environment. Vehicle projections, e.g. tow bars, bicycle racks, etc., may also pose an additional hazard for pedestrians.	Front-to-kerb

11.3. Park and Ride

Park and Ride is one of a range of transport planning tools that can be used to encourage car users to switch to public transport. There is a potential for a Park and Ride scheme by having a parking lot at the proposed sportsfield, and the SATURN model can be used to predict the change in traffic condition for a Park and Ride scheme provided the patronage for the scheme is established. More importantly, in order for Park and Ride schemes to be successful, they generally require the following conditions to be in place as noted in the Austroads Guide to Traffic Management Part 11: Parking.

- A limited and high cost public car parking system packaged with limited private off-street free car parking in the central areas served by the park-and-ride system
- A fast public transport service relative to the car
- A frequent and reliable public transport service between the park-and-ride facility and the central area, with an adequate capacity, on-site security and providing a pleasant travelling environment
- A competitive fare for the park-and-ride journey to/from the central area
- Secure car and bicycle parking facilities located within a short walking distance to the park-and-ride bus stop/train station
- Congested road conditions along routes into the central area.

An excellent fast, frequent, and reliable public transport service from the proposed Sportsfield carpark to the towncentre can come in the form of a rail/tram link using the existing rail corridor. It would provide opportunity to access local site attractions along the rail spine such as parking, sportsfield, Market sites, etc. Such a scheme needs further investigations including assessing demand, designing the scheme, preparing a case for funding, managing day-to-day operation, and so on.

11.4. Further Study

The above three sub-sections have summarised the findings regarding a Butler Street Reserve carpark, towncentre carparking situation, and potential park and ride scheme, respectively, and identified the areas needing further investigations.

Any changes in the towncentre parking needs to be considered in conjunction with the traffic and parking issues related to the Butler Street Reserve carpark and a Park and Ride scheme. For instance, the Butler Street Reserve carpark may be investigated in conjunction with measures to discourage vehicles travelling through the CBD. Possible measures include making Jonson Street more pedestrian friendly (e.g. lower speed limit, more crossings) and introducing parking enforcement in the CBD to discourage long term parking. Similarly, a Park and Ride scheme would also require constraints on parking in the towncentre. In conjunction with other traffic management measures, such as a reduction in the towncentre parking, a well designed and well located Park and Ride scheme can assist in reducing traffic levels in the towncentre. This can provide better access, improve attractiveness, and enhance the economic viability of the towncentre. A detailed study is recommended to analyse parking issues and wider public transport service based on rail corridor in totality.

12. Predicting the Future

The traffic volumes and patterns experienced in Byron Bay reflect the characteristics of the Byron Bay community and attractions. There are two distinct activities generating traffic into and through the Byron Bay town centre. First is the locally generated traffic that comprises of routine daily local business trips and recreational trips of local residents and the service trips to and from local businesses. Overlaying that traffic are the trips of day trippers, and holiday makers, many of whom may reside locally for a short period.

Future traffic volumes and the mix of day trippers and overnight visitors will be dependent upon the health of the national economy and the relative accessibility of Byron Bay. The changing demographic structure of the population is also likely to impact upon the type of journey and the mode of transport used. These subtleties are not evident in the numbers applied in the modelling for this study, but the wide range of influences such as those quoted will affect the rate of change of traffic volumes and the traffic flow patterns. The predictions are reasonable, but like all predictions of the future, they cannot be absolute.

All change creates a response. The provision of additional capacity for traffic on Ewingsdale Road will provide for the traffic generated by growth, but also will act to attract further traffic. Commonly the provision of additional capacity generates additional demand. Therefore the timing of the provision of additional capacity acts as a control lever on the generation of new trips, such that additional capacity should coincide with local development generated demand in order to not act to attract new external trips.

The amenity of the town centre is a significant draw card character of Byron Bay. The town centre is a safe walking environment due to the slow pace of traffic. Traffic flow is impeded by the congestion created by many pedestrians, parking movements and the volume of traffic. At highly congested times, much of the town centre traffic is circulating in order to locate a parking space.

As traffic grows, the amenity and accessibility of the town centre may be maintained by the provision of additional car parking around the periphery of the retail core. New parking on the periphery would need to be convenient and legible to attract visitors, and clearly identified with advice to deter entry into the central town circulation. Pedestrian gateways and access corridors between the parking areas and the retail core would also be desirable.

The current peak capacity constraints on traffic volumes act as a limitation and a pressure cap on the intensity of activity in the town of Byron Bay. The attraction of the town centre, as the destination for most trips is clear in the Origin Destination survey data. Care must be taken with the provision of additional road capacity in order to maintain the vibrancy, amenity and character of the town centre. Too much traffic can generate gridlock, whilst increased capacity may reduce the safety and pedestrian accessibility created by crawling traffic speeds. Parking policy can assist in managing travel demand, and if carefully designed, can influence the character of the town centre.

This report discusses parking policy and provision, and notes that parking policy may be an effective tool for managing the amenity of the town centre in the future. But more detailed survey, and policy development is required.

The rail corridor is an excellent future transport opportunity. If heavy rail use of the rail corridor is permanently abandoned, the remnant corridor could operate as combined cycle and public transport route. Whilst the corridor currently has access and passive surveillance limitations, it offers the benefit of separating travel by alternate modes from the road traffic corridors. As the spine of a public transport route, it could be adapted and extended to provide a local network for public transport vehicles separated from the road traffic.

Therefore the rail corridor should be considered a potential future transport and communication asset for the local community and not alienated by inappropriate development after its abandonment. To be successful and attractive to travellers as a public transport corridor, high volume trip generator land uses need to be adjacent to or nearby the corridor.

13. Conclusions

The following upgrades should be completed from a safety perspective:

- Right turn bay at the Golf Course access from Bangalow Road
- Paterson Street and Cooper Street intersections with Bangalow Road should be upgraded to include a slip lane for traffic travelling through on Bangalow Road to separate them from vehicle turning right into Paterson Street and Cooper Street.

The following upgrades should be completed in conjunction with the construction of the respective developments. These four projects are required due to the increased traffic from the developments entering Ewingsdale Road.

- Single lane roundabout at the McGettigans Lane / Ewingsdale Road intersection
- Dual lane roundabout at Sunrise Boulevard / Ewingsdale Road with access to the proposed West Byron Residential should be completed prior to the completion of the proposed West Byron Residential.
- Four lane roundabout at Sportfields, Sunnybrand and Island Quarry / Ewingsdale Road Intersection.
- Dual lane roundabout at the Bayshore Drive / Ewingsdale Road intersection should be completed prior to the completion of the proposed Bayshore Village.

The following upgrades should be completed prior to 2018 (subject to the predicted growth in traffic materialising):

- 2nd rail crossing connecting Butler Street to Jonson Street at a single lane roundabout at the Jonson Street / Marvell Street intersection.
- Upgrade Butler Street / Shirley Street roundabout.
- Fletcher Street dual lane approach to the Fletcher Street / Lawson Street roundabout should be completed prior to the completion of the proposed Byron Bay Village.

- Widening of the carriageway to four traffic lanes along Ewingsdale Road between the proposed sports field roundabout and the Sunrise Boulevard / Ewingsdale Road roundabout.

In addition to the above list of projects, the following safety upgrade should be completed prior to 2028 (subject to the predicted growth in traffic materialising):

- Single lane roundabout at Clifford Street / Broken Head Road intersection.

14. Recommendations

As per the project brief, this study has identified when, where, and what treatments would be needed to maintain and/or improve the level of service for traffic on MR545, taking account of future developments and growth. Most of the treatments are needed by 2018, and therefore it is recommended that preliminary engineering design is started now. The development of the designs will also help develop reliable cost estimates, improve the accuracy of benefit-cost ratios, and identify any land acquisition requirements.

Given the community preference for roundabouts as intersection controls, roundabouts are considered in this study instead of traffic signals. The cost of traffic signals may be less than roundabouts, and they may be considered as an alternative in the future during the detailed design of the treatments.

The second railway crossing is needed not only to improve traffic flow but also to provide another route through CBD during an emergency. It is, therefore, recommended that the Council continue its efforts to get an agreement among stakeholders for a second route across the rail line.

Given real life uncertainties such as the current economic downturn, fuel prices, variations in tourist travel, and the like, which would affect private developments and the number of tourists visiting Byron Bay, the Council should continue monitoring traffic volumes and travel times and the triggers identified in Section 9 would assist the determination of the optimal time for construction of the treatments. The Council may wish to monitor the traffic volumes and travel times as part of the annual traffic data collection program.

The tourist traffic is expected to continue contributing the most to traffic volumes (see Figure 8) and the volumes may be reduced by targeting the travel modes of certain tourist groups, such as day trippers. Changes to alternative modes would improve traffic flow but could also affect the local economy and businesses. It is therefore recommended that the Byron Bay Community be consulted before implementing travel demand management measures.

A further study of parking is recommended in order to provide a basis for planning measures to maintain the amenity of the town centre, assessing the suitability of front-to-kerb parking situation in the towncentre, patronage for the Butler Street Reserve Carpark, and detailed consideration of Park and Ride scheme.

Options for future adaptive use of the rail corridor should remain open until the future of heavy rail transport on the line is resolved.