Better Transport Futures

Mark Waugh Pty Limited
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Transport Planning & Engineering

Proposed Rural Residential Subdivision, Tinonee NSW

Orogen Pty Ltd

Traffic Impact Assessment

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1. Introduction

Mark Waugh Pty Ltd was commissioned by Orogen Pty Ltd to prepare a Traffic Impact Assessment for the proposed rural residential subdivision off Bucketts Way, Tinonee, NSW.

This report presents the findings of the traffic investigations and assessment of the proposal. It is structured as follows:

- **Chapter 2** outlines the existing situation in the vicinity of the subject site, including discussion on the planned development growth within the vicinity and road network changes to support it.
- **Chapter 3** describes the traffic and parking features of the proposal.
- **Chapter 4** details the assessment of traffic operations related to the proposal.
- **Chapter 5** summarises the findings of this investigation, outlining conclusions and recommendations for the traffic operations of the site to support the development application for the proposal.

2. Existing Situation

2.1 Background and Site Location

The subject site is located on a parcel of land off Bucketts Way between Purfleet and Tinonee. It is bounded to the south by Bucketts Way and by the Manning River to the north. The land is currently a mixture of open pasture land and rural residential. There is a number of existing access points to the site along Bucketts Way as well as a couple of access points via Urray Road along the western boundary of the site.

The location of the site is shown below in **Figure 2.1**.

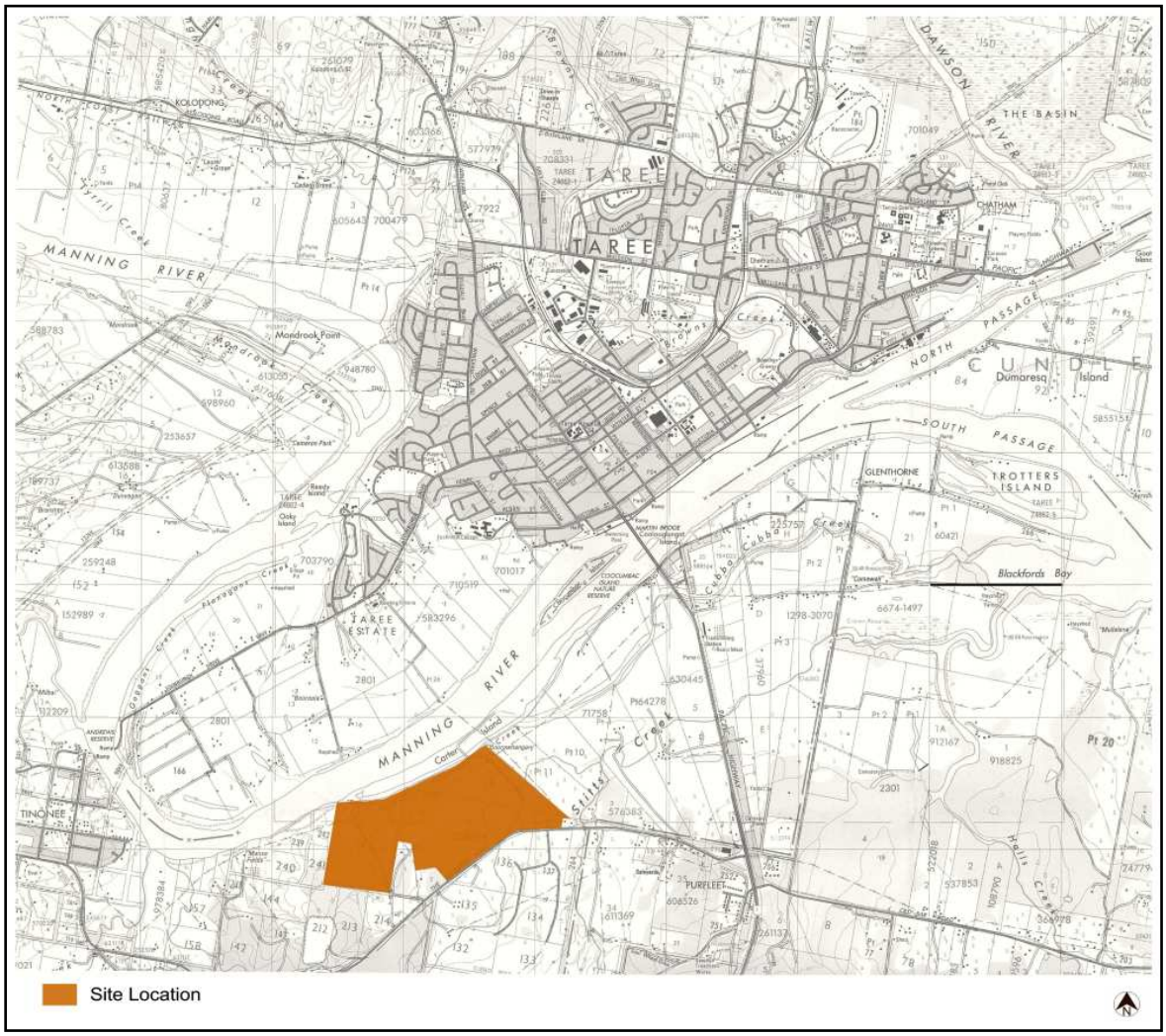


Figure 2.1 – Site Location

2.2 Local Road System

2.2.1 Road Characteristics

Bucketts Way is the main road through the locality. The Bucketts Way provides a vital link between Taree and Purfleet to the east and Gloucester and the Barrington Tops to the west. In the locality of the site, it provides a single lane of travel in both directions and has a posted speed limit of 80 km/h. To the east of the site, the speed limit reduces to 70 km/h, due to the residential and commercial development. To the west of the site, approximately 2-3 kms from the site is the village of Tinonee.

Bucketts Way in the vicinity of the site provides an overall width in the order of 5.5 metres, with no sealed shoulders or footpaths. The road surface is in poor condition with numerous potholes and patch repairs. In the vicinity of the site, it provides a reasonable straight alignment with gentle curves. Whilst no speed survey has been completed, it is considered that drivers do not speed along this length of the road, due to the combination of the road width and the road surface.

There are no street lights along Bucketts Way, due to its rural nature. There are a number of access driveways, to both the subject site and other properties as well as a number of side roads providing access to residential and rural lots. The existing intersections along Bucketts Way in this locality are all simple give way controlled intersections, with no widening.

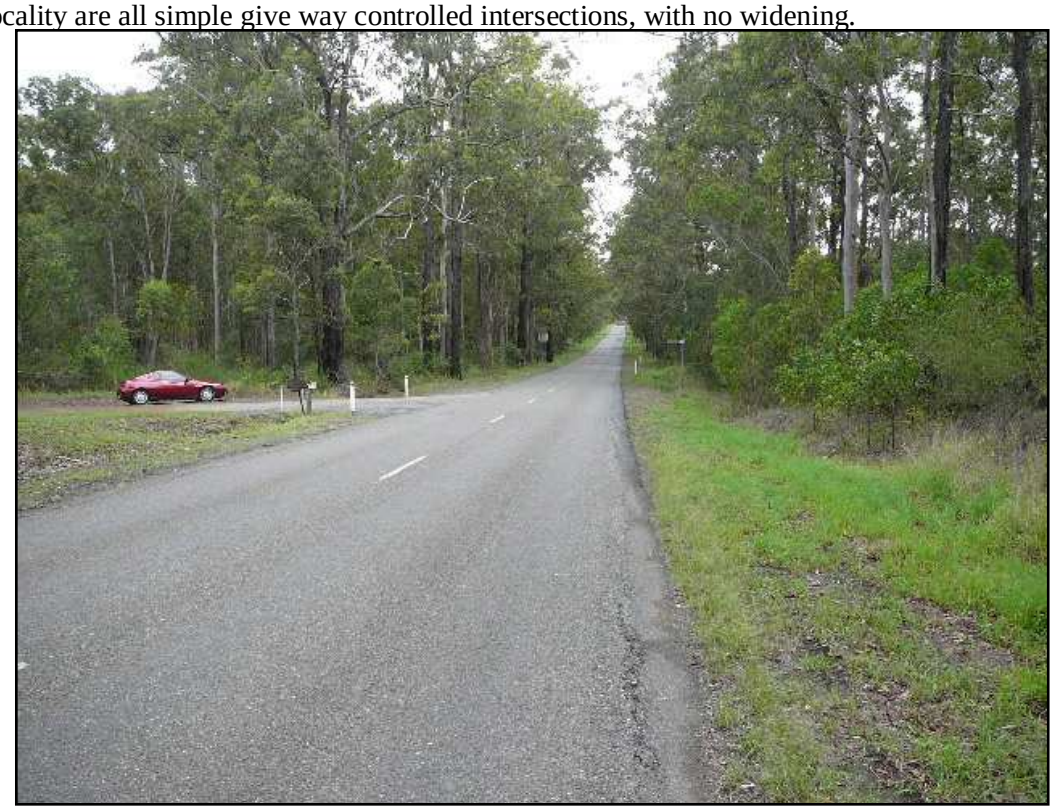


Photo 1 - View east along Bucketts Way showing typical cross section. Note Urray Road is to left of photo.

Photo 2 - View west along Bucketts Way approximately location of site access point

Bucketts Way is a classified main road (MR 90) and any new works along the length of this road will require concurrence from the RTA as well as Council. Traffic volume data for MR 90 is available from the RTA traffic data and a traffic survey has been completed by Mark Waugh Pty Ltd at the intersection of Bucketts Way and Urray Road to obtain current peak traffic flows.

2.3 Traffic Volumes

2.3.1 Traffic Survey

As discussed above, traffic volume data for the project has been collected during a survey of traffic movements along Bucketts Way. These surveys were completed on Wednesday 8th November and Thursday 9th November 2006.

The results from the traffic survey indicate that during the surveyed afternoon peak period (4.00 to 5.00 PM) the two-way traffic flow along Bucketts Way is very low, in the order of 273 vehicles. The majority of vehicles were light vehicles, with limited heavy goods vehicles observed during the survey period. The corresponding morning traffic survey showed that the two way flow was slightly higher at 317 vehicles per hour. Again, the vast majority were light vehicles.

Traffic data from the RTA indicates that the annual average daily traffic flow (AADT) in 2004 was 2,331 vehicles along Bucketts Way.

The traffic flows along Urray Road were also observed. The existing traffic flows along this minor road are very low, with less than 10 vehicles per hour recorded during the peak periods. During the morning period, a couple of cars were associated with trips to the adjacent school.

The results of the survey are summarised in **Table 2.1** below.

Table 2.1 – Traffic Volumes

Road	Direction	Peak flow	Mid-Block Road Capacity[2]	Volume / Capacity
Bucketts Way	Eastbound	225 (AM)		
		160 (PM)	900 (two-way)	0.352 (AM peak)
Bucketts Way	Westbound	92 (AM)		
		113 (PM)	900 (two-way)	0.303 (PM peak)

Notes: 1. Peak flow from November 2006 traffic survey results by Mark Waugh Pty Ltd
2. RTA 2002, Rural Road Conditions Level of Service C

Table 2.1 demonstrates that Bucketts Way is currently operating well within its technical and functional capacity levels as a main road through a rural area.

Using Table 4.5 from the RTA Guide to Traffic Generating Developments (reproduced below), it can be seen that the ultimate capacity for Bucketts Way in this location is around 2,000 to 2,500 vehicles per hour. For the current observed traffic flows along Bucketts Way it can be seen that the level of service for road users is B.

Table 4.5
peak hour flow on two-lane rural roads (veh/hr)
(Design speed of 100km/hr)

Terrain	Level of Service	Percent of Heavy Vehicles			
		0	5	10	15
Level	B	630	590	560	530
	C	1030	970	920	870
	D	1630	1550	1480	1410
	E	2630	2500	2390	2290
Rolling	B	500	420	360	310
	C	920	760	650	570
	D	1370	1140	970	700
	E	2420	2000	1720	1510
Mountainous	B	340	230	180	150
	C	600	410	320	260
	D	1050	680	500	400
	E	2160	1400	1040	820

Source: RTA Guide to Traffic Generating Developments, version 2.2 dated October 2002.

2.3.2 Historic Traffic Growth

The traffic data from the RTA automatic counter also provides historic data, providing background traffic growth in traffic volumes along Bucketts Way (station number 09.870 west of Pacific Highway). These are presented in **Table 2.1** below:

Table 2.1 – Historic Traffic Flows along Bucketts Way

Year	1990	2001	2004
AADT	1,544	2,232	2,331
Growth		44%	4.4%

The table above shows that the rate of growth in traffic flows along Bucketts Way is low. Recent growth represents an annual increase in the order of 1.5% per annum. For the purposes of this assessment it is assumed that current traffic flows have increased by 3% overall since 2004 to in the order of 2,400 per day.

2.4 Intersection Control and Operation

There are a number of intersections and driveways in the vicinity of the site. The intersections are simple give way controlled intersections. There are also a number of driveways to individual rural residential lots. The intersection of Buckets Way and Urray Road is a simple give way controlled intersection.

2.5 Road Network Improvements

It is understood there are no major road network improvements planned in the vicinity of the subject site, apart from normal road maintenance performed by Council and the RTA. With the low traffic flows and pedestrian movements it can be seen that the existing road layout provides an adequate level of service for all users.

2.6 Public Transport, Pedestrians and Cyclists

Public transport in the vicinity of the site is limited. School buses provide access for school children between Tinonee and Taree. There are no regular bus services to this location.

Cyclists are able to use the public roads in the vicinity of the site. During the survey period a single cyclist was observed on Bucketts Way.

During the survey period there were no pedestrian movements observed. There are no footpaths on Bucketts Way or Urray Road.

3. Proposed Development

3.1 Development and Access Arrangements

The proposal for the subject site is to develop a rural residential subdivision, with a total of around 143 lots once the development is fully constructed. The development will be constructed in a number of stages, with the first stage providing approximately 92 residential lots. It can be seen that with the low increase in the population in general vicinity of the site the development will take a number of years to fully develop. The second stage will provide around 30 lots and the final stage will provide the balance of lots to provide a total of 143 lots. The plans for the residential development show that access to the development will be provided via a single access on Bucketts Way with a fire trail access via Urray Road that will also serve as an emergency access.

This assessment is for the full development of 143 lots.

3.2 Traffic Generation

The level of traffic generation from the development proposal has been assessed using the rates available from the standard RTA guidelines for Traffic Generating Developments. These Guidelines indicate a range of traffic generation rates depending on the type land use activity.

The RTA guidelines indicate the critical movement periods for residential are during the morning and afternoon peak periods. These movements are associated with work and school trips. Morning peak flows are generally more critical, as the afternoon peak flows often occur over a longer time frame with less of a peak. For the purposes of this assessment, it has been assumed that the morning and afternoon traffic flows are similar.

The RTA Guide to Traffic Generating developments indicates that typical traffic generation rates for residential subdivisions such as the subject site are 0.85 trips per dwelling during the peaks and 9 trips per dwelling per day.

For the initial Stage One of the development this would indicate that the peak hour flows would be in the order of 78 vehicle movements and 828 vehicle movements per day.

For the full residential development of 143 residential lots the peak hour flows would be in the order of 121 vehicle movements per hour and 1287 vehicle movements per day.

These flow rates have been applied in the traffic analysis for these investigations, to ensure robustness of design.

3.3 Site Access

Vehicle access to the development will be via a new access on Bucketts Way. This access is close to an existing driveway access to one of the lots. This new access will replace the existing access points in this location. A secondary access will be provided to the west of the site via Urray Road, but this will not be used for vehicle access except for emergency purposes.

3.4 Traffic Distribution

It can be seen that the majority of traffic associated with the proposed development would have an origin and destination to the east of the site towards the Pacific Highway and Taree. For the purposes of this assessment all traffic will have an origin / destination to the east of the site.

3.5 Pedestrian Access

Pedestrian access to the site would be via existing facilities along Bucketts Way. Given the reasonably remote location and the lack of pedestrian facilities on Bucketts Way, it is considered that there will be little if any external pedestrian movement between the development and other local amenities. However, it is proposed to provide an internal network of footpaths, adjacent to the internal roads as well as dedicated internal off-road footpaths. Theses off-road footpaths will double as a footway/cycleway and will provide linkages across the site. These paths will be an important link between the foreshore walk way along the Manning River and the site as well as a linkage to the main entry on Bucketts Way.

3.6 Public Transport Facility

The location of the site means that school children in particular will require a bus run to service the site. There is an existing school bus run that operates along Bucketts Way which connects with Tinonee. It is proposed that a bus stop is located outside the main site entry, to serve the school bus run. This bus stop could also be incorporated into a regular bus run between Taree and Tinonee. It is considered that a bus stop should be provided on both sides of the road, with a bus shelter adjacent to the site side of the road only. This shelter will serve passengers waiting for the bus runs into Taree, as there will not be a requirement to wait for buses heading the opposite direction.

As part of this bus shelter provision, it is proposed to provide a bicycle parking facility, to encourage school children to cycle through the internal road and footpath network to the bus stop.

3.7 Site Operations and Access Arrangements

The site plans for the proposed development application are presented in **Appendix B** to this report. Overall access geometry would need to meet the requisite Council standards for residential subdivision. The internal road layout will need to be designed in accordance with Council residential subdivision code taking into account intersection controls, pedestrian requirements as well as road geometry requirements such as carriageway width etc.

The technical analysis for the development of the site is discussed further in **Section 4.**

3.8 Parking Requirements

It can be seen that the new development will require parking for the residents but that it can be contained within the site. As per Council design requirements, there will be garage requirements for the future development as well as driveway requirements etc.

It is considered that all future parking for the development can be contained on site and that there is no further requirement to review parking for the development.

4. Assessment of Transport Operations

4.1 Site Access Operations

It is proposed to provide all vehicle access to the development via the upgraded intersection on Bucketts Way. All vehicle access will be via this single access point.

4.2 Road Network Performance and Capacity

From **Table 2.1**, the current peak one-way hourly traffic flows along Bucketts Way are in the order of 317 vehicles per hour two-way in a single lane. From Table 4.5 of the RTA Guide to Traffic Generating Developments it can be seen that the level of service for the current flows is B. This assumes the heavy good vehicles content is in the order of 5% and that the road is relatively flat in this location. This table shows that the cut off point for this level of service is some 550 vehicles per hour two-way

Upon completion of the full development of 143 residential lots on the subject site, there could be up to 121 vehicles per hour generated by the development during the critical morning and afternoon peak periods. Assuming all traffic has an origin/destination to the east towards the Pacific Highway and Taree, it can be seen that traffic flows along Bucketts Way would increase by 121 vehicles per hour two-way. This would increase the total hourly flows from the current flow of 317 vehicles per hour to some 438 vehicles per hour.

This would mean that there would no change to the existing level of service of B for road users along Bucketts Way. Level of service B is defined as "*This level 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 less than that of the level of Service A*". It is considered that the additional traffic generated by the development will have a minimal impact upon the existing operation of Bucketts Way and that the existing drivers along Bucketts Way will notice little if any change in the road conditions.

The key issue will therefore be the operation of the intersection of the main site entry and Bucketts Way and to a lesser extent the operation of the intersection of Urray Road and Bucketts Way.

4.3 Intersection of Bucketts Way and the main site entry

The additional traffic associated with the proposed development has been determined above to assess the impact of the main entry to the development on Bucketts Way. The layout of this access point will need to be designed in accordance with RTA and Council requirements, taking into account the traffic flows and the speed environment. The intersection is located in an 80 km/h speed zone.

It is again useful to consider the Austroads threshold levels for intersection capacity under uninterrupted flow conditions. **Table 4.1** below presents these thresholds. Where traffic flows fall within these limits intersection operation is essentially at no delay or interruption for approaching drivers other than to obey the requisite road rules.

Table 4.1 Intersection Capacity – Uninterrupted Flow Conditions

Road Type	Light Crossing or turning volumes Maximum Design Hour Volumes, Two-way (vph)		
Two Lane through Roadway	400	500	650
Cross Road	250	200	100
Four Lane through roadway	1000	1500	2000
Cross road	100	50	25

Source: Austroads Guide to Traffic Engineering Practice - Part 5, 1988

It can be seen that with the current morning two-way peak hour flows being in the order of 320 vehicles per hour, the maximum cross road flow could be up to 250 vehicles per hour, without any delays to road users. It can be seen that with the development flows of the order of 121 vehicles per hour could use this access, well below the threshold point of 250 vehicles per hour. This indicates that no intersection modelling is required, as all traffic movements will operate at a level of service of A.

To confirm the operation of the future site access, a Sidra analysis has been completed for the new main entry point to the site.

Sidra is a traffic analysis tool developed originally by the Australian Road Research Board. It calculates the amount of delay to vehicles using an intersection, and gives a level of service rating which indicates the relative performance of the nominated intersection treatment. Levels of service of A to C are considered to be satisfactory, a level of service of D is acceptable, and levels of E and F are considered unsatisfactory. Sidra also calculates the degree of saturation, which indicates the amount of **spare capacity** available.

See **Appendix C** for full definition of Sidra results.

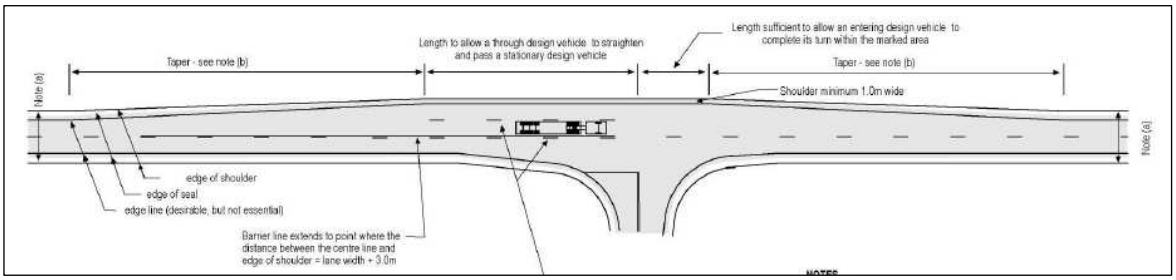
The summary results for the operation of the future intersection of Bucketts Way and the site entry for the current 2006 traffic flows together with the development traffic are presented below in **Table 4.2** with more detailed results provided in **Appendix 'A'**. This analysis below assumes that the full development of 150 lots occurs in 2006 (worst case scenario).

Table 4.2 – Intersection of Bucketts Way and Site Entry – 2006

MOVEMENT	DEGREE OF SATURATION	AVERAGE DELAY (SEC/VEH)	LEVEL OF SERVICE	95th PERCENTILE BACK OF QUEUE
Right turn in	0.017 / 0.123	11.1 / 10.7	B / B	0 / 3
Right turn out	0.011 / 0.012	11.5 / 12.2	B / B	0 / 0
Through w-bound	0.052 / 0.087	0.0 / 0.0	A / A	0 / 0
Through e-bound	0.130 / 0.066	0.0 / 0.0	A / A	0 / 0

N.B Results for AM / PM

The above results confirm that the proposed main access to the proposed development will operate well with minimal traffic delays for all users. The layout of the proposed access has been assumed to be a minimal rural treatment, with a sheltered right turn lane for traffic accessing the proposed development. From the RTA Road Design Guide, a Type AUR intersection has been assumed. Details of this type of intersection are shown below:



The proposed access to the development has also been assessed for the future design year. Allowing for 10 year growth to the future design year of 2016, it has been assumed that there will be annual increase in traffic flows of 2% giving an increase over 10 years of 20%. From Table 2.1 above it can be seen that the historic growth has been 1.5% per annum. The results for the future design year 2016 are presented in **Table 4.3** below:

Table 4.3 – Intersection of Bucketts Way and Site Entry – 2016

MOVEMENT	DEGREE OF SATURATION	AVERAGE DELAY (SEC/VEH)	LEVEL OF SERVICE	95th PERCENTILE BACK OF QUEUE
Right turn in	0.017 / 0.124	11.4 / 10.8	B / B	1 / 4
Right turn out	0.013 / 0.014	12.5 / 13.1	B / B	0 / 0
Through w-bound	0.062 / 0.104	0.0 / 0.0	A / A	0 / 0
Through e-bound	0.156 / 0.079	0.0 / 0.0	A / A	0 / 0

N.B Results for AM / PM

The above results show that the proposed entry point to the development will have adequate capacity to cater for the development flows as well as the background growth in traffic flows along Bucketts Way. The delays for the through traffic movements will continue to be minimal and well within acceptable limits for intersection operation.

4.4 Road Safety

4.4.1 Intersection of Bucketts Way and Site Entry Point

The intersection of Bucketts Way and the main site entry is proposed to be a Type AUR to cater for the right turn demand into the site. This intersection is located just outside the 70 km/h zone and is located on a straight section of Bucketts Way. This intersection will be designed in accordance with the RTA Road Design Guide as well as the requirements of Council.

It is considered that this intersection can provide a safe and appropriate level of access to the site. It is noted that there is some existing vegetation in the location of the proposed access point, including trees. As part of the design and construction of the access point, the existing vegetation will need to be trimmed and removed, to ensure the safety of vehicles and also to ensure that the visibility splay for the 80 km/h speed zone can be provided.

From the RTA Road Design Guide it can be seen that for the posted speed limit of 80 km/h, the Safe Intersection Sight Distance (SISD) should be a minimum of 181 metres. The sight distance has been measured on site and exceeds 250 metres in both directions. For traffic exiting the proposed access to the development, visibility in both directions exceeds the requirements for the posted speed limit of 80 km/h.

Photo 3 – View west along Bucketts Way showing the road alignment in the vicinity of the proposed site entry

It is considered that this intersection can provide a safe and appropriate location and layout for the proposed residential development.

4.5 Pedestrian and Cyclist Facilities

It can be seen that the future pedestrian movements associated with the proposed development will be relatively low. It is considered that the proposed development will not require any additional pedestrian facilities to be provided along Bucketts Way. From the site visit, it is noted that there are no pedestrian facilities along the length of Bucketts Way from the Pacific Highway (approximately 1.5 kms).

As part of the development of the site, it is proposed to provide a high standard of internal pedestrian and cycle links. The internal network will include footpaths along the internal road network as well as dedicated off road footway/cycleways. It is proposed to provide a walk way along the northern boundary of the site, to provide access to the Manning River. In addition, it is proposed to provide a strong pedestrian route to the main site entry point, to connect with the bus stop to be located at this location. This will provide an encouragement for future residents, especially school children, to walk or cycle to the bus stop to access the school bus runs into Taree. As part of this, it is proposed to provide security features at the bus stop to allow cycles t be safely parked in this location.

4.6 Public Transport

It can be seen that the proposed development will have a minimal impact in terms of public transport demand. However, it is considered that there will be an increase in demand for the school bus runs that currently operate along Bucketts Way. It is therefore proposed to provide a bus stop at the main site entry, together with a bus shelter to improve safety and convenience for the users. This will include security facilities for cyclists to leave their bikes at this bus stop during the day.

4.7 Internal Road Network

All of the internal roads will be designed in accordance with Council requirements and will operate under a posted speed limit of 50 km/h. All of these roads will be under the control of Council and as such need to comply with Council's standards for residential estate roads. All roads will allow for two way traffic movements.

5. Summary and Conclusions

5.1 Summary

From the study work, the following summary is provided:

1. The proposal is to provide a residential subdivision with up to 143 lots, which will be developed over a number of stages. This assessment has been completed for the full development.
2. The site is located to the north of Bucketts Way, between Purfleet and Tinonee. Bucketts Way is a classified main road and any works adjacent to this road require consent from Council as well as concurrence from the RTA. As part of this study, a traffic survey has been completed at the intersection of Bucketts Way and Urray Road and the current peak hour flows along Bucketts Way are in the order of 250-320 vehicles per hour two-way.
3. It has been assumed that the standard rates for residential developments from the RTA Guide to Traffic Generating Developments could apply, giving some 121 vehicles per hour two-way during the peak hours. The critical intersections of Bucketts Way and the new site entry point has been analysed with Sidra and the analysis shows that there will be little if any delay for existing road users created by the proposed development. Delays for the through traffic movements along the Bucketts Way will be very low.
4. The vehicle access to the site is proposed via a new entry point on Bucketts Way. This new access point will replace a number of existing entry points along Bucketts Way. The design of this new entry point will need to be in accordance with Council and RTA requirements. The internal road network will need to be in accordance with the Council design guide for residential subdivisions.
5. Internal pedestrian movements will be catered for with a mixture of off road footway/cycleways and footways along the side of roads. There will be a pedestrian and cycle link between the subdivision and the access track along the frontage to Manning River as well as access to the proposed new bus stop and shelter at the main entry point on Bucketts Way.

5.2 Conclusion

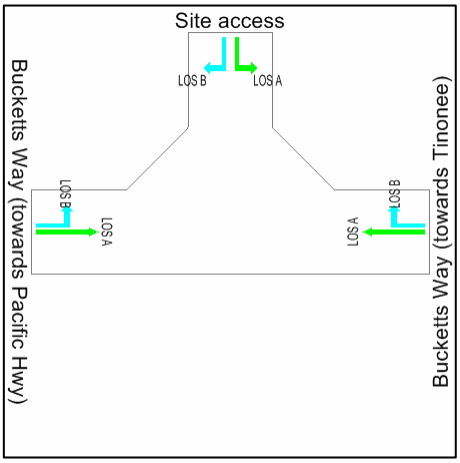
From the study, it is concluded that the existing road system is able to cater for the traffic demands of the proposed development and it is recommended that the proposal be approved on traffic.

It is concluded that the provision of a RTA Type AUR intersection control will have adequate capacity for the traffic volumes associated with the proposed development. This access will continue to provide adequate capacity for 10 years or more.

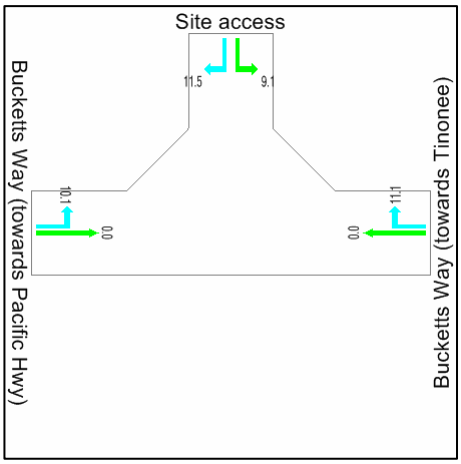
Appendix A Sidra results

Intersection Summary
Intersection of Bucketts Way and Main site entry
2006 AM flows plus development

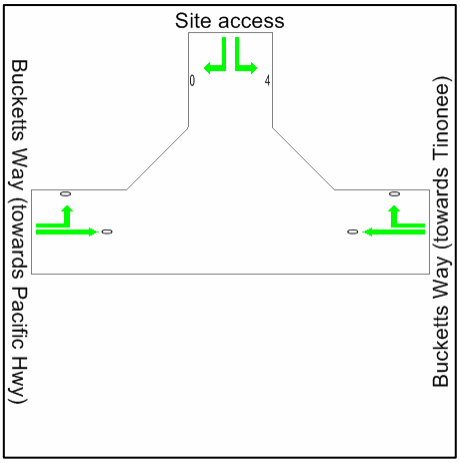
Performance Measure	Vehicles	Persons
Demand Flows - Total	490 veh/h	735 pers/h
Percent Heavy Vehicles	2.9 %	
Degree of Saturation	0.130	
Effective Intersection Capacity	3757 veh/h	
95% Back of Queue (m)	4 m	
95% Back of Queue (veh)	0.6 veh	
Control Delay (Total)	0.39 veh-h/h	0.58 pers-h/h
Control Delay (Average)	2.9 s/veh	2.9 s/pers
Level of Service	Not Applicable	
Level of Service (Worst Movement)	LOS B	
Total Effective Stops	100 veh/h	150 pers/h
Effective Stop Rate	0.20 per veh	0.20 per pers
Proportion Queued	0.11	0.11
Travel Distance (Total)	334.8 veh-km/h	502.2 pers-km/h
Travel Distance (Average)	683 m	683 m
Travel Time (Total)	5.1 veh-h/h	7.6 pers-h/h
Travel Time (Average)	37.4 secs	37.4 secs
Travel Speed	65.7 km/h	65.7 km/h
Operating Cost (Total)	191 $/h	191 $/h
Fuel Consumption (Total)	34.2 L/h	
Carbon Dioxide (Total)	85.6 kg/h	
Hydrocarbons (Total)	0.122 kg/h	
Carbon Monoxide (Total)	4.25 kg/h	
NOX (Total)	0.198 kg/h	



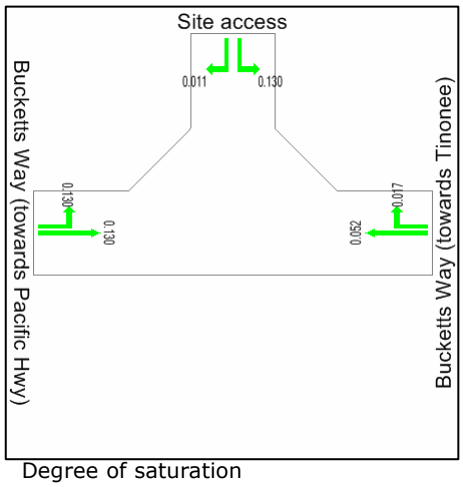
Level of service



Delay (seconds)



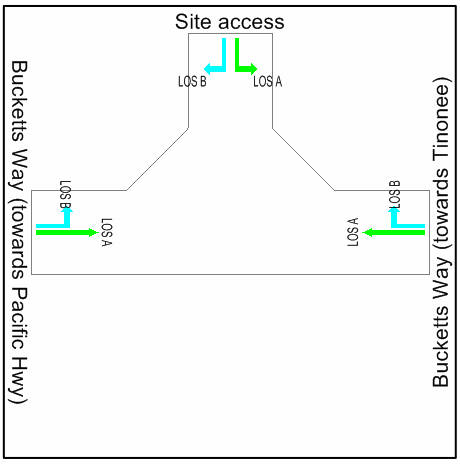
Queue (m)



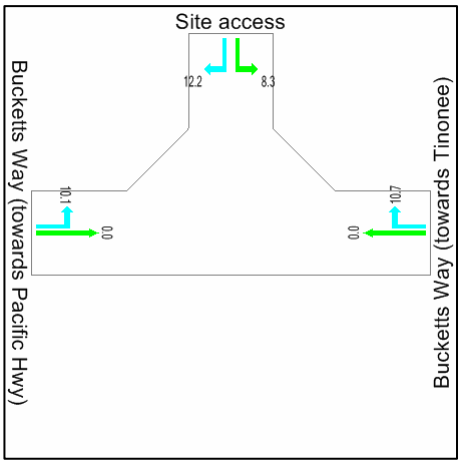
Degree of saturation

Intersection Summary
Intersection of Bucketts Way and Main site entry
2006 PM flows plus development

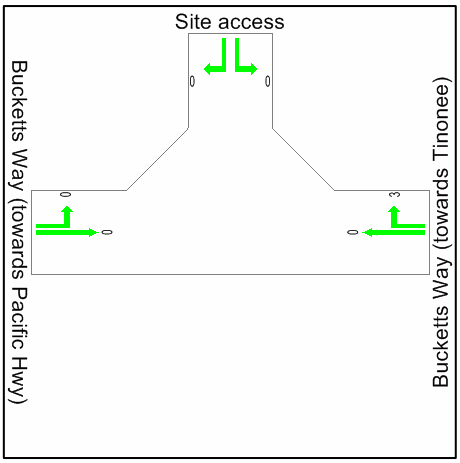
Performance Measure	Vehicles	Persons
Demand Flows - Total	438 veh/h	657 pers/h
Percent Heavy Vehicles	2.7 %	
Degree of Saturation	0.123	
Effective Intersection Capacity	3551 veh/h	
95% Back of Queue (m)	3 m	
95% Back of Queue (veh)	0.5 veh	
Control Delay (Total)	0.43 veh-h/h	0.65 pers-h/h
Control Delay (Average)	3.5 s/veh	3.5 s/pers
Level of Service	Not Applicable	
Level of Service (Worst Movement)	LOS B	
Total Effective Stops	98 veh/h	148 pers/h
Effective Stop Rate	0.22 per veh	0.22 per pers
Proportion Queued	0.08	0.08
Travel Distance (Total)	288.1 veh-km/h	432.2 pers-km/h
Travel Distance (Average)	658 m	658 m
Travel Time (Total)	4.1 veh-h/h	6.2 pers-h/h
Travel Time (Average)	34.1 secs	34.1 secs
Travel Speed	69.5 km/h	69.5 km/h
Operating Cost (Total)	153 $/h	153 $/h
Fuel Consumption (Total)	26.7 L/h	
Carbon Dioxide (Total)	66.8 kg/h	
Hydrocarbons (Total)	0.091 kg/h	
Carbon Monoxide (Total)	2.45 kg/h	
NOX (Total)	0.151 kg/h	



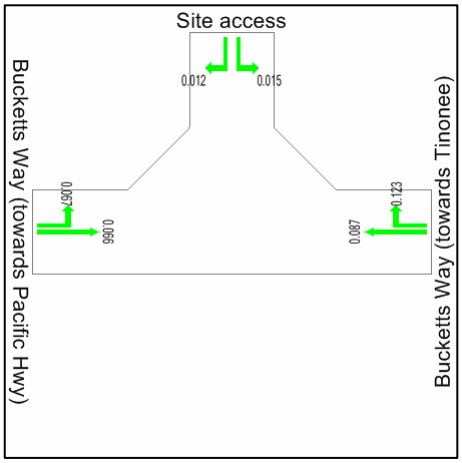
Level of service



Delays (seconds)



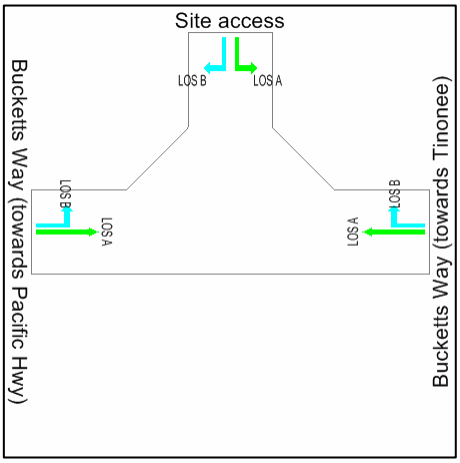
Queues (m)



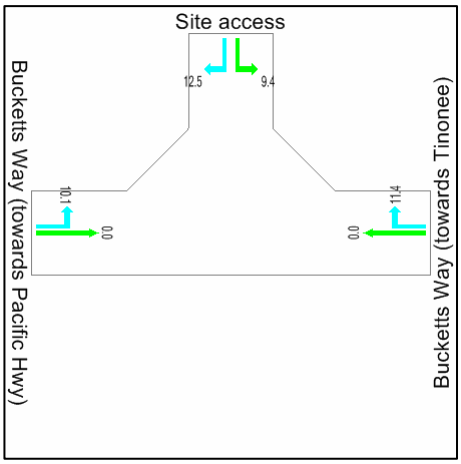
Degree of saturation

Intersection Summary
Intersection of Bucketts Way and Main site entry
2016 AM flows plus development

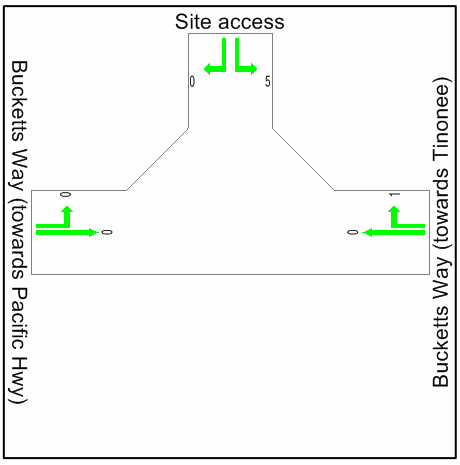
Performance Measure	Vehicles	Persons
Demand Flows - Total	559 veh/h	839 pers/h
Percent Heavy Vehicles	3.0 %	
Degree of Saturation	0.158	
Effective Intersection Capacity	3540 veh/h	
95% Back of Queue (m)	5 m	
95% Back of Queue (veh)	0.7 veh	
Control Delay (Total)	0.40 veh-h/h	0.60 pers-h/h
Control Delay (Average)	2.6 s/veh	2.6 s/pers
Level of Service	Not Applicable	
Level of Service (Worst Movement)	LOS B	
Total Effective Stops	103 veh/h	155 pers/h
Effective Stop Rate	0.18 per veh	0.18 per pers
Proportion Queued	0.10	0.10
Travel Distance (Total)	382.6 veh-km/h	573.9 pers-km/h
Travel Distance (Average)	684 m	684 m
Travel Time (Total)	5.7 veh-h/h	8.6 pers-h/h
Travel Time (Average)	36.7 secs	36.7 secs
Travel Speed	67.1 km/h	67.1 km/h
Operating Cost (Total)	214 $/h	214 $/h
Fuel Consumption (Total)	38.4 L/h	
Carbon Dioxide (Total)	96.1 kg/h	
Hydrocarbons (Total)	0.134 kg/h	
Carbon Monoxide (Total)	4.44 kg/h	
NOX (Total)	0.220 kg/h	



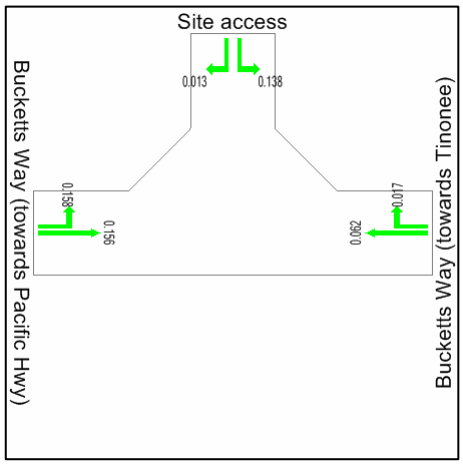
Level of service



Delays (seconds)



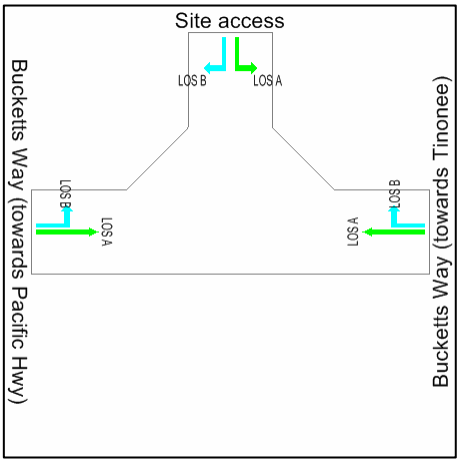
Queues (metres)



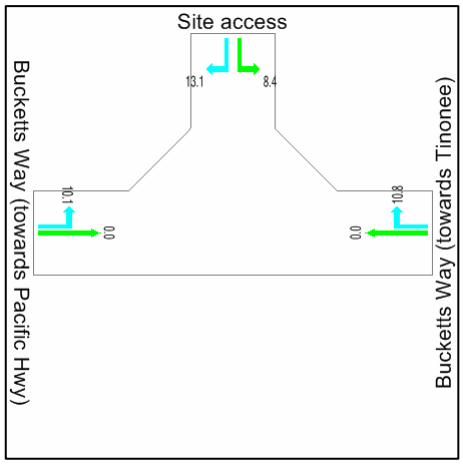
Degree of saturation

Intersection Summary
Intersection of Bucketts Way and Main site entry
2016 PM flows plus development

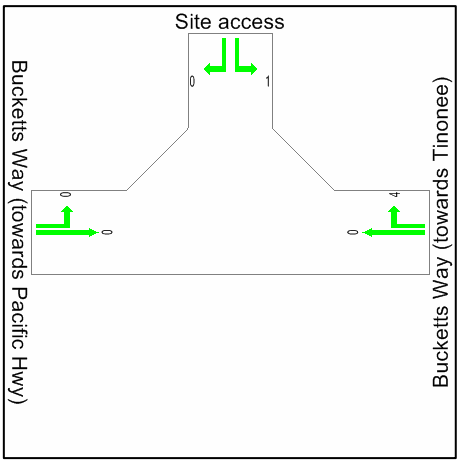
Performance Measure	Vehicles	Persons
Demand Flows - Total	496 veh/h	744 pers/h
Percent Heavy Vehicles	2.8 %	
Degree of Saturation	0.124	
Effective Intersection Capacity	3997 veh/h	
95% Back of Queue (m)	4 m	
95% Back of Queue (veh)	0.5 veh	
Control Delay (Total)	0.44 veh-h/h	0.66 pers-h/h
Control Delay (Average)	3.2 s/veh	3.2 s/pers
Level of Service	Not Applicable	
Level of Service (Worst Movement)	LOS B	
Total Effective Stops	100 veh/h	150 pers/h
Effective Stop Rate	0.20 per veh	0.20 per pers
Proportion Queued	0.08	0.08
Travel Distance (Total)	328.3 veh-km/h	492.4 pers-km/h
Travel Distance (Average)	662 m	662 m
Travel Time (Total)	4.7 veh-h/h	7.0 pers-h/h
Travel Time (Average)	33.8 secs	33.8 secs
Travel Speed	70.4 km/h	70.4 km/h
Operating Cost (Total)	173 $/h	173 $/h
Fuel Consumption (Total)	30.2 L/h	
Carbon Dioxide (Total)	75.7 kg/h	
Hydrocarbons (Total)	0.101 kg/h	
Carbon Monoxide (Total)	2.62 kg/h	
NOX (Total)	0.170 kg/h	



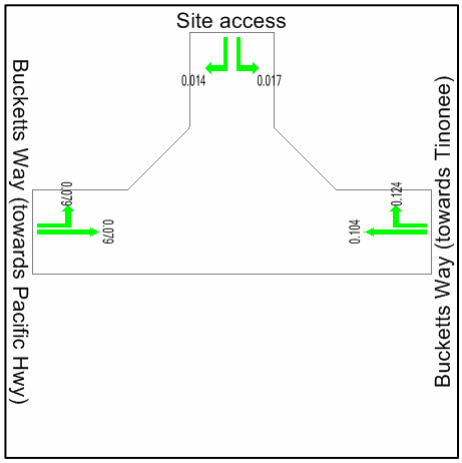
Level of service



Delay (seconds)

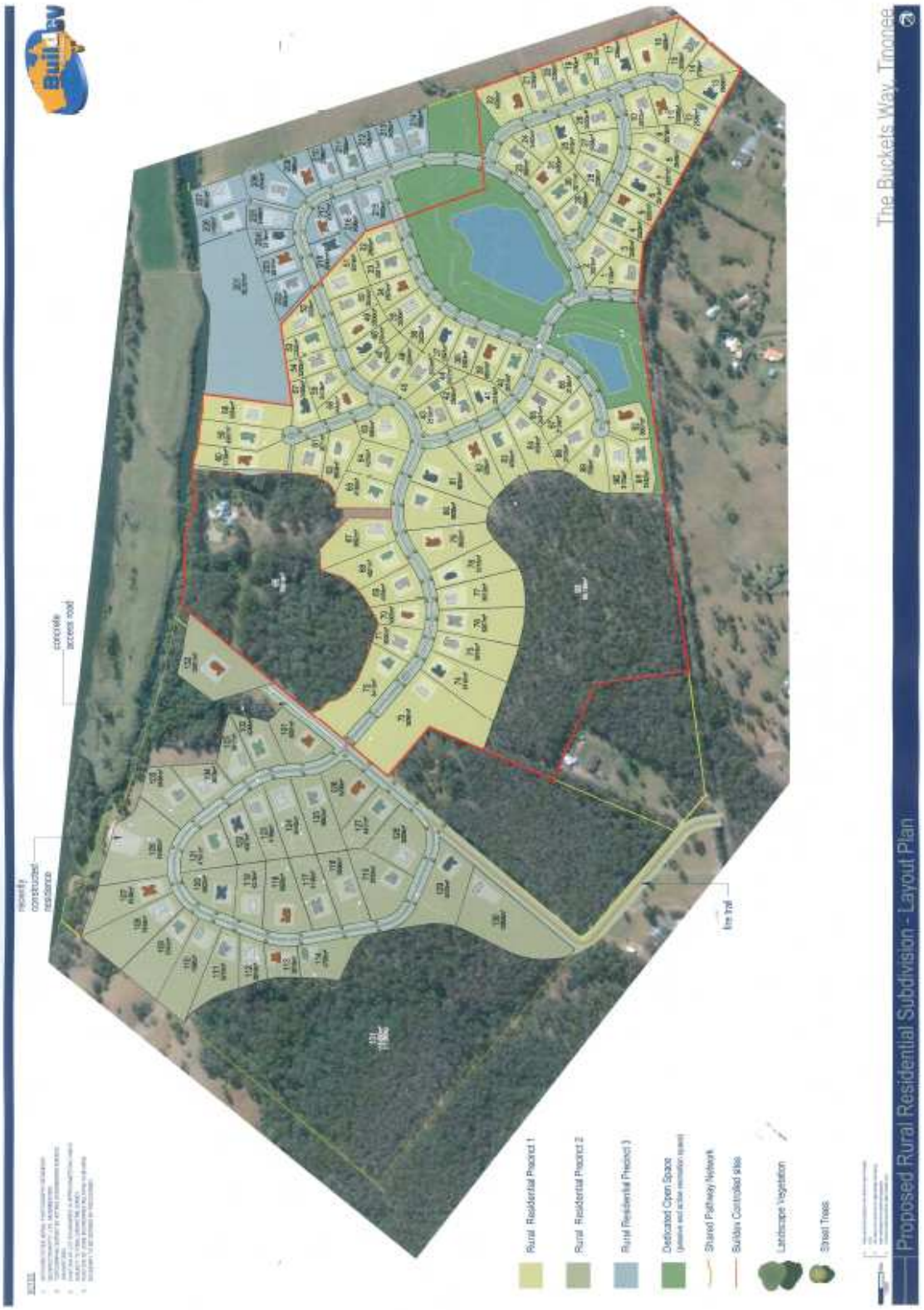


Queues (metres)



Degree of saturation

Appendix B Site Layout



Appendix C Criteria for interpreting results of Sidra

1-Level of Service (LoS)

LoS	Traffic Signals and Roundabouts	Give Way and Stop Signs
A	Good	Good
B	Good, with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	Satisfactory	Satisfactory, but requires accident study
D	Operating near capacity	Near capacity and requires accident study
E	At capacity, excessive delay: roundabout requires other control method	At capacity, requires other control mode
F	Unsatisfactory, requires other control mode or additional capacity	Unsatisfactory, requires other control mode

2-Average Vehicle Delay (AVD)

The AVD is a measure of operational performance of an intersection relating to its LoS. The average delay should be taken as a guide only for an average intersection. Longer delays may be tolerated at some intersections where delays are expected by motorists (e.g. those in inner city areas or major arterial roads).

LoS	Average Delay / Vehicle (secs)	Traffic Signals and Roundabouts	Give Way and Stop Signs
A	Less than 15	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	28 to 42	Satisfactory	Satisfactory but accident study required
D	42 to 56	Operating near capacity	Near capacity, accident study required
E	56 to 70	At capacity, excessive delays: roundabout requires other control mode	At capacity; requires other control mode
F	Exceeding 70	Unsatisfactory, requires additional capacity	Unsatisfactory, requires other control mode

3-Degree of Saturation (D/S)

The D/S of an intersection is usually taken as the highest ratio of traffic volumes on an approach to an intersection compared with the theoretical capacity, and is a measure of the utilisation of available green time. For intersections controlled by traffic signals, both queues and delays increase rapidly as DS approaches 1.0. An intersection operates satisfactorily when its D/S is kept below 0.75. When D/S exceeds 0.9, queues are expected.