Better Transport Futures

Mark Waugh Pty Limited
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Transport Planning & Engineering

Proposed Residential Development, Kings Avenue Terrigal, NSW

Traffic Impact Statement

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Contents

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1. Executive Summary

a. The proposed development allows for the provision of 145 residential homes, with home based office facilities with associated support facilities and recreational amenities located within the development. The site is located immediately to the south of Kings Avenue in Terrigal, NSW.

b. This traffic report has been prepared to accompany documentation for this development and covers the following:
- Existing situation conditions including description of the local road network
- Traffic volumes available on the adjacent road network including traffic surveys that were conducted at the time of the investigations
- Analysis using SIDRA traffic modelling of both existing (2008) and future (2018) conditions

c. The 2018 forecast flows have been extrapolated from the observed 2008 flows. Traffic volumes along Terrigal Drive have increased at varying rates over the last 20 years reflecting the growth and development of the area. Based on this and DIPNR forecasts an annual growth in traffic flows of 1% has been adopted through to the year 2018.

d. This development has been designed to introduce a level of employment containment within the local area that is not evident in traditional developments, and as such the project has the potential to reduce traffic generation over traditional forms of development.

e. The main vehicular access to the site is proposed from Kings Avenue with a second access provided via Belar Avenue to the east of the subject site.

f. Existing traffic flows along the local road network in the vicinity of the site are very low. The majority of adjacent land use is residential development or public reserve. Kings Avenue and Belar Avenue are within technical capacity limits and operational levels of service are very good, with no delays and congestion for road users observed during the traffic survey.

g. The level of traffic generation from the subject site has been determined from the RTA Guide to Traffic Generating Developments[1]. Whilst this guide makes no direct provision for the type of use proposed (home office), a number of quantitative judgements have been made to ensure currency of the guide. The RTA Guide to Traffic Generating Developments shows that during the critical morning and afternoon peak periods the total flows generated by the development is likely to be 123 vehicles per hour.

h. The additional traffic generated by the development can be accommodated on the local road network and the local roads will remain within their road capacity limits. The impact of these additional traffic movements have also been assessed upon the intersections on Terrigal Drive and it can be seen that these existing intersections will continue to operate at a good level of service, with minimal delays and congestion for road users. Based on this capacity and operation assessment, no mitigation or augmentation measures on the adjacent road network are required to accommodate the potential traffic generated by this development.

i. The provision of a bus stop at Parkside, with associated footpaths, would improve accessibility for public transport users.

j. Parking for the proposed development can be contained within the site and will ensure there will be no impact upon the local streets in the vicinity of the site.

k. All vehicles, including service vehicles, will enter and leave the site in a forward direction. The site layout can adequately cater for these movements.

From the study, it is concluded that there will be minimal traffic impacts associated with the proposed development and there will be minimal increases in delays and congestion on the local road network.

Above and beyond the immediate local impact with the provision of support facilities for the home based office, it can be seen that whilst the impact on the local road network will be similar to a standard residential development, the impact upon the greater regional and metropolitan road network is likely to have a net reduction in traffic movements. The stated aim of the development is to encourage a locally based work environment with high standard electronic facilities and support services, reducing the demand for broader external traffic movements.

The Parkside Development site presents a significant opportunity to influence travel behaviour through the application of alternate employment oriented development. The objective of reducing car dependency can be realised by providing positive local advantages to alternate transport such as walking, cycling and public transport while at the same time contributing to a potential reduction in trip lengths. Key features of the development include:

- Local on-site employment and support facilities
- Pedestrian movement focus.
- Possible integration of the on-site pedestrian and cycling network with external facilities developed in conjunction with local Council.
- Application on-site of accepted principles for transit oriented development including, mixed land use (i.e. on site employment opportunities), direct pedestrian and cycle links.

The proposed Parkside Development with the above initiatives in place represents a positive step in urban development towards shifting the balance in transport through reduced car dependency

2. Introduction

Mark Waugh Pty Ltd was commissioned by Crighton Properties Pty Ltd to prepare a Traffic Impact Assessment for a proposed residential home business development located on Kings Avenue Terrigal, NSW. The report is required to support a rezoning application to Gosford City Council for the proposed development.

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

- **Chapter 3** 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 4** describes the traffic and parking features of the proposal, access arrangements and how these meet Council's and road authority guidelines.

- **Chapter 5** details the assessment of traffic operations related to the proposal

- **Chapter 6** 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.

3. Existing Situation

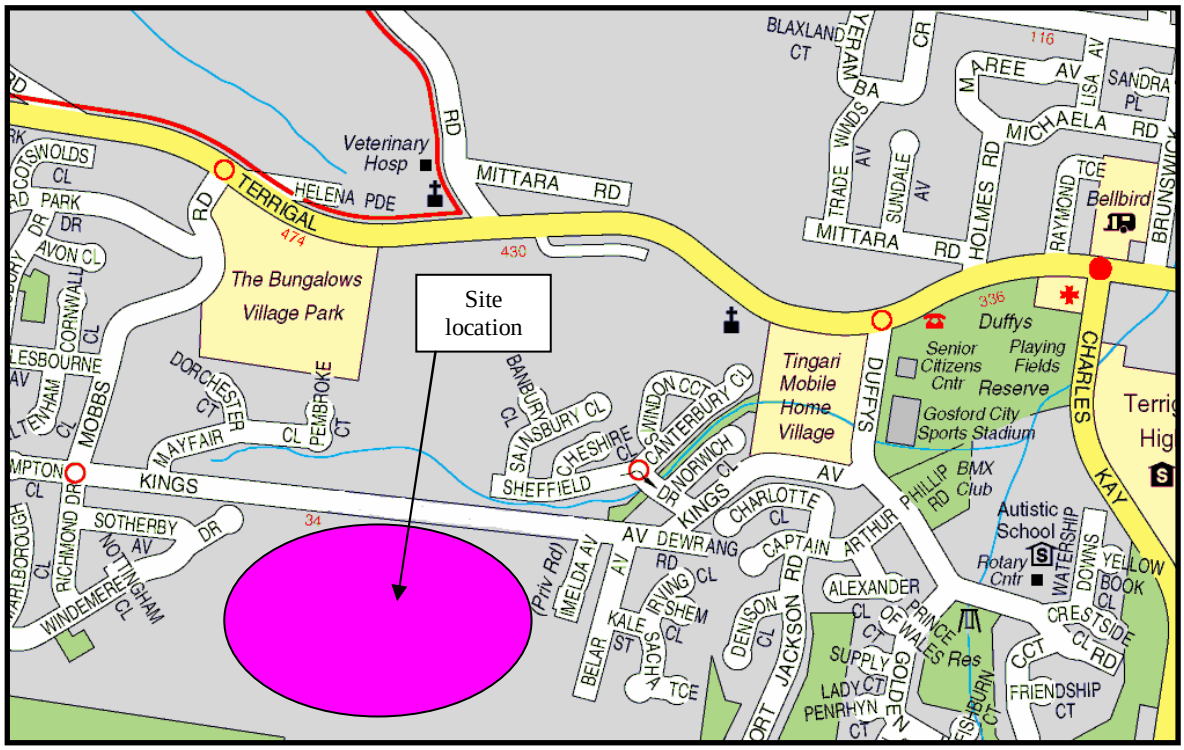
3.1 Background and Site Location

The subject site is located on a parcel of land south of Kings Avenue, between Belar Avenue to the east and Windemere Drive to the west. The site has road frontage along both Kings Avenue as well as Belar Avenue and is currently vacant rural land (7c2) and is partly zoned 7(a). Access to the site is currently available to both of these roads.

Both Kings Avenue and Belar Avenue are local roads under the control of Gosford City Council. Access to the greater road network is available via Terrigal Drive to the north of the site. The land surrounding the site is generally residential, to the north, east and west, with a mixture of established residential properties plus new residential infill being currently constructed. The site is bordered to the south by Kincumber Mountain Reserve.

The locality is illustrated in **Figure 3-1** below.

Note that Kings Avenue is now sealed along its entire length, with no gap in the centre of its length.



■ **Figure 3-1**– Subject Site Location. (Source- UBD Maps)

3.2 Local Road System

3.2.1 Road Characteristics

Terrigal Drive
Access to the greater road network is provided via Terrigal Drive to the north of the site. Terrigal Drive is a classified main road (Main Road 505) and is one of the major road links providing access between Erina and Gosford to the west and Terrigal and the coastal areas to the east of the site. In the vicinity of the site it provides a single lane of travel in both directions, with localised widening at intersections to increase capacity. All the major intersections along the length of Terrigal Drive are controlled by traffic signals or roundabouts, with a number of minor intersections allowing all turning movements controlled by giveway or stop signs. A number of the intersections have restricted turning movements, due to a raised central median.

Terrigal Drive has a posted speed limit of 70 km/h for the majority of its length, with reductions to 60 km/h at key locations. Parking restrictions apply along the majority of its length, due to the restricted width and the comparatively high traffic flows. There are a limited number of properties with direct access to this road within the vicinity of the site. The road is controlled by the RTA with Council being the consent authority for any new works on this road.

The junction of Terrigal Drive and both Duffys Road (to the east of the site) and Mobbs Road (to the west of the site) are controlled by roundabouts. Both of these roundabouts are off-set from the alignment of Terrigal Drive, allowing eastbound traffic to proceed through the intersection without having to negotiate the roundabout. This increases the capacity of these roundabouts whilst significantly reducing the delays for eastbound traffic movements along Terrigal Drive. This in turn reduces delays for westbound traffic movements along Terrigal Drive.

Sight line visibilities at the current intersection are satisfactory and are in accordance with the requirements of the RTA Road Design Guide[2] for the posted speed limit. Observations of the intersections performance during both the morning and afternoon peak periods show that current delays and congestion are minimal at this intersection. The observations show that there can on occasion be some delays for the traffic turning right out of the side roads. Gaps are generally only available when eastbound traffic from Terrigal Drive wishes to turn right into the side road. Left turning traffic from the side roads generally suffered minimal delay due to the two exit lanes available to the west of the roundabouts.

Traffic in both directions along Terrigal Drive suffered minimal delays. Outside of the peak periods there is minimal congestion for all traffic movements.

Kings Avenue
Kings Avenue has only recently been opened to through traffic and performs the function of a local collector road, providing a link between the residential development in the vicinity of the site and the major road network. It provides a single lane of travel in both directions, with a width varying between 8 to 10 metres. It provides a straight alignment along the boundary of the site, with an undulating alignment with a dip in the centre of its length. The majority of the intersections along its length are controlled by giveway controls and it has a posted speed limit of 50 km/h. Street lighting in provided along the majority of its length and there is a single footway provided along one side. Adjacent land use is residential along its length and it is a Council controlled road.

View west along Kings Avenue

View West along Kings Avenue

Duffys Drive

Duffys Drive provides a link between Kings Avenue and Terrigal Drive. It provides a single lane of travel in both directions and a footway on one side only. It has an overall width in the region of 9 metres with widening at its intersection with Terrigal Drive. Adjacent land use is a mixture of normal residential and a retirement village, made of demountable homes. It is a Council controlled road.

Belar Avenue

Belar Avenue provides a single lane of travel in both directions and provides an overall width in the order of 8 metres. It has a single footway to one side only and provides street lights along its length. Land use along its length is residential and a Childcare Centre. It is a Council controlled road.

View north along Belar Avenue

Mobbs Road

Mobbs Road provides a link between Kings Avenue and Terrigal Drive. It provides a single lane of travel in both directions and a footway on one side only. It has an overall width in the region of 9 metres with widening at its intersection with Terrigal Drive. Adjacent land use is a mixture of normal residential and a retirement village, made of demountable homes. It is a Council controlled road.

3.3 Traffic Volumes

Traffic volume data for the project has been collected from the RTA and during a survey of traffic movements at the intersections of Terrigal Drive and both Duffys Road and Mobbs Road. A morning and afternoon peak period survey was completed on Tuesday 19th August 2008
As the layout of these two intersections is designed to eliminate delays for eastbound traffic movements along Terrigal Drive, this movement was not surveyed. It can also be seen that this traffic movement does not affect the performance and operation of the two roundabout controlled intersections. All other traffic movements were surveyed as well as observations of intersection operations.

The results from the traffic survey indicate that during the surveyed morning peak period (7.45 to 8.45 am) the westbound traffic flow along Terrigal Drive to the east of Duffys Road was approximately 1,700 vehicles per hour. The morning flows reflect demand for local traffic from the coastal regions to access the main centres such as Erina, Gosford and beyond to the F3 Freeway to Sydney or Newcastle. The majority of observed vehicles were light vehicles, with limited heavy goods vehicles.

The traffic survey also recorded turning movements at the intersection of Terrigal Drive with both Mobbs Road and Duffys Road. The traffic surveys show that the traffic flows are higher in and out of Duffys Road than Mobbs Road. The surveys show that during the morning peak period the two-way flow along Duffy Road was approximately 570 vehicles per hour and approximately 300 vehicles per hour along Mobbs Road. The afternoon peak survey showed that these movements are generally reversed during this period, with the return trip from work etc meaning that eastbound traffic flows along Terrigal Drive are greater than westbound. This effectively reduces the delays for traffic exiting the side roads at these two roundabouts. The afternoon peak flows were similar to the morning flows with 596 vehicles per hour on Duffys Road and 315 vehicles per hour on Mobbs Road being recorded.

These peak flows are significantly higher than those recorded in similar surveys undertaken in April 2005, with a 15% growth recorded in the west bound peak hour flow on Terrigal Drive. This growth is higher than previously recorded in RTA counts on Terrigal Drive as discussed in Section 3.3.1 below. This growth can be attributed to the increase in the general popularity of commuting to Sydney from this area, the upgrading of Erina commercial area and the general growth in the local population. It is not anticipated that this level of growth will be sustained in the future.

No traffic surveys were completed along Kings Avenue. However, from a review of the local road network it can be seen that the traffic flow along Kings Avenue would be low, with similar if not lower flows than both Mobbs Road and Duffy Road.

The full results of the morning and afternoon peak traffic surveys are shown in **Appendix A**.

3.3.1 RTA Traffic Volume Data

The relevant traffic data provided by the RTA is for the station number 05125, which is located to the west of the site on Terrigal Drive, has also been obtained. This count station provides data for the years 2001 and 2004 only and indicates the AADT in 2004 was 26,406 vehicles. Additional data has been obtained from station number 05118, located to the east of the site on Terrigal Drive. This station provides data between 1988 and 2004, providing an indication to the background growth of traffic flows along Terrigal Drive in the location of the site.

3.3.2 Historic Traffic Growth

The traffic data from the RTA automatic counter number 05118 provides the following background traffic growth in traffic volumes along Terrigal Drive. These are presented in **Table 3-1.**

- **Table 3-1**– Historic Traffic Flows along Terrigal Drive

Year	1988	1990	1992	1995	1998	2001	2004
AADT	12590	15331	16975	17354	20544	20797	21514
Growth		21.7%	10.7%	2.2%	18.4%	1%	3.5%
Per year		11.8%	5.3%	0.7%	6.1%	0.3%	1.1%

The table above shows that the rate of growth in traffic flows along Terrigal Drive is relatively low overall, though some years show higher growth peaks. The average over the 16 years of data is in the region of 4 % per annum. However, it can be seen that the overall trend gives a lower traffic growth, which would suggest a slowing of development over the most recent period between 1998 and 2004.

3.4 Road Classification

It is usual to classify roads according to a road hierarchy, in order to determine their functional role within the road network. Changes to traffic flows on the roads can then be assessed within the context of the road hierarchy. Roads are classified according to the role they fulfil and the corresponding volume of traffic they should carry. The Roads and Traffic Authority of New South Wales (RTA) has set down the following guidelines for the functional classification of roads.

Arterial Road
Typically a main road carrying over 15,000 vehicles per day and fulfilling a role as a major inter-regional link with over 1,500 vehicles per hour during the peak hours. The Entrance Road to the west of the site would be classified as an arterial road.

Sub-arterial Road
Defined as secondary inter-regional links, typically carrying volumes between 5,000 and 20,000 vehicles per day with between 500 and 2,000 vehicles per hour during the peak hours. Terrigal Drive would be classified as a sub-arterial road.

Collector Road
Provides a link between local areas and regional roads, typically carrying between 2,000 and 10,000 vehicles per day. At volumes greater than 5,000 vehicles per day, residential amenity begins to decline noticeably. Peak hour flows would be between 250 to 1,000 vehicles per hour. Kings Avenue is classified as a Collector Road and it can be seen that it is currently carrying traffic flows much lower than its classification suggests it can carry.

Local Road
Provides access to individual allotments, carrying low volumes, typically less than 2,000 vehicles per day with peak hour flows up to 250 vehicles per hour. Belar Avenue would be classified as a local road.

Peak hour volumes on all types of roads are typically within the range of eight to twelve per cent of the daily flows.

The RTA provides the following advice on levels of service for flows on urban roads.

- **Table 3-2 – RTA Levels of Service**

Urban road peak hour flows per direction

Level of Service	One Lane (veh/hr)	Two Lanes (veh/hr)
A	200	900
B	380	1400
C	600	1800
D	900	2200
E	1400	2800

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

Table 3-2 demonstrates that Terrigal Drive is currently operating at the upper end of this scale, with the level of service being at E during the peak periods. This indicates that through traffic movements can expect some delay although the level of intersection control means that through traffic movements experienced minimal delays during the survey periods. The local roads i.e. Mobbs Road, Duffys Road and Kings Avenue are currently operating well within their limits with a level of service ranging from A to C. This shows that the local roads have significant spare capacity for increased traffic flows.

3.5 Intersection Performance

The operation of the intersections of both Mobbs Road and Duffy Road with Terrigal Drive were observed during the survey periods and the existing delays to turning vehicles were generally low for road users along both roads, although some delays were noted at times for traffic wishing to turn right out of the side roads. For traffic movements along Terrigal Drive, there are currently negligible delays.

For traffic exiting the side roads, visibility in both directions is acceptable, as Terrigal Drive in this location provides a reasonable straight alignment and the posted speed limit would appear to be generally adhered too. Traffic turning right into the side roads also has good visibility.

Intersection of Terrigal Drive and Duffys Road

The analysis applied here relates to the observed levels of westbound traffic on Terrigal Drive at the junction with both Mobbs Road and Duffy Road. Firstly it is useful to consider the Austroads threshold levels for intersection capacity under uninterrupted flow conditions. **Table 3-3** 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 3-3- Intersection Capacity – Uninterrupted Flow Conditions**

Major Road Type[1]	Major Road Flow (vph)[2]	Minor Road Flow (vph)[3]
Two-lane	400	250
	500	200
	650	100
Four-lane	1000	100
	1500	50
	2000	25

Notes:

1. Major road is through road (i.e. has priority).
2. Major road design volumes include through and turning movements.
3. Minor road design volumes include through and turning volumes.

Source: Table 4.1 from Austroads Guide to Traffic Engineering Practice –Part 5, 2005[3]

Based on the data observed in surveys presented in discussed above, the existing westbound peak period flows on Terrigal Drive are in the region of 1700 vehicles per hour during weekday AM periods. Corresponding side-road peak flows on the side roads were 400 and 238 vehicles. Thus the threshold values presented in **Table 3-3** are exceeded and it is necessary to analyse existing operations.

3.6 Road Network Improvements

As part of the study, the RTA has been consulted to determine the extent of road upgrades proposed for Terrigal Drive. The RTA have indicated that Terrigal Drive will be upgraded to provide two lanes in both directions for the majority (if not all) its length, including the length in the vicinity of the subject site. As part of this upgrade, the intersection with Duffy Road and/or Mobbs Road could be upgraded to provide traffic signals. The RTA indicated that whilst this upgrade will occur in the future, there are no plans available nor is there a start date identified for this work.

3.7 Public Transport, Pedestrians and Cyclists

Public transport in the vicinity of the site is limited to buses only. School buses provide access for school children to local schools in the vicinity of the site. There is a bus route (route 68) provided along Kings Avenue, connecting via Duffys Road and Mobbs Road to Terrigal Drive. Buses run on a frequency of 30-60 minutes during the peak periods.

Cyclists are able to utilise the shoulders of Terrigal Drive in the vicinity of the site. The local street network, with a combination of relatively wide roads and low traffic flows, provide a safe and acceptable road for cyclists to use. During the survey periods, there was limited cyclist use observed.

Pedestrians are reasonably well catered for, with footways provided on one side of all the local roads in the vicinity of the site. Pedestrians in both directions used sealed shoulders along Terrigal drive. During the survey period there were no cyclist movements observed and pedestrian activity was minimal.

4. Proposed Development

4.1 Transport Principles

4.1.1 Project Background

This section presents a range of key transport objectives confronting new land development projects, outlining some solutions that will aid in realising State Government planning objectives of reducing the demand for car based travel by focussing on improved choice in transport alternatives and better land use development options.

A unique opportunity to achieve a development shift and contribute to the location choice and use of transport exists as a consequence of the proposal to develop the Parkside at Terrigal Site.

The commitment of the developers to implement a range of initiatives to achieve a development with a difference, including influencing transport behaviour is one of the major contributions offered by the development proposal.

This type of development is one of the keystone to achieving the transport outcomes identified in Strategies such as *Connecting the Central Coast, The Central Coast Transport Action Plan"* released by the NSW Government in 2002[4]. The change in residents' car dependency can begin with a change in the way our suburbs are designed, Parkside has been designed to achieve this specific goal.

Specific initiatives relating to the Parkside Development site are discussed and illustrated to demonstrate how a positive focus on alternative urban development form and consequent transport choice can be used to provide better choices focussed on reducing overall dependence on the private motor vehicle.

4.1.2 Transport Goals and Principles

The Parkside Development site aims to match the Government's stated objectives in the areas of Transport, and Air Quality. These objectives and the identified opportunities are described below:

Transport Goal

- "To provide a transport system that provides for the efficient movement of people and goods, which increases transport options and which is based on ecological sustainability."

Opportunities to Improve Development Practice

Principal 1: To provide local options for employment aimed at reducing the length of trips

Principal 2: To maximise the efficiency of the local street network through placement of development, to reduce trip lengths, enhance the viability of public transport and encourage cycling and walking as viable alternatives.

Principal 3: To reduce the load on regional and metropolitan transport linkages.

Air Quality Goal

"To ensure that occupants of the site are not exposed to higher levels of air pollution than elsewhere in the greater Sydney Region; and that the site's use generates air pollution at a significantly lower rate than previous development areas.

Opportunities to Improve Development Practice

Principal 1: To encourage an increased level of trip containment by providing on site employment and support facilities to reduce reliance on the use of the private car.

Principal 2: To restrict non-transport sources of air pollution.

Both the Transport and Air Quality goals of the development emphasise alternative transport as well as trip containment as a positive measure towards achieving ecological sustainability. There is also a strong emphasis on reducing dependency on the private motor vehicle.

4.2 Improving Development Practice

4.2.1 General

Cooperation and integration of employment opportunity and transport are essential to ensure attractive alternatives aimed at reducing car dependency. This will require the support of the developer, local councils, state authorities and transport operators to achieve a successful outcome.

The Parkside Development as an example of improved urban development practice will include the following transport initiatives:

- Local Employment though mandatory home office development on every site
- On site business support facilities
- Provision of pedestrian links catering for movement to and through the site. Possibly also cycle links that may present attractive and real alternatives to the private car.
- Provide linkages through the site to external pedestrian and cyclist networks. Linkages may possibly be matched by complimentary facilities developed by Council to complete access to other key centres such as Erina Fair.

4.2.2 Road Demand Management

Issues

"Demand management" is not a new idea. In the past, travel demand has been managed in a way that favours the use of private motor vehicles over all other means of transport. Changes in demand management are sometimes described as the "carrot and stick" approach to reducing car dominance. This paper suggests some "carrots" which can be offered through design measures.

A basic aim is to ensure that walking, cycling and public transport appear as attractive as possible both in their own right and, where appropriate, relative to private transport.

The Parkside development can influence this balance through its positive initiatives aimed at containing trip generation through on site local employment.

The importance of trip length in reducing the extent of Private Car Use

It may be possible to measure traffic generation also in terms of the lengths of trips, not just the quantity. In this way developments such as Parkside that have the potential to contribute to a reduction in trip lengths through containing trips within a local area can be seen to be contributing more positively than traditional style residential development. (Even though the local level of trip generation may not reduce)

4.2.3 Shifting the Balance

The Parkside Development site represents a significant opportunity to influence local travel through considered development initiatives that encourage local employment and trip containment alternatives that will assist in reducing car dependency.

Creating local activity is an important contributor to reducing overall travel. By containing travel to on site and local opportunities, other transport choices such as walking and cycling become real and attractive alternatives. The on site pedestrian and cycling facilities will further encourage their use.

Improved development practices that focus on promoting trip containment and using alternative transport choices to the private motor vehicle will lead to greater acceptance and patronage. This in turn will assist in achieving the overriding objectives of reducing car dependency and at the same time improving air quality.

The measures put forward in this document are relevant in the wider metropolitan context, and cannot therefore be delivered by the Parkside Development alone. The potential measures are many and varied and it will take a highly cooperative approach by all parties to achieve the key objectives of reducing car dependency in a regional context.

The nature of this development seeks to introduce a level of containment of some trips within the local area that is not evident in traditional developments, and as such the project has the potential to reduce traffic generation over traditional forms of development. On the other hand it is contended that the development may introduce a higher level of traffic in a local sense by attracting trips that otherwise would not have been on the network. There are a number of considerations here:

a. Even if it is assumed that the development were to generate trips at the traditional rate (which it is NOT expected to do) then the so called “extra” trips attracted to the development would be in fact contra flow to a normal peak condition, and hence will not expand the absolute peak flow from the development.
b. By taking advantage of spare capacity in the contra flow direction the development is actually realising a higher asset utilisation than traditional developments, without increasing the peak flows
c. By attracting more local employment and containing trips to within the local area it can be argued that the amount of travel in a regional sense is again reduced. This is in the sense that trip lengths are reduced meaning less vehicle kilometres of travel on the broader network.
d. If this phenomenon is considered and implemented on a wider scale then the positive benefits would be substantial in that the “base” traffic load on many parts of the road network would be reduced. This would lead to lower overall delays and less vehicle kilometres travelled. This would be a positive outcome in terms of all the environmental goals the NSW Government support.

4.3 Development and Parking Arrangements

The proposed development for the subject site is a residential home business based development. The proposed development is intended to provide a high technical based environment, with the aim of enhancing the local environment. The residential development aims to provide a central hub, providing dedicated technical support allowing the residents to work from home. The home offices will also provide employment opportunities for up to 2 staff, allowing for some work related activity on the site.

4.4 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 of land use activity, including residential type developments. The RTA guidelines provide advice on the critical movement periods during the morning and afternoon peak periods as well as daily traffic flows.

Advice from the project team indicates that the proposed development will provide a wide range of facilities aimed at encouraging home based work, as well as the provision of support staff for this home based office. The development will also provide high speed digital links to encourage in addition to home business, the use of home based shopping, video on demand and other entertainment options ensuring a reduced external traffic demand.

The RTA Guide to Traffic Generating Developments provides advice on traffic generation rates based upon the number of residential lots for the development. The information provided by the RTA Guide to Traffic Generating Developments is reproduced in **Table 4-1** below:

■ **Table 4-1 Traffic Generation rates for residential developments**

Land use	Peak rate	Daily Rate
Residential units	0.85 per dwelling	9 per dwelling

Source: RTA Guide to Traffic Generating Developments

145 residential lots are proposed within the site area. Based on the current planning for the development and the RTA guide for Traffic Generating Developments, the traffic flows associated with the proposed development would be in the region of 123 vehicles during the morning and afternoon peak periods and some 1305 vehicles per day.

The above traffic generation rates do not allow for any reduction in traffic flows due to the containment of traffic within the site due to the home business initiatives provided as part of the development. However, it can also be seen that the support staff who could be employed at the home based offices will generate additional traffic over and above normal residential traffic flows. The applicant advises an expected home business participation rate of 75% and an approximate external employment rate of 1 full time position per home owner participant. Overall it is considered that the possible reduction in external traffic movements due to the home based work will be balanced by additional traffic attracted to the site as part of the support staff.

From details collected as part of the home interview surveys in 1991, the percentage of work trips compared with daily trips has been determined to be in the region of 17%, as shown in **Table 4-2** below.

- **Table 4-2: Trips by Purpose - Morning Peak Hour**

Trip Purpose	Residents (% of trips)	Employees (% of trips)
Work	17	100
Education	30	-
Other	53	-
Total	100	100

Source: 1991 Home Interview Survey

This shows that by people choosing to work at home, the daily trip rate associated with a house can be reduced by up to typically 17% or two trips per day. However, in the proposed development this reduction in trips will be balanced by additional trips for support staff working in the houses. The numbers of which are expected to match home owner participation on average.

For the purposes of this assessment, the standard traffic generation rates provided by the RTA have been used. However, the normal directional split of 85/15 has been altered to 75/25, to reflect the lower external trips and the support staff accessing the site to work in the home based offices.

Whilst the impact on the local road network will be similar to a normal residential subdivision, it can be argued that the development would have a far greater positive impact upon the broader road network. It will help contain traffic movements within the local area, by providing local employment opportunities. In 2001 25.2% of Central Coast residents worked outside the region of which, 79% travelled by car to work. The provision of a projected 219 full time positions on site in addition to further 'spin off' local employment opportunities is therefore likely to result in a significant net reduction in movements on the broader road network and F3 freeway.

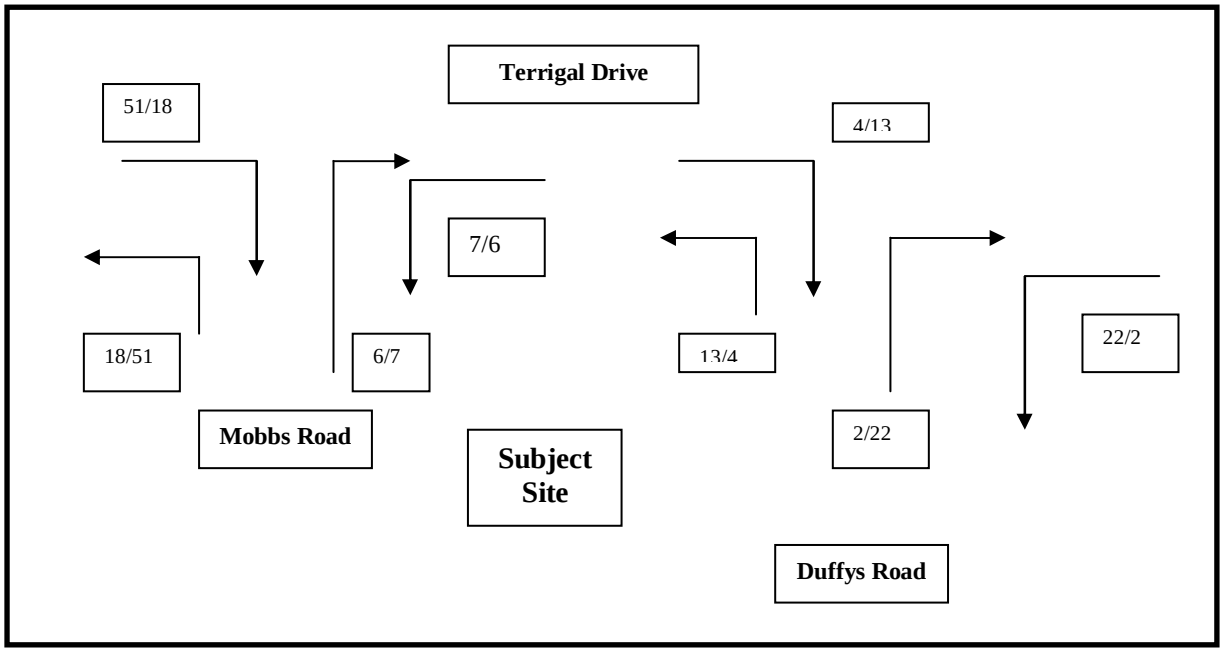
4.5 Traffic Distribution

It is considered that the traffic to and from the development would be split in a similar pattern to the current flows at the intersection of Mobbs Road and Terrigal Drive. These splits have been used to assess the impact of the development upon the local road network. It is considered that the majority of the traffic to and from the site will have an origin/destination to the west of the site, towards Erina and Gosford. The majority of commercial and retail centres are located to the west of the site in these locations.

For the purposes of this assessment, it is assumed that 70% of the traffic will have an origin/destination to the west of the site along Terrigal Drive.

It is also assumed that during the morning peak, the predominant traffic flow is inbound with some 75% of trips inbound and 25% outbound. The higher inbound flows are associated with the support staff working at the home based offices. During the afternoon peak periods, the traffic flows would be reversed It is considered that the split may be more equal, with 60% out and 40% during the morning peak. However, to ensure robustness of analysis for the intersections in the vicinity of the site a conservative 75/25 split has been assumed.

The future full development flows are presented in **Figure 4-1** below:



- **Figure 4-1**- Future Traffic Movements Associated with the Full Proposed Development

4.6 Parking

Parking is proposed to be provided on site in a number of locations. There will be normal residential parking spaces provided within each residential lot, with private garages and driveways for each lot. The applicant has advised that any additional parking required for the support staff who will be working within the development can be accommodated within these areas as a result of special setback requirements. Additional off street parking will also be provided to service the support facilities on site. The layout of the carparks will be in accordance with Council and/or Australian Standards.

Overall, it is considered that there will be no external parking impacts upon the local streets in the vicinity of the site.

4.7 Pedestrian and Cyclist Access

Pedestrian and cyclist will be able to access the site via the existing road network in the vicinity of the site. Due to the low traffic flows on the local road network it is considered that this provides an acceptable environment for pedestrians and cyclists. Within the site, it is proposed to provide a number of dedicated off street paths that will provide connections around the site and links to the major attractions such as the reserve area, with its recreational facilities. All of these off-street paths will provide a combined pedestrian/cyclist path and will be freely open for public access.

4.8 Public Transport

Current public transport facilities are provided by Busways and in the vicinity of the site are limited to Route 68. There are regular bus services to Terrigal and Erina Fair as well as regular school bus runs, which will provide a good service for the development as well as aid the reduction in general car demand. As indicated in **Table 4-2** above it can be seen that some 30% of morning peak hour trips are associated with education trips. With the provision of a school bus run immediately fronting the site there is scope for further reductions in traffic flows in and out of the site.

It is considered that a bus stop could be located to service the development, with good pedestrian link from the development to the stop. A bus stop should be provided on both sides of Kings Avenue to allow for both outward bound and inbound bus trips associated with this development.

4.9 Site Operations and Access Arrangements

The overall site plans for the proposal are presented in **Appendix C** to this report. The overall layout and road alignment for the internal roads are in accordance with Council requirements as well as advice provided within the AMCORD design handbook[5].

The main entry to the site is provided off Kings Avenue, with this access providing entry to the majority of the site. A secondary access is provided off Belar Avenue to the east. The intersection with Kings Avenue will be designed in accordance with Council requirements and it is considered that an intersection can be safely located in the locality indicated in the Masterplan, with adequate sight visibility splays in both directions being available. The link to Belar Avenue will connect directly onto the southern end of the existing sealed road carriageway.

It is considered that the vast majority of traffic associated with the site will be light vehicles. We are advised by the applicant that home business usage will be restricted to these services that place minimal demand upon commercial vehicle movements. The majority of heavy vehicles will be associated with refuse collection (by standard Council trucks) and the occasional delivery vehicle/removal truck. The layout of the site ensures that all vehicles will be able to enter and exit the site in forward direction.

The technical analysis of the site access operation is discussed further in **Section 5.**

4.10 Summary

The Parkside Development site presents a significant opportunity to influence travel behaviour through the application of alternate employment oriented development. The objective of reducing car dependency can be realised by providing positive local advantages to alternate transport such as walking, cycling and public transport while at the same time contributing to a potential reduction in trip lengths. Key features of the development include:

- Local on-site employment and support facilities
- Pedestrian movement focus.

- Possible integration of the on-site pedestrian and cycling network with external facilities developed in conjunction with local Council.

- Application on-site of accepted principles for transit oriented development including, mixed land use (i.e. on site employment opportunities), direct pedestrian and cycle links.

The proposed Parkside Development with the above initiatives in place represents a positive step in urban development towards shifting the balance in transport through reduced car dependency

5. Assessment of Transport Operations

5.1 Site Access Operations

5.1.1 Site Access on the Local Road Network

The proposed two access points from the development onto the local road network will ensure that the impacts of the development will be reduced, with the dispersion of flows between the two access points. It can be seen that the additional 123 vehicles generated by the development during the peak periods will have a minimal impact upon the local road network. The current local road network is currently operating well, with minimal delays to existing road users. It is considered that the additional traffic generated by the site will have a minimal impact upon the operation of the local road network.

The key impact of the additional traffic generated by the development on the local road network will be at the connections to Kings Avenue and Belar Avenue. It is considered that the intersection of the development with Kings Avenue can be provided in a safe location, offering good visibility for drivers approaching the intersection. Delays and congestion at this intersection would be minimal and safety can be maintained for all road users.

The existing intersection of Belar Avenue and Kings Avenue provides a safe and acceptable intersection layout. Whilst visibility is slightly restricted to the east of the site due to the brow of the hill on Kings Avenue, it is considered that safe stopping sight visibility, appropriate to the posted speed limit is provided and hence road safety is maintained.

5.2 Intersection Operation

The intersections of both Mobbs Road and Duffy Road have been analysed using the standard computer package SIDRA. SIDRA is a computer package designed to model the performance of a wide range of intersections including roundabouts, and is a package widely used by consultants, Councils and the RTA. It provides results on a wide range of performance indicators for intersection operation. 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.

The critical intersection in the vicinity of the site is the intersection of Duffy Road and Terrigal Drive and Mobbs Road with Terrigal Drive. While both of these intersections perform well now, additional traffic from the proposed development will use both of these intersections and the impact should be assessed.

5.2.1 Intersection Operation- 2008

The development flows shown above in Figure 3 have been used together with the existing traffic flows surveyed as part of the study to determine the operation of the existing roundabout controlled intersections on Terrigal Drive. It has been assumed that the full development will be provided from day one of opening as a worse case scenario. A summary of the results of the SIDRA analysis are presented below in **Table 5-1**and **Table 5-2** include the full development flows. Full details provided in **Appendix 'B'**.

- **Table 5-1**– Intersection performance, Terrigal Drive and Duffys Road 2008

Approach	Movement	LoS AM/PM	Delay (seconds) AM/PM	Queue (metres) AM/PM	D/S AM/PM
Terrigal Drive westbound	Through	A/A	8/8	63/27	0.7/0.47
	Left turn	A/A	8.4/8.6	63/27	0.75/0.47
Duffys Road	Left turn	B/A	16.6/12.4	18/7	0.415/0.197
	Right turn	B/A	19.0/14	27/11	0.527/0.275
Terrigal Drive eastbound	Right	A/A	12.3/12.0	4/8	0.103/0.176

- **Table 5-2**– Intersection performance, Terrigal Drive and Mobbs Road 2008.

Approach	Movement	LoS AM/PM	Delay (seconds) AM/PM	Queue (metres) AM/PM	D/S AM/PM
Terrigal Drive westbound	Through	A/A	8/8	77/28	0.78/0.50
	Left turn	A/A	9.2/10	77/28	0.78/0.299
Mobbs Road	Left turn	B/A	18/10.4	32/8	0.6/0.2
	Right turn	B/B	20.7/15.0	10/3	0.2/0.1
Terrigal Drive eastbound	Right	A/A	11.2/11.1	3/9	0.1/0.203

The above analysis shows that the current intersections on Terrigal Drive provide adequate capacity for the development to proceed.

5.2.2 Intersection Performance- 2018

The intersection has also been assessed assuming background growth in traffic volumes. A 1% per annum growth rate has been assumed, giving 10% growth over 10 years to the future design year of 2018. It should be noted that DIPNR have forecast Gosford to grow by 10% over the next 25 years representing a growth rate of only 0.4% p.a.

The summary results for the design year 2018 are shown below in **Table 5-3** and **Table 5-4** with more details provided in **Appendix 'B'.**

- **Table 5-3**– Intersection performance, Terrigal Drive and Duffys Road 2018

Approach	Movement	LoS AM/PM	Delay (seconds) AM/PM	Queue (metres) AM/PM	D/S AM/PM
Terrigal Drive westbound	Through	A/A	8/8	89/35	0.8/0.55
	Left turn	A/A	9/8.	89/35	0.8/0.55
Duffys Road	Left turn	B/A	23.6/12.8	30/10	0.6/0.25
	Right turn	B/B	29.8/16.1	50/15	0.75/0.34
Terrigal Drive eastbound	Right	A/A	12.6/12.9	6/9	0.1/0.2

- **Table 5-4**– Intersection performance, Terrigal Drive and Mobbs Road 2018

Approach	Movement	LoS AM/PM	Delay (seconds) AM/PM	Queue (metres) AM/PM	D/S AM/PM
Terrigal Drive westbound	Through	A/A	8/9	77/39	0.78/0.6
	Left turn	A/A	9/10	77/39	0.78/0.6
Mobbs Road	Left turn	B/A	24.3/12.1	32/10	0.58/0.24
	Right turn	B/B	28.2/17.9	10/14	0.253/0.11
Terrigal Drive eastbound	Right	A/A	12.3/12.2	4/11	0.1/0.23

The results of the analysis above show that the roundabouts at the intersection of both Mobbs Road and Duffys Road with Terrigal Drive will continue to have adequate capacity in 2018 with the proposed subject development flows, based on the DIPNR indicated growth rates.

6. Summary and Conclusions

The following summary is provided from the study work:

a. The proposed development allows for the provision of 145 residential homes, with home based office facilities with associated support facilities and recreational amenities located within the development. The site is located immediately to the south of Kings Avenue in Terrigal, NSW.

b. The main vehicular access to the site is proposed from Kings Avenue with a second access provided via Belar Avenue to the east of the subject site.

c. Existing traffic flows along the local road network in the vicinity of the site are very low. The majority of adjacent land use is residential development or public reserve. Kings Avenue and Belar Avenue are within technical capacity limits and operational levels of service are very good, with no delays and congestion for road users observed during the traffic survey.

d. The level of traffic generation from the subject site has been determined from the RTA Guide to Traffic Generating Developments. Whilst this guide makes no direct provision for the type of use proposed (home office), a number of quantitative judgements have been made to ensure currency of the guide. The RTA Guide to Traffic Generating Developments shows that during the critical morning and afternoon peak periods the total flows generated by the development is likely to be 123 vehicles per hour.

e. The additional traffic generated by the development can be accommodated on the local road network and the local roads will remain within their road capacity limits. The impact of these additional traffic movements have been assessed upon the intersections on Terrigal Drive and it can be seen that these existing intersections will continue to operate at a good level of service, with minimal delays and congestion for road users.

f. The traffic generated by the development of Parkside will not require any road upgrades on the adjacent road network.

g. The provision of a bus stop at Parkside, with associated footpaths, would improve accessibility for public transport users.

h. Parking for the proposed development can be contained within the site and will ensure there will be no impact upon the local streets in the vicinity of the site.

i. All vehicles, including service vehicles, will enter and leave the site in a forward direction. The site layout can adequately cater for these movements.

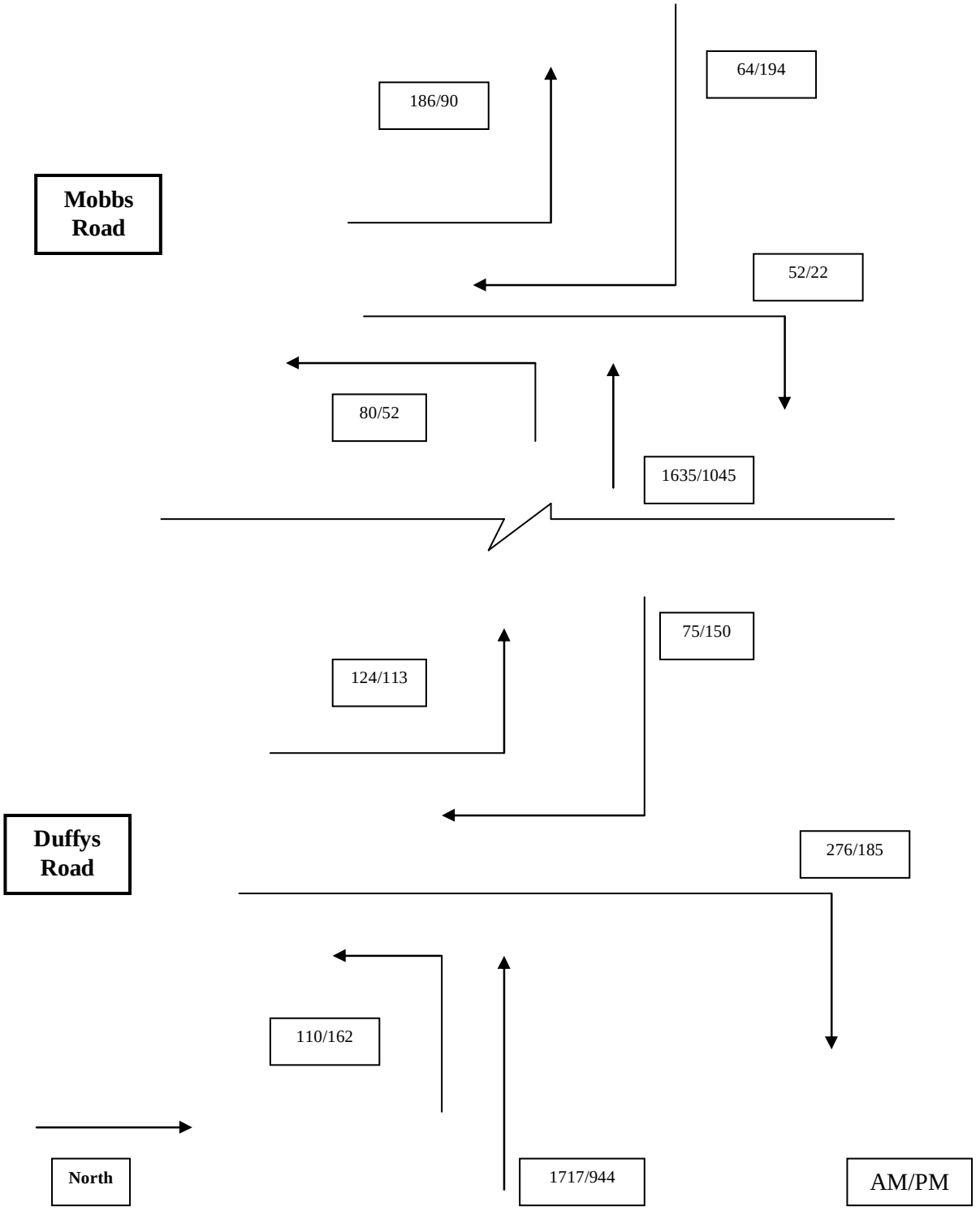
From the study, it is concluded that there will be minimal traffic impacts associated with the proposed development and there will be minimal increases in delays and congestion on the local road network.

Above and beyond the immediate local impact with the provision of support facilities for the home based office, it can be seen that whilst the impact on the local road network will be similar to a standard residential development, the impact upon the greater regional and metropolitan road network is likely to have a net reduction in traffic movements. The stated aim of the development is to encourage a locally based work environment with high standard electronic facilities and support services, reducing the demand for broader external traffic movements.

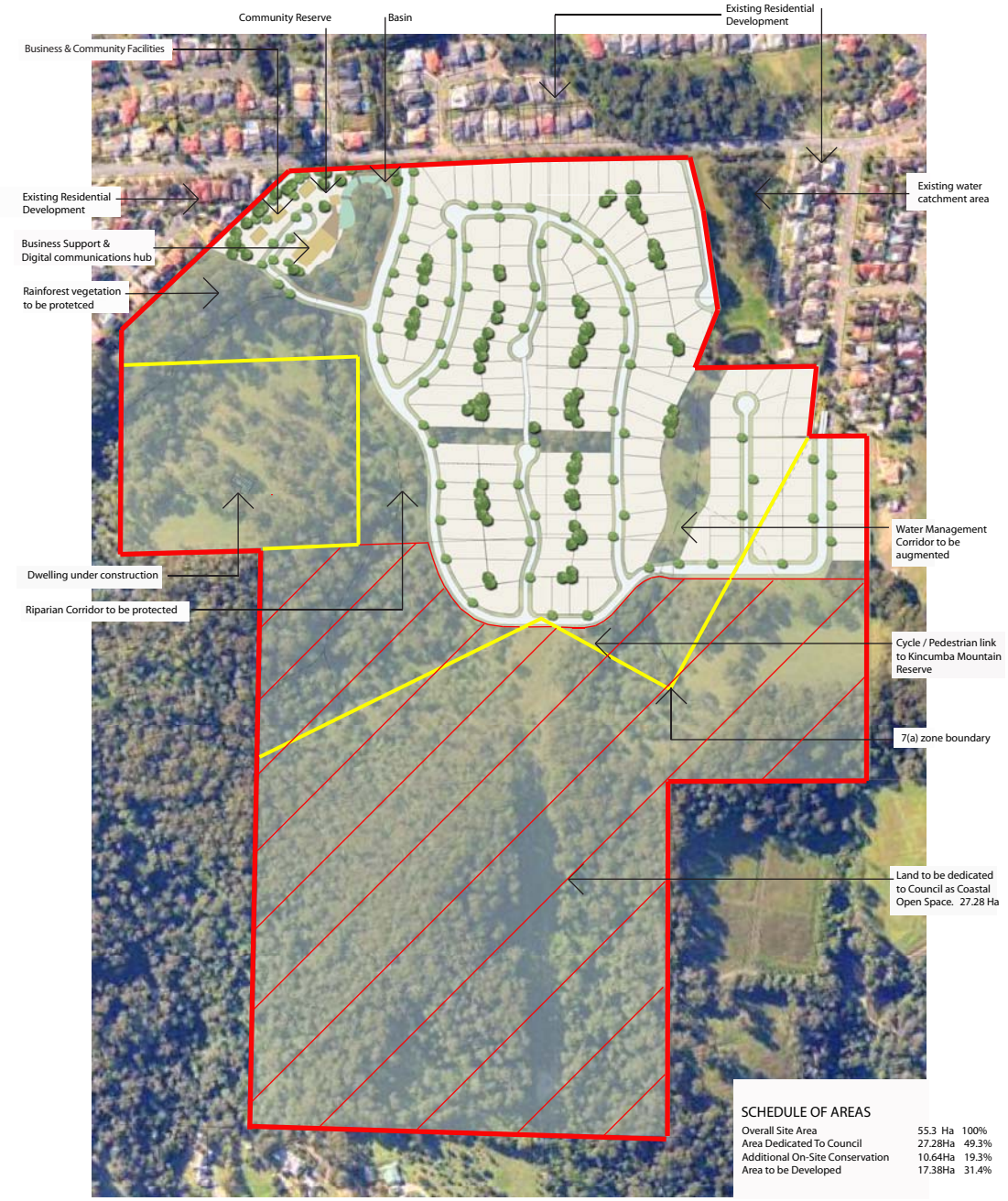
It is considered that the development should be approved on traffic and parking grounds.

Appendix A Traffic Survey Results

AUGUST 2008



Appendix B Site Plans



Appendix C Results for SIDRA Analysis

Full Sidra results are available upon request.

Intersection Summary
Roundabout controlled intersection of Duffy Road and Terrigal Dr * AM2008~1
2008 AM peak surveyed flows plus development flows

Performance Measure	Vehicles	Persons
Demand Flows - Total	2498 veh/h	3747 pers/h
Percent Heavy Vehicles	2.2 %	
Degree of Saturation	0.704	
Effective Intersection Capacity	3547 veh/h	
95% Back of Queue (m)	63 m	
95% Back of Queue (veh)	8.8 veh	
Control Delay (Total)	6.64 veh-h/h	9.95 pers-h/h
Control Delay (Average)	9.6 s/veh	9.6 s/pers
Level of Service	LOS A	
Level of Service (Worst Movement)	LOS B	
Total Effective Stops	1591 veh/h	2387 pers/h
Effective Stop Rate	0.64 per veh	0.64 per pers
Proportion Queued	0.53	0.53
Travel Distance (Total)	1520.7 veh-km/h	2281.0 pers-km/h
Travel Distance (Average)	609 m	609 m
Travel Time (Total)	32.8 veh-h/h	49.2 pers-h/h
Travel Time (Average)	47.3 secs	47.3 secs
Travel Speed	46.3 km/h	46.3 km/h
Operating Cost (Total)	1153 $/h	1153 $/h
Fuel Consumption (Total)	178.8 L/h	
Carbon Dioxide (Total)	447.3 kg/h	
Hydrocarbons (Total)	0.744 kg/h	
Carbon Monoxide (Total)	35.91 kg/h	
NOX (Total)	1.081 kg/h	

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Intersection Summary

Roundabout controlled intersection of Duffy Road and Terrigal Dr * PM2008~1
2008 PM peak surveyed flows plus development flows

Performance Measure	Vehicles	Persons
Demand Flows - Total	1682 veh/h	2523 pers/h
Percent Heavy Vehicles	1.8 %	
Degree of Saturation	0.471	
Effective Intersection Capacity	3574 veh/h	
95% Back of Queue (m)	27 m	
95% Back of Queue (veh)	3.9 veh	
Control Delay (Total)	4.28 veh-h/h	6.43 pers-h/h
Control Delay (Average)	9.2 s/veh	9.2 s/pers
Level of Service	LOS A	
Level of Service (Worst Movement)	LOS A	
Total Effective Stops	1122 veh/h	1683 pers/h
Effective Stop Rate	0.67 per veh	0.67 per pers
Proportion Queued	0.47	0.47
Travel Distance (Total)	1025.7 veh-km/h	1538.6 pers-km/h
Travel Distance (Average)	610 m	610 m
Travel Time (Total)	21.8 veh-h/h	32.7 pers-h/h
Travel Time (Average)	46.6 secs	46.6 secs
Travel Speed	47.1 km/h	47.1 km/h
Operating Cost (Total)	764 $/h	764 $/h
Fuel Consumption (Total)	118.8 L/h	
Carbon Dioxide (Total)	297.1 kg/h	
Hydrocarbons (Total)	0.497 kg/h	
Carbon Monoxide (Total)	23.95 kg/h	
NOX (Total)	0.718 kg/h	

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Intersection Summary
Roundabout controlled intersection of Duffy Road and Terrigal Dr * AM2018~1
2018 AM peak surveyed flows plus development flows

Performance Measure	Vehicles	Persons
Demand Flows - Total	2821 veh/h	4232 pers/h
Percent Heavy Vehicles	2.2 %	
Degree of Saturation	0.802	
Effective Intersection Capacity	3517 veh/h	
95% Back of Queue (m)	89 m	
95% Back of Queue (veh)	12.4 veh	
Control Delay (Total)	8.95 veh-h/h	13.42 pers-h/h
Control Delay (Average)	11.4 s/veh	11.4 s/pers
Level of Service	LOS A	
Level of Service (Worst Movement)	LOS B	
Total Effective Stops	1907 veh/h	2860 pers/h
Effective Stop Rate	0.68 per veh	0.68 per pers
Proportion Queued	0.68	0.68
Travel Distance (Total)	1717.4 veh-km/h	2576.1 pers-km/h
Travel Distance (Average)	609 m	609 m
Travel Time (Total)	38.8 veh-h/h	58.2 pers-h/h
Travel Time (Average)	49.5 secs	49.5 secs
Travel Speed	44.3 km/h	44.3 km/h
Operating Cost (Total)	1354 $/h	1354 $/h
Fuel Consumption (Total)	206.5 L/h	
Carbon Dioxide (Total)	516.8 kg/h	
Hydrocarbons (Total)	0.868 kg/h	
Carbon Monoxide (Total)	41.74 kg/h	
NOX (Total)	1.248 kg/h	

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Intersection Summary
Roundabout controlled intersection of Duffy Road and Terrigal Dr * PM2018~1
2018 PM peak surveyed flows plus development flows

Performance Measure	Vehicles	Persons
Demand Flows - Total	1925 veh/h	2888 pers/h
Percent Heavy Vehicles	1.8 %	
Degree of Saturation	0.551	
Effective Intersection Capacity	3494 veh/h	
95% Back of Queue (m)	35 m	
95% Back of Queue (veh)	5.0 veh	
Control Delay (Total)	5.08 veh-h/h	7.62 pers-h/h
Control Delay (Average)	9.5 s/veh	9.5 s/pers
Level of Service	LOS A	
Level of Service (Worst Movement)	LOS B	
Total Effective Stops	1329 veh/h	1993 pers/h
Effective Stop Rate	0.69 per veh	0.69 per pers
Proportion Queued	0.54	0.54
Travel Distance (Total)	1173.8 veh-km/h	1760.7 pers-km/h
Travel Distance (Average)	610 m	610 m
Travel Time (Total)	25.1 veh-h/h	37.7 pers-h/h
Travel Time (Average)	47.0 secs	47.0 secs
Travel Speed	46.7 km/h	46.7 km/h
Operating Cost (Total)	882 $/h	882 $/h
Fuel Consumption (Total)	136.9 L/h	
Carbon Dioxide (Total)	342.4 kg/h	
Hydrocarbons (Total)	0.574 kg/h	
Carbon Monoxide (Total)	27.72 kg/h	
NOX (Total)	0.829 kg/h	

Intersection Summary
Roundabout controlled intersection of Mobbs Road and Terrigal Dr * AM2008~2
2008 AM peak surveyed flows plus development flows

Performance Measure	Vehicles	Persons
Demand Flows - Total	2223 veh/h	3335 pers/h
Percent Heavy Vehicles	2.3 %	
Degree of Saturation	0.662	
Effective Intersection Capacity	3359 veh/h	
95% Back of Queue (m)	50 m	
95% Back of Queue (veh)	7.0 veh	
Control Delay (Total)	5.28 veh-h/h	7.92 pers-h/h
Control Delay (Average)	8.5 s/veh	8.5 s/pers
Level of Service	LOS A	
Level of Service (Worst Movement)	LOS B	
Total Effective Stops	1359 veh/h	2038 pers/h
Effective Stop Rate	0.61 per veh	0.61 per pers
Proportion Queued	0.46	0.46
Travel Distance (Total)	1349.6 veh-km/h	2024.5 pers-km/h
Travel Distance (Average)	607 m	607 m
Travel Time (Total)	28.4 veh-h/h	42.7 pers-h/h
Travel Time (Average)	46.1 secs	46.1 secs
Travel Speed	47.5 km/h	47.5 km/h
Operating Cost (Total)	1003 $/h	1003 $/h
Fuel Consumption (Total)	157.4 L/h	
Carbon Dioxide (Total)	393.9 kg/h	
Hydrocarbons (Total)	0.650 kg/h	
Carbon Monoxide (Total)	31.49 kg/h	
NOX (Total)	0.953 kg/h	

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Intersection Summary
Roundabout controlled intersection of Mobbs Road and Terrigal Dr * PM2008~2
2008 PM peak surveyed flows plus development flows

Performance Measure	Vehicles	Persons
Demand Flows - Total	1614 veh/h	2421 pers/h
Percent Heavy Vehicles	2.0 %	
Degree of Saturation	0.500	
Effective Intersection Capacity	3225 veh/h	
95% Back of Queue (m)	28 m	
95% Back of Queue (veh)	4.0 veh	
Control Delay (Total)	4.05 veh-h/h	6.07 pers-h/h
Control Delay (Average)	9.0 s/veh	9.0 s/pers
Level of Service	LOS A	
Level of Service (Worst Movement)	LOS B	
Total Effective Stops	1095 veh/h	1643 pers/h
Effective Stop Rate	0.68 per veh	0.68 per pers
Proportion Queued	0.47	0.47
Travel Distance (Total)	983.5 veh-km/h	1475.2 pers-km/h
Travel Distance (Average)	609 m	609 m
Travel Time (Total)	20.8 veh-h/h	31.2 pers-h/h
Travel Time (Average)	46.4 secs	46.4 secs
Travel Speed	47.3 km/h	47.3 km/h
Operating Cost (Total)	733 $/h	733 $/h
Fuel Consumption (Total)	114.6 L/h	
Carbon Dioxide (Total)	286.8 kg/h	
Hydrocarbons (Total)	0.477 kg/h	
Carbon Monoxide (Total)	23.12 kg/h	
NOX (Total)	0.695 kg/h	

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Intersection Summary
Roundabout controlled intersection of Mobbs Road and Terrigal Dr * AM2018~2
2018 AM peak surveyed flows plus development flows

Performance Measure	Vehicles	Persons
Demand Flows - Total	2595 veh/h	3893 pers/h
Percent Heavy Vehicles	2.4 %	
Degree of Saturation	0.785	
Effective Intersection Capacity	3305 veh/h	
95% Back of Queue (m)	77 m	
95% Back of Queue (veh)	10.8 veh	
Control Delay (Total)	6.81 veh-h/h	10.21 pers-h/h
Control Delay (Average)	9.4 s/veh	9.4 s/pers
Level of Service	LOS A	
Level of Service (Worst Movement)	LOS B	
Total Effective Stops	1651 veh/h	2477 pers/h
Effective Stop Rate	0.64 per veh	0.64 per pers
Proportion Queued	0.61	0.61
Travel Distance (Total)	1575.6 veh-km/h	2363.5 pers-km/h
Travel Distance (Average)	607 m	607 m
Travel Time (Total)	34.1 veh-h/h	51.2 pers-h/h
Travel Time (Average)	47.3 secs	47.3 secs
Travel Speed	46.2 km/h	46.2 km/h
Operating Cost (Total)	1201 $/h	1201 $/h
Fuel Consumption (Total)	187.3 L/h	
Carbon Dioxide (Total)	468.8 kg/h	
Hydrocarbons (Total)	0.779 kg/h	
Carbon Monoxide (Total)	37.86 kg/h	
NOX (Total)	1.139 kg/h	

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Intersection Summary
Roundabout controlled intersection of Mobbs Road and Terrigal Dr * PM2018~2
2018 PM peak surveyed flows plus development flows

Performance Measure	Vehicles	Persons
Demand Flows - Total	1834 veh/h	2751 pers/h
Percent Heavy Vehicles	2.1 %	
Degree of Saturation	0.592	
Effective Intersection Capacity	3098 veh/h	
95% Back of Queue (m)	39 m	
95% Back of Queue (veh)	5.4 veh	
Control Delay (Total)	4.87 veh-h/h	7.30 pers-h/h
Control Delay (Average)	9.6 s/veh	9.6 s/pers
Level of Service	LOS A	
Level of Service (Worst Movement)	LOS B	
Total Effective Stops	1316 veh/h	1974 pers/h
Effective Stop Rate	0.72 per veh	0.72 per pers
Proportion Queued	0.54	0.54
Travel Distance (Total)	1117.3 veh-km/h	1676.0 pers-km/h
Travel Distance (Average)	609 m	609 m
Travel Time (Total)	23.8 veh-h/h	35.7 pers-h/h
Travel Time (Average)	46.8 secs	46.8 secs
Travel Speed	46.9 km/h	46.9 km/h
Operating Cost (Total)	839 $/h	839 $/h
Fuel Consumption (Total)	131.2 L/h	
Carbon Dioxide (Total)	328.3 kg/h	
Hydrocarbons (Total)	0.547 kg/h	
Carbon Monoxide (Total)	26.59 kg/h	
NOX (Total)	0.798 kg/h	

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Appendix D List of References

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