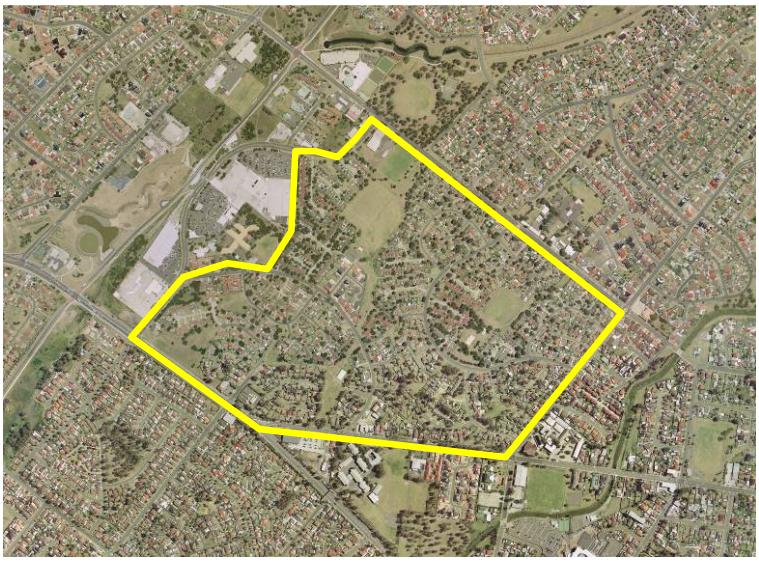
Traffic and Transport Study for Bonnyrigg Living Communities



TRANSPORT MANAGEMENT AND ACCESSIBILITY PLAN (TMAP)

- Final Report
- 28 October 2008

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1. Introduction

1.1. Summary

Sinclair Knight Merz was commissioned by Hughes Trueman Pty Ltd, on behalf of Bonnyrigg Partnerships, to undertake a Traffic and Transport Assessment for Bonnyrigg Living Communities. As part of the engagement, a Transport Management and Accessibility Plan (TMAP) was prepared for submission as part of the application process.

This report was prepared in accordance with the guidelines for TMAPs to support a Part 3A application to the Department of Planning and Fairfield City Council.

1.2. Background

The Bonnyrigg Living Communities forms part of the Department of Housing's broader "*Living Communities Program*" to renew and strengthen communities in high-need public housing estates in NSW. The Bonnyrigg Living Communities commenced in December 2004.

The project involves the integrated renewal of the Bonnyrigg Estate which covers an area of 81 hectares and contains about 830 Social Housing dwellings. Approximately 90 privately owned properties are located within the Estate boundaries. However, these private sites are not included within the Concept Plan. The regeneration of the Bonnyrigg Estate includes:

- Design and construction of new infrastructure;
- Design and construction of new Social Housing and private housing;
- Rehabilitation of existing infrastructure;
- Refurbishment of existing Social Housing; and
- Potentially increasing the number of cottages, townhouses and units located within the Estate.

Under the project, private sector involvement includes responsibility for financing, planning, developing, designing, construction, refurbishment and maintenance of the public housing, as well as providing tenancy management services over a 30 year period.

Crucial to the development process is the retention of services to all existing residents. A Draft Concept Plan has been prepared and a partnership with the community has been forged to ensure the success of the project.

1.3. Structure of this Report

Following this Introductory Section, **Section 2** presents the Study Objective and **Section 3** presents the Strategic Context of the planning exercise;

Section 4 presents the objectives and targets for the TMAP;

Section 5 of this report elaborates on the existing transport situation and details the opportunities and constraints to development for ensuring the effective, timely and economical achievement of the project goals and objectives;

Section 6 describes travel demand, including the trip generation rates associated with the type of development, the target mode shift, as well as the distribution of trips during the peak hours;

Details of the proposed re-development are explained in **Section 7**;

Section 8 describes the future transport situation and summarises the traffic modelling undertaken and identifies traffic impacts related to the proposed development. Impacts and opportunities of other modes are also discussed;

Section 9 details the mode choice and discusses the parking occupancy surveys results;

Section 10 describes the proposed package of measures;

Section 11 determines the costs and apportionment and outlines the TMAP Agreement; and

Section 12 summarises the key conclusions and recommendations;

Appendix A contains the "*Paramics Modelling Report*" dated 9 November 2007 which describes the development, calibration and validation of the Paramics 2007 AM and PM peak hour Base Case models;

Appendix B contains the "*Bonnyrigg Urban Renewal Project Sensitivity Analysis*" memorandum dated 9 November 2007 which describes the impact of intersection performance under a higher background traffic growth rate;

Appendix C contains the "*School Safety Measures Report*" dated 13 March 2008 which assesses the current safety measures at schools located in close proximity to Bonnyrigg and provides measures to further enhance safety; and

Appendix D contains the "*Parking Occupancy Surveys – Malabar, Stanhope Gardens, North Parramatta and Bonnyrigg*" memorandum dated 29 April 2008 which describes the parking supply and demand in similar areas to proposed Bonnyrigg development.

2. Study Objective

A Concept Plan and Stage 1 Project Plan has been lodged simultaneously with the Department of Planning (DoP) and assessed concurrently by Fairfield City Council under delegation from the Director General of the DoP. A preliminary staging plan prepared for the project indicates project implementation in 18 stages. The primary purpose of staging is to facilitate continued functioning of the Bonnyrigg community during the project life, thus ensuring uninterrupted services to the remaining community as development takes place.

As part of the approval process, a Traffic and Transport Assessment was undertaken to address issues associated with the environmental assessment requirements in the development of the Master Plan and the Development Application for Stage 1. Brief traffic reports for each of the subsequent Staged DA's will also be prepared in the future.

The environmental assessment requirements under part 3A of the Environmental Planning and Assessment Act 1979 identified the following key issues to be addressed:

- Strategic transport policy matters;
- Opportunities to minimise traffic on sensitive road frontages (schools, high density residential development, Town Centre streets);
- Efficiency of new roads, as well as proposed access and circulation, car parking (including parking restrictions), and drop off arrangements for schools and facilities;
- Emergency and any service vehicle access/egress;
- Proposed access from the wider road network, as well as opportunities and constraints of alternative vehicular access points;
- Measures to promote public transport usage and influence mode share;
- Pedestrian and bicycle linkages;
- Capacity assessment of intersection and measures for improvements; and
- Initiatives which help lessen reliance on private vehicles by residents.

This TMAP was developed to assess the transport implications of the future development of the Bonnyrigg Estate area. The TMAP concept embodies critical elements of a traffic and transport impact assessment associated with land development, wherein traffic generation was estimated, its impact on regional and sub-regional traffic network was assessed, avenues to achieve mode shift away from private car commuting were developed, and cost sharing explored.

A range of optimum transport measures were identified to accommodate future development within the Bonnyrigg Living Communities over the next 15 to 20 years. The concept plan introduced a number of changes to the future development of the Bonnyrigg Living Communities. This study

assessed the impact of the proposed development, and identified measures (in terms of infrastructure and services) necessary to ensure a successful outcome for the project. A responsibility cost sharing matrix for the package of transport measures is an important result of the study. This includes the cost, timing and funding implications of additional infrastructure and services.

3. Strategic Context

NSW Government Planning Strategies have been articulated in the following documents:

- State Plan : A New Direction for NSW (2006);
- Urban Transport Statement: Responding to the Challenges of Travel and Transport within and across Sydney (2006);
- State Infrastructure Strategy: NSW 2006-07 to 2015-16 (2006);
- Metropolitan Strategy (2005);
- Action for Transport 2010 – an Integrated Transport Plan for Sydney;
- Shaping our Cities (1999);
- Shaping Western Sydney (1998);
- Action for Air (1999);
- Draft SEPP 66 "Integration of Landuse and Transport" and
- Review of Bus Services in New South Wales (Unsworth Review).

A summary of the priorities identified in these documents is provided below.

3.1. State Plan

The State Plan outlines the government's initiatives towards governance, delivering community services, creating opportunity and managing economic growth and management of the environment. The Plan guides key services, set priorities and plans for the long term development of NSW.

The State Plan explicitly defines "*increasing share of peak hour journeys on a safe and reliable public transport system*" as one of its objectives and seeks to increase the use of public transport by providing quality service and increasing capacity. The 2005 figures show that 72.8% of commute to the Sydney CBD during peak hour were made through public transport. However, this figure changes to 22% when considering the proportion of trips being made by public transport through the Sydney Metropolitan area. The following are specific targets to achieve the overall objective of increasing public transport journeys:

- Increase the share of commute trips made by public transport to and from Sydney CBD during peak hours to 75% by 2016;
- Increase the proportion of total journeys to work by public transport in the Sydney metropolitan region to 25%; and
- Consistently meet public transport reliability targets for all forms of public transport.

The State Plan describes initiatives currently being implemented to improve the overall transport capacity and reliability, and includes additional infrastructure and rolling stock for bus and rail. New initiates to improve public transport include:

- Improved rail capacity through improved signalling and other technology;
- Improved public transport service quality, frequency and extensions to peak hour services;
- Improved passenger information systems; and
- Better coordinated timetable and public transport interchanges/stops.

3.2. Urban Transport Statement

The Urban Transport Statement identifies key transport issues in Sydney some of which being population growth, diverse / complex travel patterns and travel time reliability. Sydney is expected to reach a population of 5 million by 2022, with a projected increase of 400,000 homes by the same year in the west alone. An overall increase of 25% in daily trips is also expected by 2022 from the current weekday average of 15.54 million trips. The statement reaffirms balanced investment in both road and rail will continue and would include:

- Expansion of the motorways network, arterial upgrades, added infrastructure and pinch point alleviation for roads;
- Extension of the rail network and untangling of the system through the rail clearways program;
- Strategic bus corridors and bus priority routes across Sydney as well as the increased use of technology and expansion of bus fleets;
- Improving the safety and reliability of existing ferry fleets;
- Providing for cycling facilities as part of all major road construction and the continual expansion of Sydney's bicycle network; and
- Maximising pedestrian access within key centres and integrating pedestrian networks.

The Urban Transport Statement broad goal to the States transport needs is "*increasing the number of daily trips on public transport*" and that "*maintaining public transport systems at high levels of reliability as a precondition of greater patronage*".

3.3. State Infrastructure Strategy

The State Infrastructure Strategy defines infrastructure commitments and priorities until 2016. An investment of $1.6 billion is planned on transport with public transport spending exceeding the amount spent on roads. Major investment commitments include road and rail corridor preservation, rail upgrade and expansion, bus priority and ticketing and information systems.

3.4. Metropolitan Strategy

The Metropolitan Strategy for Sydney was released by the New South Wales Government in December 2005. "*City of Cities – A Plan for Sydney's Future*" is a broad framework to secure Sydney's place in the global economy by promoting and managing growth. It is a strategic document that outlines a vision for Sydney over the next 25 years.

The Metropolitan Strategy supports continued economic growth while balancing social and environmental impacts. It is based on anticipated population, economic and demographic trends. The Strategy includes priorities for planning, and responsibilities of each level of Government including investment priorities and a context for decision-making by Local Government and the private sector. The document elaborates on strategies for separate components relating to housing, employment and economy, centres and corridors, transport, parks and public places. The relevant key elements of the vision include:

- Continued growth of Sydney and North Sydney with an increased role for Parramatta, Penrith and Liverpool as regional centres;
- Directed growth in jobs to regional centres and specialised centres in Western Sydney; specifically concentrated around the M7/M4 corridors;
- Containment of the urban footprint;
- Strengthened major centres, which will be the focus for regional shopping, health and tertiary education, and some medium and high density housing;
- Improved access to existing and planned centres through investment in rail and strategic bus corridors;
- Ensured bus speed of at least 25km/hour and bus priority on all strategic corridors; and
- Linked growth in housing with improved communication and transport connections.

The Metropolitan Strategy identified Fairfield as a potential "major centre" that could become increasingly important to Bonnyrigg Living Communities for shopping and services. The Bonnyrigg Living Communities is located within a potential renewal corridor that runs between Liverpool, Prairiewood and Parramatta. This corridor offers high amenity to residential uses due to its proximity to public transport, employment, shopping and services. The Liverpool – Parramatta Transitway that serves Bonnyrigg Living Communities is an integral part of the strategic bus corridors identified in the Metropolitan Strategy.

Funding is an integral component to the planning of the new metropolitan strategy. The Government has indicated its commitment to identifying innovative sources of funding to cover costs for the infrastructure required to support the growth of the region. The funding and apportionment of the package of measures identified through this TMAP process is discussed in more detail in **Section 10**.

3.5. Other Relevant Planning Strategies

3.5.1. Action for Transport 2010 – Integrated Transport Plan for Sydney

Action for Transport 2010 – An Integrated Transport Plan for Sydney was produced by the New South Wales Government with the objective of providing a transport plan for Sydney to 2010 and beyond. It outlined the challenges for the Sydney transport system, namely:

- reducing traffic congestion;
- improving air quality;
- reducing greenhouse emissions;
- increasing public transport use;
- expanding CityRail capacity;
- making freight more competitive; and
- improving road safety.

The Plan also established targets that would enable the current growth in VKT (vehicle-kilometres of travel) to be halted. In order to achieve these targets the following ten-point action plan for Sydney was proposed:

- getting the best out of the Sydney system;
- improving Sydney's air quality;
- reducing car dependency;
- meeting the needs of our growing suburbs;
- getting more people on public transport;
- safeguarding our environment;
- making space for cyclists and walkers;
- preventing accidents and saving lives;
- making freight more competitive; and
- giving the community value for money.

Against each of these actions, specific projects and requirements to achieve the targets were identified. Options for achieving the targets for alternative modes were also considered.

Action for Bikes 2010 was an accompanying document to Action for Transport 2010 and was released in September 1999. Action for Bikes seeks to increase levels of cycling in Sydney through a four step plan that includes improving the cycling network, making it safer to cycle, improving personal and environmental health, and raising community awareness.

A key innovation of Action for Bikes was the development of rail trails, such as the Liverpool-Parramatta rail trail, by the RTA in cooperation with rail agencies.

Whilst it is recognized that the Action for Transport is no longer considered an adequate current Government policy statement since the release of the Sydney Metropolitan Strategy, the general principles remain the same. Furthermore, the accompanying documents, ie Action for Bikes, continue to influence policy directions.

3.5.2. Shaping our Cities, 1999

Shaping our Cities was a NSW State Government Initiative, which set out the planning strategy for the greater metropolitan area of Sydney. Its core function was about managing our cities and forging stronger partnerships with councils and communities to enable the goals of the region to be matched with local needs and aspirations.

The travel strategy formulated in this document was based on the premise that significant changes to managing travel demand and influencing transport choice were underway. New directions were proposed to maintain high levels of access without causing excessive road congestion and poor air quality.

The strategy encourages:

- Urban structures which make public transport, walking and cycling more attractive and viable while moderating car use;
- Giving priority to the proper consideration of transport in the land use planning and assessment process with active discouragement of unnecessary car use;
- Improved public transport infrastructure and services with stronger cross regional links and support for Parramatta and other major centres; and
- Better management of commercial vehicle movements, especially freight.

3.5.3. Shaping Western Sydney, 1998

Shaping Western Sydney consolidated the range of planning policies that apply to Western Sydney. The Western Sydney region comprises the local government areas of: Auburn, Bankstown, Baulkham Hills, Blacktown, Hawkesbury, Penrith, Blue Mountains, Parramatta, Holroyd, Fairfield, Liverpool, Campbelltown, Camden and Wollondilly.

Shaping Western Sydney covers the key planning areas of work, environment, housing and access. The accessibility outcomes targeted in Western Sydney include:

- Public transport that is accessible throughout Western Sydney;

- Defined transit corridors that provide public and private transport links to major activity areas within the region;
- Urban areas structured to make public transport, walking and cycling more attractive and viable while moderating car use; and
- Major employment areas that have excellent access to the major road and rail network for freight movement.

3.5.4. Action for Air, 1999

Action for Air - The New South Wales Government made a significant commitment to develop and implement a comprehensive long-term plan to protect air quality across NSW. Action for Air incorporates a 25-year plan that tackles the range of emissions specifically affecting the Greater Metropolitan Region of Sydney, the Illawarra and the Lower Hunter.

Reducing emissions from motor vehicles was the highest priority if the goals within the document were to be met in the long term. The Government set in place a multi-pronged approach to achieve this. Improving transport choices and encouraging people to take fewer and shorter trips by individual motor vehicles were key objectives. This would rely heavily on developing a progressive transport plan, which was linked to the regions' five-year urban infrastructure management plan. Providing improved public transport and encouraging cycling and walking, as well as integrating the planning of freight movement, were also essential objectives on the path to achieving clean air.

3.6. Draft SEPP 66 – Integration of Landuse and Transport, 1999

Draft SEPP 66 addresses the need to integrate landuse planning with transport planning. It recognises a fundamental issue that these two disciplines are inextricably linked, and implication of each need to be addressed. SEPP 66 embodies a number of key transport planning issues and identifies a number of key principles that must be recognised in proposing landuse developments.

The ten principles of SEPP 66 that support integrated landuse/transport interaction include:

- *Concentrate in centres* - Develop concentrated centres containing the highest appropriate densities of housing, employment, services and public facilities within an acceptable walking distance (400 to 1000 metres) of major public transport nodes, such as railway stations and high frequency bus routes (with at least a 15 minute frequency at peak times);
- *Mix uses in centres* - Encourage a mix of housing, employment, services, public facilities and other compatible land uses, in accessible centres;
- *Align centres within corridors* - Concentrate high density, mixed use, accessible centres along major public transport corridors within urban areas;

- *Link public transport with land use strategies* - Plan and implement public transport infrastructure and services in conjunction with land use strategies to maximise access along corridors, and to and from centres;
- *Connect streets* - Provide street networks with multiple and direct connections to public transport services and efficient access for buses;
- *Improve pedestrian access* - Provide walkable environments and give greater priority to access for pedestrians, including access for people with disabilities;
- *Improve cycle access* - Maximise cyclists' accessibility to centres, services, facilities and employment locations;
- *Manage parking supply* - Use the location, supply and availability of parking to discourage car use;
- *Improve road management* - Improve transport choice and promote an integrated transport approach by managing road traffic flow and priority of transport modes; and
- *Implement good urban design* - Design with an emphasis on the needs of pedestrians, cyclists and public transport users.

The release of a draft State Environmental Planning Policy (SEPP) on integrated land use and transport planning in 2001 was indicative of the Government's heightened focus on this issue. Increasing densities, providing public transport, walking and cycling infrastructure and developing travel demand management programs will be critical in the delivery of the Metropolitan Strategy.

The policy represents an integrated approach to urban management and transport planning. The package emphasises the importance of effectively integrating land use and transport planning in order to improve urban environments.

3.7. Review of Bus Services in New South Wales (Unsworth Review)

The Unsworth Review was aimed at examining and making recommendations to improve the provision of bus services in New South Wales. The Review primarily considered regular bus services and recommended changes to bus operations and licensing (bus reform), contract boundaries and a network of strategic corridors between Centres.

Unsworth proposed a network of 43 strategic bus corridors to link Sydney's major centres, railway stations, hospitals, education facilities and other community facilities, improving access to important destinations. The strategic network would be complemented with local bus services through bus contract reform to create larger, integrated compact regions. The Liverpool-Parramatta Transitway, located along Bonnyrigg Living Communities, forms one of the strategic corridors.

4. TMAP Objectives and Targets

4.1. TMAP Objectives

The fundamental objective of this TMAP is to identify a package of appropriate transport measures and strategies which will facilitate improved transport outcomes for Bonnyrigg Living Communities. The TMAP aims to:

- Manage the transport impacts of the proposed development;
- Provide an integrated transport network between modes and land uses;
- Provide alternative modes to private car to help reduce reliance on private car and allow optimum use of public transport, walking and cycling;
- Provide a system that is efficient and comprehensively accessible; and
- Provide a healthy environment.

The TMAP objectives are consistent with wider planning context, described in **Section 3** and specifically the, State Plan, State Infrastructure Strategy, Urban Transport Statement and Metropolitan Strategy (that supports reduced travel by private car and increased public mode share). Crucial to successfully achieving these objectives is adequate consideration of factors that have an impact of people's travel behaviour. These factors include but are not limited to:

- Availability of alternative modes;
- Service frequency of public transport;
- Accessibility to non-car modes;
- Pedestrian amenities and quality of pedestrian environment; and
- Availability of parking.

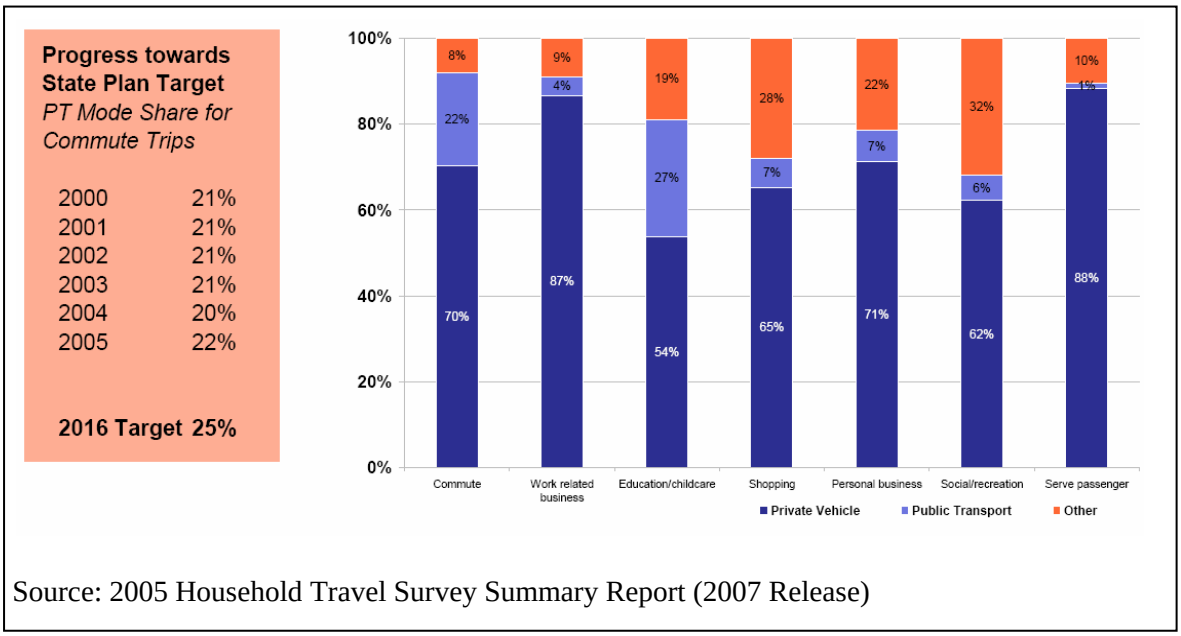
4.2. TMAP Target

In New South Wales, the state government formalised its commitment to sustainability in transport by stipulating as one of its key priorities in the 2006 State Plan its aim of "*increasing share of peak hour journeys on a safe and reliable public transport system*". This objective identified the following two targets pertaining to the use of public transport (Premiers Department, 2006):

- Increase the share of trips made by public transport to and from the Sydney CBD during peak hours to 75% by 2016 (currently 72%); and
- Increase the proportion of total journeys to work by public transport in the Sydney metropolitan region to 25% by 2016 (currently 20-22%).

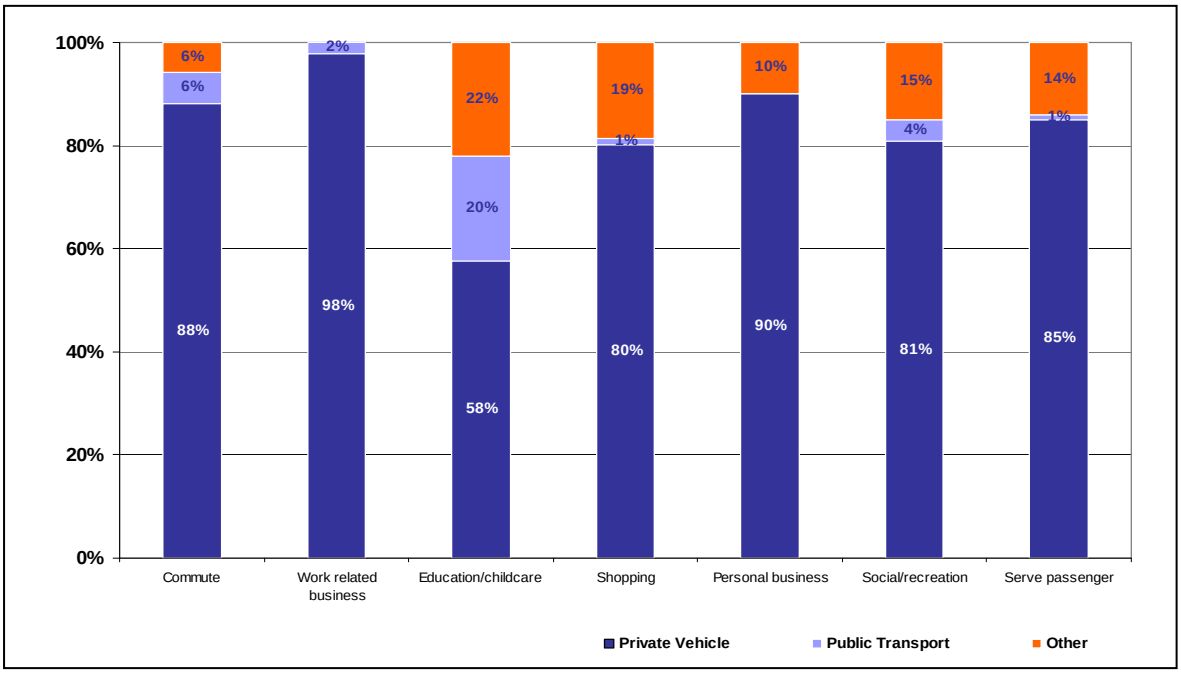
The State target considered more relevant to Bonnyrigg redevelopment is the target that applies to total journey to work. **Figure 4-1** illustrates the proportion of trips by mode on an average weekday, 2005. **Figure 4-2** illustrates the trips by purpose and mode for Bonnyrigg, 2005.

- **Figure 4-1 Overall Proportion of Trips by Purpose and by Mode on an Average Weekday, 2005**



Source: 2005 Household Travel Survey Summary Report (2007 Release)

- **Figure 4-2 Bonnyrigg Proportion of Trips by Purpose and by Mode on an Average Weekday, 2005**



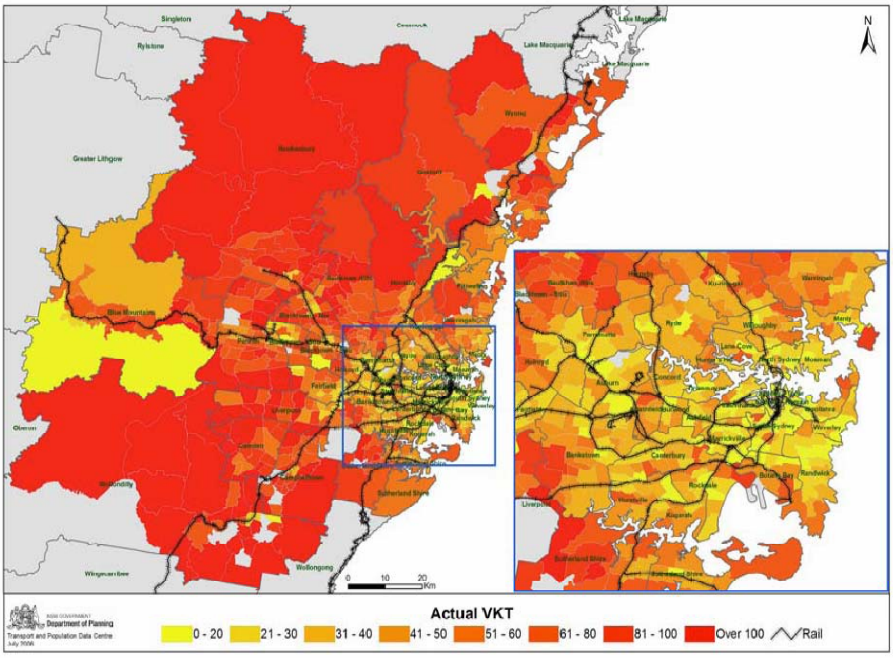
4.2.1. Bonnyrigg Total Daily Trips

Data from the Household Travel Survey[1] indicates that 20% of daily trips and peak period trips for all purposes in the Bonnyrigg Precinct are already undertaken using non-car modes. About 15% of trips are walking with the remaining 5% by public transport.

4.2.2. Bonnyrigg Journey to Work

Of the journey to work (commuter) trips, 6% walked to work, while a further 6% travelled by public transport (1% by bus and 5% by train), 78% of commuters were vehicle drivers, while 10% were passengers in a vehicle. During the AM and PM peak hours 7% of commuters travelled by public transport while 6% travelling by public transport during the PM peak. 8% of AM peak commuters and 7% of PM peak commuters walked. The journey to work mode share in Bonnyrigg is less than one fifth of the Sydney average. Similarly as shown in **Figure 4-3** the average vehicle kilometres travelled in Fairfield Council area and Bonnyrigg is higher that the average value. Thus the use of the average value State target value was considered inappropriate to use for the Bonnyrigg TMAP. The Bonnyrigg TMAP target is described below.

- **Figure 4-3 Average VKT Generated by Household by Travel Zone**



Source: Corpuz, McCabe and Ryszawa, 2006

[1] Household Travel Survey by Statistical Local Area (Total Daily Travel), Transport Data Centre, 2004.

4.2.3. TMAP Target

The recently implemented Liverpool-Parramatta Transitway provides Bonnyrigg Living Communities with a good platform for increased public transport usage and increased public transport mode share. The Transitway coupled with current MoT bus routes review and the provision of good infrastructure to support bus operations could increase existing public transport mode share by 50% from existing levels of around 5% to 7% - 8%. A stretch target would be to increase public transport mode share to 10%.

4.2.4. Bus Service Delivery

The current Service Planning Guidelines for bus services focuses on delivering an integrated network whilst providing greater flexibility for operators to allow more flexible routing and servicing. It is envisioned the 90% of households should be within 400 metres of a bus route during commuter peaks and day times. For night time services, 90% of the households should be within an 800 metres coverage area.

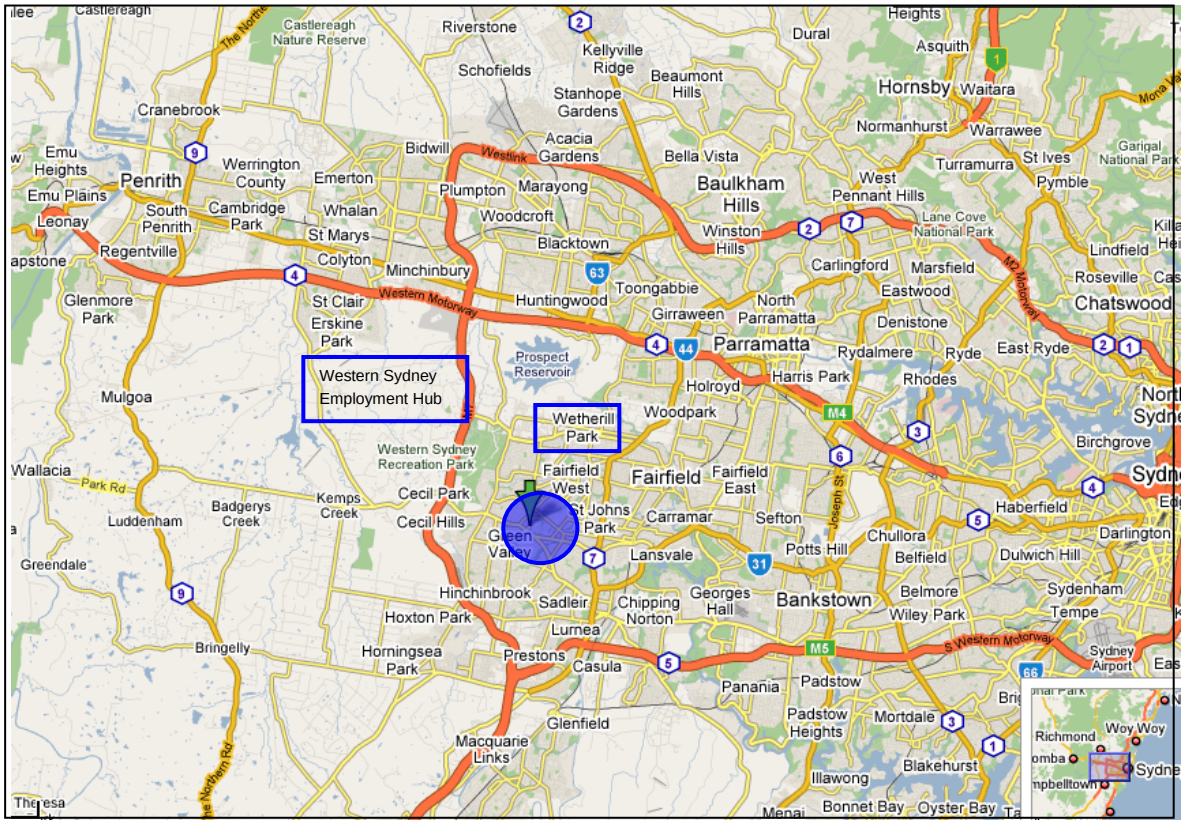
4.2.5. Road Network Performance Targets

Road network capacity is mainly controlled by intersections within the network. A simple index to assessing intersection performance is based on the level of service provision. A Level of Service "D" is acceptable to the RTA as it relates to traffic levels at 85% of theoretical maximum capacity. Achieving a Level of Service "D" or better, for the main intersections in the Bonnyrigg precinct development, was used as the benchmark for intersection performance.

5. Existing Transport Situation

The Bonnyrigg Living Communities is located in the Fairfield Local government area in Western Sydney. The nearest major regional city is Liverpool. The site is easily accessible from the Westlink M7 and the M5 motorway, with access provided via Elizabeth Drive and the Cumberland Highway. The site is in close proximity to the Liverpool-Parramatta Transitway, and is located within reasonable proximity to significant employment lands such as the Western Sydney Employment Hub and Wetherill Park.

- **Figure 5-1 Location of the Study Area**



5.1. Road Network

The main roads in the Bonnyrigg Living Communities and their characteristics are presented below. Average Annual Daily Traffic (AADT) flows for key roads were sourced from the most recent RTA data sources[2].

[2] RTA NSW Traffic Volume , 2002

5.1.1. Elizabeth Drive

Elizabeth Drive runs north-west from Bigge Street in Liverpool to the Northern Road in Luddenham and provides connection to the M7 in Cecil Hills. This Arterial Road varies between 1, 2 and 3 lanes, and has a posted speed of 50, 60 and 80kph. Towards Liverpool, a "T2" lane operates in the South East Direction.

5.1.2. Cabramatta Road West

Cabramatta Road West is an arterial road running east and west from Elizabeth Drive in Bonnyrigg to Railway Parade at Cabramatta Station. It consists of 2 lanes in both directions and has a posted speed of 60kph.

5.1.3. Humphries Road

Humphries Road runs north-east from Cabramatta Road West to Avoca Road in Canley Heights. This road is classified as a collector and has one lane in each direction and a posted speed of 60kph.

5.1.4. Edensor Road

Edensor Road runs north-west from Harrington Street in Cabramatta West to Cowpasture Road in Edensor Park. This road is classified as a sub-arterial and has a posted speed of 60kph. Two lanes run in each direction between Bonnyrigg Avenue and Smithfield Road, and one lane from Harrington to Bonnyrigg and one lane from Smithfield Road to Cowpasture Road.

5.1.5. Bonnyrigg Avenue

Bonnyrigg Avenue is a sub-arterial road running north-east between Elizabeth Drive and Edensor Road. This road varies between 1 and 2 lanes with a posted speed limit of 60kph. Bonnyrigg Avenue is the address for many community facilities such as the Bonnyrigg Plaza, Bunnings Retail, Health Centre, The Croatian Club and Buddhist Temple.

5.2. Public Transport

The Study Area is serviced by buses, with the Liverpool-Parramatta Transitway passing north-south immediately to the west of Bonnyrigg Living Communities. The nearest railway station is Cabramatta, approximately 4.4 kilometres to the east of the site. From Cabramatta, trains run north to Parramatta (during the AM and PM peak), to Sydney CBD to the east and Campbelltown in the south (between 4AM and 12AM).

The remainder of this analysis concentrates on bus services.

5.2.1. Existing Bus Services

Bonnyrigg Living Communities is within the service area of the Westbus bus company. Westbus is a private bus company which operates a number of routes throughout Sydney's western and south western suburbs.

Three Westbus services operate within the Study Area, while an additional two operate on Cabramatta Road, Elizabeth Drive and Edensor Road that form the boundary to Bonnyrigg Living Communities. Routes passing through Bonnyrigg Living Communities include:

- **Route 831**: Cabramatta - Greenfield Park via St John and Bonnyrigg. This route enters the Study Area from Greenfield Park to the north along Bonnyrigg Avenue, follows Tarlington Parade to Cabramatta Road, then continues east along Cabramatta Road to Cabramatta;
- **Route 835**: Liverpool - Penrith via Bonnyrigg, Cecil Park and Erskine Park. This route utilises Cabramatta Road and Elizabeth Drive and passes on the southern boundary of the Study Area; and
- **Route 827**: Fairfield - Cabramatta via Brenan Street, Stockland Mall, Bosley Park, Abbotsbury, Edensor Park, Bunker Parade and St Johns Road. This route stops at various sites within the Study Area.

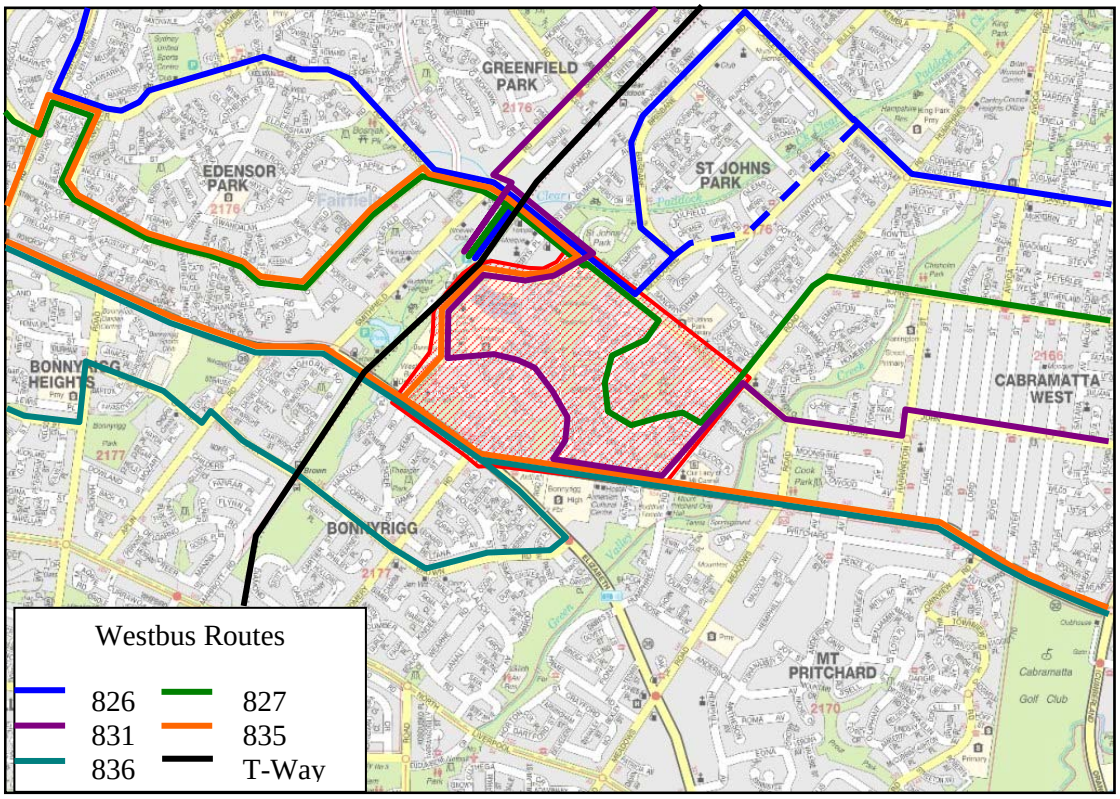
Routes which operate on the boundary of Bonnyrigg Living Communities include:

- **Route 826**: Fairfield - Cabramatta via Polding Street, Fairfield Hospital, Stockland Mall, Prairie Vale Road, Edensor Park, St Johns and Canley Heights. This route operates along the Edensor Road, which forms the boundary of the Study Area; and
- **Route 836**: Liverpool - Badgerys Creek via Bonnyrigg, Cecil Park and Kemps Creek. This route operates on Elizabeth Drive.

The Liverpool-Parramatta Transitway (T-Way) passes north-south immediately to the west of the Bonnyrigg Living Communities, with the Bonnyrigg Station located immediately to the west at Bonnyrigg Plaza.

Existing bus routes around the Bonnyrigg Living Communities are displayed in **Figure 5-2**.

- **Figure 5-2 Existing Bus Routes**



Westbus, in consultation with the Ministry of Transport (MoT), has plans to reassess their current operations through the site, and that these routes may change in the near future. Future public transport operation is discussed in **Section 9.2**.

5.2.2. Level of Service

The Transport Research Boards' Transit Capacity and Quality of Service Manual (2003)[3] outline a means of determining the Level of Service of bus routes. Based on an assessment of service frequency, service hours, and coverage, an indicative Level of Service for a given area can be determined.

The criterion for Level of Service based on service frequency is shown in **Figure 5-3** while Level of Service criteria for service hours is shown in **Table 5-2**. Level of Service C and above is considered acceptable and would be attractive to users.

[3] Washington DC, USA.

Figure 5-3 Table 5-1 Level of Service Criteria for Bus Route Frequency

Level of Service	Average Headway (minutes)	Buses per Hour	Comments
A	<10	>6	Passengers do not need schedules
B	10-14	5-6	Frequent service, passengers consult schedules
C	15-20	3-4	Maximum desirable time to wait if bus/train missed
D	21-30	2	Service unattractive to choice riders
E	31-60	1	Service available during the hour
F	>60	<1	Service unattractive to all riders

Table 5-2 Level of Service Criteria for Bus Route Operating Hours

Level of Service	Hours of Service	Comments
A	19-24	Night or “owl” service provided
B	17-18	Late evening service provided
C	14-16	Early evening service provided
D	12-13	Daytime service provided
E	4-11	Peak hour service only or limited midday service
F	0-3	Very limited or no service

The Level of Service results for the 6 bus routes passing through the Study Area are shown in **Table 5-3**. The Liverpool-Parramatta T-Way is currently operating at Level of Service A during peak periods, while Routes 826 and 827 operate at Level of Service C. Route 831 operates at Level of Service D for frequency and C for hours of operation, while routes 835 and 836 operate at Level of Service D and F respectively for frequency and Level of Service F for hours of operation. During the interpeak period, the T-Way operates at Level of Service C with four buses per hour, while routes 826, 827 and 831 operate at Level of Service D. Route 836 operates at Level of Service F during interpeak periods.

Table 5-3 Level of Service Results

Bus Route	Buses per Hour		Level of Service (Frequency)[4]	Hours of Operation	Level of Service (Hours of Operation)
	AM / PM	Interpeak			
T-Way	7	4	A (C)	20	A
826	3	2	C (D)	16	C
827	3	2	C (D)	16	C
831	2	2	D (D)	16	C
835	2	0	D (F)	3	F
836	1	0	F (F)	3	F

[4] “A (C)” means: A is during peak periods and C is during inter peak periods

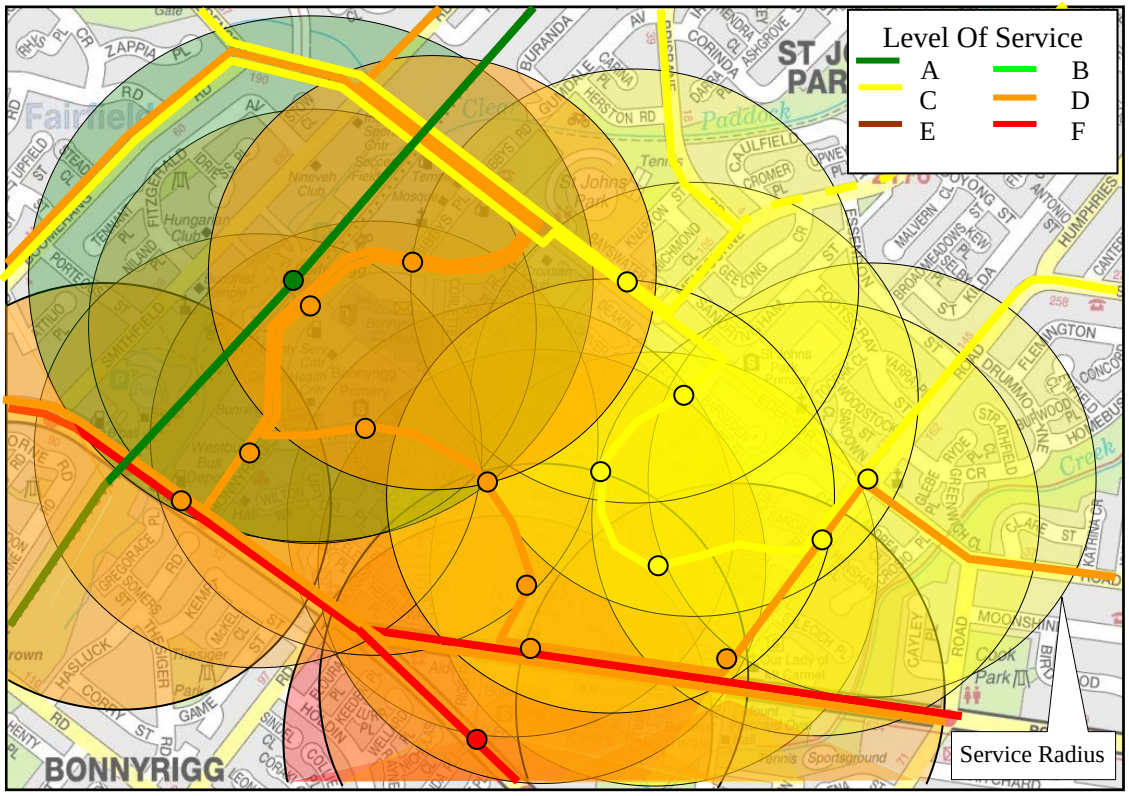
The TRB Manual notes that a housing density of 4.5 dwellings/hectare or a job density of 4 jobs/hectare is the minimum required for an hourly bus service to be feasible. The Study Area currently has a housing density of approximately 25 dwellings per hectare. Hence, the existing area has sufficient density to warrant substantial levels of service. Based on the amount of coverage of a given area, Level of Service can again be determined. The Level of Service criteria is outlined in **Table 5-4**.

Table 5-4 Level of Service Criteria for Service Coverage

Level of Service	% Area Covered	Comments
A	90.0-100.0%	Virtually all major origins and destinations served
B	80.1-89.9%	Most major origins and destinations served
C	70.0-79.9%	About 3/4 of higher density areas served
D	60.0-69.9%	About 2/3 of higher density areas served
E	50.0-59.9%	At least half of the higher density areas served
F	<50%	Less than half of the higher density areas served

In total, there are approximately 17 bus stops within Bonnyrigg Living Communities area. Each dwelling within Bonnyrigg Living Communities has access to at least one bus stop (assuming a 400 metre catchment area for each stop), with the majority of dwellings within the range of at least two or three stops. Despite the large number of bus stops within the Study Area, Level of Service can be expected to vary from stop to stop as a result of the frequency of the bus routes which utilise a given stop. Hence, a more detailed analysis is required which accounts for the frequency of buses at each stop. The results of this analysis are presented in **Figure 5-4**.

- **Figure 5-4 Bus Stop Locations**



As can be seen in **Figure 5-4**, Level of Service is higher on the western side of the Study Area. This is most likely a result of the concentration of bus routes around Bonnyrigg Plaza and the T-Way station. All areas within Bonnyrigg Living Communities experience a Level of Service D or higher during peak times.

5.2.3. Ministry of Transport

Table 5-5 and **Table 5-6** summarise Ministry of Transport Service Planning Guidelines (2006) for network coverage, frequency and patronage. These criteria are currently being used by the Ministry of Transport in its current Integrated Network Planning review process.

Table 5-5 Ministry of Transport Bus Network Planning Benchmarks and Criteria

Bus Planning Characteristic	Benchmark/Criteria
Network (Area) Coverage	90% of households to be within 400 metres of a rail line and/or a Regional or District bus route during commuter peaks, inter peak and weekend day time. 90% of households to be within 800m of a rail line and/or a Regional or District bus route at other times
Network Legibility	Peak and off-peak services should use the same route wherever possible.
Route Design	Regional Routes to be between 10 and 25 kilometres in length. Routes to be between 30 and 60 minutes in duration. Maximum diversion from the fastest or shortest route (between termini) to be no more than 20%.
Accessible Buses	Low floor, wheelchair accessible buses to be allocated to Strategic Transport Corridor routes. Accessible buses to be evenly timetabled on the corridors and advertised as “accessible” trips in the public timetable.
Dedicated School Services	Dedicated school services should be kept to a minimum in order to maximise the frequency and availability of normal route services. Average 5 boardings per revenue kilometre. Students to be delivered to their school within half an hour of school commencement time and picked up within half an hour of school finishing.
Section Points	The range of section point lengths to be between 1.3 km and 1.9 km. The average length of section points within each route to be 1.6 km.
Patronage	Average 1.5 to 2.5 boardings per revenue kilometre (based on an average operating speed of 24 kph). Peak period patronage to be in the range of 50% (25% at other times) seated capacity and 85% of the legal bus capacity (averaged by the number of trips operated during any 20 minute period) at maximum load point. Passengers not to stand for more than 30” of a timetabled service.

Source: Service Planning Guidelines, Ministry of Transport, (June 2006)

Table 5-6 Ministry of Transport Frequencies by Route Type

Route Type	Frequency - Equal to or Better Than
Regional Routes	• Pre peak 30 mins • Peaks 20 mins • Inter Peak 30 mins • Night time 60 mins • Saturday daytime 30 mins • Sunday daytime 30 mins
District Routes	• Peaks 60 mins • Inter Peak 60 mins • Saturday daytime 60 mins • Sunday daytime 60 mins
Local Routes	
Fixed Routes	Inter Peak 120 mins
Flexible Transport Services	As required (Negotiated with the Ministry)

Source: Service Planning Guidelines, Ministry of Transport, (June 2006)

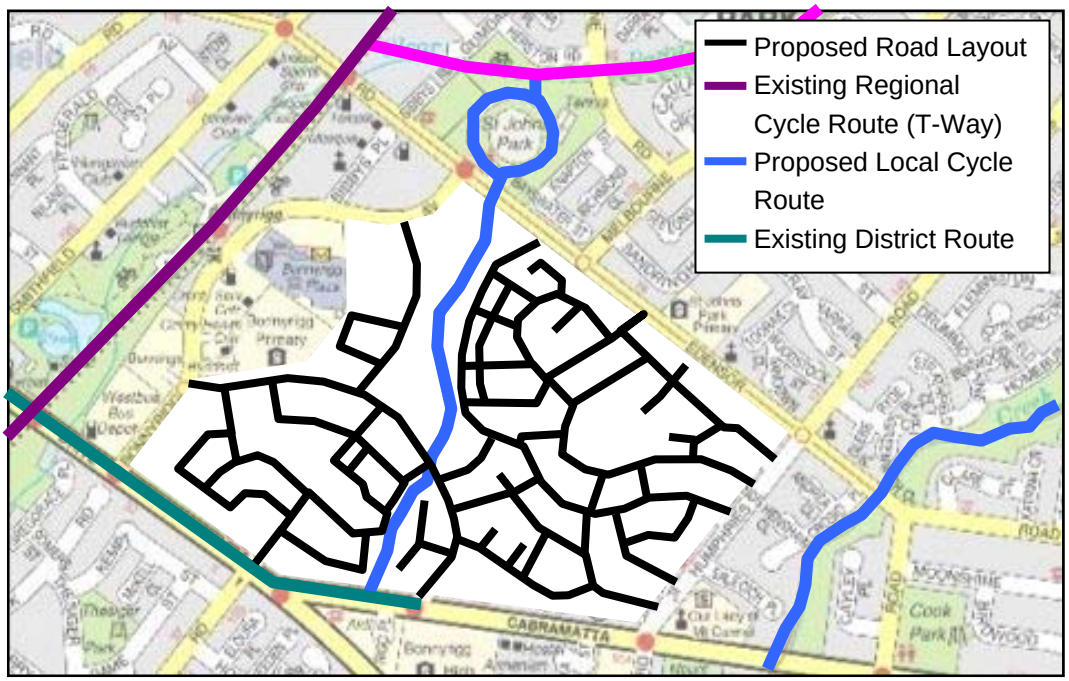
5.3. Regional Cycle Links

RTA's (2004) Western Sydney Cycleways proposed that off-road cycle routes be provided along the T-Way and along Elizabeth Drive. Both these routes have already been constructed. These routes would connect with other routes heading to destinations such as Liverpool, Parramatta, Fairfield and Canley Vale. These routes are in line with the RTA's (2010) Action for Bikes 2010.

Fairfield City Council has also released its plans for cycle routes in the area (Bonnyrigg Cycleways, 2004) and proposes to build off-road cycle routes along Green Valley Creek, and along the grassed areas in the study site, connecting Cabramatta Road to St Johns Park adjacent to the Croatian Club.

Existing and proposed cycle routes in the area are shown in **Figure 5-5**.

- **Figure 5-5 Cycle Routes**



There is the potential for a cycle link along the realigned Bunker Parade to connect with the route along the creek to the east of the site. Cycle facilities could be provided along Bunker Parade, Tarlington Parade and the road connecting the two through the centre of the estate. The proposed local cycle route shown in **Figure 5-5** could be realigned to follow Tarlington Parade, the link through to Bunker Parade and then follow Bunker Parade to St Johns Park.

6. Travel Demand

6.1. Household Travel Survey Data

Mode split information was determined from the Household Travel Survey (HTS) data collected by the Transport Data Centre (TDC) of the NSW Ministry of Transport. Data was provided for each Strategic Travel Zone (STZ) in the vicinity of the Bonnyrigg Living Communities and included the following information:

- Origin zone;
- Destination zone;
- Trip purpose;
- Travel mode;
- Time of day; and
- Number of trips.

The origin and destination zones are given as Statistical Local Areas (SLAs) which generally correspond with Local Government Areas (LGAs). Trip purpose is divided into the following categories:

- Commute (journey to work);
- Education / childcare;
- Personal business;
- Serve passenger;
- Shopping;
- Social / recreation;
- Work related business; and
- Other.

Travel mode categories are shown in **Table 6-1**. Each mode type can include more than one means of transport, based on a hierarchy of modes as described below. For example, a commuter walking to the station to catch a train would be classified as travelling by 'Train'.

Table 6-1 HTS Travel Mode Definitions

Mode Type	Mode Definition
Ferry	Includes ferry plus another mode
Train	Includes train plus other mode not ferry.
Bus	Includes bus plus other mode not train or ferry.
Vehicle driver	Includes vehicle driver plus other mode not bus, train or ferry.

Mode Type	Mode Definition
Vehicle passenger	Includes vehicle passenger plus other mode not car driver, bus, train or ferry.
Taxi	Includes taxi plus other mode not vehicle passenger, vehicle driver, bus, train or ferry.
Bicycle	Includes bicycle plus other mode not taxi, vehicle passenger, vehicle driver, bus, train or ferry.
Walking	Includes walking (including pram).
Other	Includes any other mode combinations other than the above.

The data is divided into times of day with each day divided into four time periods, the AM and PM peaks, midday and night. The definitions of these categories are shown in **Table 6-2**.

- **Table 6-2 HTS Time Period Definitions**

Time Period	Time Covered
AM Peak	6.30 AM to 9.30 AM
Midday	9.30 AM to 3.00 PM
PM Peak	3:00 PM to 7:00 PM
Night	7:00 PM to 6.30 AM

6.1.1. HTS Data for Bonnyrigg Living Communities

Household Travel Survey data was acquired for five zones surrounding Bonnyrigg Living Communities. These zones consist of similar types of development, with the majority of land uses in the area being low to medium density residential. Data from these zones were considered to be similar to those of the Study Area. The data covered the following suburbs:

- Bonnyrigg;
- Bonnyrigg Heights;
- Cabramatta West;
- Canley Vale;
- Edensor Park;
- Greenfield Park;
- Green Valley;
- Mount Pritchard;
- Prairiewood;
- St Johns Park; and
- Wakeley.

As the results of the 2005 Census have not yet been consolidated, the latest available data from 2001 was used.

6.2. Current Mode Share

In total 274,333 trips were identified as either originating or terminating in the HTS data area, with 137,863 of these originating in the data area and 136,472 trips terminating. The highest number of trips occurred during the PM peak period (96,227 trips or 35 % of all trips), with the least occurring during the night time inter-peak (35,269 trips or 13 %). A total of 61,636 trips occurred during the AM peak, while 81,201 trips occurred during the midday inter-peak period. These constituted 22 and 30 % of all trips respectively.

6.2.1. Trips by Purpose

Analysis of the data revealed that over the whole day the greatest number of trips were for social and recreational purposes (66,507 trips), with commuting to work only 35,124 trips (fifth highest). There were 59,569 trips made to serve passengers, 41,610 shopping trips, 37,726 education/childcare trips, 20,337 personal business trips, 10,973 work related business trips and 2,487 trips for other purposes.

The majority of peak hour trips were serve passenger trips (36 % of all trips in the AM and 25.6 % in the PM), followed by commute (32.2 % in the AM and 23.5 % in the PM). In the AM, shopping trips were then third highest; followed by social/recreation trips, work related business, personal business and education / childcare. During the PM peak the third most popular trip purpose was social/recreation trips, followed by shopping, work related business, personal business, other purposes and education / childcare trips.

During the midday inter-peak period the majority of trips were made for social/ recreation purposes (23,338 trips) followed by shopping (22,949 trips), serve passenger trips (14,313 trips), personal business (9,961 trips), education/childcare (4,815), work related business (2,073 trips), commute to work (2,012 trips), and other purposes (1,741 trips).

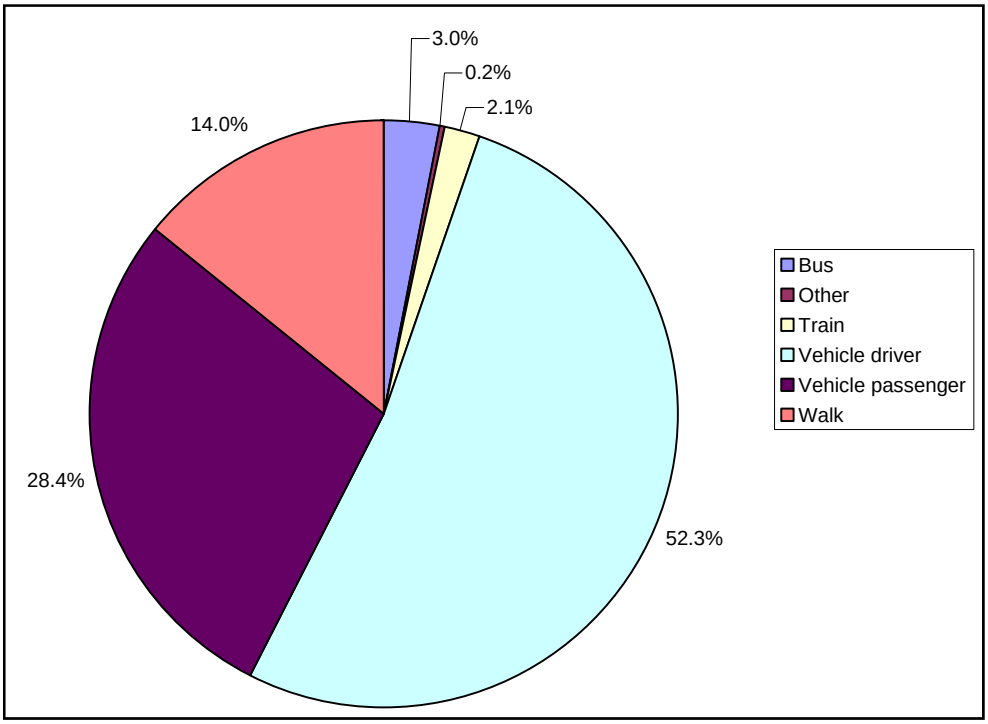
During the night time inter-peak period the majority of trips were again carried out for social/recreational purposes (16,812) followed by commute to work (6,081), trips to serve passengers (5,626), work related business (2,286), shopping (2,280), personal business (1,685) and education/childcare (501).

6.2.2. Trips by Mode

The highest numbers of trips were completed by car, either as a driver or passenger, during all time periods. Vehicle drivers constituted 52 % of all travellers, while vehicle passengers comprised a further 28 %, totalling 80 % of all trips. Walking constituted a further 14 % of all trips while only 3% and 2 % of people travelled by buses and trains respectively. This pattern remained relatively

constant throughout the day, with buses being more popular than trains in all but the night time inter-peak. The mode split for all tips over all time periods is shown in **Figure 6-1**.

- **Figure 6-1 Mode Split for all Trips**



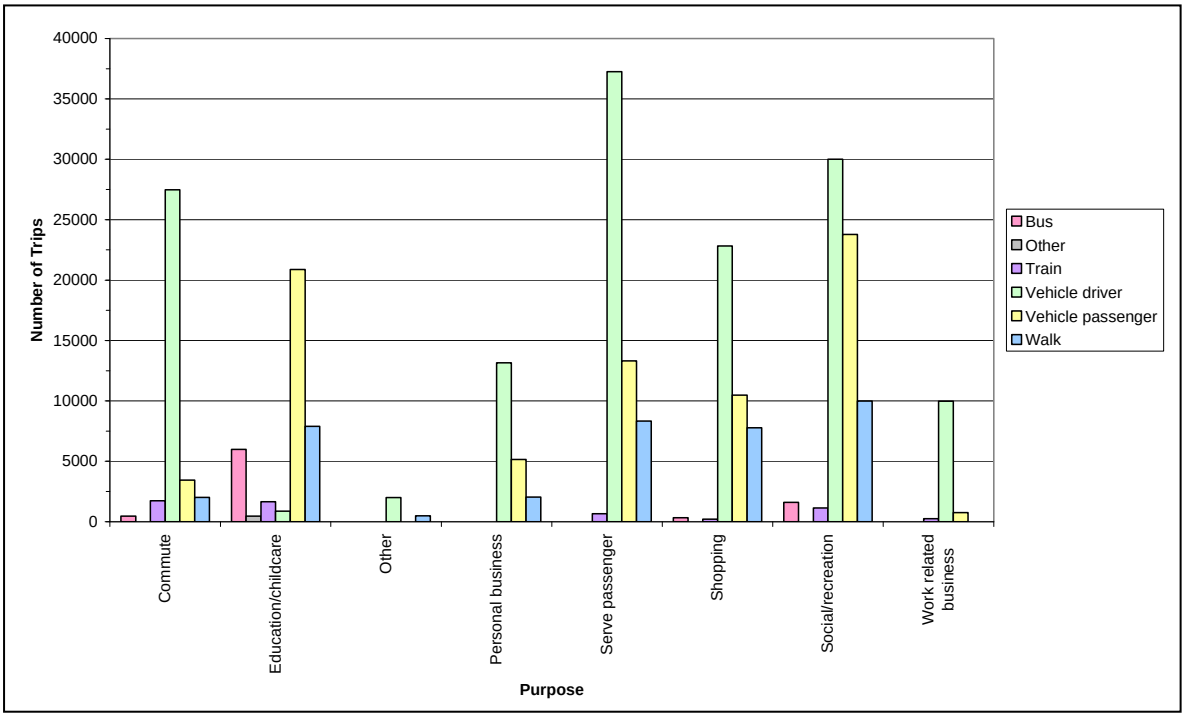
6.2.3. Mode by Purpose

Vehicles were the most popular means of transport for all travel purposes. Mode by purpose data is displayed in **Figure 6-2**.

Of the commute trips, 6 % walked to work, while a further 6 % travelled by public transport (1 % by bus and 5 % by train), 78 % of commuters were vehicle drivers, while 10 % were passengers in a vehicle.

Work related business trips had the highest proportion of car usage, with 98 % of all trips (91 % driving and 7 % passengers). The remaining 2 % travelled by train. Education/childcare trips also were completed mainly by vehicle (57 %). 20% of trips were by public transport (16 % by bus and 4 % by train), while 21 % walked

- **Figure 6-2 Mode by Purpose (All Trips)**



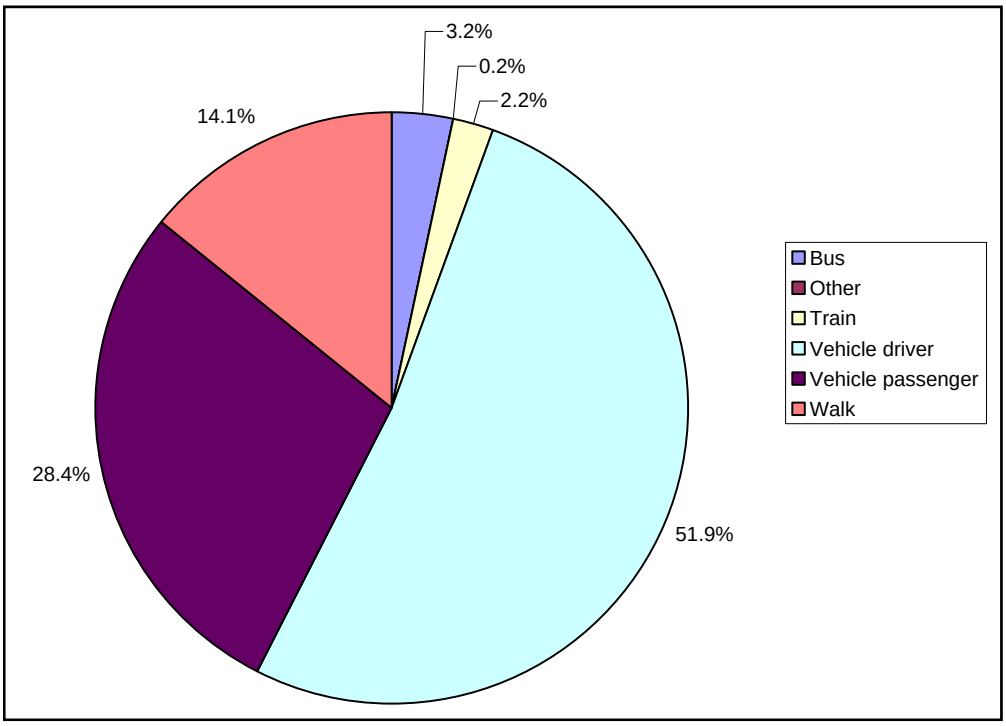
Personal business trips were also made mainly by vehicle (65 % drivers and 25 % passengers) with the remaining 10 % of travellers choosing to walk. Serve passenger trips followed a similar pattern, with 63 % of travellers driving and 22 % passengers, and 14 % walking. In this instance 1 % of trips were made by train. Similarly, for shopping trips the vehicle was most popular (80 %) with 19 % walking, 1 % catching a bus and 0.5 % travelling by train.

Only 4 % of social/recreation trips were by public transport, while 81 % were by car. A further 15 % walked. 80 % of trips for other purposes were carried out by vehicle drivers, with the remaining 20 % of travellers walking to their destination.

6.2.4. Mode by Time during Peak Periods

The majority of commuter trips were completed by car, with 85 % of all AM and 87 % of all PM peak commuters either driving or being a passenger in a vehicle. Only 7 % of commuters travelled by public transport during the AM peak, while 6 % travelled by public transport during the PM peak. 8 % of AM peak commuters and 7 % of PM peak commuters walked. Combined peak mode splits are displayed in **Figure 6-3**.

- **Figure 6-3 AM and PM Median Peak Hour Mode Split**



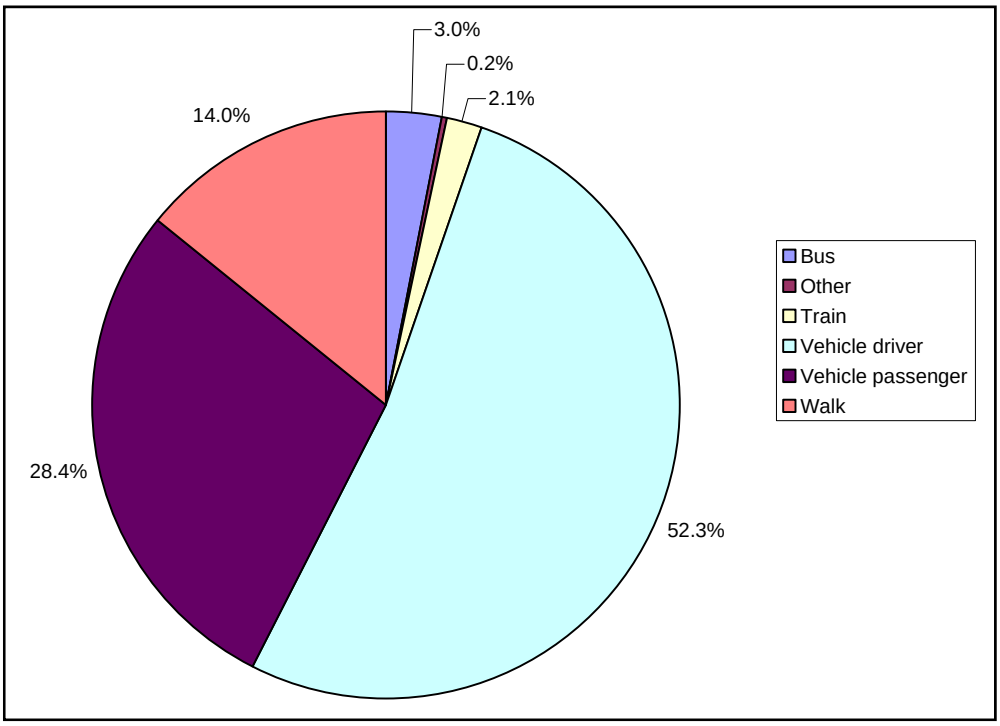
Commuters did not walk or travel by bus during non-peak times. The proportion of commuters travelling by car altered throughout the day, with a higher proportion during the night (95 %) and the lowest proportion during the AM peak (85 %).

The proportion of commuters travelling by train was highest during the midday inter-peak period (10.4 %) and lowest during the PM peak period (4 %). 8 % of commuters travelled by train in the AM peak, and 5 % during the night time inter-peak.

6.3. Public Transport Patronage

Public transport patronage, as seen in the **Figure 6-4** is relatively low (5 % of trips). However as the data is from 2001, it pre-dates Liverpool-Parramatta T-Way operations. While there would have been an increase in the number of residents using public transport as a result of the T-Way, the majority of patrons living within 0.5 to 1 kilometre of the T-Way have simply transferred their patronage from local bus routes. Hence, there has been a slight shift in the public transport mode share since the opening of the T-Way, but to the detriment of other local routes. In order to determine the existing mode split in 2007, it was necessary to estimate the impact of the T-Way. Based on discussion with local bus operators, it was estimated that public transport usage would be approximately 6%, with 3.8% of that being by bus.

- **Figure 6-4 Mode Split for Commuters**



6.4. Peak Hour Car versus Public Transport Travel Times

Car versus public transport travel times are illustrated in **Table 6-3** from Bonnyrigg to Parramatta, Liverpool and Sydney CBD. In general public transport travel was slightly less than double car travel times in the AM peak hour.

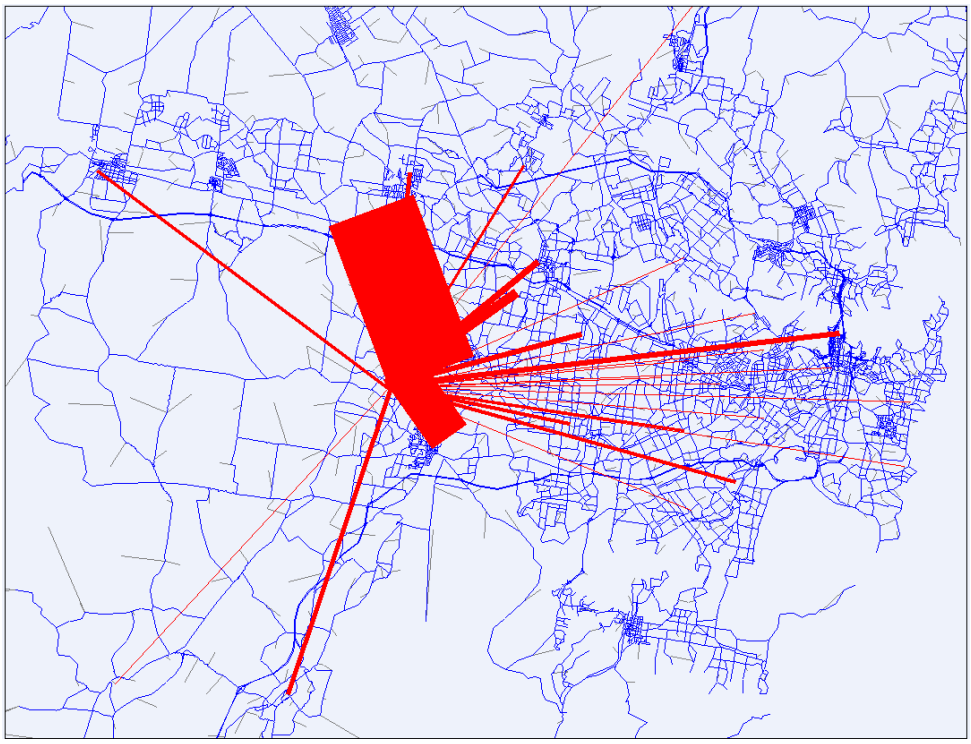
- **Table 6-3 Car and Public Transport Travel Times in the AM Peak Hour**

Destination	Mode	Total Travel Time (minutes)
Parramatta	Bus via T-way	35-40
Parramatta	Car	25
Liverpool	Bus via T-way	20-25
Liverpool	Car	10
Sydney CBD	Bus/train via Parramatta	80-90
Sydney CBD	Bus/train via Cabramatta	85-95
Sydney CBD	Bus/train via Liverpool	75-105
Sydney CBD	Car	55

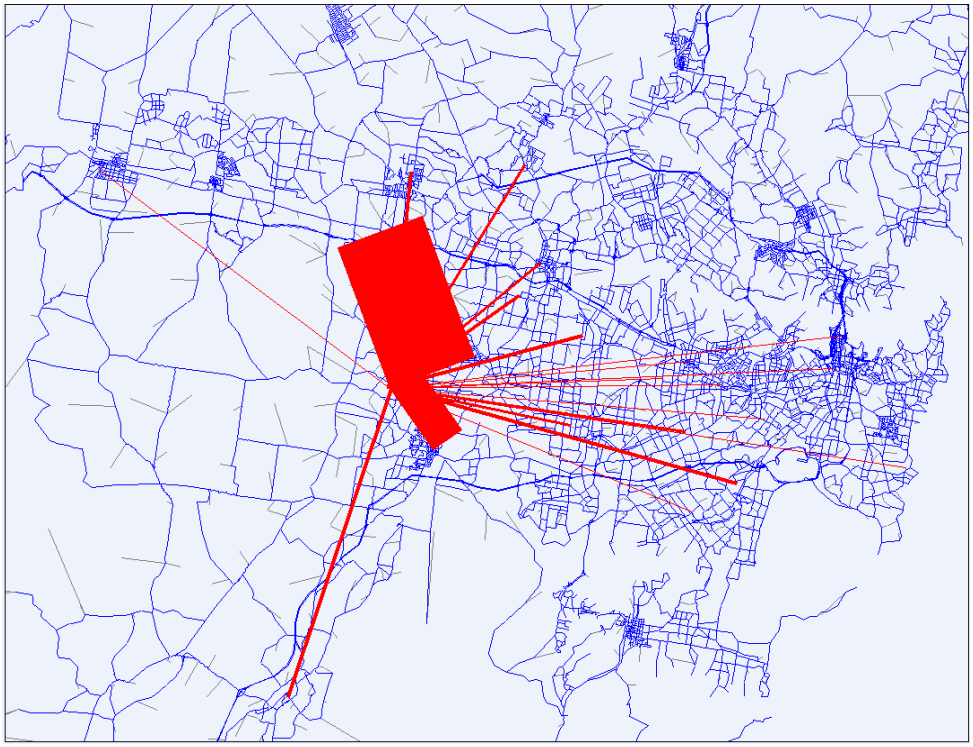
6.5. Car and Public Transport Desire Lines by Purpose

Household travel survey desire line data for car and public transport by commuter and non-commuter purposes is illustrated in **Figure 6-5** through **Figure 6-9**.

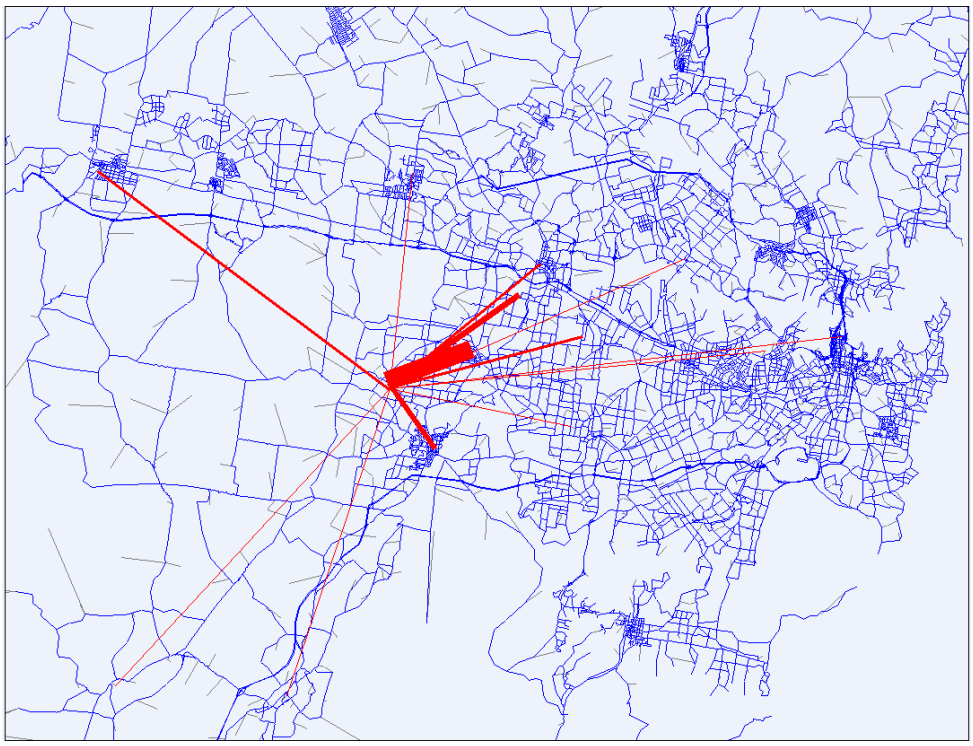
- **Figure 6-5 Total Trips**



- **Figure 6-6 Car Commute Trips**



- **Figure 6-7 Car Non-Commute Trips**



- **Figure 6-8 Public Transport Commute Trips**

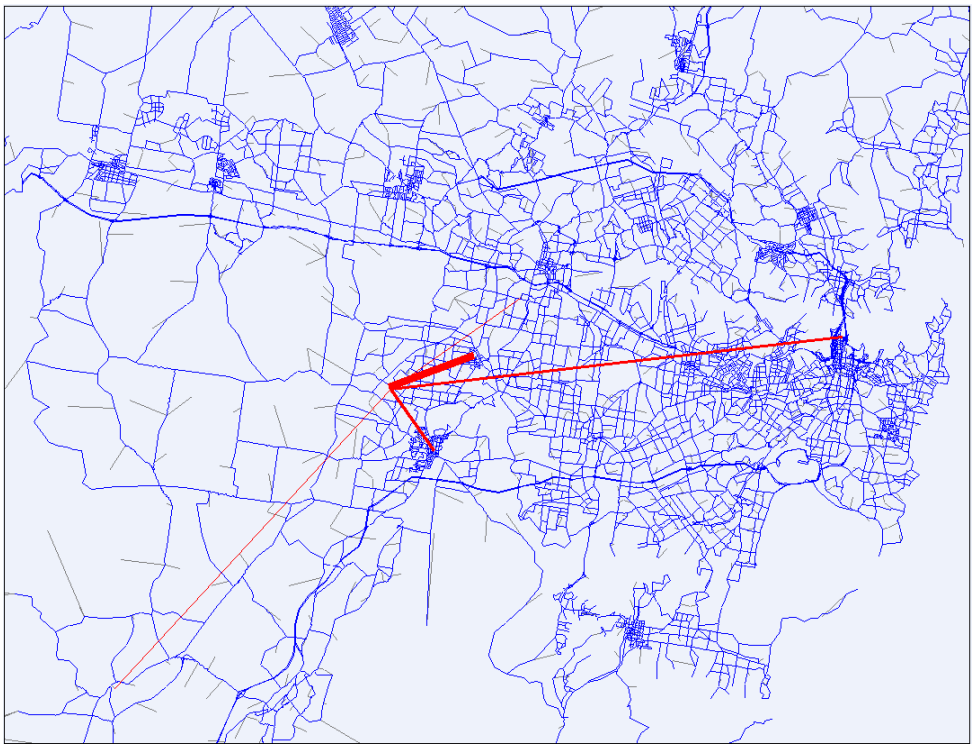
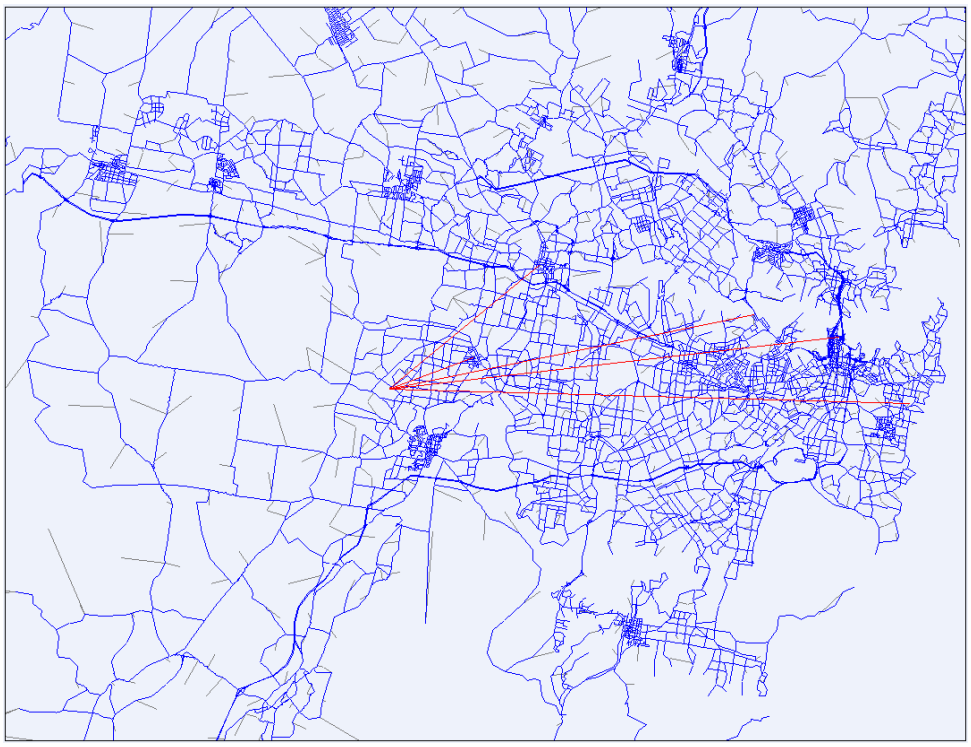


Figure 6-9 Public Transport Non-Commute Trips



7. Development Framework

7.1. Proposed Re-Development

The Bonnyrigg Living Communities covers an area of 81 hectares which currently houses approximately 830 units of social housing dwellings. Approximately 90 privately owned houses are located within the estate boundaries; however, these dwellings do not form part of this Concept Plan. The Bonnyrigg Living Communities aims to renew and strengthen the communities in high need public housing estates. The key features of the redevelopment proposed as part of Bonnyrigg Living Communities include:

- An overall increase in density from approximately 910 dwellings to approximately 2330 dwellings;
- The existing social housing dwellings would be reduced from 830 to approximately 699 resulting in a public-private mix of 30% public and 70% private. The balance of 134 social housing dwellings would be accommodated offsite so there is no loss in social housing;
- The redevelopment is planned to occur over a period of 13 years with a total of 18 stages; and
- The dwelling types would include single detached housing; attached dwellings in configurations of two, four, six and eight; and lifted (up to six-storey) apartments.

7.2. Staging of the Bonnyrigg Living Communities

The re-development would be implemented in 18 stages. It is envisioned that minimal disruption to existing activities would occur. The staging plan is shown in detail in **Table 7-1**.

Table 7-1 Staging Plan for Bonnyrigg Living Communities

Year	Staging	Private Dwellings	Public Dwellings	Total Dwellings
2010	Stage 1	77	36	113
2011	Stage 2	61	32	93
2012	Stage 3	102	74	176
	Stage 4	68	36	104
2013	Stage 5	56	25	81
	Stage 6	61	80	141
2014	Stage 7	53	21	74
	Stage 8	54	15	69
2015	Stage 9	39	12	51
	Stage 10	112	40	152
2016	Stage 11	107	48	155

Year	Staging	Private Dwellings	Public Dwellings	Total Dwellings
	Stage 12	324	6	330
2017	Stage 13	80	34	114
	Stage 14	77	86	163
2019	Stage 15	91	38	129
	Stage 16	164	72	236
2020	Stage 17	59	26	85
2021	Stage 18	58	18	76
Total		1643	699	2342

7.3. Development Traffic Generation

Traffic generation was estimated on the basis of the RTA's *Guide to Traffic Generating Developments*. The Guide provides trip generation rates to estimate peak hour vehicle traffic to and from the development. The traffic generation for residential uses is further differentiated by type of dwelling. The Guide specifies a range of generation rates for private housing and suggests lower rates may generally apply to public housing. For this assessment, the lower limit was applied to estimate traffic generation from public housing while the upper limit was applied to estimate traffic generation for private dwellings.

The rates provided by the Guide as relevant to this current proposal are summarised in **Table 7-2**.

For residential developments, the Guide suggests that 25% of the trips are internal to the subdivision involving local shopping, schools and local social visits.

Table 7-2 Peak Hour Traffic Generation Rates for Bonnyrigg Living Communities

Dwelling Type	Peak Hour Vehicle Trip Rates	
	Private	Public
Lifted Apartments	0.65 /dwelling	0.5 /dwelling
8 attached multi dwelling	0.65 /dwelling	0.5 /dwelling
6 attached multi dwelling	0.65 /dwelling	0.5 /dwelling
4 attached multi dwelling	0.65 /dwelling	0.5 /dwelling
Town House	0.65 /dwelling	0.5 /dwelling
Single Detached	0.85 /dwelling	0.85 /dwelling

Source: Guide to Traffic Generating Developments v2.2, NSW RTA, 2002

Table 7-3 shows the generated peak hour trips for Stage 1 in 2010 and for full Bonnyrigg Living Communities development in 2021.

SKM

Table 7-3 Peak Hour Trips for Proposed Bonnyrigg Living Communities

Stage	Dwelling Type	No. of Dwellings		Peak Hour Trips		Total Peak Hour Trips
		Private	Public	Private	Public	
Year 2010: Stage 1	Lifted Apartments	0	0	0	0	0
	8 attached multi dwelling	0	0	0	0	0
	6 attached multi dwelling	0	0	0	0	0
	4 attached multi dwelling	42	22	27	11	38
	Duplex	19	9	12	4	16
	Single detached	10	4	9	3	12
	Existing/Retained	86	20	73	17	90
	Total	157	55	119	35	156
Year 2011 to 2020: Stages 2-14	Retirement	230	0	150	0	150
	Lifted Apartments	124	172	81	86	167
	8 attached multi dwelling	96	16	62	8	70
	6 attached multi dwelling	174	66	113	33	146
	4 attached multi dwelling	422	138	274	69	343
	Duplex	247	205	161	103	264
	Single detached	179	47	152	40	192
	Total	1472	644	993	338	1331
Year 2020: Total	Retirement	230	0	150	0	150
	Lifted Apartments	124	172	81	86	167
	8 attached multi dwelling	96	16	62	8	70
	6 attached multi dwelling	174	66	113	33	146
	4 attached multi dwelling	464	160	302	80	381
	Duplex	266	214	173	107	280
	Single detached	189	51	161	43	205
	Existing/Retained	86	20	73	17	90
	Total	1629	699	1114	374	1488

The Bonnyrigg Living Communities area, at present, already comprises of 833 public dwellings and 88 private dwellings. The growth of traffic already generated by the existing dwellings is assumed to be accounted for in the growth factors applied to the 2007 base. In order to eliminate double counting, the traffic generated by the existing dwellings is deducted from the calculated future generation and only the additional trips attributed to the future dwelling mix is added as new traffic.

The additional trips for each of the stages to be accounted for in the 2020 future matrices are shown in **Table 7-4**.

- **Table 7-4 Net Traffic Generation**

Stage Development	Peak Hour Trips	Trips already generated by the development site	Additional Trips
Stage 1	67	30	37
Stage 2-18	1421	387	1034
Completion	1488	417	1071

In the 2020 AM Peak Base Model, it was assumed that for the residential developments, 85% of trips would be generated and 15% attracted to the development site in the AM Peak. It was also assumed that 25% would be internal trips for local shopping, schools and local visits. The trip attraction and generation numbers for the Bonnyrigg Living Communities for the AM Peak is shown in **Table 7-5**.

In the 2020 PM Peak Base Model, it was assumed that for the residential developments 15% of trips would be generated by and 85% attracted to the development site in the PM Peak. The trip attraction and generation numbers for the proposed Bonnyrigg Living Communities for the PM Peak is shown in **Table 7-5**.

- **Table 7-5 AM and PM Peak Trip Attraction and Generation Figures for 2010 and 2020 Future Models**

Stage Development	Peak Hour Trips	AM Peak		PM Peak	
		Trips Attracted	Trips Generated	Trips Attracted	Trips Generated
Stage 1	67	10	57	57	10
Stages 2 - 18	1421	213	1208	1208	213
Total	1488	223	1265	1265	223

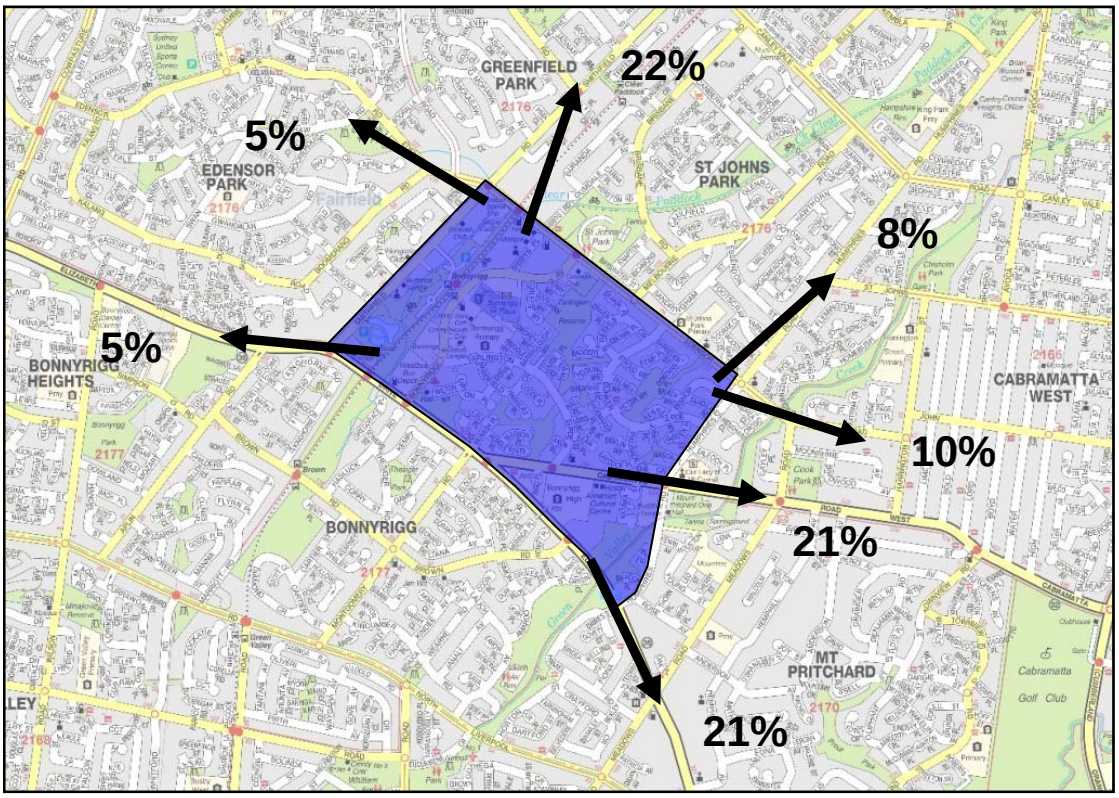
7.4. Trip Distribution

Existing distribution patterns revealed in the Household Travel Survey (HTS) were taken to reflect future distribution patterns as the proposed development land use will largely remain the same albeit at a higher in density.

It is noted that distribution patterns may change relative to variables such as employment zones, transport network amenities and economic status of residents in the area. The HTS showed that the trip distribution patterns did not differ much between the trip purposes. For journey to work and other trips, 70% of the trips are to Fairfield. The remaining trips are mainly distributed to Liverpool, Bankstown, Parramatta and Baulkham Hills. It is assumed that the key destination areas will prevail and still account for a significant amount of future traffic.

Figure 7-1 shows future trip distribution for the Bonnyrigg Living Communities.

- **Figure 7-1 Trip Distribution Patterns for the Bonnyrigg Living Communities**



8. Future Transport Demand & Assessment

8.1. Future Traffic Assessment

8.1.1. Paramics Network

Paramics is a transport modelling tool that has the ability to model the movements of individual vehicles – braking and acceleration, turning, lane-changing, queuing and delays. Paramics is also capable of representing the network constraints of road geometry, angle of turn and length of turning lane. Thus, the behaviour of individual vehicles and their interactions with other traffic and network constraints can be replicated in Paramics. This level of modelling is well suited for modelling traffic circulation in urban centres, and residential developments such as Bonnyrigg Living Communities.

The base models (2007) were developed to reflect the existing traffic conditions in the study area. Two models were developed, an AM Peak model from 07:00-09:00 and a PM Peak model from 16:00-18:00. The models were then calibrated and validated to ensure that the models adequately represent reality.

The 2010 and 2020 Base models were then developed to incorporate future development and background traffic growth in the study area. The 2010 model incorporates the completion of Stage 1 and 2020 was the modelled year for full development of Bonnyrigg Living Communities.

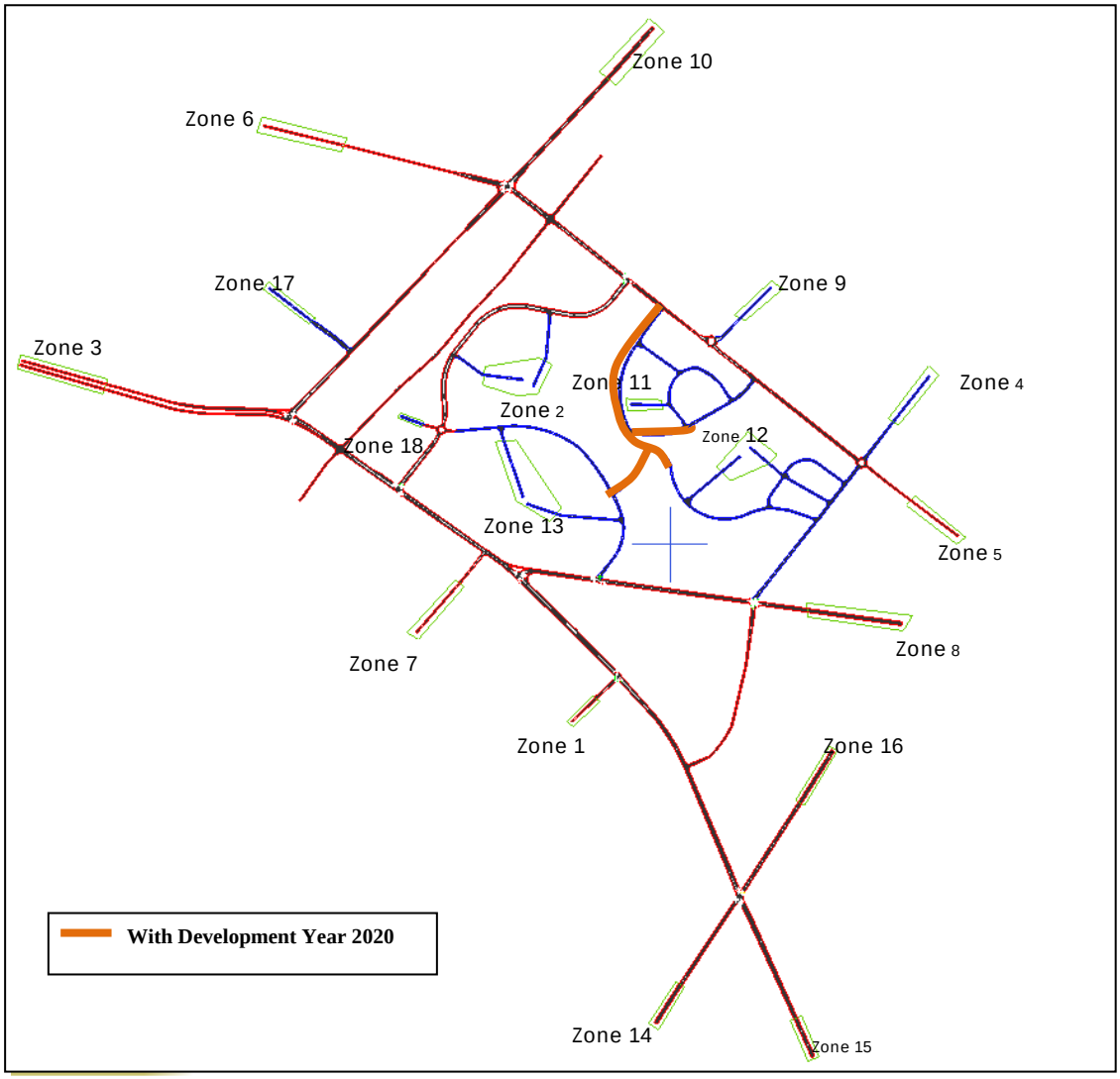
In Paramics, roads are classified into major and minor roads, corresponding to main roads and local roads in the RTA road classifications. The classification of roads used in the model is shown in **Table 8-1**.

Table 8-1 Road Classifications

Road	Classification	Number of Lanes	Posted Speed (kph)
Elizabeth Drive	Major	2	70WB / 60EB
Cabramatta Road West	Major	2	60
Humphries Road	Minor	1	60
Edensor Road	Major	1	60
Bonnyrigg Avenue	Major	1,2	60
Tarlington Parade	Major	1	50
Bunker Parade	Minor	1	50

Demand zones were created for traffic generation and attraction. A total of 18 demand zones were created to accommodate external and internal traffic, as presented in **Figure 8-1**.

- **Figure 8-1 Demand Zones**



Around the network boundary, zones were associated with each external link, representing connection with external traffic. The modelled area was extended beyond the study area as requested by the RTA. Additional internal zones were created to accommodate traffic generated and attracted by the proposed developments.

8.1.2. Traffic Demand Matrices

Demand matrices were estimated from the count data carried out by SKM for the following 14 intersections:

- Elizabeth Drive and Smithfield Avenue;
- Smithfield Avenue and Edensor Road;

- Bonnyrigg Avenue and Elizabeth Drive;
- Bonnyrigg Avenue and Tarlington Parade;
- Bonnyrigg Avenue and Corlette Way;
- Bonnyrigg Avenue and Edensor Road;
- Sandringham Street and Bunker Parade and Edensor Road;
- Humphries Road and Edensor Road;
- Humphries Road and Bunker Parade;
- Cabramatta Road and Humphries Road;
- Cabramatta Road and Tarlington Parade;
- Elizabeth Drive and Cabramatta Road;
- Elizabeth Drive and Meadows Road; and
- Elizabeth Drive and Brown Street.

The counts were undertaken on Wednesday the 15th August 2007 from 07:00-09:00 and from 16:00-18:00. The counts were carried out at the same time as the signal phasing and timings surveys so that a complete set of data was collected for that day. The demand matrices for the AM Peak and the PM Peak were estimated from the surveyed turning movement counts. In addition, 15-minute validation counts were undertaken at selected intersections. These matrices were further refined during the calibration process.

8.2. Future Scenario

Base future trip matrices were adjusted to reflect the changes made between the 2007 base and the calibrated trip matrices. These future 2010 and 2020 base matrices were factored to reflect expected traffic growth in the study area.

The 2010 and 2020 base models were developed based on the calibrated and validated 2007 base case models. The 2010 future model comprises Stage 1 development while the 2020 future model assumes full development of all 18 stages.

In order to factor the 2007 AM and PM Peak matrices from 2007 to 2020, reference was made to the four permanent counting stations in the study area. The growth factors based on a review of counts over the past 10 years (1996-2005) averaged at 0.4% per annum. However, a growth factor of 1.25% per annum was used for the future year 2020 scenarios (as agreed with the RTA) as it represented a more accurate forecast growth rate in the study area.

The average annual growth was applied to the model to factor background traffic to 2020.

8.3. Calibration and Validation of the Models

The criteria for the calibration of a model include the GEH assessment criteria based on the UK Design Manual for Roads and Bridges requirements. This assessment criteria requires no less than 85% of the total modelled flows to be greater than a GEH value of 5. In addition, all GEH values are required to be less 10.

The Paramics models for both the AM and PM Peaks complied with these requirements.

The models also have to comply with the following requirements for validation purposes which further confirm the robustness of the models.

- Demand release is to be within 4% of the total traffic flows in the model (or released demands to be 96% or higher); and
- Travel times of all modelled journey times are to be within one minute or 15% of the observed journey times.

The Base AM and PM peak models met the travel times and demand release requirements. All future scenario models (with and without development) met the demand release criterion.

Appendix A contains the "*Paramics Modelling Report*" dated 9 November 2007 which describes the development, calibration and validation of the Paramics 2007 AM and PM peak hour Base Case models.

8.4. Intersection Assessment

8.4.1. Intersection Modelling

Intersections are the critical constraining element within the transport network. Fourteen intersections were selected for analyses under existing and future conditions. These intersections are:

- Bonnyrigg Avenue / Elizabeth Drive;
- Bonnyrigg Avenue / Tarlington Parade;
- Bonnyrigg Avenue / Corlette Way;
- Bonnyrigg Avenue / Edensor Road;
- Smithfield Road / Edensor Road;
- Elizabeth Drive / Smithfield Road;
- Elizabeth Drive / Brown Street;
- Elizabeth Drive/ Meadows Road;
- Cabramatta Road / Humphries Road;

- Cabramatta Road / Tarlington Parade;
- Cabramatta Road / Elizabeth Drive;
- Bunker Parade / Humphries Road;
- Bunker Parade / Edensor Road; and,
- Humphries Road / Edensor Road.

The operation of these intersections was assessed based on criteria outlined in **Table 8-2**, as specified by the NSW Roads and Traffic Authority.

- Generally it is desirable to aim at achieving a Level of Service of C, or better, at all intersections in the short term. However, in practise, for the long term it is reasonable to assume that intersection may operate at Level of Service D at peak times. Intersections should not operate at Levels of Service lower than Level of Service D.

- **Table 8-2 Performance Criteria for Intersections**

LoS	Average Delay per Vehicle (seconds)	Traffic Signals, 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	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity; at signals incidents will cause excessive delays	At capacity, requires other control mode
F	Greater than 70	Roundabouts require other control mode	

Source: RTA Guide to Traffic Generating Developments, October 2002

As a rule of thumb, for signalised intersections, the average delay for the intersection is reported while for un-signalised and roundabout intersections, the LoS and delay for the worst movement is reported.

8.4.2. 2007 Intersection Operation

The results of the intersection analyses for the existing conditions for the AM and PM peaks are shown in **Figure 8-2** and **Table 8-3**.

- **Table 8-3 AM Peak Intersection Analysis Results using Sidra (2007)**

Intersection	Level of Service (LoS)	Average Delay (secs/veh)
Bonnyrigg Avenue / Elizabeth Drive	C	42.3
Bonnyrigg Avenue / Tarlington Parade	A	8.5
Bonnyrigg Avenue / Corlette Way	B	21.5
Bonnyrigg Avenue / Edensor Road	B	22.5
Smithfield Road / Edensor Road	F	>200
Elizabeth Drive / Smithfield Road	D	44.0
Elizabeth Drive / Brown Street	C	32.3
Elizabeth Drive / Meadows Road	C	41.4
Cabramatta Road / Elizabeth Drive	B	20.9
Cabramatta Road / Humphries	B	25.3
Cabramatta Road / Tarlington Parade	A	12.7
Humphries Road / Edensor Road	B	17.5
Bunker Parade / Humphries Road	A	3.3
Bunker Parade / Edensor Road	A	3.9

The table shows that the Smithfield Road / Edensor Road intersection is currently operating at unacceptable Levels of Service during the AM peak.

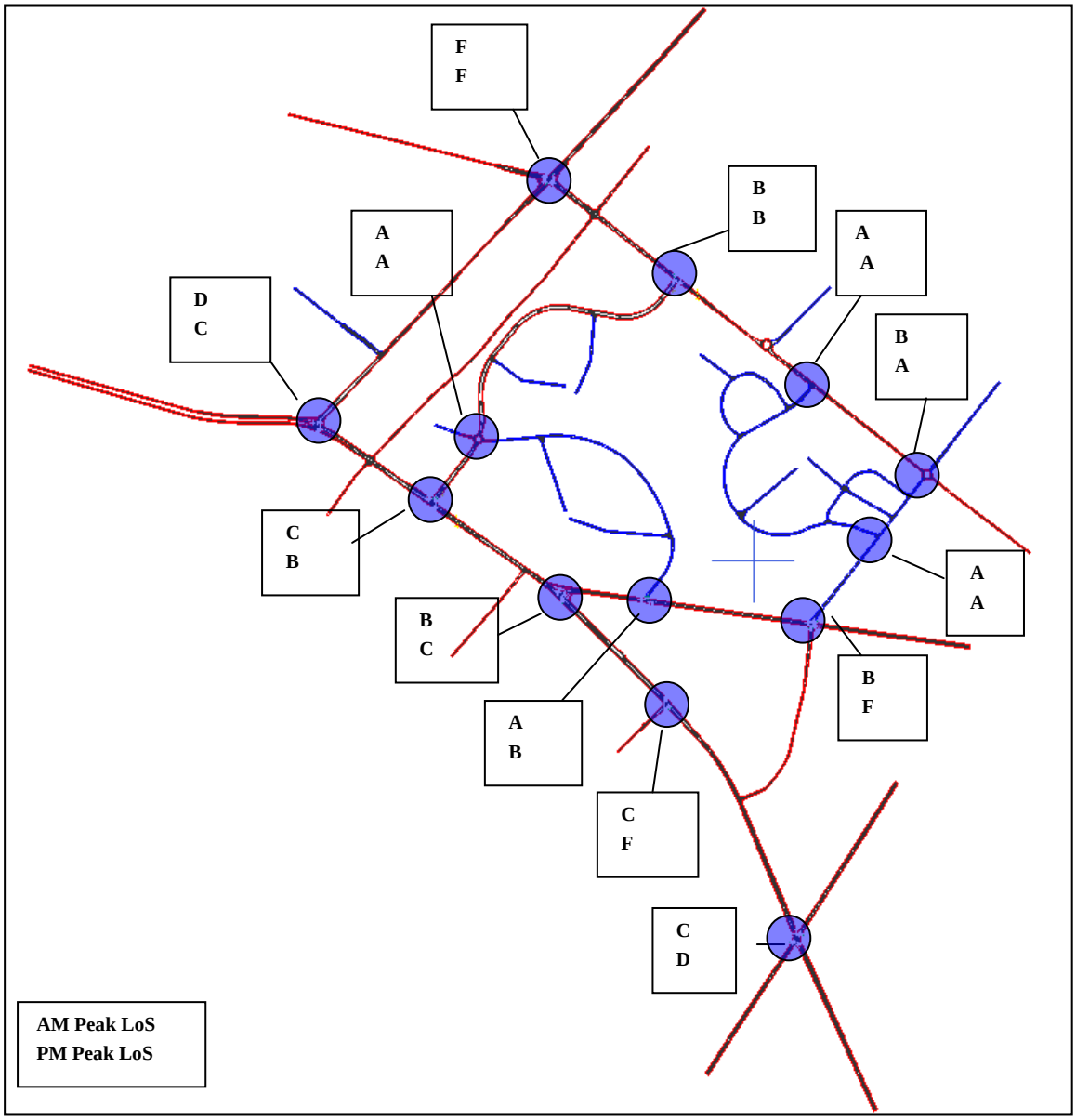
The 2007 PM peak intersection analysis results can be seen in **Figure 8-2** and **Table 8-4**.

- **Table 8-4 PM Peak Intersection Analysis Results using Sidra (2007)**

Intersection	Level of Service (LoS)	Average Delay (secs/veh)
Bonnyrigg Avenue / Elizabeth Drive	B	20.0
Bonnyrigg Avenue / Tarlington Parade	A	8.7
Bonnyrigg Avenue / Corlette Way	C	32.6
Bonnyrigg Avenue / Edensor Road	B	20.3
Smithfield Road / Edensor Road	F	>200
Elizabeth Drive / Smithfield Road	C	31.5
Elizabeth Drive / Brown Street	F	>200
Elizabeth Drive / Meadows Road	D	54.3
Cabramatta Road / Elizabeth Drive	C	33.5
Cabramatta Road / Humphries Road	F	89.4
Cabramatta Road / Tarlington Parade	A	10.5
Humphries Road / Edensor Road	B	3.4
Bunker Parade / Humphries Road	A	4.3
Bunker Parade / Edensor Road	A	14.0

Table 8-4 indicates that Bonnyrigg Road/Edensor Road, Elizabeth Drive/Brown Street and Cabramatta Road/Humphries Road intersections are currently operating at an unacceptable level of service during the PM peak.

Figure 8-2 2007 Intersection Analysis Results for the AM and PM Peaks



8.5. Road Network

Compared to the existing road layout, the proposed road network provides more connections to the surrounding regional road network. Access by services and emergency vehicles is therefore increased and efficiency of the road network improved as local traffic is more evenly distributed across the internal road network. Bonnyrigg Avenue would remain the main access to Bonnyrigg Plaza, Bonnyrigg Primary School and other religious and community facilities.

The detailed internal road network design should encourage slow speeds to facilitate increased pedestrian and cycle activity. Any through traffic should discouraged by traffic engineering measures to manage speed and volume, whilst providing unhindered through-access for buses and other service vehicles[5]. Drop-off arrangements for schools and other community facilities remain unchanged under the proposed road layout

Since the capacity of a network is limited by the delays caused by intersections, the remainder of this traffic assessment only considers improvements to intersections and does not consider mid-block improvements.

The RTA has confirmed there are no plans to carry out further road widening on Elizabeth Drive and Cabramatta Road (both these roads under care and control of the RTA).

The intersection analyses detailed in **Section 8.4** identified intersections requiring capacity enhancements necessary to provide a satisfactory level of service. In this context, the Level of Service "D" concept relates to traffic levels at 85% theoretical maximum capacity and is used as the threshold. It should be noted that where network capacity is not exceeded, no additional investment is required, and routine costs associated with road use are provided through normal road user charges.

Capacity requirements relating to the future year when the Precinct is fully developed was estimated by identifying forecast traffic levels, relative to the available capacity, and assessing incremental capacity requirements to meet the future demand. This study has identified the marginal contribution associated with the development in terms of level of development traffic in proportion to the whole capacity. This means the development only contributes its share of the marginal investment, with the remainder of the investment being supported by future developments and future road users. This is consistent with the arrangements of local government Section 94 planning and contribution requirements.

[5] Narrow speed humps have been effectively used to discourage light vehicles while permitting larger vehicles such as busses to cross unhindered.

8.5.1. 2010 and 2020 Future Intersection Operation

For future conditions, the intersections were analysed with and without the proposed Bonnyrigg Living Communities development. A comparison of intersection operation for the AM and PM peak periods showed that the PM peak was the worst case scenario. Intersection assessment is further undertaken in detail for the 2010 and 2020 PM peak period with the Bonnyrigg Living Communities traffic. Given that the 2007 Base model already showed unacceptable LoS for three of the intersections, the future base models (2010 and 2020 without the development) were tested for any changes to intersection operation for the other eleven intersections. The results showed marginal increases in average delay without significant changes to the LoS.

The assessment of intersection performance was aimed at identifying the impact of Bonnyrigg Living Communities traffic on intersection operation. As full re-development is anticipated to be completed over a period of 13 years, full occupation is expected by 2020. The 2020 Base model includes only normal traffic growth based on existing traffic volumes. The 2020 With Development model includes the base traffic with normal traffic growth plus additional traffic generation attributed to the re-development of the study area. A comparison of the Level of Service for the 2007 base conditions and 2010 and 2020 AM and PM peak With Development is given in **Table 8-5**.

- **Table 8-5 Intersection Operation 2007 and 2010 PM (AM) Peak**

Intersection	Control	2007 Base		2010 PM(AM) Peak Background		2010 PM(AM) Peak With Development	
		LoS	Average Delay (sec/veh)	LoS	Average Delay (sec/veh)	LoS	Average Delay (sec/veh)
Bonnyrigg Avenue / Elizabeth Drive	Signal	B (C)	20.0 (42.3)	B (B)	15.7 (21.8)	B (B)	15.8 (23.4)
Bonnyrigg Avenue / Tarlington Parade	Roundabout	A (A)	8.7(8.5)	A (A)	8.7 (8.5)	A (A)	8.7 (8.5)
Bonnyrigg Avenue / Edensor Road	Signal	B (B)	20.3 (22.5)	B(B)	20.5 (19.0)	B (B)	20.0 (19.1)
Smithfield Road / Edensor Road	Signal	F (F)	>200 (>200)	F (F)	>200 (194.4)	F (F)	>200 (197.0)
Elizabeth Drive / Smithfield Road	Signal	C (D)	31.5 (44)	B (C)	26.2 (30.1)	C (C)	31.6 (30.4)
Elizabeth Drive / Brown Street	Signal	F (C)	>200 (32.3)	F (B)	>200 (21.3)	F (B)	>200 (21.4)
Elizabeth Drive / Meadows Road	Signal	D (C)	54.3 (41.4)	D (C)	56.1 (30.9)	E (C)	58.5 (31.2)
Cabramatta Road / Elizabeth Drive	Signal	C (B)	33.5 (20.9)	C (B)	30.4 (17.6)	C (B)	29.5 (16.8)
Cabramatta Road / Humphries	Signal	F (B)	89.4 (25.3)	F (B)	131.8 (19.2)	F (B)	150 (20.8)

Intersection	Control	2007 Base		2010 PM(AM) Peak Background		2010 PM(AM) Peak With Development	
		LoS	Average Delay (sec/veh)	LoS	Average Delay (sec/veh)	LoS	Average Delay (sec/veh)
Cabramatta Road / Tarlington Parade	Signal	B (A)	15.4 (12.7)	B (B)	20.3 (22.4)	B (B)	20.4 (18.9)
Humphries Road / Edensor Road	Roundabout	A (B)	10.5 (17.5)	A (A)	11.4 (12.9)	A (A)	13 (13.1)
Bunker Parade / Humphries Road	Give Way	A (A)	11.2 (12.2)	A (A)	11.3 (11.7)	A (A)	12.6 (11.9)
Bunker Parade / Edensor Road	Give Way	A (A)	13.5 (11.4)	A (A)	13.6 (11.4)	B (A)	5.3 (4.3)

- **Table 8-6 Intersection Operation 2020 PM (AM) Peak**

Intersection	Control	2020 PM(AM) Peak Background		2020 PM(AM) Peak With Development		2020 PM(AM) Peak With Improvements	
		LoS	Average Delay (sec/veh)	LoS	Average Delay (sec/veh)	LoS	Average Delay (sec/veh)
Bonnyrigg Avenue / Elizabeth Drive	Signal	B (B)	16.0 (24.6)	B (C)	19.5 (29.5)		
Bonnyrigg Avenue / Tarlington Parade	Roundabout	A (A)	8.7(8.5)	A (A)	9.6 (10.2)		
Bonnyrigg Avenue / Edensor Road	Signal	B (B)	21.2 (19.7)	B(A)	23.1 (19.3)		
Smithfield Road / Edensor Road	Signal	F (F)	>200 (>200)	F (F)	96.8 (76.6)	D (C)	51.4 (34.3)
Elizabeth Drive / Smithfield Road	Signal	C (C)	29.4 (31.7)	C (B)	34.5 (25.6)		
Elizabeth Drive / Brown Street	Signal	F (B)	>200 (26.3)	A (B)	14.1 (21.8)		
Elizabeth Drive / Meadows Road	Signal	E (C)	62.5 (32.4)	D (E)	47.6 (64.8)	D(D)	45.8(45.3)
Cabramatta Road / Elizabeth Drive	Signal	C (B)	31.0 (17.2)	C (A)	33.1 (15.9)		
Cabramatta Road / Humphries	Signal	F (B)	>200 (22.7)	F (F)	>200 (82.4)	D(D)	54.5 (54.7)
Cabramatta Road / Tarlington Parade	Signal	B (B)	20.4 (21.4)	B (C)	25.6 (31.3)		
Humphries Road / Edensor Road	Roundabout	A (A)	12.0 (13.1)	B (D)	18.6 (53.1)		
Bunker Parade / Humphries Road	Give Way	A (A)	11.5 (12.1)	A (A)	13.9 (12.8)		
Bunker Parade / Edensor Road	Give Way	B (A)	14.1 (11.9)	B (A)	26.5 (13.2)		

Figure 8-3 shows the intersection analysis results for 2010 and 2020 for the AM peak.

- **Figure 8-3 2010 and 2020 Future Model (With Development) Results for Intersection Analysis for AM Peak**

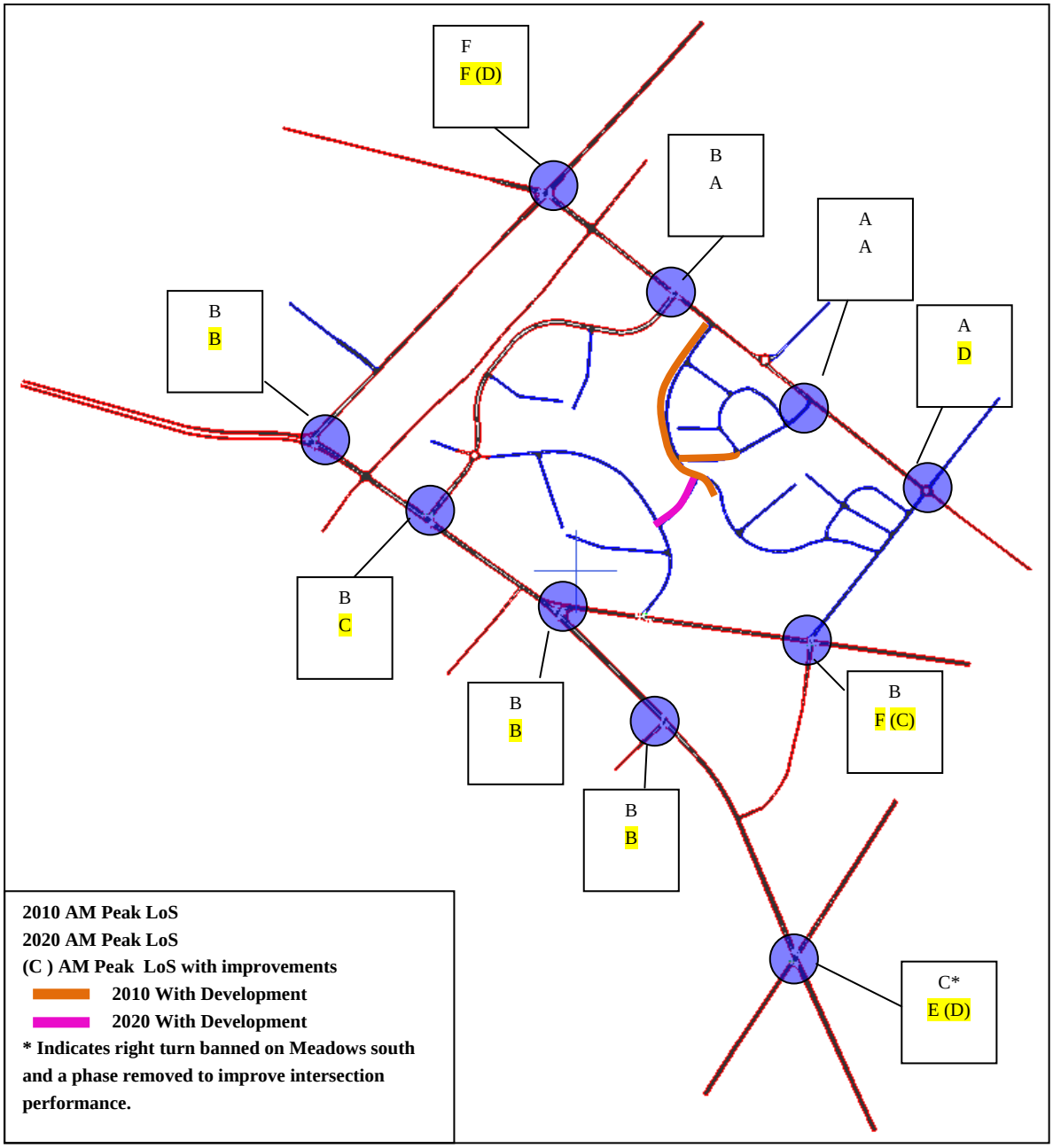
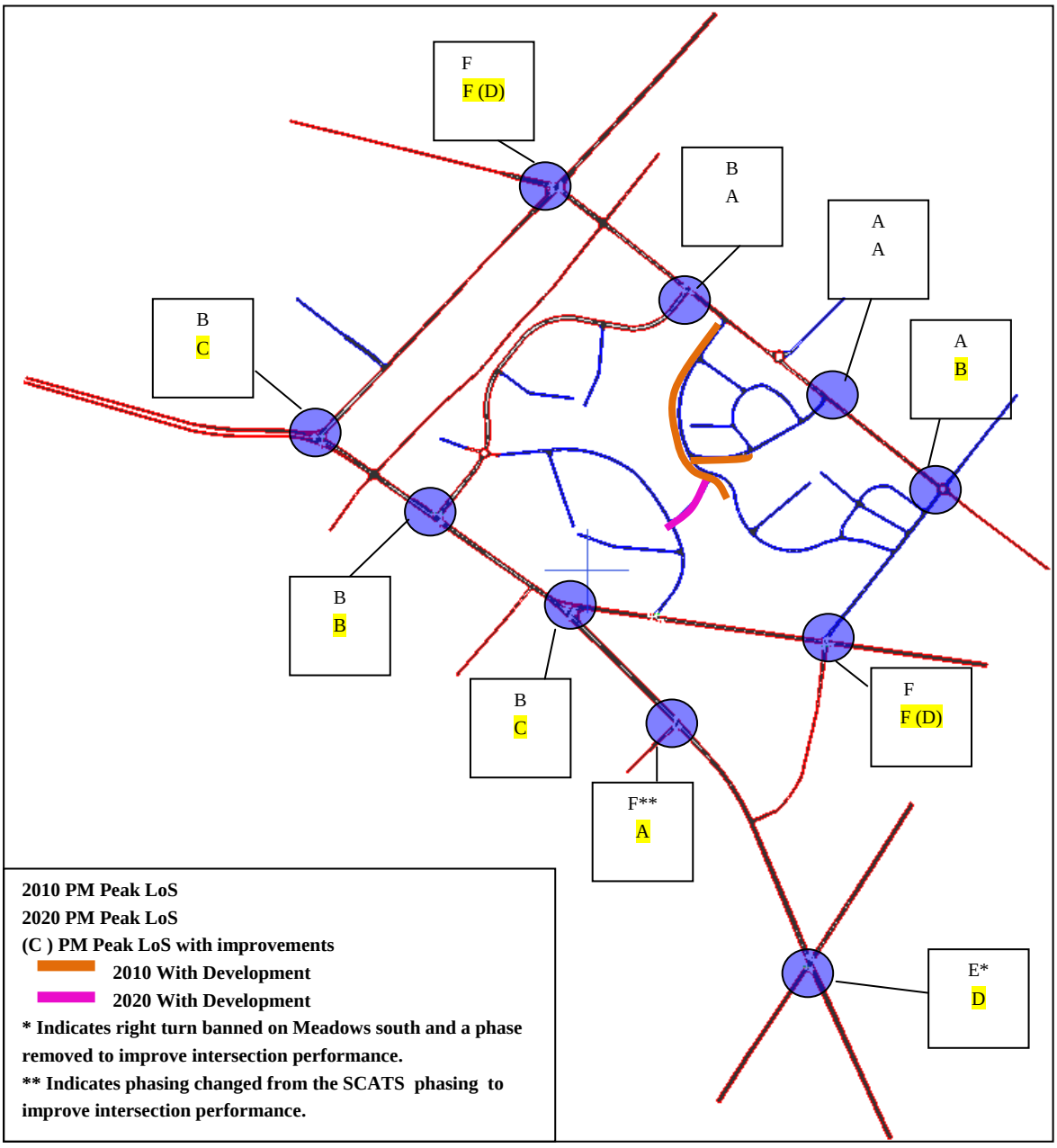


Figure 8-4 below shows the intersection analysis results for 2010 and 2020 for the PM peak.

- **Figure 8-4 2010 and 2020 Future Model (With Development) Results for Intersection Analysis for PM Peak**



8.5.2. Treatment of Impacted Intersections

Our initial intersection analysis was based on the phasing and phase splits as provided by the RTA's TCS data for the Base, 2010 scenarios, and 2020 without development scenarios. The TCS data provides a conservative result in terms of LoS and delays incurred at the intersection. The existing TCS data does not indicate phasing types, sequences and green time splits to suit increased

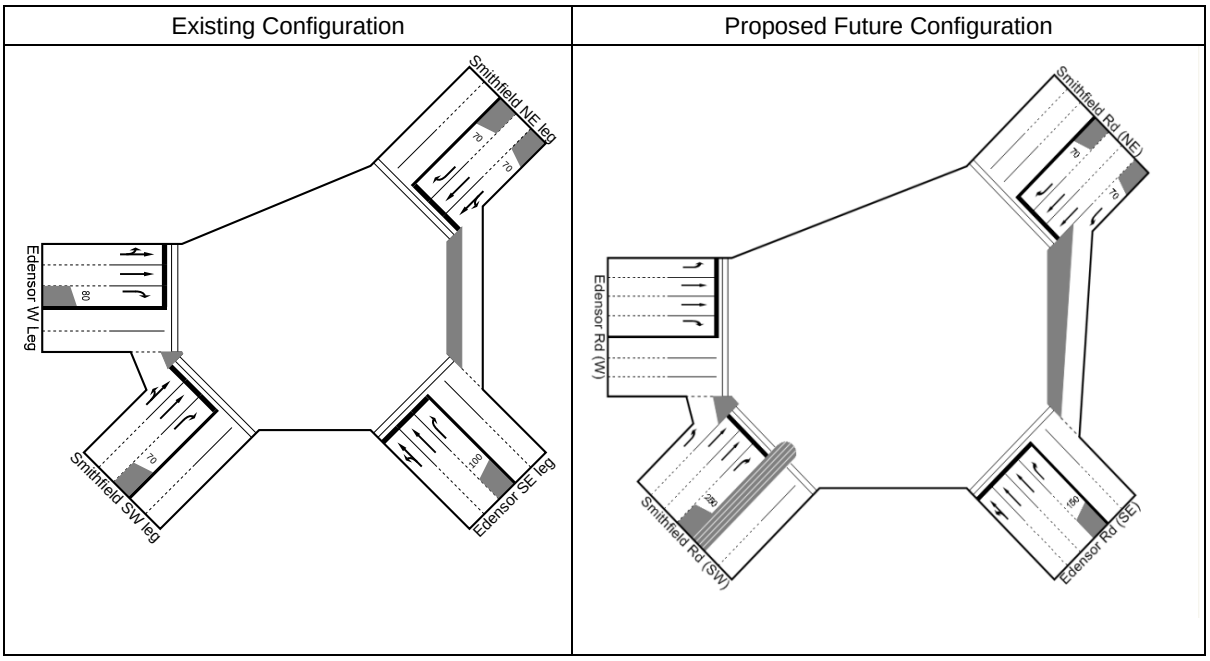
traffic volume at an intersection in the future scenario. Hence, on recommendation from RTA we implemented phasing sequences and phasing type for problematic intersections that varied from the TCS plans but which better suited the predicted traffic volumes to improve the overall intersection performance.

8.5.2.1. Smithfield Road and Edensor Road

Smithfield Road/Edensor Road intersection operates at an unacceptable level with the 2007 base traffic and the future scenarios do not alleviate that position. This analysis included the Bonnyrigg Living Communities traffic impact as part of the base traffic for the 2010 and 2020 scenario. Re-phasing the intersection traffic control to alleviate the poor level of service was tested, but resulted in insignificant improvements. The analysis indicates that demand exceeds the physical intersection capacity, requiring an enhancement in intersection geometry. The failure of the intersection is observed in both AM and PM peaks, although the PM peak is considered the worst case.

The Smithfield Road / Edensor Road intersection will require an additional through lane on Edensor Road (NW leg) and a short through lane on Edensor Road (SE leg) Edensor Road. This configuration would allow for through traffic to clear the intersection with less delay. These improvements would result in the intersection operating at the level of service to "D" for the projected future levels of traffic in year 2020 with the development.

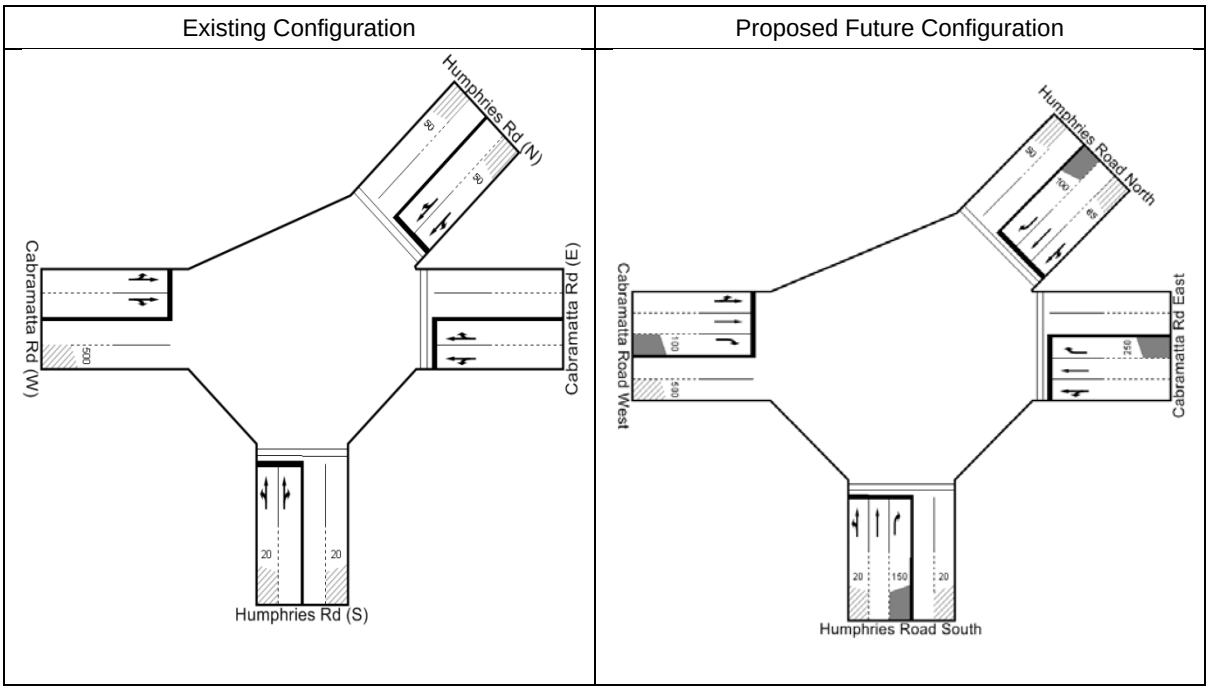
- **Figure 8-5 Existing and Proposed Future Intersection Configuration**



8.5.2.2. Cabramatta Road and Humphries Road

The Cabramatta Road / Humphries Road intersection is operating at a LoS F during both AM and PM peak periods and with the existing traffic flows. Hence, the intersection remained at this level of service with the projected traffic growth levels in the future scenarios. Separating the right turn and through movements on all four approaches by adding in right turns bays would help alleviate the additional delays caused at this intersection with the projected future traffic growth and proposed development.

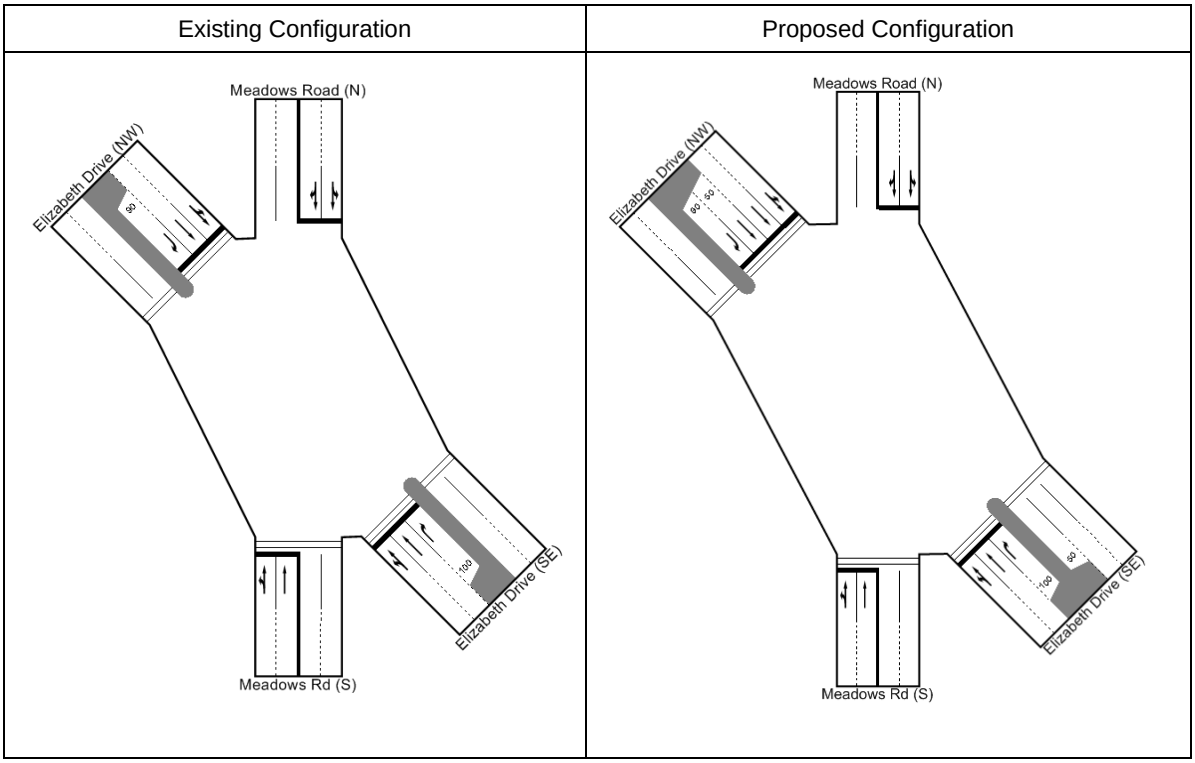
- **Figure 8-6 Existing and Proposed Future Intersection Configuration**



8.5.2.3. Elizabeth Drive and Meadows Road

This intersection was forecast to operate at LoS E (worse case) in the AM peak period in the future 2020 with development scenario. To help alleviate the delays incurred at this intersection, and improve the level of service, it is recommended that an additional through lane be added on the Elizabeth Drive north west approach. This would increase the capacity of the through movements and hence reduce delays on the Elizabeth Drive approach.

- **Figure 8-7 Existing and Proposed Future Intersection Configuration**



8.5.2.4. Elizabeth Drive and Brown Road

The SCATS phasing plan does not indicate a left turn movement from Elizabeth Drive into Brown Road (due to a parallel pedestrian phase operating on Brown Road). However, by adding a left turn movement in this phase (without deleting the pedestrian phase) and by providing more green time for left turning traffic on Elizabeth Drive east, delays on this approach can be reduced, and the overall intersection LoS can be improved.

8.6. Meadows Road Intersections Analysis

In additional to the Paramics and SIDRA analysis at the 14 intersections described in **Section 8.5**, SIDRA analysis was also undertaken at Edensor Road/Meadows Road and Cabramatta Road/Meadows Road intersections that were originally considered outside the study area. This analysis was undertaken to assess any likely impact that the proposed Bonnyrigg development could have on these intersections, and if improvements made at these intersections would have on the performance of other intersections in the study area.

SIDRA analysis was undertaken for both the AM and PM peak scenarios based on traffic survey undertaken for SKM on 28 February 2008.

The future traffic scenario includes predicted development traffic and background traffic growth for the year 2020. Background traffic growth is based on a 0.4% growth rate per annum over the 20 year period. Development traffic was based on the 2020 forecast distribution of traffic at Edensor Road/Humphries Road and Cabramatta Road/Humphries Road intersections (which lie adjacent to these two intersections) with the external zones located east of the study area. The future intersection turning movements was based on existing turning movement proportions.

Table 8-7 summarises the results for these two scenarios at the two intersections.

Table 8-7 Results of SIDRA Modelling - Level of Service (Average Delay)

Intersection	Existing Conditions		Year 2020 With Development	
	AM	PM	AM	PM
Edensor Road and Meadows Road	LoS A (10.1 s)	LoS A (10.2 s)	LoS A (13.2 s)	LoS A (11.9 s)
Cabramatta Road and Meadows Road	LoS C (34.2 s)	LoS C (32.8 s)	LoS D (50.1 s)	LoS C (29.9 s)

Table 8-7 indicates that both intersections are currently operating within capacity levels. With the future increase in traffic (including future background traffic growth and development traffic) the level of service at these intersections is expected to decrease.

The worst case scenario for the Cabramatta Road/Meadows Road in the Year 2020 with the development traffic is a LoS E in the AM peak while Edensor Road/Meadows Road intersection is expected to operate at a LoS A during both peak periods.

However, some diversion of traffic between Humphries and Meadows Road is likely to occur due to the expected future congestion on Humphries Road with the development in place. The proportion of traffic in Year 2020 that could be diverted from Humphries Road onto Meadows Road (without Edensor Road/Meadows Road or Cabramatta Road/Meadows Road intersections operating beyond LoS E) was estimated at 23% (traffic diverted from travelling down onto Humphries Road and accessing Cabramatta Road/Humphries Road intersection onto Meadows Road).

The results of our analyses are indicated in **Table 8-8** below.

- **Table 8-8 SIDRA Results Based on Diverted Traffic Volumes - Level of Service (Average Delay)**

Intersection	Initial SIDRA results (Year 2020)		Revised SIDRA Results (Year 2020)	
	AM	PM	AM	PM
Cabramatta Road/Humphries Road	LoS F (82.4s)	LoS F (>200s)	LoS E (58.6s)	LoS F (182.3 s)
Edensor Road/Humphries Road	LoS D (53.1s)	LoS B (18.6 s)	LoS D (46.2s)	LoS B (18.1s)
Edensor Road/Meadows Road	LoS A (13.2s)	LoS A (11.9 s)	LoS B (15.9s)	LoS B (14.1 s)
Cabramatta Road/ Meadows Road	LoS D (50.1s)	LoS C (29.9 s)	LoS D (53.1s)	LoS C (31.5 s)

The results indicate that the level of service at Edensor Road/Meadows Road intersection is expected to change from A to B. The intersection will continue to operate well within capacity during both peak periods.

The delay at Cabramatta Road/Meadows Road intersection is likely to increase slightly however, it will continue to operate at a LoS C during the AM peak and D during the PM peak.

8.7. School Safety Measures

An analysis of the existing safety measures at schools located in close proximity to the proposed Bonnyrigg development was undertaken. The assessment also identified additional safety measures that would be required at the schools due future background traffic increases and the increase in traffic associated with the Bonnyrigg development.

Four schools were surveyed:

1) St Johns Primary School;
2) Bonnyrigg High School;
3) Our Lady of Mt Camel Primary School; and
4) Bonnyrigg Primary School.

A site visit to assess the safety measures was undertaken on 27 February 2008 during both AM and PM school zone periods (8:00- 9:30am and 2:00-4.30pm). A detailed report is attached as **Appendix C** and summarised below.

8.7.1. Existing Measures Observed Within the School Zones

The following measures were observed/ recorded within each school zone:

- Speed limit enforcement and road signage (pedestrian crossing, speed limits signs, speed cameras);
- Pedestrian crossings (zebra crossing, school patrol, raised pavements, pedestrian bridge);

- Pedestrian footpaths and access through developments in vicinity of the school areas;
- Student drop-off and pick-up areas; and
- Painted road pavements signage indicating school zone areas with speed limit enforcements.
- The measures indicated above are currently enforced at the four schools.

8.7.2. Recommended Safety Improvements for Existing Traffic Conditions

The following measures were recommended to improve safety under existing traffic conditions:

St Johns Primary School

- Additional footpath on south side of Edensor Road; and
- Further investigation should be conducted to determine the provision of additional pedestrian facilities within vicinity of the school.

Bonnyrigg High School

- Upgrade to existing pedestrian crossing on Cabramatta Road (pedestrian refuge island or zebra crossing).

Our Lady of Mt.Camel Primary School

- Provide crossing facilities in the mid block section of Cabramatta Road (between Humphries and Meadows Road).

Bonnyrigg Primary School

- Consider placing a 'lollipop' person at the pedestrian crossing on Tarlington Parade.

8.7.3. Recommended Safety Improvements for Future Traffic Volumes

- In addition to the measures described above, the following measures should be investigated to improve safety due to increased traffic (proposed development and background traffic growth):

Bonnyrigg High School

- Further improvement to recommend upgrade of the existing pedestrian crossing on Cabramatta Road (including a pedestrian signalisation).

Our Lady of Mt.Camel Primary School

- Provide an additional crossing facility such as pedestrian refuge on Humphries Road between Bunker Parade and Salecich Place.

9. Achieving Mode Shift

A list of alternative TDM measures to increase public transport mode share and that could be applied to Bonnyrigg estate is shown in **Table 9-1** and includes supply-side measures such as increasing the quality/quality of bus/pedestrian and cycle transport supply; incentives such as limiting parking supply/roads to encourage public transport usage, various land use measures and various travel demand management policies or programs. The table also highlight those measures that have been incorporated into the development and recommends proposals to further increase mode share.

Table 9-1 Travel Demand Measures to Increase Public Transport Mode Share

Measure	Recommendation/status	Responsible (Funding) Agent
Supply-Side Management		
Increase Quality of Bus Supply		
Review of bus services in Bonnyrigg and surrounding areas	Early engagement with Ministry of Transport to advocate good quality bus service (frequency, hours of service)(Refer to **Table 5.5** and **Table 5.6**)	MoT in consultation with Bonnyrigg Living Communities
Expand coverage by providing an additional bus route (through Bonnyrigg using Tarlington Parade, Bunker Parade and Bonnyrigg Avenue)	Engage with Ministry of Transport. Support as a measure to "make a public transport statement". Consider as a community bus service.	MoT in consultation with Bonnyrigg Living Communities
Increased timetable coordination, service frequency and longer hours of services	Early engagement with Ministry of Transport to advocate good quality bus service (frequency, hours of service)	MoT in consultation with Bonnyrigg Living Communities
Improved bus shelters/seating (Edensor Road & Elizabeth Drive) including safety through design (lighting etc)	Implementation shortly after bus service contract review	Bonnyrigg Living Communities
Provide bus information	Implementation shortly after bus service contract review	Bonnyrigg Living Communities in consultation with operator/MoT
Improved real-time passenger information	TDM measure	
Marketing of bus services	TDM measure	Bonnyrigg Living Communities
Queue jumper lanes/bus priority traffic signals	Unlikely to be warranted	
Special event buses	TDM measures	Bonnyrigg Living Communities

Measure	Recommendation/status	Responsible (Funding) Agent
Increase Pedestrian/Cycle Transport Supply		
Pedestrian oriented design	Incorporated into master plan	Bonnyrigg Living Communities
Improved cycle and pedestrian access through development and to stops/stations from activity centres	Cycle/pedestrian links incorporated into master plan. Ongoing negotiation with owners of Bonnyrigg Plaza.	Bonnyrigg Living Communities
Provide adequate phasing at signalised intersections to accommodate pedestrians/cyclists	Liaise with RTA	RTA
Provision of good quality street furniture and other pedestrian design features (including landscaping)	Incorporated into master plan	Bonnyrigg Living Communities
Provide cycle facilities (lockers/racks) at bus stops/T-way station	Recommended	RTA/MoT in consultation with Bonnyrigg Living Communities
Provide bicycle rental at T-way stations, Bonnyrigg Plaza and at community facilities within Bonnyrigg	Unlikely to be successful due to social-economic environment	
Provide cycle/pedestrian maps	TDM measure	Bonnyrigg Living Communities
Arrange cycling/walking event/activities	TDM measure	Bonnyrigg Living Communities
Increase taxi supply		
Provide additional taxi stands/kerbs at Bonnyrigg Plaza/community centre	TDM measure	Bonnyrigg Plaza in consultation with Bonnyrigg Living Communities
Install direct telephone link booking system at Bonnyrigg Plaza/community centre	TDM measure	Bonnyrigg Plaza in consultation with Bonnyrigg Living Communities
Work with local operators to improve driver skills/courtesy	TDM measure	Bonnyrigg Living Communities
Provide educational material about taxis	TDM measure	Bonnyrigg Living Communities
Car Pooling		
Develop scheme/data base to support car-pooling	TDM measure	Bonnyrigg Living Communities
Provide ride-share fleet for development	Unlikely to be successful due to social-economic environment	
Provide preferential ride share parking spaces	Unlikely to be successful due to social-economic environment	

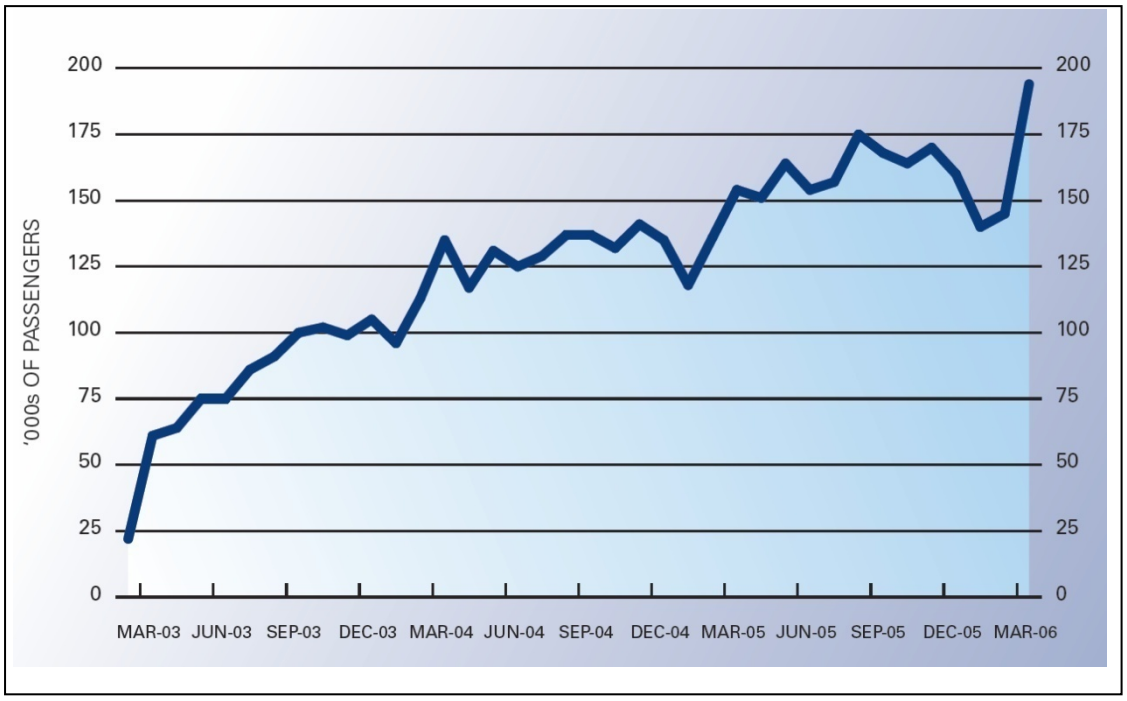
Measure	Recommendation/status	Responsible (Funding) Agent
Incentive		
Parking		
Limit supply of parking	See revised DCP (Incorporated into master plan) Visitor parking to be provided off-street	Bonnyrigg Living Communities
Time-limit on street parking	TDM measure	Bonnyrigg Living Communities
Price on-street parking	TDM measure	Bonnyrigg Living Communities
Develop an overflow parking plan	TDM measure	Bonnyrigg Living Communities
Establish maximum parking standards	Limit parking supply recommended	
Road Network		
Traffic speed and volume control measures and other environmental design considerations (to discourage car use and encourage active transport)	Incorporated into master plan	Bonnyrigg Living Communities
Land Use Management		
Increase density of development	Incorporated into master plan	Bonnyrigg Living Communities
Provide mixed land use	Different housing mixes incorporated into master plan. Ongoing negotiation with owners of Bonnyrigg Plaza to increase pedestrian/cycle connectivity.	Bonnyrigg Living Communities
Human scale development	Incorporated into master plan	Bonnyrigg Living Communities
Co-locate development alongside high quality transit station	Incorporated into master plan. Ongoing negotiation with owners of Bonnyrigg Plaza to improve cycle/pedestrian linkages	Bonnyrigg Living Communities

Measure	Recommendation/status	Responsible (Funding) Agent
Policies and Programs		
Appoint a travel plan co-ordinator to develop a site specific Transport Demand Management strategy. This could include the following tasks: ■ Survey users and potential users of alternative modes to determine preferences, knowledge, barriers and opportunities for changing travel behaviour and providing Transport Demand Management services; ■ Targeted, personalized marketing campaigns, which identify consumers who are most able and willing to change their travel patterns and providing them with suitable incentives to try alternatives; ■ Educate community about the benefits of alternative modes including walking, cycling, bus travel, taxi and car-pooling; ■ Develop information packages about each mode and how to access a particular destination by alternative modes; ■ Provide walk, cycle and bus maps; ■ Improved real-time passenger information; ■ Promote public transport and active modes via a newsletter, notice board or internet; ■ Organize walk and cycle events; ■ Responds to public transport and parking problems and complaints; ■ Coordinate any special event public transport; ■ Manage supply, pricing and time-management of parking; ■ Liaise with Bonnyrigg Plaza to provide free shopping delivery to encourage both use of public transport use and walking/cycling; and ■ Other measures recommended above.	Responsibility of the development manager	Bonnyrigg Living Communities

9.1. Bus Supply

Bonnyrigg is located in close proximity to the Liverpool to Parramatta Transitway. This facility provides Bonnyrigg with a good platform for increased public transport usage and increased public transport mode share. The growth of the Transitway illustrated in **Figure 9-1** is typical of the impact that high quality public transport schemes has on mode share.

- **Figure 9-1 Liverpool to Parramatta Transitway Monthly Patronage**



Source: State Infrastructure Strategy New South Wales 2006/7 to 2015/16

9.1.1. Current Ministry of Transport Bus Route Review

The MoT, in close liaison with Westbus and in consultation with residents, is currently reviewing existing bus routes in the area. Future routes will be developed through the adoption of the following principles[6]:

- More direct routes, which in turn will assist in decreasing travel times;
- Maximise service frequency and Level of Service;
- Improved connectivity between major towns and centres;
- Improved access to services for residents;

[6] From Ministry of Transport (2006) *Service Planning Guidelines - Sydney Metropolitan Regions*.

- Improved legibility of the wider network.

It is expected that through the implementation of these measures patronage numbers will increase.

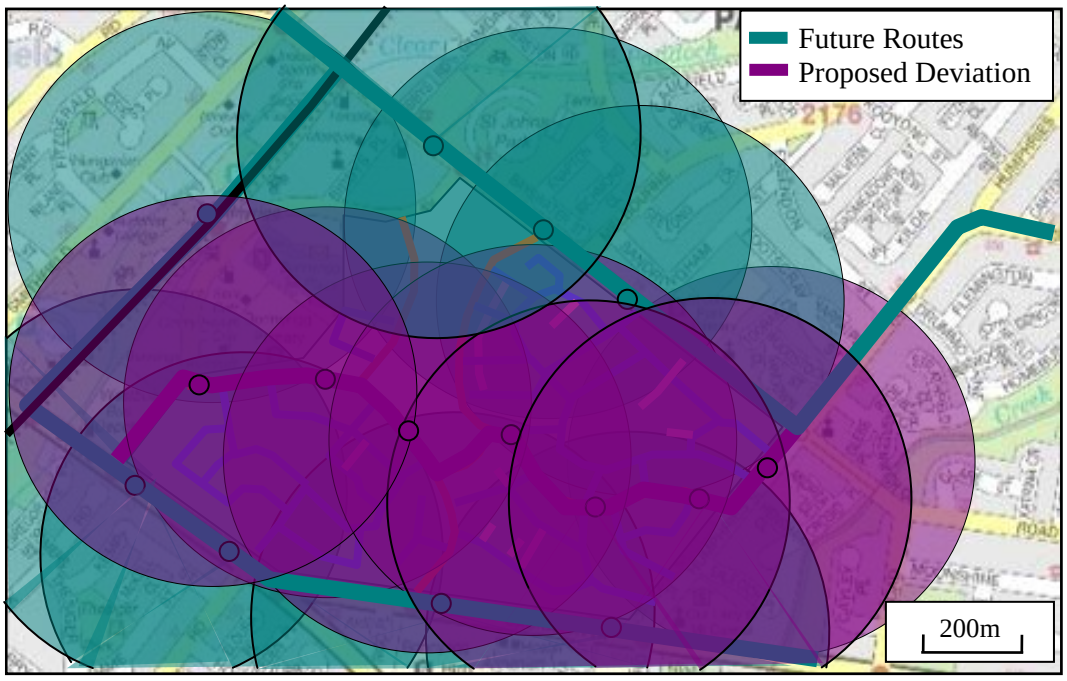
For Bonnyrigg the review is likely to result in the following arrangements:

- Continuation of good levels of service on the Liverpool-Parramatta T-Way; and
- Increased service frequency on roads on the boundary of Bonnyrigg including Cabramatta Road and Edensor Road connecting Bonnyrigg with Fairfield and Cabramatta.

9.1.2. Possible Future Bus Routes

The Ministry of Transport's Integrated Network Planning process for bus contract 3 is nearing completion and is likely to be put on public exhibition by mid 2008. It is likely that higher frequency routes would operate on primary roads such as Edensor Road and Elizabeth Drive / Cabramatta Road. Under this scenario, the majority of residents would continue to be within the 400 metre catchments of a bus stop.

- **Figure 9-2 Proposed Road Layout and Possible Future Route Network**



There is potential for a secondary bus route to operate through the estate along Tarlington Parade, Link Road, then on to Bunker Parade. It is recommended that the roads along this potential route be designed with sufficient road width to accommodate easy passage by buses (a minimum of 7 metres wide with no parking). All intersections along these roads should also be easily navigated

by buses. These measures will ensure that buses can move freely within the estate and avoid conflicts with road features and other vehicles.

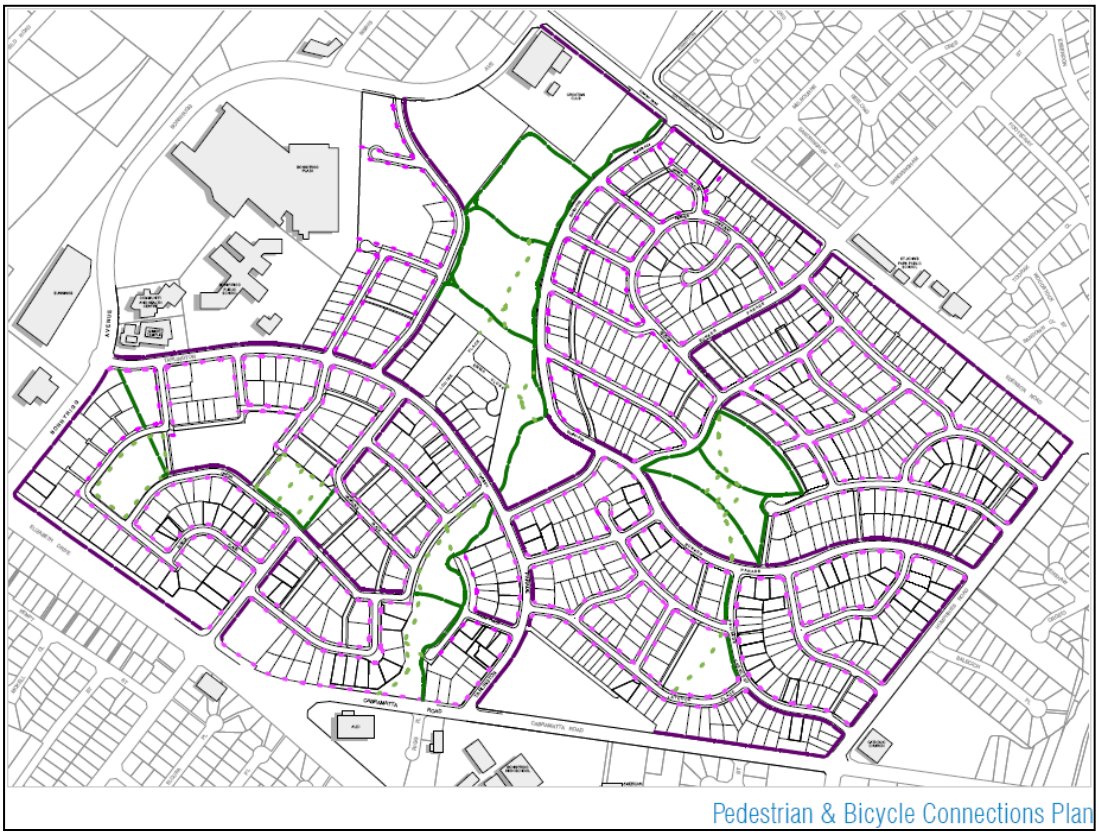
Bus routes would operate at Ministry of Transport bus network planning benchmarks and criteria described in **Table 5-5**.

Bus stops should be in existence from the beginning of construction to ensure that residents are aware of them from the start. Similarly, buses should be travelling through the development from the commencement of construction to ensure that people know they are there. Bus stops should be within easy 400m walking distance. Bus stops should be of a high standard and clearly visible. Adequate shelter and seating should be provided to ensure that patrons are comfortable while waiting for buses. Timetable information for the routes relevant to that stop should be provided in an easily read format, with information on connecting routes also provided to promote the utilisation of the buses.

9.2. Pedestrian and Cycle Supply

A number of alternative pedestrian and cycle alternatives are discussed in **Table 9-1**. The overall pedestrian and cycle strategy is discussed in greater detail in the Final Bonnyrigg Master Plan (Part 4). The pedestrian and bicycle connections plan is illustrated in **Figure 9-3**.

- **Figure 9-3 Pedestrian and Bicycle Connections Plan**

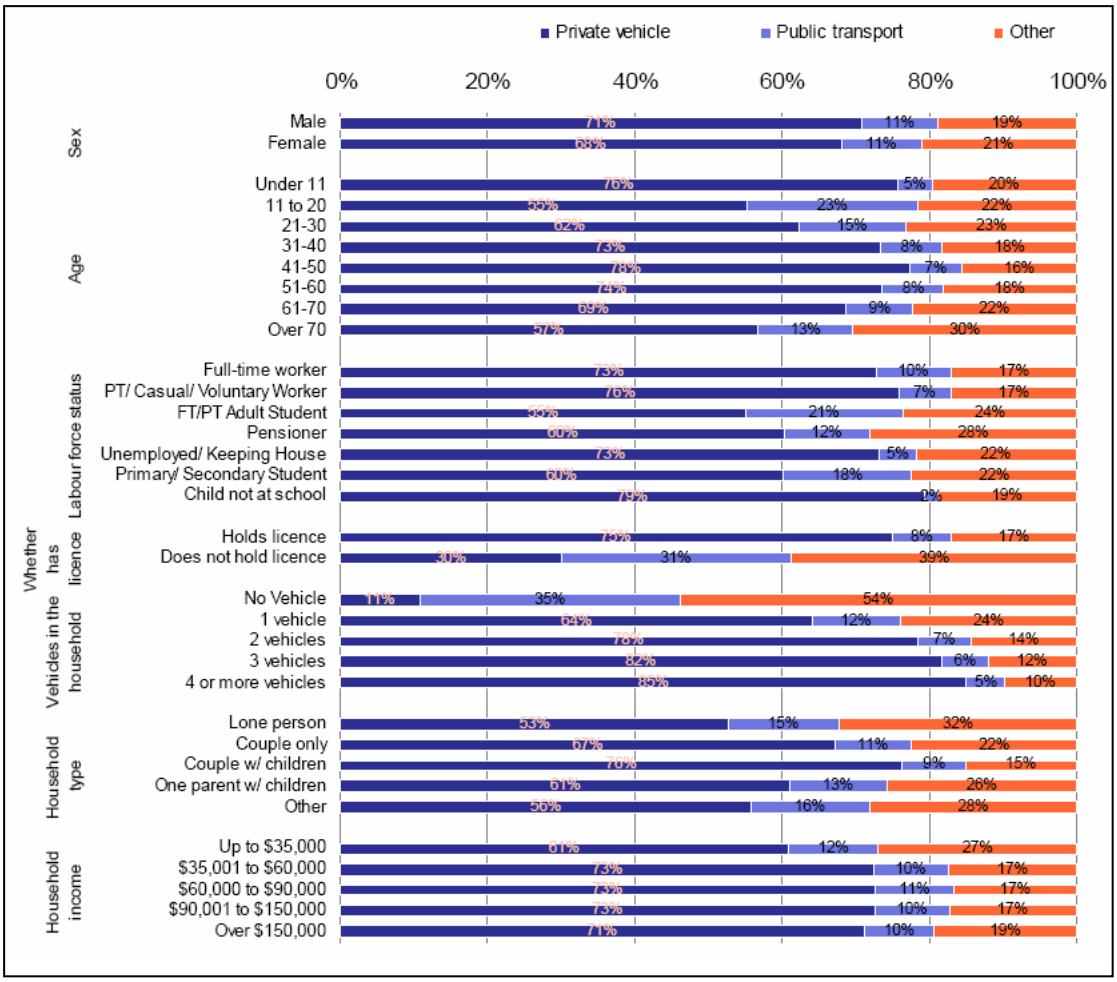


9.3. Parking

Figure 9-4 shows the differences in mode usage to a number of socio-demographic characteristics. Corpuz (2007)[7] concludes that among the different socio-demographic characteristics, the analyses suggest that access to a vehicle appears to have the greatest impact of enhancing vehicle use. Conversely, the lack of access to a vehicle is associated with lower vehicle use and higher public transport use. Corpuz suggest that "policies and/or urban planning scenarios that impinge on the access to the vehicle, and in particular access to more than one vehicle could potentially have a significant impact in reducing car use and promoting more sustainable modes". Managing parking (through reducing supply or managing utilisation (either through time or pricing controls)) would be an effective measure to support public transport mode share.

[7] Public transport or private vehicle: factors that impact on mode choice (Corpuz, TDC), 2007

- **Figure 9-4 Number of Travellers on Motorised Modes by Mode and Time of Day**



Source: Public transport or private vehicle: factors that impact on mode choice (Corpuz, TDC), 2007

9.3.1. Parking Surveys

Parking occupancy surveys were undertaken to determine the existing parking supply and demand generated by the specific housing development types and assist determine the expected parking demand in the proposed Bonnyrigg development area.

In addition to parking surveys undertaken at Bonnyrigg (Tarlington and Bunker Parade) surveys were conducted on the 22nd and 23rd April, 2008 at the following locations:

- Malabar (area surrounding Bilga Crescent);
- Stanhope Gardens (area surrounding Somerset Street); and
- North Paramatta (Governors Way and Hunterford Crescent).

The sites are representative of proposed Bonnyrigg development, in terms of size, scale and density. These surveys were conducted no earlier than 7:00pm to allow residents to have returned to their homes after work and represents full parking demand. The full survey results are attached as **Appendix D** and summarised below:

9.3.1.1. Malabar (Southern End of Bilga Crescent)

Malabar is comprised mainly of high rise apartments and town houses. A total of 228 on-street parking was observed of which 40% were occupied. A total of 279 off-street parking spaces (including 10 visitor parking spaces) were available with 55% occupied during the survey period.

Malabar falls within Randwick local government area. The Randwick DCP for parking requires approximately 360 resident parking spaces and 100 visitor parking spaces.

There is a shortfall in both the number of residential and visitor parking spaces. However, our site visit observations and surveys show that the existing parking supply exceeds demand. In addition, there are sufficient on-street parking spaces available in the area to accommodate both residential and visitor parking demands.

9.3.1.2. Stanhope Gardens (Somerset Street)

Stanhope Gardens is a newly developed area and consists mainly of modern double-storey houses and town houses.

As all off-street parking is provided in enclosed single or double garages off-peak parking was not surveyed.

There were a total of 250 carparks on the property. In addition to the on-street parking, visitors were able to park in the driveways of the homes that they were visiting (as was observed on-site). With absence of specifically marked visitor parking it was assumed that on-street parking is available for visitors to the area as well for the residents.

Only 54 of the total 220 on-street parking spaces (25%) were occupied during the survey. Thus there appears to be sufficient on-street and off-street car parks to meet the demands for residents and visitors to the area.

The Blacktown DCP requires approximately 225 spaces for resident parking and approximately 50 spaces are required for visitor parking. It is considered that there are adequate parking spaces provided for the residents with supply exceeding demand.

9.3.1.3. North Parramatta (Hunterford subdivision - Opposite King's School)

This site is comprised of newly built houses and townhouses. A large number of off -street parking surveyed in this area were garages and driveways. There was also basement parking space serving a cluster of townhouses.

Only 55% of the total on-street car parks surveyed in the study area was occupied. Hence, it is considered that there are sufficient on-street parking spaces available for the residents and the visitors to the area.

There were a total of 200 off-street parking provided in the study area. In additional approximately 27 off-street car-parks were provided for a group townhouses located on Governors Way. Seven spaces were allocated for visitor parking. A total of 19 visitor car parks were available in the study area.

Paramatta Council's DCP acknowledges a difference for parking provision between land uses within 400m of a rail station or beyond 400m. The Paramatta Council's DCP states that approximately 140 resident and 25 visitor parking spaces should be provided in this study area.

Our site visit and surveys indicate that there are sufficient parking spaces provided for the residents. There is a shortfall in the number of visitor parking spaces. Overall supply of parking exceeds supply.

9.3.1.4. Bonnyrigg (Tarlington Parade and Bunker Parade)

Bonnyrigg comprises detached houses with either single car ports or single separate garages. There were approximately six access roads that adjoined with Bunker and Tarlington Parade and which provide access to the parking areas of several proprieties in the study area.

Off-street parking occupancy is difficult to survey with cars parked in garages and behind closed property gates. A total of 254 off-street parking spaces were recorded (including Tarlington Parade, Bunker Parade and access roads). There are a total of 10 visitor car-parks available in the surveyed area.

Only 3% of the total on-street car parks surveyed in the study area were occupied. Despite the availability of on-street parking, a high number of cars were observed to be parked in the driveways or on the lawns of the dwellings.

The Fairfield Council DCP parking requirements is illustrated in **Table 9-2**.

- **Table 9-2 Fairfield Council DCP Parking Requirements**

	Dwelling Houses	Medium Density	High Density
Resident's Parking	1 /dwelling (1-2 bedroom) 1.5 -2/dwelling (3+ bedrooms)		
Visitor's Parking	0.25/dwelling		

The Fairfield Council DCP requires in the order of 144-192 resident parking and approximately 30 visitors parking to be provided in the study area.

Based on the Fairfield DCP resident parking rate requirement there are adequate off-street parking spaces provided for the residents. Only 10 visitor spaces were provided in the area. However overall supply for parking exceeds demand and there is sufficient parking available on-street.

9.3.2. Summary

The supply of parking exceeds the demand for parking at the four locations surveyed. All four areas currently have a shortfall in visitor parking spaces but all sites have adequate on-street parking spaces available to accommodate visitor parking. It is unlikely that a slight restriction in parking supply would adversely affect residential or visitor parking convenience.

9.4. Recommended Parking Supply

The application of the car parking rates in the Fairfield City-Wide Development Control Plan 2006 is considered inappropriate as the prescribed parking rates are excessive and would result in a poor urban outcome:

- Encouraging the continued use of the private motor car as a primary means of transport;
- Discouraging the use of alternative forms of transport, such as public transport, cycling and walking; and
- Visual impacts of an over-supply of car parking (as is currently observed).

The car parking rates illustrated in **Table 9-3** and described in the Concept Plan are considered appropriate for the site, taking into account the strategic objectives of land use and transport planning, including:

- Parking surveys (at developments similar in size, scale and intensity to that proposed at Bonnyrigg) in Malabar, Blacktown, and Parramatta that show parking supply exceeds parking demand. Parking surveys at Bonnyrigg show similar results and it is unlikely that a slight restriction in parking supply would adversely affect residential or visitor parking convenience;
- Proximity of the site to Bonnyrigg Plaza and Liverpool to Parramatta Transitway;
- Extensive infrastructure investment in improving pedestrian and cycle access across the site

- The range of behavioural change measures to encourage modal shift away from the private motor car (described below); and
- The effectiveness of parking as a measure to discourage car use.

- **Table 9-3 Proposed Bonnyrigg DCP Parking Rates**

	Detached Housing	Medium Density	High Density
Resident's Parking	2/dwelling	1/dwelling (1-2 bdrms) 1.5/dwelling (3+bdrms)	0.6/apartment (1 bdrm) 0.9/apartment (2 bdrms) 1.4/apartment (3 bdrms)
Visitor's Parking	On-street	On-street	0.2/apartment

9.5. Behavioural Change

Community attitudes towards non-car travel are affected by a wide range of issues, from peer attitudes, privacy and security, flexibility of timing, multi-purpose trips, and confidence of the return-home trip.

A number of community and government based initiatives have been put in place over recent years endeavouring to alter people's behaviour and decrease the number of people travelling by private car. The most common behaviour change strategy is TravelSmart, an Australian government based program that promotes the use of public transport for routine travel by encouraging individuals to reconsider their need for the use of a private car.

Achieving reduced travel by improving public transport, pedestrian and cycling facilities is increased when their introduction coincides with a marketing campaign informing potential users of the benefits of using these modes. This has been demonstrated in Perth by the "*TravelSmart*" program introduced by the West Australian Department of Transport.

Individuals need to determine if car travel is necessary for most daily travel requirements and to consider if public transport, which is a cheap and efficient mode of travel, could be implemented into their daily routine.

Travelsmart Households is a program operating in each state of Australia with thousands of residents participating by leaving their cars at home in favour of public transport, walking and cycling. The TravelSmart program included an individualised marketing program for each area, which provided specific information on the travel alternatives and motivation and localised information to promote the use of alternative modes of transport. Programs in South Australia have been particularly successful, showing a significant decline in the amount of cars on the road and an increase in the use of public transport. Eighteen cities and suburbs have participated in the Households program since its introduction in 1997, including Cambridge, Subiaco, Melville and Vincent. Cambridge showed a 7% decline in the amount of cars, with a 13% increase in the use of

public transport. Subiaco resulted in a 12% decline and an increase of 39%, Melville a 12% decline and 20% increase and Vincent a 9% decline and 11% increase. The program offers incentives to those who take part including a visit from a Travelsmart advisor to provide tips and advice on public transport and cycling/walking and various discounts on goods and services. In Western Australia Travelsmart Household project results, averaged across eight projects with 143,000 residents, demonstrate that car trips have declined 10%, with 13% less kilometres travelled and an increase in public transport usage by 18%.

Funding for the South Perth project was provided by the Western Australian Department of Transport, the City of South Perth Council and other contributors. The TravelSmart program cost some $0.5M for a community of 10,400 people in South Perth.

Whilst infrastructure (road and rail) and public transport service provision are costly to deliver, travel demand management measures are usually inexpensive to implement. This include activities such as setting up information kiosks in the area and at bus stops, and initiatives to ensure employers provide transport information, and programs to support car-pooling opportunities, and non-transport support such as onsite services.

9.5.1. Options for Bonnyrigg

The main means of achieving behaviour change within Bonnyrigg Living Communities is to ensure that the required public transport are made available (eg. bus routes, footpaths, cycle-ways), and then to ensure that the community knows of their existence, and what benefits they gain from using the facilities. Bus stops should be highly visible. Up-to-date route and timetable information should be provided at each stop. Leaflets and timetables should also be made available through letterbox drops, and be readily available at local shopping and community centres. Community discussions throughout the development of the estate would be an additional forum for promoting public transport, cycle and pedestrian information to residents. Other TravelSmart processes, such as calling residents to inform them of what is available and assist them in achieving the mode shift they so desire, should also be undertaken.

Engineering improvements, such as ensuring buses can easily negotiate the proposed route, ensuring that cycleways and pedestrian footpaths are provided and providing high quality bus stops throughout the estate will also assist in achieving mode shift.

It can therefore be concluded that the Transitway coupled with current MoT bus routes review, the provision of good infrastructure to support bus operations, various TDM measures and the control and management of parking could increase existing public transport mode share by 50% from existing levels of around 5% daily trips to 7%-8%. A stretch target would be to increase public transport utilisation to 10% shift to non-car modes relative to the existing mode split base in the Bonnyrigg Living Communities precinct.

9.5.2. Conclusions

It is estimated that a target mode shift of 50% over the existing public transport mode share could be achieved, resulting in a public transport mode share between 7-8 %. The recommended measures are described in **Table 9-1**.

10. Package of Measures

10.1. Introduction

This section discusses the package of measures recommended for implementation as part of the Bonnyrigg Living Communities. The package includes a range of initiatives, addressing:

- Infrastructure measures to improve walking, cycling and public transport opportunities while maintaining adequate vehicle access;
- Public transport service frequency by providing sufficient service thresholds to ensure quality of transport service and thus, providing incentives for modal shift;
- Intersection improvements to maintain adequate intersection performance in the long term; and
- Travel behavioural changes.

The initiatives discussed below should be implemented as an integrated package to realize its benefits. A number of the measures are interrelated and will achieve its maximum benefits when implemented in a coordinated manner.

10.2. Infrastructure Enhancements

10.2.1. Pedestrian and Cycleways

The internal roads within Bonnyrigg Living Communities should be connected to the existing network without compromising pedestrian and cycle access or creating any diversions. Connections to established pedestrian and cycle paths should be provided where appropriate and linkages to the regional cycle network along the T-Way and along Elizabeth Drive should be constructed.

Introducing direct walking and cycling connections between the residential zones to the retail, education and leisure zones within the Estate is considered vital for the development. Easy access to public transport mainly along Tarlington Parade, Bunker Parade and Bonnyrigg Avenue are essential to promote modal shift.

10.2.2. Bus Infrastructure

The proponent of Bonnyrigg Living Communities should engage in early discussions with the Ministry of Transport and Westbus to advocate for good quality bus services during the current review process and a secondary bus route on Tarlington Parade, Link Road and Bunker Parade. The timing of this route would need to be linked to the construction of Link Road. An indicative framework for provision of bus stops suggests the construction of bus stops within the residential development along Tarlington and Bunker Parade. Bus stops and bus services should be in

existence from the beginning of construction to ensure that residents are aware of them from the start.

The location of bus stops is a detailed precinct planning issue. Care needs to be exercised to ensure that their location does not create any inherent safety issues with respect to, or interfere with, the operation of the road network, and meets needs of natural surveillance. Bus stops should be within easy walking distance (400 metres maximum) from all residences. Bus stops should be of a high standard and clearly visible. Adequate shelter and seating should be provided to ensure that patrons are comfortable while waiting for buses.

Buses should operate through the development from the commencement of construction to ensure that people know they are there. Timetable information for the routes relevant to that stop should be provided in an easily read format, with information on connecting routes also provided to promote the utilisation of the buses. The provision of real-time information at bus stops should be considered.

Upgrading of regional bus stops on roads major roads surrounding the development is also recommended.

10.3. Travel Behaviour Change

A travel plan framework should be developed to outline the following:

- Existing transport services available in the local area;
- Access to information on travel to the site;
- Review of local pedestrian and cycle network;
- Timescale for initiatives; and
- Details for future monitoring.

The main means of achieving behaviour change in Bonnyrigg Living Communities to ensure that the required public transport services and infrastructure are made available (eg. bus routes, footpaths, cycle-ways), and then to ensure that the community knows of their existence, and the benefits to them of using the facilities. Bus stops should be highly visible. Up-to-date route and timetable information should be provided at each stop. Leaflets and timetables should also be made available through letterbox drops, and be readily available at local shopping and community centres. Community discussions throughout the development of the estate would be an additional forum for promoting public transport, cycle and pedestrian information to residents. Other measures to support mode share are summarised in **Table 9-1**.

Engineering improvements, such as ensuring buses can easily negotiate the proposed route, ensuring that cycleways and pedestrian footpaths are provided and providing high quality bus stops throughout the estate will also assist in achieving mode shift.

10.4. Intersection Improvements

The assessment of intersection improvements was based on the traffic modelling analysis undertaken as part of this TMAP. Two future year scenarios were conducted based on the staging plan for the re-development and the full redevelopment. The results of the modelling process revealed that the intersection upgrades identified are already necessary to provide additional capacity for the existing traffic levels and hence, are required regardless of planned density of future development. Two intersections from the 2007 base model that would require capacity enhancements include:

- Cabramatta Road / Humphries Road – additional right turn lanes for all four approaches;
- Smithfield Road / Edensor Road – additional through lane on both legs of Edensor Road; and
- Elizabeth Drive/Meadows Road – additional through lane on north west approach of Elizabeth Drive.

11. TMAP Agreement

11.1. Introduction

This section identifies funding mechanisms available to the proponent and consent authority, including probable costs, available funding options and apportionment of funding, timing and delivery responsibility.

Table 11-1and **Table 11-2** provide indicative apportionment of the funding between the proponent and other consent authorities for the proposed improvements at the three intersections.

Two separate methodologies were applied to calculate these apportionments. The first methodology was applied to the Smithfield/Edensor Road and Cabramatta/Humphries Road intersections and assessed total development traffic over existing plus future background traffic growth.

The second methodology applied to the Elizabeth Drive/Meadows Road intersection. This methodology looked at the implications of the additional development traffic over the future background traffic at this intersection in Year 2020.

This method provides a conservative apportionment of the total funding that would be required at these intersections and is appropriate for use at the two that are currently operating over-capacity. Any additional traffic at these intersections would not significantly affect the level of service.

Elizabeth Drive/Meadows Road intersection is currently operating at an acceptable level of service. With the future development in place, this intersection is predicted to have increased delays and was forecast to operate at a poor level of service. As the development and future background traffic creates a problem at this intersection we have apportioned the additional development traffic over future background traffic. Hence the apportionment is significantly higher that the first methodology.

Table 11-1 and **Table 11-2** below indicate the apportionment of the funding for the improvements at the three intersections.

- **Table 11-1 Development Traffic and Future Background Traffic by Intersection**

Intersection	Year 2020						Average
	AM			PM			
	With Develop-ment	Without Develop-ment	Develop-ment %	With Develop-ment	Without Develop-ment	Develop-ment %	
Cabramatta Road Humphries Road	2417	2231	7.7%	2720	2466	9.3%	8.5%
Smithfield Road / Edensor Road	3882	3705	4.6%	4800	4350	9.4%	7.0%

- **Table 11-2 Summary of apportionment funding –Elizabeth Drive/Meadows Road**

Intersection	Year 2020						Average
	AM			PM			
	Development Traffic	Future Background Traffic	Develop-ment %	Development Traffic	Future Background Traffic	Develop-ment %	
Elizabeth Drive/Meadows Road	269	139	51.6%	348	161	46.3%	**49.0%**

11.2. Cost and Timing Summary

Table 11-3 provides indicative costs and timing for the recommended improvement measures as well as the apportionment of funding between the proponent and other consent authorities.

- **Table 11-3 Summary of Indicative Costs for Package of Measures**

Measure	Indicative Cost*	Apportionment to Proponent	Probable Cost	Timing
Pedestrian and cycle paths	Nil (covered under infrastructure costs)	N/A	Nil	N/A
Installation of five internal local bus shelters, seats and passenger information	Nil[1]	100%	N/A	N/A
Installation of five regional bus stops with real time passenger information on major roads	Nil[1]	Up to 50%	N/A	N/A
Cabramatta Road / Humphries Road - additional right turn lanes for all four approaches	$1,307,045[2]	8.5%	$111,099[2]	2008

Measure	Indicative Cost*	Apportionment to Proponent	Probable Cost	Timing
Cabramatta Road / Humphries Road –land acquisition cost	$194,870[2]	8.5%	$16,564[2]	2008
Smithfield Road / Edensor Road - additional through lane on both legs of Edensor Road	$1,621,415[2]	7.0%	$113,500[2]	2008
Smithfield Road / Edensor Road – land acquisition cost	$422,400[2]	7.0%	$29,568[2]	2008
Elizabeth Drive/Meadows Road –additional through lane on north west approach	$354,152[2]	49.0%	$173,535[2]	2008
Elizabeth Drive/Meadows Road –land acquisition cost	$2400[2]	49.0%	$1,176[2]	2008
Provision of information kiosks, data boards, leaflets as part of a comprehensive Travel Plan	Nil [3]	N/A	Nil	N/A
TOTAL			**$444,442**	

1. Cost included in Fairfield Council VPA. 2. Cost provided by project quantity surveyor and valuation provided by project valuer (refer to WT Partnership letter dated 24 October 2008). 3. Tasks to be undertaken by Bonnyrigg Management as part of their ongoing community consultation role.

The indicative costs were identified with regard to the need for costs to be borne across a range of stakeholders and the need to agree apportionment and funding. The estimates are strategic in nature and are subject to more detailed cost estimation following detailed investigation and design. The potential for change in the development mix may also affect the cost structure.

12. Conclusions

The development of Bonnyrigg Living Communities provides a major challenge in delivering a sustainable development in an area where cars remain the dominant mode. The main purpose of the TMAP was to develop a balanced and integrated package of measures to maximise the potential for mode shift and increase the use of public transport, walking and cycling for travel.

The site is well located in terms of transport corridors, with the Liverpool-Parramatta Transitway being a strategic bus corridor. Providing good cycle and pedestrian access to this corridor would be essential for a successful and sustainable development. Significant opportunities exist to encourage mode shift away from car. A range of supply side measures, incentives, and management policies and programs should be implemented to ensure that mode share targets are achieved.

The results of the traffic modelling confirmed that the development will not have a significant adverse impact on the surrounding road network. The proposed intersection upgrades are required to mitigate the impacts of existing traffic. The key recommendations of this TMAP are reflected in the package of measures discussed in Section 10. These measures are deemed to meet the needs of both the existing and new residents, while achieving a realistic shift towards public transport over the next 10 to 15 years.

Appendix A Paramics Modelling Report

Bonnyrigg Traffic and Transport Study to the Urban Renewal Project

PARAMICS MODELLING REPORT

Draft

9 November 2007

Bonnyrigg Traffic and Transport Study to the Urban Renewal Project

Paramics Modelling Report

Draft

9 November 2007

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1. Introduction

Sinclair Knight Merz (SKM) was commissioned by Hughes Trueman Pty Ltd, on behalf of Bonnyrigg Partnerships to develop a Paramics model for Bonnyrigg area enclosed by Smithfield Drive, Elizabeth Drive, Edensor Road and Humphries Road.

Paramics is a transport modelling tool. It has the ability to model the movements of individual vehicles – braking and acceleration, turning, lane-changing, queuing and delays. Paramics is also capable of representing the network constraints of road geometry, angle of turn and length of turning lane. The behaviour of individual vehicles and their interactions with other traffic and network constraints can be adequately modelled in Paramics. The Paramics level of detail is well suited for modelling traffic circulation of existing and planned residential developments.

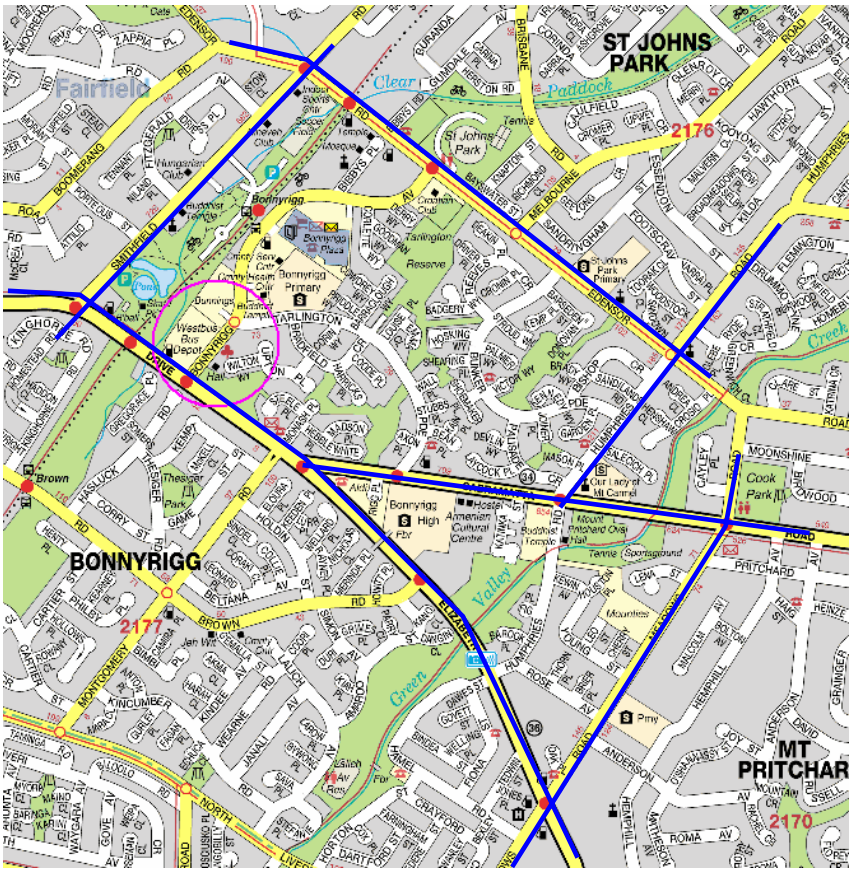
The base models (2007) were developed by SKM to reflect existing traffic conditions in the study area. Two models were developed, an AM Peak model from 07:00-09:00 and a PM Peak model from 16:00-18:00. The models were then calibrated and validated to ensure that the models adequately reflected current traffic conditions.

This report describes the development, calibration and validation of the Paramics 2007 Base Case models for the AM and PM peak hours. The report also details the results, for the individual intersection operation, for both the AM and PM peak hours using the intersection analysis software aaSIDRA.

2. Study Area

The study area is presented in **Figure 2-1.** The study area is bounded by Smithfield Road to the west, Meadows Road to the east, Elizabeth Drive to the south and Edensor Road to the north. An aerial photograph with the super-imposed Paramics network is shown in **Figure 2-2**.

- **Figure 2-1 The Study Area**



- **Figure 2-2 Aerial image of study area**

3. Model Development

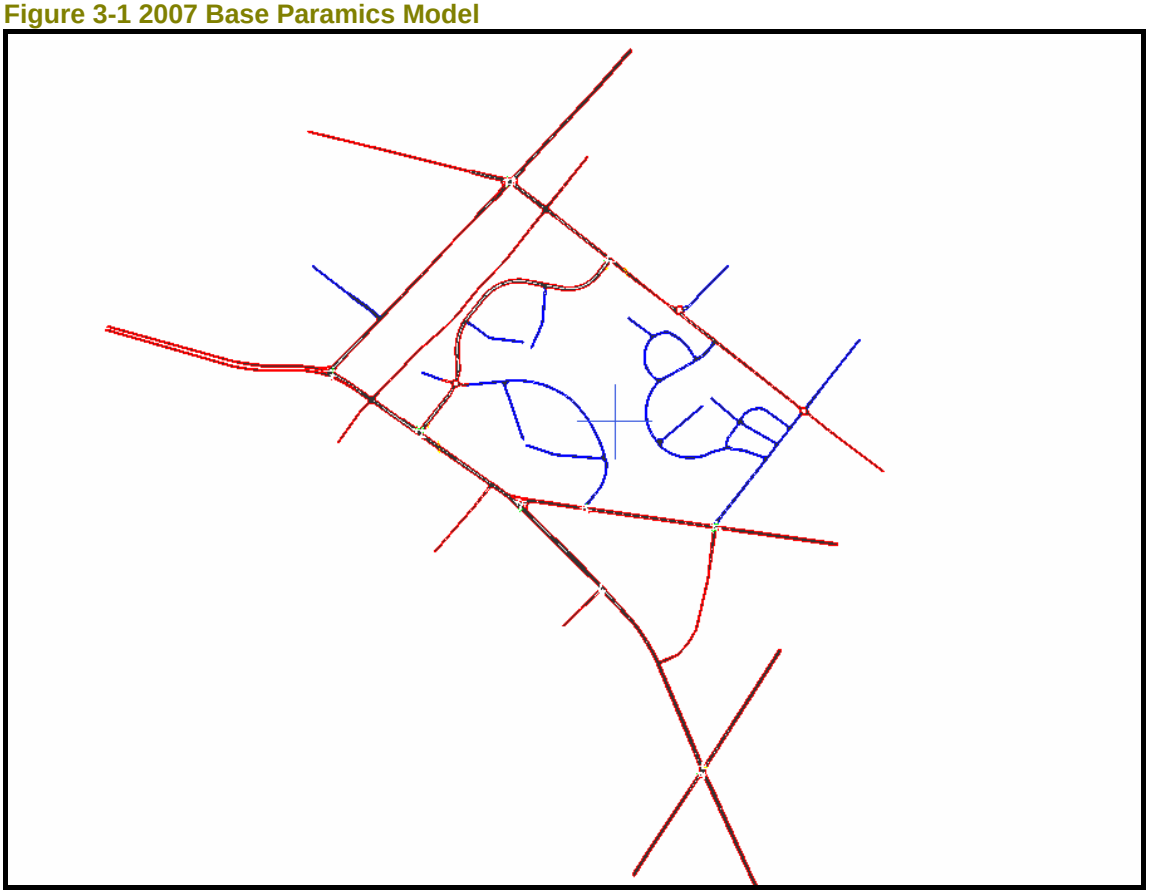
Traffic surveys were undertaken on Wednesday the 15th of August 2007 between 07:00-09:00 and 16:00-18:00. The AM and PM peak hours were selected based on the most trafficked period identified from the surveys completed in the study area.

A site visit was also undertaken on the 22nd June 2007 to confirm and supplement the information extracted from the aerial photograph image. In addition, the site visit allowed for collection of data for speed limit attributes for each modelled road link and to observe existing traffic behaviour to queuing.

The Paramics model classifies roads into major and minor roads, corresponding to main roads and local roads in the RTA road classification.

The layout of the Base Paramics model is presented in **Figure 3-1** below.

- **Figure 3-1 2007 Base Paramics Model**



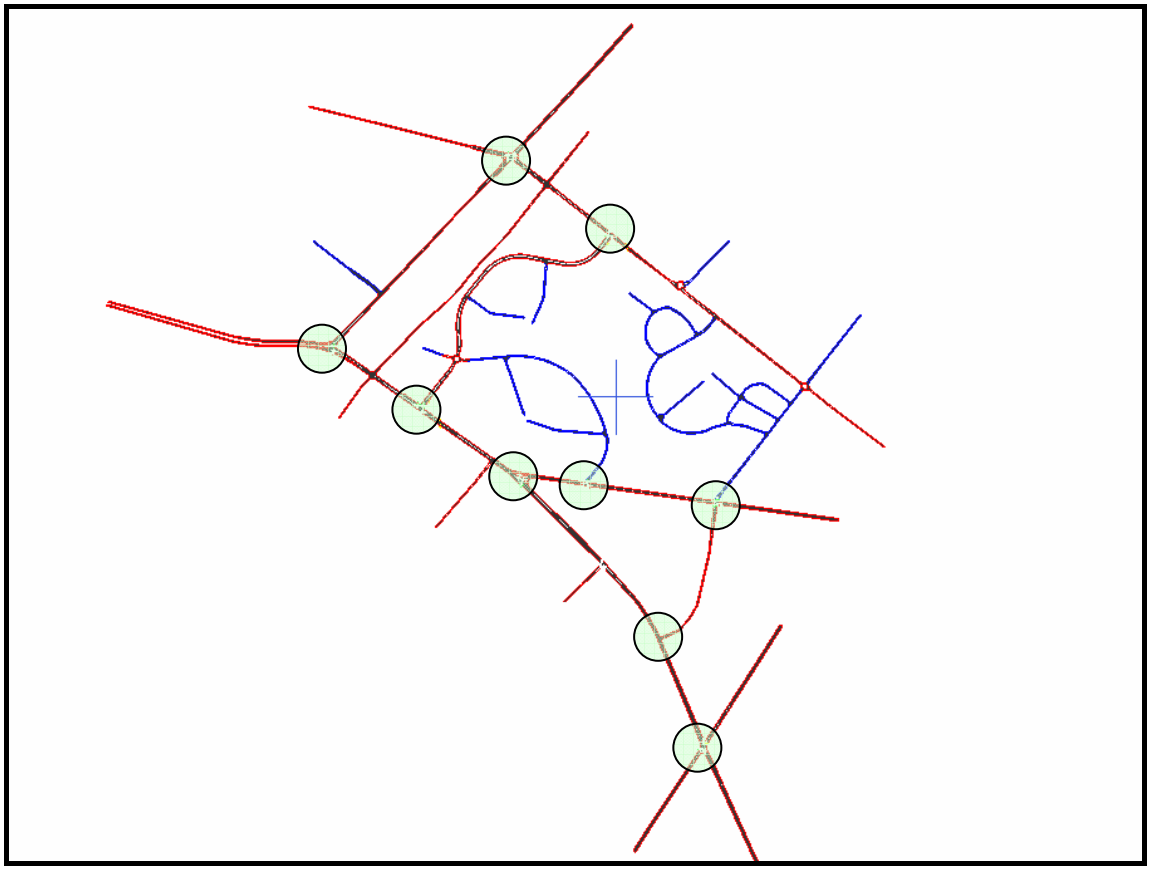
3.1 Signalised Intersections

A total of nine of traffic signals were identified within the designated study area and were coded in the models. The signalised junctions are:

- Elizabeth Drive and Smithfield Road;
- Smithfield Road and Edensor Road;
- Edensor Road and Bonnyrigg Avenue;
- Humphries Road and Cabramatta Road;
- Meadows Road and Elizabeth Drive;
- Elizabeth Drive and Brown Road;
- Elizabeth Drive and Cabramatta Road;
- Bonnyrigg Avenue and Elizabeth Drive; and
- Cabramatta Road and Tarlington Parade.

Figure 3-2 identifies the location of each of the signalised intersections.

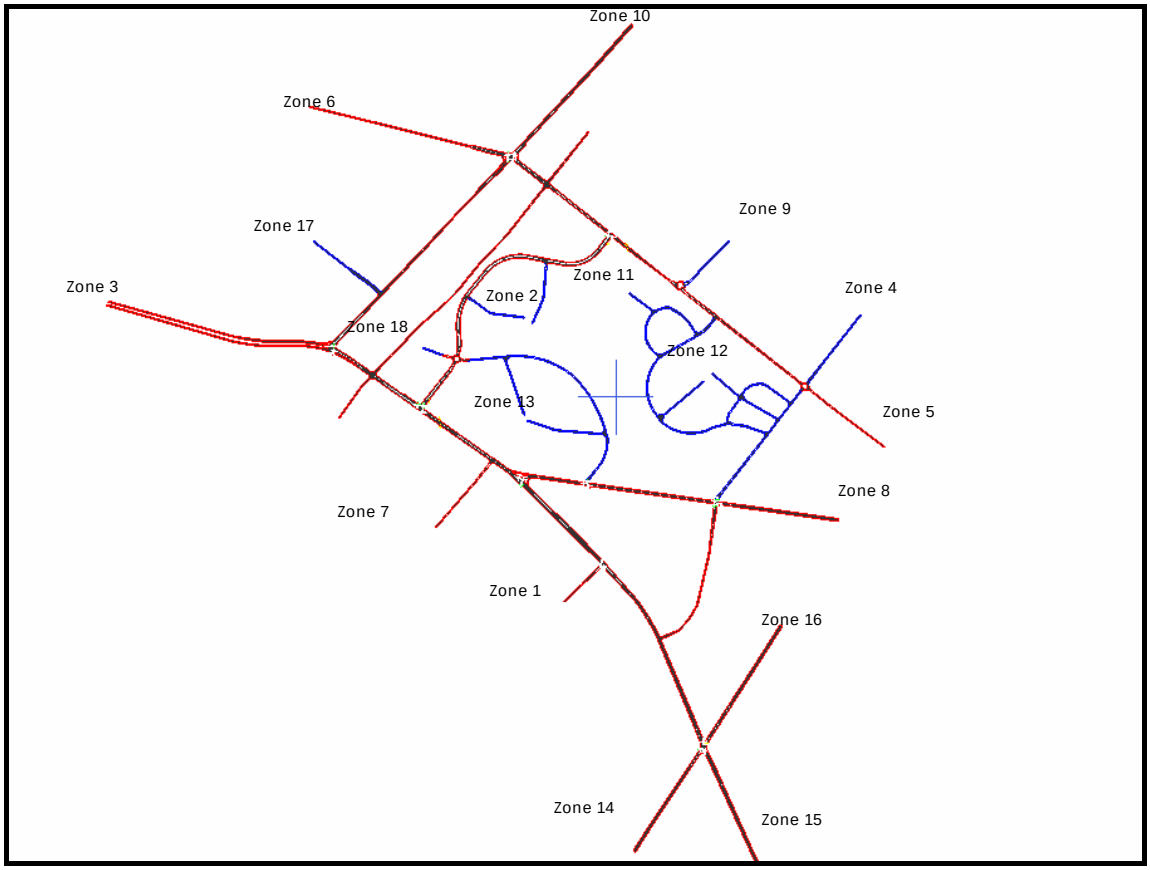
- **Figure 3-2 Signalised intersections identified within the Base Paramics Model**



3.2 Demand Zones

Demand zones were created for traffic generation and attraction. A total of 18 demand zones were created to accommodate external and internal traffic, as presented in **Figure 3-3**.

- **Figure 3-3 2007 Base Model Demand Zones**



Around the network boundary, zones were associated with each external link, representing connection with external traffic.

3.3 Traffic Demand Matrices

Demand matrices were estimated from the count data carried out by SKM for the following intersections:

- Elizabeth Drive and Smithfield Road;
- Smithfield Road and Edensor Road;
- Bonnyrigg Avenue and Edensor Road;
- Edensor Road and Humphries Road;
- Humphries Road and Cabramatta Road;
- Cabramatta Road and Tarlington Parade;
- Tarlington Parade and Bonnyrigg Avenue;
- Bonnyrigg Avenue and Elizabeth Drive;

- Elizabeth Drive and Meadows Road;
- Elizabeth Drive and Brown Road;
- Elizabeth Drive and Cabramatta Road;
- Bunker Parade and Edensor Road; and
- Humphries Road and Bunker Parade.

The demand matrices for the AM Peak and the PM Peak were estimated from the surveyed turning movement counts. The proportion of traffic distribution travelling to/from each zone was calculated using the percentages gained from the 2005 Household Travel Survey Data information. Paramics Estimator was incorporated to estimate the matrices for the AM and PM base models, these matrices were further refined during the calibration process.

3.4 Model Calibration

Model calibration was undertaken to review the overall model operation under the estimated demand and covered the following main tasks:

- Model parameters; and
- Network coding.

The calibration process is typically undertaken in two phases. The first phase involves a thorough check of input data i.e. road geometry, traffic demand matrices, verification of vehicle routes. On completion of these checks, and confirming that they are acceptable, the second stage of the analysis is to compare modelled output statistics (link turning flow/delay/journey times) to observed survey data. If the observed to modelled comparisons are within recommended guidelines, and the visualisation of the vehicles is realistic, then the model is deemed to be adequately calibrated. Model validation assesses the performance of the base model against independent observations to confirm the model credibility.

3.4.1 Model Parameters

This section is focused on the following Paramics parameters:

- Demand profile;
- Assignment method;
- Link cost factor; and
- Headway and Reaction Time.

3.4.2 Demand Profile

A demand profile was created for each of the AM and PM demand matrices. Demand profiles were based on the manual classified counts at the key intersections. The demand profile for the AM Peak is detailed in **Table 3-1.**

- **Table 3-1 Demand profile for the modelled hour 07:00-09:00AM**

Time Period			Demand
07:00	to	07:15	9%
07:15	to	07:30	10%
07:30	to	07:45	11%
07:45	to	08:00	12%
08:00	to	08:15	13%
08:15	to	08:30	15%
08:30	to	08:45	16%
08:45	to	09:00	14%

The demand profile for the PM Peak period is presented in **Table 3-2**.

- **Table 3-2 Demand profile for the modelled hour 16:00-18:00**

Time Period			Demand
16:00	to	16:15	12%
16:15	to	16:30	12%
16:30	to	16:45	12%
16:45	to	17:00	12%
17:00	to	17:15	13%
17:15	to	17:30	13%
17:30	to	17:45	13%
17:45	to	18:00	13%

3.4.3 Assignment Method

Paramics provides three types of traffic assignment methods: “all or nothing”, stochastic and dynamic. The “all-or-nothing” assignment method assumes that all drivers travelling between two zones choose the same route, and it also assumes that link costs do not depend on link flow levels. The stochastic assignment method accounts for the variability in travel costs (or drivers perception of those costs). It assumes that the perceived cost of travel on each network link varies randomly within predefined limits. The dynamic feedback assignment method assumes that drivers who are familiar with the network will re-route if information on the present state of traffic conditions is fed back to the drivers. This is achieved by taking real time information

from the Paramics model and using the data to update the routing calculations. The assignment method applied in the modelling affects the route choice of vehicles.

The study area has multiple routes between individual origins and destinations. Vehicle assignment between one origin and one destination is based on the minimum generalised cost between the origin and destination. Normally, the generalised cost is a combination of time and distance.

When congestion occurs, the travel time varies from the free-flow condition. This leads to the generalised cost varying over time. A dynamic with pertubation assignment method was adopted.

3.4.4 Link Cost Factor

In Paramics, the category of roads also influences the route choice. The generalised cost for a route also depends on the link cost factor. As drivers are categorised into "familiar" and "unfamiliar", "familiar" drivers perceive all links with the cost factor of 1, whereas minor links have a double link cost factor (2) to "unfamiliar" drivers.

To reflect the realistic routes selected by the drivers the following cost factors as indicated in **Table 3-3** below were applied.

3.4.5 Headway and Reaction Time

The headway and reaction time affects interactions between vehicles and hence vehicle flows along roads and at intersections. The RTA standard values for these parameters are between 0.5 and 1.0. In this model the default value for reaction time used was 1.0 and headway was also 1.0. This default value was adopted for this study. In addition, the RTA standard values for other parameters such as "awareness" and "aggression" were adopted.

- **Table 3-3 Modified Link Cost Factor**

Road	Link	Direction	Cost Factor	Purpose
Tarlington Parade	161b:103 103:55 55:56 56:178 178:57 57:47 47:54	Both Directions	0.8	Increasing the volume of traffic travelling on the links from Cabramatta Road and Bonnyrigg Avenue
Bunker Parade and New Development Road	178:179 177:27 27:180 180:181 181:179 179:43 43:123 123:25 25:121 121:24	Both Directions	0.8	Increasing the volume of traffic travelling on the links from Edensor Road and Humpheries Road
Humphries Road	24:97 97:22	Both Directions	0.8	Increasing the volume of traffic travelling on the links from Cabramatta Road and Elizabeth Drive
Cabramatta Road	62:54 54:22	Both Directions	1.2	Increasing the volume of traffic travelling on the links from Elizabeth Drive
Bonnyrigg Avenue (AM peak only)	105:161a 67:105	Southbound	0.8	Increasing the volume of traffic travelling on the links from Edensor Road

3.4.6 Network Coding

Network coding refers to the coding of roads and intersection signals. This section is focused on the following aspects:

- Road category file;
- Signal adjustment; and

- Other techniques.

3.4.7 Road Category File

In Paramics, roads are classified into major and minor roads, corresponding to main roads and local roads in the RTA road classifications. All roads were coded as Urban Major or Urban Minor with a varying number of lanes and speed limits. The classification of roads used in the model can be seen in **Table 3-4.**

- **Table 3-4 Road Classifications**

Road	Classification	Speed Limit (kph)
Elizabeth Drive	Major	70 Westbound , 60 Easrbound
Cabramatta Road West	Major	80
Humphries Road	Minor	60
Edensor Road	Major	60
Bonnyrigg Avenue	Major	60
Tarlington Parade	Minor	50
Bunker Parade	Minor	50
Meadows Road	Major	60
Smithfield Road	Major	60

3.4.8 Signal Adjustment

The intersection signals coded in the model were based on actual RTA traffic control data outlining the traffic movements for each phasing and the ordering thereof. This data also includes the percentage of green time allocated for each phase. The SCATS sub system plans indicated a minimum and maximum cycle time of 42 seconds and 140 seconds, respectively at all intersections. Based on this a cycle time of 130 seconds was generally assumed for the signalised intersections. There were some exceptions where a cycle time of 65 seconds was coded, these included Bonnyrigg Avenue and Edensor Road, Cabramatta Road and Humphries Road, and Cabramatta Road and Tarlington Parade.

The initial model runs showed that the recorded signal plans resulted in congestion along Smithfield Road and Edensor Road.

3.4.9 Additional Techniques

Additional Paramics techniques were also used to improve the traffic performance of the model. These techniques included:

- Next Lanes – Forcing vehicles into the correct lanes and avoiding the attractive but incorrect lanes which the vehicles should not move into;

- Lane Choices - Forcing vehicles into the correct lanes and avoiding the attractive but incorrect lanes;
- Sign Posting – increasing the signposting distance as long as possible, which is often subject to the link length to improve earlier lane changes and reduce unrealistic congestion;
- Node Blocking – Avoiding vehicles staying at signalised intersections when congestion occurs; and
- Force Merge / Across – Forcing right-turning vehicles to cross the oncoming traffic after they have been delayed for some time when oncoming traffic leaves a gap at non-signalised intersections.

The criteria for the calibration of the model were the GEH assessment criteria from the UK Design Manual for Roads and Bridges[1]. The assessment criteria are described below:

1) Difference in link flow within 15% for flows 700-2,700vph
2) Difference in link flow within 100vph for flows < 700vph } greater than 85% of links
3) Difference in link flow within 400vph for flows >2,700vph
4) GEH Statistic: less than 5 for greater than 85% of links

The GEH Statistic (a form of Chi-squared statistic) is given by the formula:

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

Where:
GEH is the GEH statistic
M is the modelled flow; and
C is the observed flow.

The nature of the study area network is such that traffic congestion, queue lengths and travel times tend to vary significantly from day to day. In order to account for this kind of variation in a micro-simulation model, a number of modelled runs are typically undertaken. Each run is assigned its own random seed and therefore each model run will produce different results. Results are then combined to represent an average situation. The Draft RTA Manual (p3, A5) recommends a minimum of 5 seeds be run or up to 10 for more variable traffic conditions.

[1] Volume 12, Section 2, Part 1 Traffic Appraisal of Roads Schemes – Traffic Appraisal in Urban Areas Assignment Validation: Acceptability Guidelines

To ensure the robustness of the AM and PM peak models, five different seed values were run for calibration and validation purposes. The turning movement volumes incorporated in the calibration were the average turning movement volumes for the five seed values. For the validation the journey times used, were the average travel time for the five seeds. The seed values are pre-determined by the RTA. The seed values used in the AM and PM peak models were 560, 28, 771, 86524 and 2849.

Detailed statistics for the calibration and validation are presented in **Appendix A** confirming 87% of flows in the AM Peak model and 91% in the PM Peak model meet the link flow criteria. Therefore the AM and PM Peak models satisfied the calibration and validation criterion.

3.5 Model Validation

Model validation was incorporated to confirm the model's credibility. It involves comparing the model results with observations recorded during surveys. The base model was validated on the following aspects:

- Demand release; and
- Travel times.

3.5.1 Demand Release

Demand release is a validation indicator of the base model. **Table 3-5** presents the demand release percentages for the AM and PM peak periods.

Table 3-5 Demand Release

Period	Total Demand (vehicles)	Released Demand (vehicles)	Release Percentage
08:00 – 09:00	8053	8053	100%
17:00 – 18:00	9587	9364	97.7%

Table 3-5 shows the released demand was within 4% of the total demand for both the AM and PM models. The demand release was acceptable for both models.

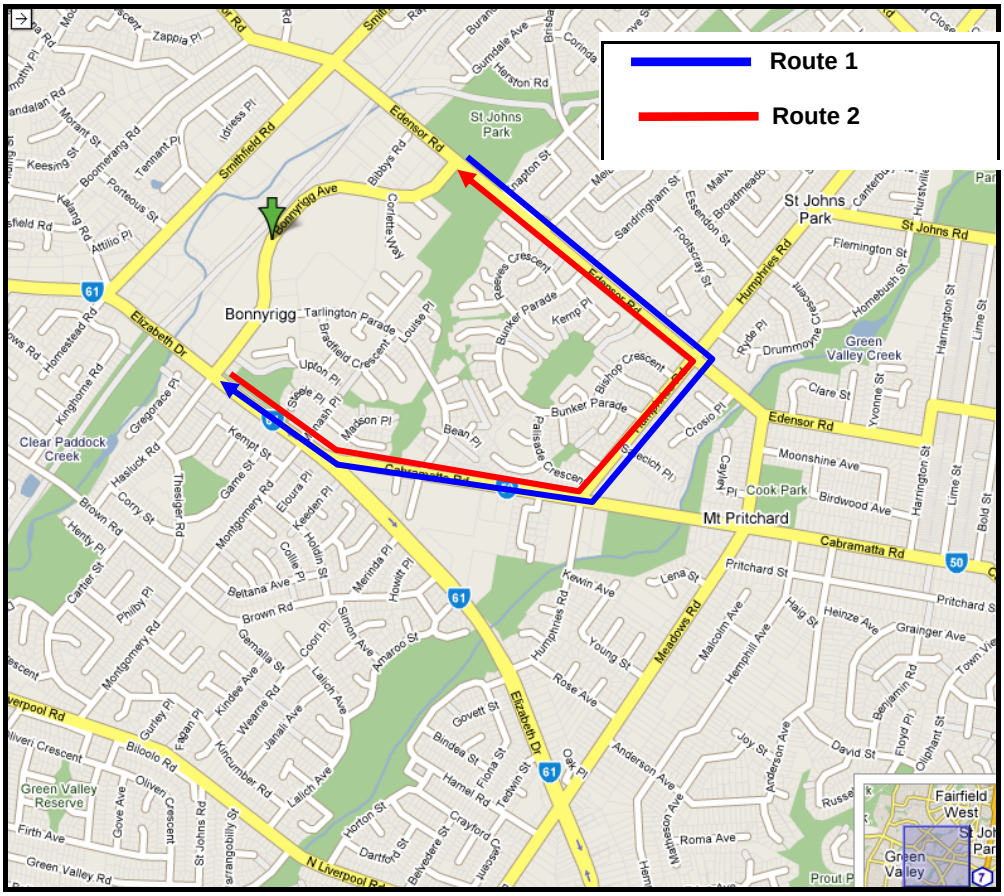
3.5.2 Travel Times

Travel times were measured along four routes in the study area between 07:00-09:00 and 16:00-18:00 on Wednesday 15th August 2007. These routes were Edensor Road, Humphries Road, Cabramatta Road and Elizabeth Drive. Each direction of the roads was surveyed at least seven times. The travel survey routes were:

- Edensor Road – from Bonnyrigg Avenue to Humphries Road;
- Humphries Road – from Humphries Road to Cabramatta Road;
- Cabramatta Road – from Humphries Road to Elizabeth Drive; and
- Elizabeth Drive – from Cabramatta Road to Bonnyrigg Avenue.

These travel time survey routes are also shown in **Figure 3-4**.

- **Figure 3-4 Journey Time Survey Routes**



The criterion for model validation is that all modelled journey times are within 1 minute or 15% of observed journey times. **Table 3-6** presents the validation results of travel times along these routes for the AM Peak. The surveyed travel times adopted were the average of all the run trips. The modelled travel times were the averages of all vehicles over the modelled hour.

Table 3-6 shows that all the modelled journey times are within 1 minute or 15% of observed journey times for the AM Peak. Therefore the AM-Peak Base model satisfied this criterion.

- **Table 3-6 AM Peak Travel Times (seconds)**

Location	Survey	Modelled	Difference
Route1 – Edensor Road at Bonnyrigg Avenue to Elizabeth Drive at Bonnyrigg Avenue	361	310	-14
Route2 – Elizabeth Drive at Bonnyrigg Avenue to Edensor Road at Bonnyrigg Avenue	285	255	-11

The validation results for the PM Peak are presented in **Table 3-7**. **Table 3-7** shows that all the modelled journey times are within 1 minute or 15% of observed journey times for the PM peak. Therefore the PM Peak Base model also satisfied this criterion.

- **Table 3-7 PM Peak Travel Times (seconds)**

Location	Survey	Modelled	% Difference
Route1 – Edensor Road at Bonnyrigg Avenue to Elizabeth Drive at Bonnyrigg Avenue	298	328	10
Route2 – Elizabeth Drive at Bonnyrigg Avenue to Edensor Road at Bonnyrigg Avenue	263	263	0

The results of model validation show that the 2007 base models were acceptable on all criteria.

The results of the model calibration and validation including the demand estimation show that the AM and PM Peak models are acceptable in terms of the assessment criteria. The results of the model calibration and validation, including the demand estimation, show that both the AM Peak and PM Peak models, adequately replicate existing traffic conditions, and can therefore be used to examine future development scenarios.

4. 2007 Intersection Analysis

The Paramics visual interface displays how the network operates as a whole. It does not however provide any detail on individual intersection performance. Intersection analysis software, aaSIDRA was used, to analyse thirteen key intersections in the study area. These intersections can be seen in **Figure 4-1**. SIDRA is a **S**ignalised & Unsignalised **I**ntersection **D**esign & **R**esearch **A**id. aaSidra provides estimates of capacity and performance statistics (queue length, delay, etc) for intersections, using inputs such as traffic volumes and signal phase times.

A range of criteria can be used to evaluate the capacity of intersections. The RTA Guide to Traffic Generating Developments indicates the following criteria for non-signalised intersections:

- Degree of Saturation should be less than 1.0; and
- The Level of Service, determined by the average vehicle delay for the worst movement. Generally it is desirable to aim at achieving a Level of Service of C, or better, at all intersections. However, in practise, it is reasonable to operate at Level of Service D at peak times. Intersections should not be operating at Levels of Service lower than Level of Service D.

For signalised intersections RTA indicates the following criteria:

- Degree of Saturation should be less than 1.0; and
- The Level of Service, determined by the average vehicle delay over all movements at an intersection. Generally it is desirable to aim at achieving a Level of Service of C, or better, at all intersections. However, in practise, it is reasonable to operate at Level of Service D at peak times. Intersections should not be operating at Levels of Service lower than Level of Service D.

A qualitative rating and its corresponding Level of Service are applied to the average delay per vehicle as shown in **Table 4-1**.

- **Table 4-1: Performance Criteria for Intersections**

LoS	Average Delay per Vehicle (seconds)	Traffic Signals, 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	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity; at signals incidents will cause excessive delays	At capacity, requires other control mode
F	Greater than 70	Roundabouts require other control mode	

Source: RTA Guide to Traffic Generating Developments, October 2002

Thirteen intersections that serve as access points to the network were assessed and then analysed. The thirteen intersections assessed were:

- Smithfield Road / Edensor Road (Signalised);
- Edensor Road / Bonnyrigg Avenue (Signalised);
- Edensor Road / Bunker Parade (Priority);
- Edensor Road / Humphries Road (Roundabout);
- Humphries Road / Bunker Parade (Priority);
- Humphries Road / Cabramatta Road (Signalised);
- Cabramatta Road / Tarlington Parade (Signalised);
- Cabramatta Road/ Elizabeth Drive (Signalised);
- Elizabeth Drive / Bonnyrigg Avenue (Signalised);
- Elizabeth Drive / Smithfield Road (Signalised);
- Bonnyrigg Avenue / Tarlington Parade (Roundabout);
- Elizabeth Drive / Brown (Signalised); and
- Elizabeth Drive / Meadows Road (Signalised).

4.1 Results

The intersection analysis results for the AM peak are detailed in **Table 4-2.** The location and the level of service results for the AM peak can be seen in **Figure 4-1**.

- **Table 4-2 2007 AM Peak intersection analysis results using Sidra**

Intersection	Level of Service	Average Delay
Bonnyrigg Avenue / Elizabeth Drive	C	42
Bonnyrigg Avenue / Tarlington Parade	A	9
Bonnyrigg Avenue / Edensor Road	B	23
Smithfield Road / Edensor Road	**F**	>120
Elizabeth Drive / Smithfield Road	D	44
Elizabeth Drive / Brown Street	C	32
Elizabeth Drive / Meadows Road	C	41
Cabramatta Road / Elizabeth Drive	B	21
Cabramatta Road / Humphries Road	B	25
Cabramatta Road / Tarlington Parade	A	13
Humphries Road / Edensor Road	B	18
Bunker Parade / Humphries Road	A	3
Bunker Parade / Edensor Road	A	4

The table shows that one intersection, Smithfield Road and Edensor Road operates at an unacceptable Levels of Service during the AM peak.

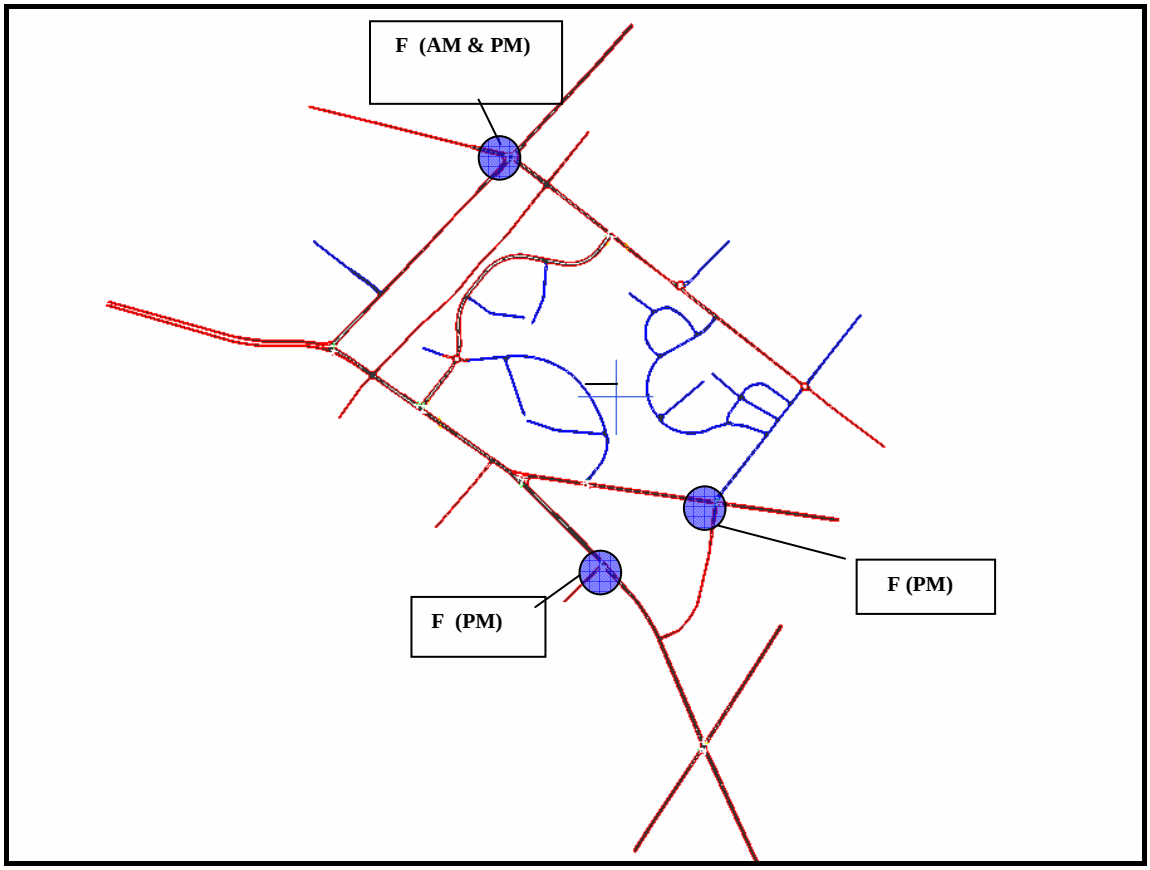
The PM peak intersection analysis results can be seen in **Table 4-3**. The location and the level of service results for the 2006 PM peak are presented in **Figure 4-1**.

- **Table 4-3 2007 PM Peak intersection analysis results using Sidra**

Intersection	Level of Service	Average Delay
Bonnyrigg Avenue / Elizabeth Drive	B	20
Bonnyrigg Avenue / Tarlington Parade	A	9
Bonnyrigg Avenue / Edensor Road	B	20
Smithfield Road / Edensor Road	**F**	>120
Elizabeth Drive / Smithfield Road	C	32
Elizabeth Drive / Brown Street	**F**	>120
Elizabeth Drive / Meadows Road	D	54
Cabramatta Road / Elizabeth Drive	C	34
Cabramatta Road / Humphries	**F**	89
Cabramatta Road / Tarlington Parade	A	15
Humphries Road / Edensor Road	B	11
Bunker Parade / Humphries Road	A	3
Bunker Parade / Edensor Road	A	4

The PM Peak model indicates that Edensor Road and Smithfield Road, Elizabeth Drive and Brown Street, and Cabramatta Road and Humphries Road currently operate at unacceptable levels of service in the PM peak period.

- **Figure 4-1 Intersection Analysis Results indicating Intersections with Unaccpeatble LoS for the 2007 AM and PM Peaks**



5. Conclusions

The 2007 AM and PM Peak models were built, calibrated and validated. The models were calibrated against link flow counts and then validated alongside surveyed journey times. The results of the model calibration and validation, including the demand estimation, show that both the AM Peak and PM peak models, adequately replicate existing traffic conditions, and can therefore be used to examine future development scenarios.

The results of the intersection analysis indicated that the intersections of Elizabeth Drive and Brown Road, and Cabramatta Road and Humphries Road currently operate at an unacceptable Level of Service in the PM Peak. Smithfield Road and Edensor Road currently operates at an unacceptable Level of Service in both AM and PM peak periods.

Appendix A Calibration Results

AM Peak Calibration Results

							GEH		700-2700 <700		>2700
Link	Direction	Node From - Node To		Count	Model	% Diff	Stat	GEH<5=0	<10%=0	diff<100=0	diff<400=0
Bonnyrigg Ave (Tarlington Pde intersection) (S)	NB	100	102	427	249	-41.8%	9.70	0	1	0	0
Bonnyrigg Ave (Tarlington Pde intersection) (S)	SB	101	102	145	130	-10.1%	1.25	1	0	0	0
Tarlington Pde	EB	103	55	112	37	-66.6%	8.63	0	0	1	0
Smithfield Rd	NB	110	157	1149	1,079	-6.0%	2.07	1	0	0	0
Edensor Rd	EB	113	155	757	683	-9.8%	2.75	1	0	0	0
Smithfield(N)	NB	115	156	1469	1,447	-1.5%	0.56	1	0	0	0
Edensor (E) (Melbourne Intersection)	EB	117	33c	791	666	-15.8%	4.62	1	1	0	0
Edensor (E) East of Humpheries Rd	WB	119	41b	418	362	-13.2%	2.79	1	0	0	0
Humphereis Rd N (North of Edensor)	SB	120	41a	335	286	-14.6%	2.77	1	0	0	0
Bunker Pde (intersection of Humpheries)	WB	121	24	69	78	13.6%	1.09	1	0	0	0
Bunker Pde (intersection of Edensor)	NB	126	26	87	95	9.2%	0.84	1	0	0	0
Elizabeth (West of Bonnyrigg Ave)	WB	128	143	950	908	-4.3%	1.36	1	0	0	0
Elizabeth Rd (West of Brown Rd)	WB	129	64	596	461	-22.5%	5.83	0	1	0	0
Elizabeth Rd (West of Humphries Rd)	EB	130	134	1006	1,070	6.4%	2.01	1	0	0	0
Elizabeth Rd (West of Humphries Rd)	WB	134	130	584	589	0.9%	0.22	1	0	0	0
Meadows Rd (N)	NB	134	140	918	981	6.9%	2.05	1	0	0	0
Elizabeth Rd (East of Meadows)	EB	137	139	1015	1,028	1.3%	0.42	1	0	0	0
Elizabeth Rd (East of Meadows)	WB	139	137	712	685	-3.9%	1.04	1	0	0	0
Meadows Rd (N)	SB	140	134	365	365	0.0%	0.01	1	0	0	0
Brown Rd	NB	141	64	556	574	3.3%	0.77	1	0	0	0
Elizabeth (West of Bonnyrigg Ave)	EB	143	128	1365	1,390	1.8%	0.66	1	0	0	0
Elizabeth Rd (east of Bonnyrigg Ave)	WB	144	48	1068	1,021	-4.3%	1.44	1	0	0	0
Elizabeth Rd (west of Brown Rd)	EB	145	64	901	855	-5.1%	1.54	1	0	0	0
Elizabeth Rd (east of Cabramatta)	WB	146	63	641	603	-5.9%	1.52	1	0	0	0
Tarlington Pde	SB	147	54	108	82	-24.0%	2.66	1	0	0	0
Edensor Rd (East of Smithfield)	WB	151	116	488	516	5.7%	1.23	1	0	0	0
Edensor Rd (West of Bonnyrigg)	EB	152	32	694	643	-7.3%	1.95	1	0	0	0
Edensor Rd (west of Smithfield)	EB	155	112	757	683	-9.8%	2.75	1	0	0	0
Edensor (W)	WB	155	113	332	358	8.0%	1.43	1	0	0	0
Smithfield Rd (N)	SB	156	115	745	737	-1.1%	0.29	1	0	0	0
Smithfield Rd	SB	157	110	594	567	-4.6%	1.14	1	0	0	0
Tarlington (East of Bonnyrigg)	EB	161b	103	112	37	-66.6%	8.63	0	0	1	0
Bonnyrigg (south of Tarlington)	SB	161c	101	145	130	-10.1%	1.25	1	0	0	0
Carpark Access	WB	161d	106	62	60	-3.1%	0.24	1	0	0	0
Humpheries (South of Cabramatta)	SB	162	133	211	247	17.1%	2.38	1	0	0	0
Meadows Rd (S)	NB	164	134	757	781	3.3%	0.89	1	0	0	0
Smithfield (S)	NB	165	78	1149	954	-17.0%	6.01	0	1	0	0
Elizabeth (West of Smithfield)	WB	167	168	996	912	-8.4%	2.72	1	0	0	0
Elizabeth (West of Smithfield)	EB	172	83	1874	1,856	-1.0%	0.41	1	0	0	0
Cabramatta (Humpheries Intersection) (E)	EB	22	127	772	728	-5.7%	1.62	1	0	0	0
Cabramatta (Humpheries Intersection) (S)	SB	22	162	211	247	17.1%	2.38	1	0	0	0
Cabramatta (E of Tarlington)	EB	22	54	373	284	-23.7%	4.88	1	1	0	0
Cabramatta (Humpheries Intersection) (N)	NB	22	97	486	501	3.2%	0.70	1	0	0	0
Bunker Pde (intersection of Humpheries)	EB	24	121	88	20	-76.7%	9.14	0	0	1	0
Humhperies (cabramatta intersection) (S)	NB	24	73	515	481	-6.5%	1.50	1	0	0	0
Humpheries (South of Bunker)	SB	24	97	300	369	23.2%	3.80	1	0	1	0
Bunker Pde (intersection of Edensor)	SB	26	126	69	24	-65.7%	6.63	0	0	0	0
Bunker Pde (intersection of Edensor)	WB	26	154	392	449	14.6%	2.78	1	0	0	0
Edensor Rd (E of Bunker)	EB	26	41d	588	484	-17.7%	4.49	1	1	0	0
Humpheries (Ednesor Intersection) (S)	NB	30	98	469	571	21.8%	4.48	1	1	0	0
Edensor Rd (West of Bonnyrigg)	WB	32	152	482	516	7.0%	1.50	1	0	0	0
Bonnyrigg (south of Edensor)	SB	32	95	293	257	-12.3%	2.17	1	0	0	0
Edensor (E)	WB	33c	117	522	593	13.7%	3.02	1	0	0	0
Humphereis Rd N (North of Edensor)	NB	41a	120	528	546	3.4%	0.79	1	0	0	0
Edensor Rd E (east of Humpheries Rd)	EB	41b	119	498	524	5.1%	1.13	1	0	0	0
Edensor Rd (E of Bunker) (E)	WB	41d	26	340	378	11.2%	2.01	1	0	0	0
Elizabeth Rd (east of Bonnyrigg Ave)	EB	48	144	1365	1,372	0.5%	0.18	1	0	0	0
Elizabeth Rd (West of Cabramatta) (W)	EB	49	51	1424	1,385	-2.8%	1.05	1	0	0	0
Elizabeth (cabramatta intersection) (E)	EB	63	146	912	855	-6.3%	1.92	1	0	0	0
Elizabeth Rd (West of Cabramatta) (W)	WB	51	49	864	883	2.3%	0.66	1	0	0	0
Elizabeth Dr (left turn into cabramatta)	NE bound	51	62	554	561	1.3%	0.30	1	0	0	0
Tarlington Pde	NB	54	147	85	19	-77.8%	9.17	0	0	1	0
Cabramatta (E of Tarlington)	EB	54	22	636	597	-6.1%	1.57	1	0	0	0
Cabramatta (W of Tarlington)	WB	54	62	353	323	-8.5%	1.64	1	0	0	0
Tarlington Pde	WB	55	103	100	57	-43.5%	4.92	1	0	0	0
Cabramatta (Elizabeth Intersection)	SB	62	50	360	292	-19.0%	3.80	1	1	0	0
Cabramatta (W of Tarlington)	EB	62	54	593	572	-3.5%	0.87	1	0	0	0
Elizabeth Rd (east of Cabramatta)	EB	63	146	912	855	-6.3%	1.92	1	0	0	0
Elizabeth (cabramatta intersection) (E)	WB	63	50	641	603	-5.9%	1.52	1	0	0	0
Elizabeth Rd (West of Brown Rd)	EB	64	129	1322	1,176	-11.0%	4.12	1	0	0	0
Brown Rd	SB	64	141	140	112	-19.7%	2.45	1	0	0	0
Elizabeth Rd (west of Brown Rd)	WB	64	145	641	603	-6.0%	1.54	1	0	0	0
Smithfield (elizabeth intersection (N)	NB	65	86	1076	993	-7.7%	2.58	1	0	0	0
Bonnyrigg Ave	SB	67	105	229	125	-45.6%	7.86	0	0	1	0
Elizabeth (Smithfield intersection) (E)	EB	72	66	1436	1,390	-3.2%	1.24	1	0	0	0
Humhperies (cabramatta intersection) (S)	SB	73	24	345	292	-15.4%	2.97	1	0	1	0
Smithfield (Edensor Intersection) (S)	SB	78	111	594	567	-4.6%	1.14	1	0	0	0
Smithfield (elizabeth intersection (N)	SB	86	65	638	530	-16.9%	4.46	1	1	0	0
Smithfield (S of Edensor) (S)	SB	87	157	594	567	-4.6%	1.14	1	0	0	0
Bonnyrigg (south of Edensor)	NB	95	32	351	203	-42.1%	8.87	0	1	0	0
Cabramatta (Humpheries Intersection) (N)	SB	97	22	344	369	7.4%	1.35	1	0	0	0
Humpheries (South of Bunker)	NB	97	24	489	501	2.6%	0.57	1	0	0	0
Humpheries (Ednesor Intersection) (S)	SB	98	30	351	255	-27.2%	5.49	0	1	0	0
Edensor Rd (East of Smithfield)	EB	116	151	744	643	-13.6%	3.84	1	0	0	0
Edensor Rd (Smithfield Intersection) (E)	WB	116	78	488	516	5.7%	1.23	1	0	0	0
Humpheries (South of Cabramatta)	NB	133	162	517	480	-7.1%	1.64	1	0	0	0
Cabramatta (Humpheries Intersection) (S)	NB	162	22	517	480	-7.1%	1.64	1	0	0	0
Meadows Rd (S)	SB	134	164	323	303	-6.3%	1.14	1	0	0	0
Bonnyrigg (Tarlington Intersection) (N)	NB	105	67	458	408	-10.8%	2.38	1	0	0	0
Edensor Rd (west of Smithfield)	WB	112	155	332	358	8.0%	1.43	1	0	0	0
Tarlington Pde (E of Bonnyrigg Ave)	WB	103	55	112	37	-66.6%	8.63	0	0	1	0
								79	11	8	0
								87%	88%	91%	100%

PM Peak Calibration Results

Link	Direction	Node From - Node To		Count	Modelled	Diff	GEH Statistic	GEH<5=0	700-2700 <10=0	<700 diff<100=0	>2700 diff<400=0
Bonnyrigg Ave (Tarlington Pde intersection) (S)	NB	100	102	356	362	1.7%	0.33	1	0	0	0
Bonnyrigg Ave (Tarlington Pde intersection) (S)	SB	101	102	519	494	-4.8%	1.10	1	0	0	0
Tarlington Pde	EB	103	55	190.5	240	26.0%	3.37	1	0	0	0
Smithfield Rd	NB	110	157	725	702	-3.1%	0.85	1	0	0	0
Edensor Rd	EB	113	155	504.5	467	-7.4%	1.70	1	0	0	0
Smithfield(N)	NB	115	156	1025.5	942	-8.1%	2.65	1	0	0	0
Edensor (E) (Melbourne Intersection)	EB	117	33c	774	784	1.3%	0.37	1	0	0	0
Edensor (E) East of Humpheries Rd	WB	119	41b	499.5	550	10.1%	2.19	1	0	0	0
Humphereis Rd N (North of Edensor)	SB	120	41a	397.5	394	-1.0%	0.20	1	0	0	0
Bunker Pde (intersection of Humpheries)	WB	121	24	108	32	-70.8%	9.16	0	0	1	0
Bunker Pde (intersection of Edensor)	NB	126	26	91.5	23	-74.8%	9.04	0	0	1	0
Elizabeth (West of Bonnyrigg Ave)	WB	128	143	1724.5	1,667	-3.3%	1.39	1	0	0	0
Elizabeth Rd (West of Brown Rd)	WB	129	64	1099.5	1,072	-2.5%	0.83	1	0	0	0
Elizabeth Rd (West of Humphries Rd)	EB	130	134	891	868	-2.5%	0.76	1	0	0	0
Elizabeth Rd (West of Humphries Rd)	WB	134	130	1024	1,013	-1.0%	0.33	1	0	0	0
Meadows Rd (N)	NB	134	140	752	745	-1.0%	0.27	1	0	0	0
Elizabeth Rd (East of Meadows)	EB	137	139	819.5	805	-1.8%	0.52	1	0	0	0
Elizabeth Rd (East of Meadows)	WB	139	137	1196.5	1,161	-2.9%	1.02	1	0	0	0
Meadows Rd (N)	SB	140	134	831.5	839	0.9%	0.26	1	0	0	0
Brown Rd	NB	141	64	292.5	279	-4.6%	0.80	1	0	0	0
Elizabeth (West of Bonnyrigg Ave)	EB	143	128	1104.5	1,064	-3.7%	1.24	1	0	0	0
Elizabeth Rd (east of Bonnyrigg Ave)	WB	144	48	1633	1,629	-0.3%	0.11	1	0	0	0
Elizabeth Rd (west of Brown Rd)	EB	145	64	970	841	-13.3%	4.27	1	0	0	0
Elizabeth Rd (east of Cabramatta)	WB	146	63	971	889	-8.4%	2.68	1	0	0	0
Tarlington Pde	SB	147	54	191	197	3.2%	0.44	1	0	0	0
Edensor Rd (East of Smithfield)	WB	151	78	1100.5	950	-13.7%	4.71	1	0	0	0
Edensor Rd (West of Bonnyrigg)	EB	152	32	744.5	750	0.8%	0.21	1	0	0	0
Edensor Rd (west of Smithfield)	EB	155	112	504.5	467	-7.4%	1.70	1	0	0	0
Edensor (W)	WB	155	113	894	838	-6.3%	1.90	1	0	0	0
Smithfield Rd (N)	SB	156	115	1625.5	1,573	-3.2%	1.32	1	0	0	0
Smithfield Rd	SB	157	110	1292.5	1,149	-11.1%	4.10	1	0	0	0
Tarlington (East of Bonnyrigg)	EB	161b	103	190.5	240	26.0%	3.37	1	0	0	0
Bonnyrigg (south of Tarlington)	SB	161c	101	519	494	-4.8%	1.10	1	0	0	0
Carpark Access	WB	161d	106	105.5	95	-10.4%	1.10	1	0	0	0
Humpheries (South of Cabramatta)	SB	162	133	397	334	-15.9%	3.31	1	0	0	0
Meadows Rd (S)	NB	164	134	552	544	-1.5%	0.36	1	0	0	0
Smithfield (S)	NB	165	78	725	526	-27.4%	7.95	0	0	0	0
Elizabeth (West of Smithfield)	WB	167	168	2159	2,079	-3.7%	1.74	1	0	0	0
Elizabeth (West of Smithfield)	EB	172	83	1185.5	1,184	-0.1%	0.05	1	0	0	0
Cabramatta (Humpheries Intersection) (E)	EB	22	127	437	419	-4.1%	0.87	1	0	0	0
Cabramatta (Humpheries Intersection) (S)	SB	22	162	397	334	-15.9%	3.31	1	0	0	0
Cabramatta (E of Tarlington)	EB	22	54	973	865	-11.1%	3.57	1	0	0	0
Cabramatta (Humpheries Intersection) (N)	NB	22	97	397	447	12.6%	2.43	1	0	0	0
Bunker Pde (intersection of Humpheries)	EB	24	121	92	86	-6.7%	0.66	1	0	0	0
Humhperies (cabramatta intersection) (S)	NB	24	73	460	361	-21.5%	4.88	1	0	0	0
Humpheries (South of Bunker)	SB	24	97	584.5	533	-8.7%	2.16	1	0	0	0
Bunker Pde (intersection of Edensor)	SB	26	126	108	105	-2.6%	0.27	1	0	0	0
Bunker Pde (intersection of Edensor)	WB	26	154	652.5	635	-2.6%	0.67	1	0	0	0
Edensor Rd (E of Bunker)	EB	26	41d	542.5	580	7.0%	1.60	1	0	0	0
Humpheries (Ednesor Intersection) (S)	NB	30	98	435.5	340	-22.0%	4.86	1	0	0	0
Edensor Rd (West of Bonnyrigg)	WB	32	152	896	950	6.0%	1.76	1	0	0	0
Bonnyrigg (south of Edensor)	SB	32	95	559	456	-18.4%	4.55	1	0	0	0
Edensor (E)	WB	33c	117	971	980	0.9%	0.28	1	0	0	0
Humphereis Rd N (North of Edensor)	NB	41a	120	373	317	-15.1%	3.03	1	0	0	0
Edensor Rd E (east of Humpheries Rd)	EB	41b	119	498	366	-26.4%	6.34	0	0	0	0
Edensor Rd (E of Bunker) (E)	WB	41d	26	610.5	633	3.6%	0.89	1	0	0	0
Elizabeth Rd (east of Bonnyrigg Ave)	EB	48	144	1104.5	1,145	3.7%	1.21	1	0	0	0
Elizabeth Rd (West of Cabramatta) (W)	EB	49	51	1114.5	1,158	3.9%	1.28	1	0	0	0
Elizabeth (cabramatta intersection) (E)	EB	63	146	889.5	844	-5.1%	1.54	1	0	0	0
Elizabeth Rd (West of Cabramatta) (W)	WB	51	49	1805	1,758	-2.6%	1.12	1	0	0	0
Elizabeth Dr (left turn into cabramatta)	NE	51	62	297.5	317	6.6%	1.12	1	0	0	0
Tarlington Pde	NB	54	147	143	86	-39.6%	5.28	0	0	1	0
Cabramatta (E of Tarlington)	EB	54	22	436.5	420	-3.8%	0.79	1	0	0	0
Cabramatta (W of Tarlington)	WB	54	62	957.5	912	-4.8%	1.50	1	0	0	0
Tarlington Pde	WB	55	103	100	30	-70.4%	8.75	0	0	1	0
Cabramatta (Elizabeth Intersection)	SB	62	50	987	908	-8.0%	2.58	1	0	0	0
Cabramatta (W of Tarlington)	EB	62	54	373	356	-4.5%	0.87	1	0	0	0
Elizabeth Rd (east of Cabramatta)	EB	63	146	889.5	844	-5.1%	1.54	1	0	0	0
Elizabeth (cabramatta intersection) (E)	WB	63	50	971	889	-8.4%	2.68	1	0	0	0
Elizabeth Rd (West of Brown Rd)	EB	64	129	997	936	-6.2%	1.98	1	0	0	0
Brown Rd	SB	64	141	420.5	368	-12.6%	2.66	1	0	0	0
Elizabeth Rd (west of Brown Rd)	WB	64	145	944.5	889	-5.8%	1.82	1	0	0	0
Smithfield (elizabeth intersection (N)	NB	65	86	856	816	-4.7%	1.39	1	0	0	0
Bonnyrigg Ave	SB	67	105	701.5	611	-12.8%	3.52	1	0	0	0
Elizabeth (Smithfield intersection) (E)	EB	72	66	992	1,064	7.2%	2.24	1	0	0	0
Humhperies (cabramatta intersection) (S)	SB	73	24	628	502	-20.1%	5.31	0	0	0	0
Smithfield (elizabeth intersection (N)	SB	86	65	1083	1,110	2.5%	0.83	1	0	0	0
Bonnyrigg (south of Edensor)	NB	95	32	513.5	461	-10.2%	2.38	1	0	0	0
Cabramatta (Humpheries Intersection) (N)	SB	97	22	628	533	-15.1%	3.93	1	0	0	0
Humpheries (South of Bunker)	NB	97	24	400.5	447	11.6%	2.26	1	0	0	0
Humpheries (Ednesor Intersection) (S)	SB	98	30	514.5	548	6.5%	1.44	1	0	0	0
Edensor Rd (East of Smithfield)	EB	116	151	743.5	752	1.2%	0.32	1	0	0	0
Edensor Rd (Smithfield Intersection) (E)	WB	151	78	1100.5	950	-13.7%	4.71	1	0	0	0
Humpheries (South of Cabramatta)	NB	133	162	353	342	-3.0%	0.57	1	0	0	0
Cabramatta (Humpheries Intersection) (S)	NB	162	22	353	342	-3.0%	0.57	1	0	0	0
Meadows Rd (S)	SB	134	164	875.5	850	-3.0%	0.88	1	0	0	0
Bonnyrigg (Tarlington Intersection) (N)	NB	105	67	425.5	267	-37.2%	8.51	0	0	0	0
Edensor Rd (west of Smithfield)	WB	112	155	894	838	-6.2%	1.89	1	0	0	0
Tarlington Pde (E of Bonnyrigg Ave)	WB	103	55	190.5	240	26.0%	3.37	1	0	0	0
								81	0	4	0
								91%	100%	96%	100%

Appendix B Bonnyrigg Urban Renewal Project Sensitivity Analysis

File Note

Date	9 November 2007
Project No	IN90937
Subject	**Bonnyrigg Urban Renewal Project Sensitivity Analysis**

This filenote summarises the results of the Bonnyrigg Urban Renewal Project sensitivity analysis undertaken for year 2020 with the development for both AM and PM peak scenarios. The sensitivity analysis looked at increase in background traffic growth rate and a higher trip generation rate for the public dwellings.

1. Sensitivity Analysis

The sensitivity analysis was carried out for the AM and PM peak models for year 2020 background and development traffic. The sensitivity analysis looked at two variables that were changed in the models. These include:

- Background traffic growth rate; and
- Trip generation rate

1.1 Background Traffic Growth

The background traffic growth rate used for the final Paramics analysis was 0.4% per annum (documented in SKM report titled "IN90937_Final Report R01 T121" dated 23rd October 2007. This value was averaged from historical traffic counts in the Bonnyrigg area. The sensitivity analysis adopted a higher traffic growth rate of 1.0 % per annum to the background traffic.

1.2 Trip Generation rate

The trip generation rate associated with the future proposed dwellings in the area was based on the RTA's Guide to Traffic Generating Developments. The RTA guideline differentiates residential trip generation rate by the type of residential dwelling.

For the original assessment, the lower trip rate (0.5 trips per dwellings per peak hour) was applied to estimate traffic generation for public housing while the upper trip rate (0,65 trips per dwelling per peak hour) was applied to estimate traffic generation for private dwellings.

For the purposes of testing the worse case scenario the upper trip rate of 0.65 per dwelling per peak hour was applied to both private and public dwellings.

2. Further Improvements Proposed on the Road Network

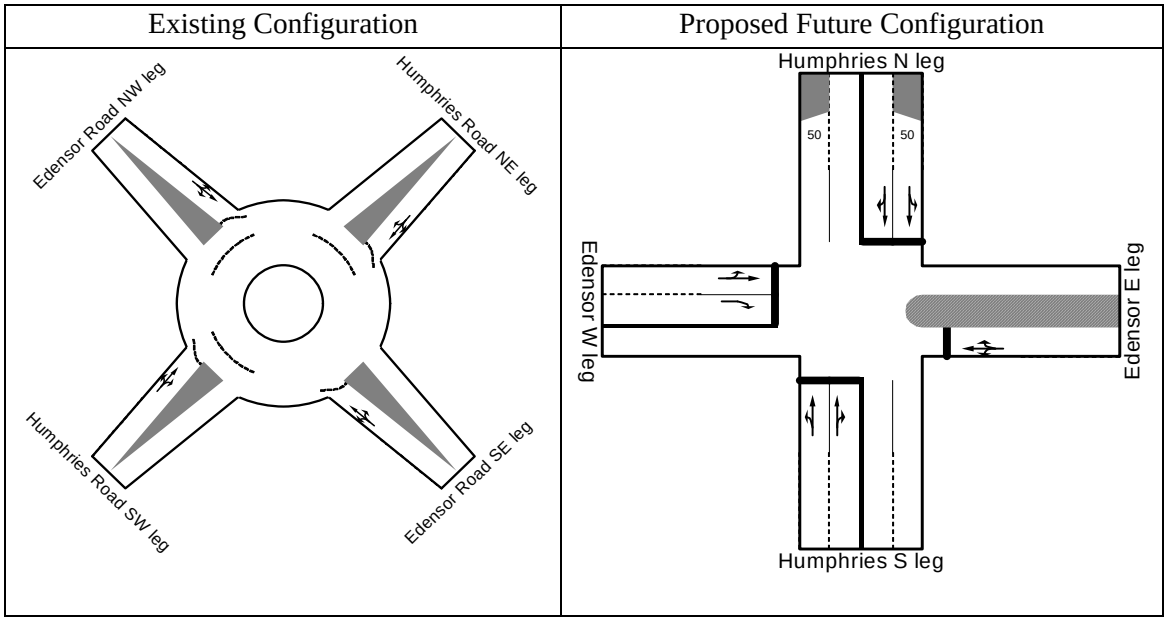
The sensitivity analysis considered additional traffic volumes using the road network due to a higher growth rate and trip generation rate factors. Hence, we looked at further improvements that may be required to ease the congestion on the road network due to the additional traffic volumes. The proposed improvements include:

- Signalising Humphries Road/Elizabeth Drive intersection;

- Signalising Edensor Road/Humphries Road intersection;
- Signalising New Development Road/Edensor Road intersection;
- Widening the New Development Road approach at the intersection with Edensor Road, from one to two lanes (and separating the left and right turn movements); and
- Widening all four approaches at the Edensor Road/Humphries Road intersection.

The change in the layout of the Edensor Road/Humphries Road roundabout to a signalised intersection is illustrated in Figure 2-1 below. Please note that there is no change in the layout of the New Development Road/Edensor Road and Humphries Road/Elizabeth Drive intersection.

- **Figure 2-1: Humphries Road/Edensor Road Intersection**



3. Results

New demand matrices were calculated for the AM and PM peaks year 2020 scenarios (with development traffic), based on the 1.0% per annum traffic growth rate and 0.65 trip generation rate.

Five Paramics runs based on the RTA's prescribed seeds numbers of 560, 28,771, 86524 and 2849 were carried out for the AM and PM 2020 models.

The Paramics visual shows how the network operates as a whole. It does not however provide any detail on individual intersection performance. Intersection analysis software, aaSIDRA was used, to analyse thirteen key intersections in the study area.

As stated in our Final TMAP report dated 23rd October 2007, the RTA Guide to Traffic Generating Developments criteria for intersection operation is that the Level of Service (as determined by the average delay by the worse movement) should not be lower than D.

The average delay with its corresponding Level of Service (LoS) for each of the thirteen intersections is indicated in Table 3-1 below.

- **Table 3-1: Sensitivity Test: AM Intersection Analysis Results Using aaSIDRA**

Intersection	2020 With Development		2020 With Development – Sensitivity Analysis	
	Level of Service	Average Delay (s)	Level of Service	Average Delay (s)
Bonnyrigg Avenue / Elizabeth Drive	D	56.3	D	54.0
Bonnyrigg Avenue / Tarlington Parade	A	13.3	A	13.4
Bonnyrigg Avenue / Edensor Road	A	13.5	B	19.3
Smithfield Road / Edensor Road (with improvements)	E	62.5	**E**	**68.5**
Elizabeth Drive / Smithfield Road	B	28.0	C	30.6
Elizabeth Drive / Brown Street (with improvements)	B	16.4	B	16.9
Elizabeth Drive / Meadows Road (with improvements)	C	35.2	D	43.0
Cabramatta Road / Elizabeth Drive	A	14.2	B	21.2
Cabramatta Road / Humphries (with improvements)	E	58.9	**F**	**72.4**
Cabramatta Road / Tarlington	B	21.7	B	23.4
Humphries Road / Edensor Road	F	72.8	C	33.7
Bunker Parade / Humphries Road	A	13.9	A	14.0
Bunker Parade / Edensor Road	A	13.2	A	12.8

- **Table 3-2: Sensitivity Test : PM Intersection Analysis Results Using aaSIDRA**

Intersection	2020 With Development		2020 With Development – Sensitivity Analysis	
	Level of Service	Average Delay (s)	Level of Service	Average Delay (s)
Bonnyrigg Avenue / Elizabeth Drive	B	16.8	B	17.9
Bonnyrigg Avenue / Tarlington Parade	A	13.7	B	20.1
Bonnyrigg Avenue / Edensor Road	B	22.4	B	24.5
Smithfield Road / Edensor Road (with improvements)	D	53.1	**E**	**67.5**
Elizabeth Drive / Smithfield Road	C	30.4	C	37.9
Elizabeth Drive / Brown Street (with improvements)	B	17.7	B	17.9
Elizabeth Drive / Meadows Road (with improvements)	C	37.4	C	40.2
Cabramatta Road / Elizabeth Drive	C	36.1	C	40.4
Cabramatta Road / Humphries (with improvements)	F	90.9	**F**	**126.2**
Cabramatta Road / Tarlington	B	23.6	B	25.0
Humphries Road / Edensor Road	F	85.6	**E**	**58.7**
Bunker Parade / Humphries Road	A	12.8	A	12.8
Bunker Parade / Edensor Road	B	26.5	C	38.7

The results of Table 3-1 indicate that in the AM peak the average delay for Cabramatta Road/Humphries Road intersection has increased significantly and have an unacceptable LoS F.

For the PM peak scenario the Humphries Road/Edensor Road and Smithfield Road/Edensor Road intersections have an unacceptable LoS whilst the Cabramatta Road/Humphries Road intersection has significant increases in the average delay. Additional capacity would be required at these intersections to improve overall intersection performance and LoS.

The rest of the intersections remain at an acceptable level of service in both AM and PM peak periods.

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Appendix C School Safety Measures Report

Bonnyrigg Urban Renewal Project

SCHOOL SAFETY MEASURES - BONNYRIGG STUDY AREA

- Draft
- 13 March 2008

Bonnyrigg Urban Renewal Project

SCHOOL SAFETY MEASURES - BONNYRIGG STUDY AREA

- Draft
- 13 March 2008

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1. Introduction

Sinclair Knight Merz was commissioned by Becton Properties, on behalf of the Bonnyrigg Partnerships, to analyse current safety measures at schools located in close proximity to the proposed Bonnyrigg development.

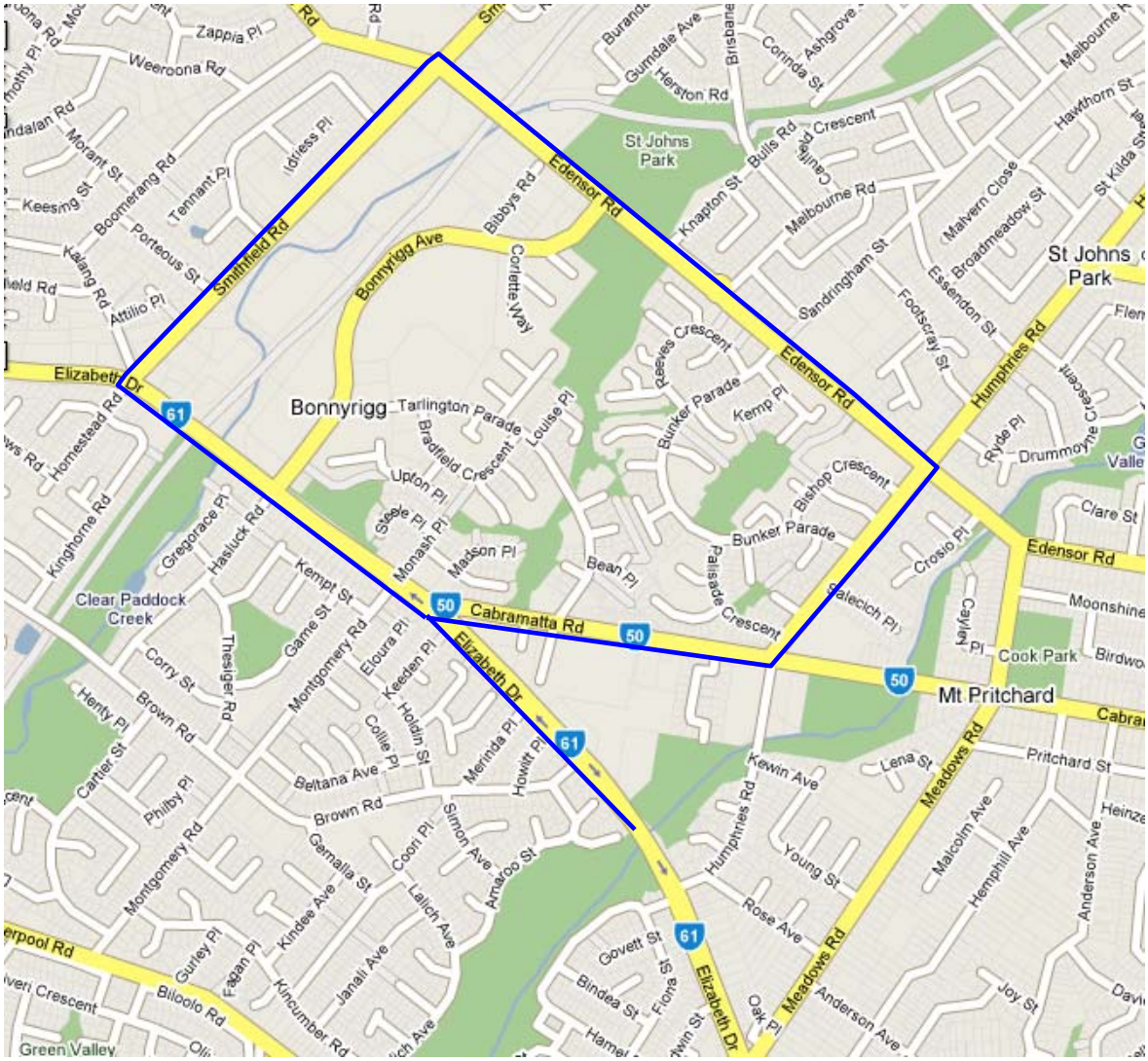
The purpose of this report was to consider the existing safety measures within the vicinity of the school areas (within the school zones) and analyse and recommend any further safety measures that would be required due to the predicted increase in traffic level within the school zones due to the proposed development and future background traffic.

Hence, this report is divided into two sections. The first part details the existing safety measures within the school zones in the study area. The second part provides recommendations to further enhance the safety measures with the existing traffic scenario and secondly analyses any safety measures that would be required as a result of increased traffic level on the affected roads within the school zones.

2. Study Area and Background

The study area is enclosed by Meadows Road, Edensor Road, Elizabeth Drive and Smithfield Road, as shown in the **Figure 2-1** below.

- **Figure 2-1 Study Area**



The proposed development includes integrated renewal of the Bonnyrigg Estate and will include approximately 830 social dwelling houses. The development is intended to be constructed in stages with the start of construction in year 2010 and the final stages proposed to finish in the year 2020.

The total increase in traffic including the background traffic growth and the predicted traffic generation of the development is considered to be in the order of 1.5% increase by 2010 and a 17%

in the year 2020. The total proposed trip generated by the development in 2010 is up to 67 trips and in 2020 up to 1071 trips over a peak hour period in the study area.

Without the development the total increase in the background traffic was predicted to be 5% in the year 2020 (AM and PM peak periods). With the development there would be approximately 12% additional traffic in the study area, in the year 2020.

Four schools were considered to be within the Bonnyrigg development area. These schools are:

- St Johns Primary School;
- Bonnyrigg High School;
- Our Lady of Mt Camel Primary School; and
- Bonnyrigg Primary School.

The specific locations of these schools are indicated in **Figure 2-2** below.

- **Figure 2-2 School Locations**

The first section of this report reviews existing school safety measures that are in place in the study area. A site visit to assess the safety measures was undertaken on 27 February 2007 during both AM and PM school zone periods (8:00 9:30am and 2:00-4.30pm).

3. Existing School Safety Measures

3.1 St Johns Primary School

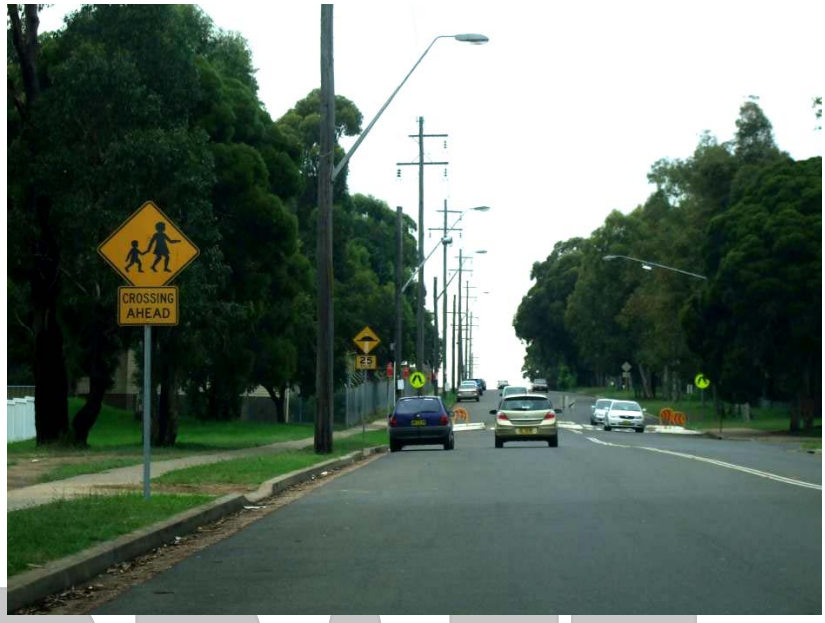
St Johns Primary School is located on Edensor Road between Bunker Parade and Humphries Road, north of the development area as indicated in **Figure 2-2** above.

3.1.1 Speed Limit Enforcement and Road Signage

- **Figure 3-1 Speed Limit Enforcement on Edensor Road**

Location(s)	Safety Measure(s)
1) Both sides of Edensor Road at the start/end of the school zone area.	40km/h speed limit enforcement within the school zone area on Edensor Road and Bunker Parade. Signs on both sides of the road.
2) Both Sides of Bunker Parade (at the approach to intersection with Edensor Road).	40 km/h sign painted on the road pavement in either direction at the entrances to the school zone area on Edensor Road and Bunker Parade.

- **Figure 3-2 Pedestrian Crossing Road Signs on Edensor Road**



Location(s)	Safety Measure(s)
Edensor Road (Both approaches to the pedestrian crossing).	Pedestrian crossing and speed hump signage at the approaches to the pedestrian crossing (I both travel directions). These measures advise and warn drivers to slow down and look out for pedestrians crossing ahead.

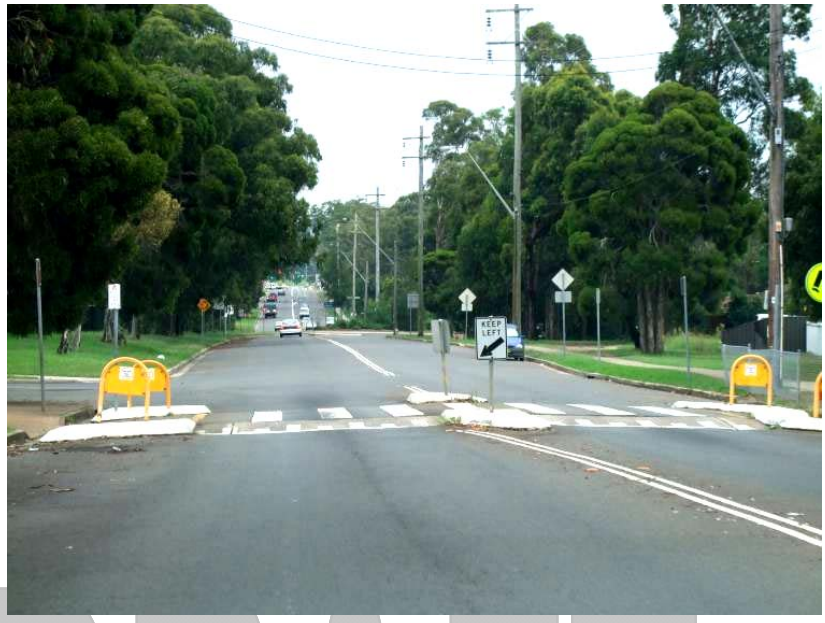
3.1.2 Pedestrian Access

- **Figure 3-3 Pedestrian Crossing on Edensor Road**

Location(s)	Safety Measure(s)
Edensor Road (near the intersection of Bunker Parade).	Zebra crossing with raised road pavement (speed hump) to reduce vehicle speed. Raised concrete platforms with barricades at the ends of the crossing and pedestrian refuge island in the centre of the road to protect the pedestrians from the vehicles. Pedestrian crossing road signs on both sides of the road and in both directions to advise and warn vehicles of the approaching pedestrian crossing.

- **Figure 3-4 Pedestrian Footpaths Looking South West on Edensor Road**

- **Figure 3-5 Pedestrian Footpath Looking North East on Edensor Road**



Location(s)	Safety Measure(s)
Edensor Road (north side of the road).	Footpath providing link from/to the adjacent and adjoining roads onto Edensor Road and to/from the school entrance on Edensor Road. Footpath extends from Melbourne Avenue to Humphries Road.

- **Figure 3-6 Pedestrian Access to Edensor Road**

Location(s)	Safety Measure(s)
At six separate locations between Humphries Road and Melbourne Avenue along the south side of Edensor Road.	The six footpaths provide links from residential area south of Edensor Road onto Edensor Road. However, these footpaths lead directly to the Road where no pedestrian crossing is provided.

3.1.3 Student Drop-Off and Pick-Up

- **Figure 3-7 Student Drop-Off and Pick-Up on Edensor Road**

Location(s)	Safety Measure(s)
Edensor Road either side of pedestrian crossing.	Parents or guardians gather on the south side of Edensor Road at the corner of Bunker Parade. Children exit the school on the north side of Edensor Road and are assisted by the 'lollypop' person to cross the road. Parents or guardians also meet their children on the north side of Edensor Road towards Melbourne Avenue and towards Humphries Road.

3.2 Bonnyrigg High School

This High School is located between Cabramatta Road and Elizabeth Drive opposite Tarlington Parade.

The existing safety measures in place for this school are described below.

3.2.1 Speed Limit Enforcement and Road Signage

- **Figure 3-8 Speed Limit Enforcement on Cabramatta Road**

Location(s)	Safety Measure(s)
Cabramatta Road	Flashing school zone sign on Cabramatta Road between Tarlington Parade and Humphries Road enforcing 40km/h speed limit. 40km/h speed limit enforcements for eastbound traffic heading towards the school.

- **Figure 3-9 School Zone Limit Enforcement on Cabramatta Road**

Location(s)	Safety Measure(s)
1) Either side of Cabramatta Road (in both directions of travel) at the start/end of school zone area. 2) Cabramatta Road between Elizabeth Drive and Tarlington Parade 3) Humphries Road (in both directions of travel) at the start/end of school zone area.	40km/h speed limit enforcements within the school zone area on Cabramatta Road extending to Elizabeth Drive. Signs located on left hand side of Tarlington Parade on approach to Cabramatta Road. 40 km/h sign painted on the road pavement in both directions at the entrances to the school zone area on Cabramatta Road, Elizabeth Drive and Tarlington Parade.

- **Figure 3-10 Speed Enforcement Signage on Cabramatta Road**

- **Figure 3-11 Variable Speed Camera on Cabramatta Road**

Location(s)	Safety Measure(s)
1) Speed Camera Signs on both sides of Cabramatta Road advising drivers in both directions of variable speed cameras. 2) Speed Cameras on the north side of Cabramatta Road detecting speed of cars travelling in both directions.	Speed camera advisory sign within the school zone area on Cabramatta Road and Humphries Road. Speed Camera enforcing speed limit in school zones for both Bonnyrigg High School and Our Lady of Mt. Carmel Primary School.

- **Figure 3-12 Pedestrian Crossing Road Signs on Cabramatta Road**

Location(s)	Safety Measure(s)
1) Cabramatta Road pedestrian crossing road sign.	Before Tarlington Parade intersection on both directions approaching signalised pedestrian crossing. On both sides of Cabramatta Road between Tarlington Parade and Katinka Street. On eastern approach to Humphries Road.
2) Humphries Road pedestrian crossing road sign.	At zebra crossing on Humphries Road near Mason Place. On southern approach to intersection with Cabramatta Road.
3) Tarlington Parade pedestrian crossing road sign.	On approach to Cabramatta Road

3.2.2 Pedestrian Access

- **Figure 3-13 Signalised Pedestrian Crossing on Cabramatta Road**

- **Figure 3-14 Pedestrian Crossing Facility at Cabramatta Road/Elizabeth Drive**

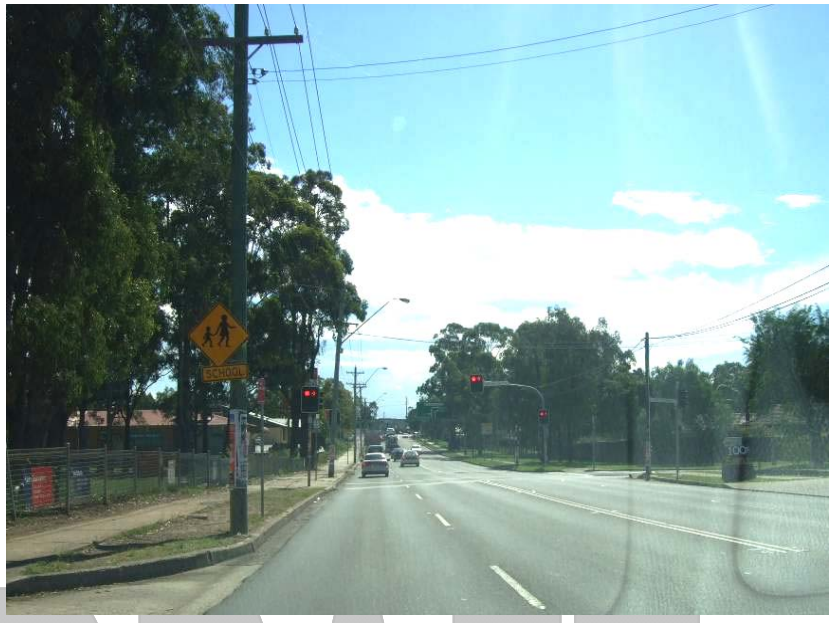
Location(s)	Safety Measure(s)
1) Cabramatta Road at intersection with Tarlington Parade.	Providing pedestrian access on north side of Cabramatta Road crossing Tarlington Parade. Providing pedestrian access across Cabramatta Road at intersection with Tarlington Parade.
2) Cabramatta Road at intersection with Humphries Road	Providing pedestrian access across Humphries Road on both sides of intersection with Cabramatta Road.
	Providing access across eastern approach of Cabramatta at Humphries Road.
3) Cabramatta Road intersection with Elizabeth Drive.	Pedestrian access across Cabramatta Road at intersection with Elizabeth Drive.
4) Elizabeth Drive intersection with Cabramatta Road.	Pedestrian access across east and west legs of Elizabeth Drive at intersection with Cabramatta Road.

- **Figure 3-15 Pedestrian Bridge over Elizabeth Drive**

- **Figure 3-16 Ramp leading to Pedestrian Bridge**

Location(s)	Safety Measure(s)
Elizabeth Drive between Cabramatta Road and Brown Road.	Providing safe means for pedestrians to cross the four lane arterial road. A barricade along the median of Elizabeth drive encourages pedestrians to use foot bridge. Foot bridge is accessed by ramps on either side of Elizabeth Drive.

- **Figure 3-17 Pedestrian Footpaths on Cabramatta Road**



Location(s)	Safety Measure(s)
1) Along both sides of Cabramatta Road.	Providing pedestrian access along Cabramatta Road from Humphries Road to Elizabeth Drive.
2) Both sides of Elizabeth Drive	Providing pedestrian access along Elizabeth Drive from Bonnyrigg Avenue to Brown Road.
3) Both sides of Tarlington Parade.	Providing pedestrian access along Tarlington Parade from Cabramatta Road to Bradfield Crescent.

3.2.3 Student Drop-Off and Pick-Up

A no parking restriction is imposed on Cabramatta Road between Humphries Road and Elizabeth Drive and hence parents picking and dropping off their children drive into the pick-up/drop-off and bus access area off Cabramatta Road near the school entrance. This separates the pedestrians from the main traffic stream and hence enhances safety and accessibility to/from school for the school children. This also reduces conflicts between manoeuvring vehicles and the through traffic.

- **Figure 3-18 Bus Access from Cabramatta Road**

- **Figure 3-19 Bus Access from Elizabeth Drive**

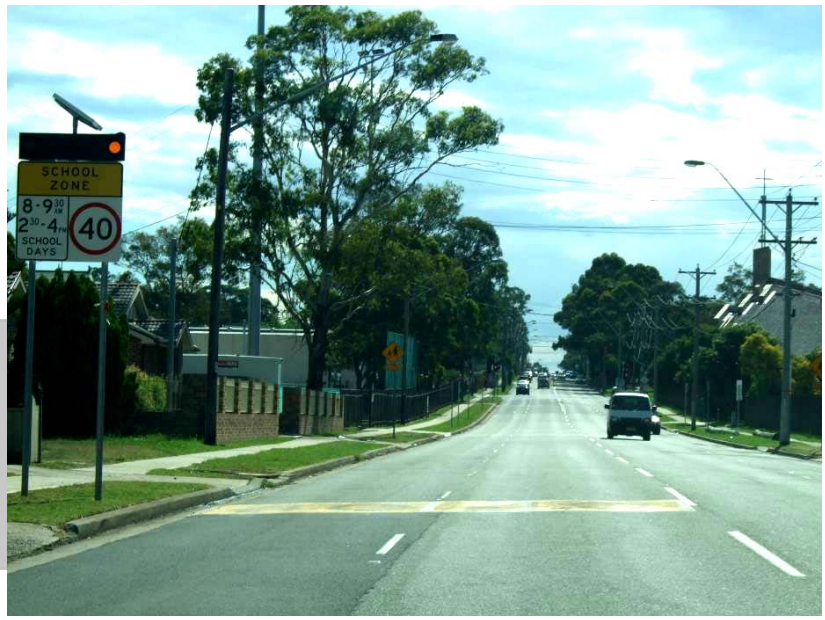
Location(s)	Safety Measure(s)
1) Cabramatta Road opposite Tarlington Parade.	Student drop-off and pick-up off on Cabramatta Road in bus bay.
2) Elizabeth Drive at pedestrian footbridge.	Student drop-off and pick-up on Elizabeth Drive in bus bay.

3.3 Our Lady of Mt. Carmel Primary School

Our Lady of Mt. Carmel Primary School is located on the corner of Cabramatta Road and Humphries Road.

3.3.1 Speed Limit Enforcement and Road Signage

- **Figure 3-20 Speed Limit Enforcement on Cabramatta Road**



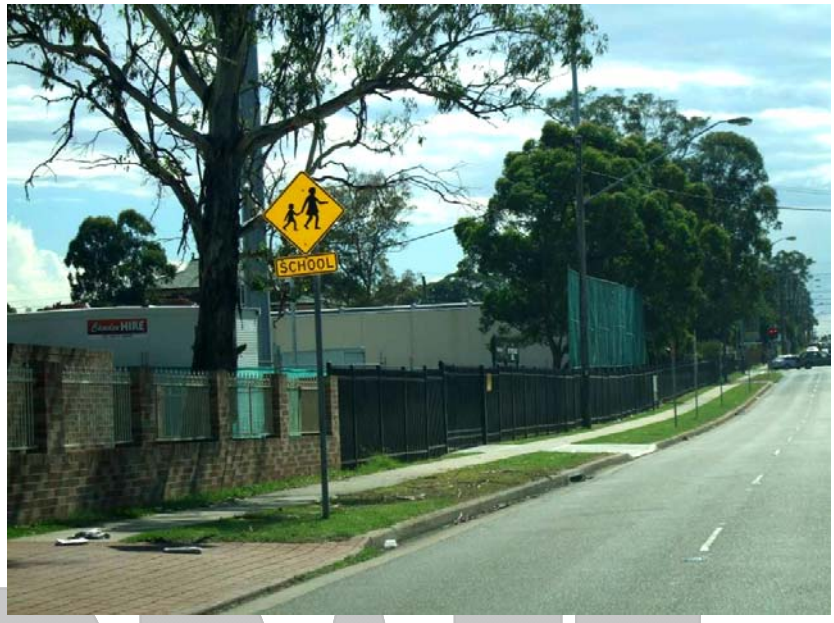
Location(s)	Safety Measure(s)
1) Both sides of Cabramatta Road at start/end of school zone.	Flashing school zone sign on Cabramatta Road between Meadows Road and Humphries Road enforcing 40km/h speed limit.
2) Humphries Road at start/end of school zone.	40km/h speed limit enforcements on both sides of Humphries Road entering school zone. 40 km/h sign painted on the road pavement in both directions at the entrances to the school zone area on Cabramatta Road and Humphries Road.

- **Figure 3-21 Speed Limit Enforcement Signage on Humphries Road**

- **Figure 3-22 Variable Speed Camera on Cabramatta Road**

Location(s)	Safety Measure(s)
1) Speed camera signs on both north and south legs of Humphries Road at intersection with Cabramatta Road.	Speed camera advisory sign within the school zone area on Cabramatta Road and Humphries Road to help manage speed limits.
2) Speed camera on north side of Cabramatta Road between Meadows Road and Humphries Road.	Variable speed camera enforcing speed limit in school zones for both Bonnyrigg High School and Our Lady of Mt. Carmel School

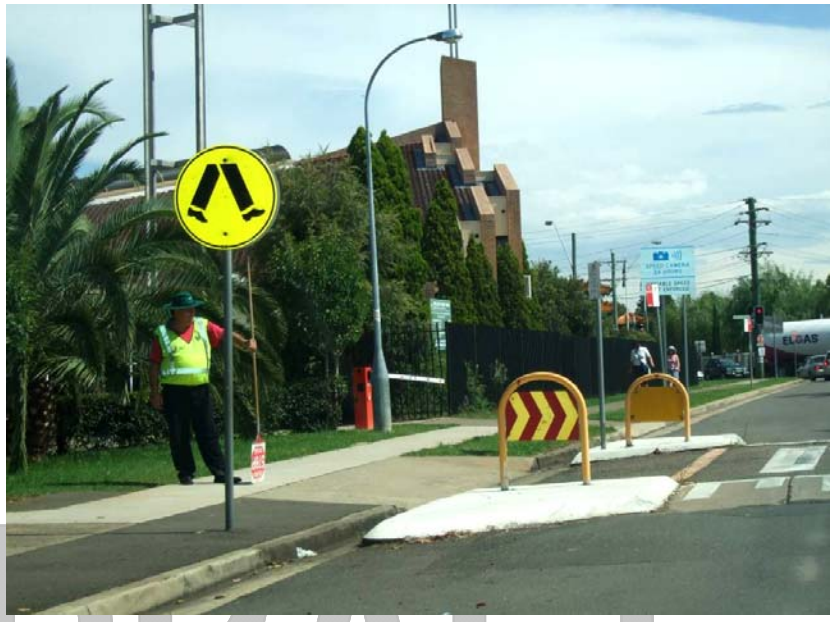
- **Figure 3-23 Pedestrian Crossing Road Sign on Cabramatta Road**



Location(s)	Safety Measure(s)
1) Cabramatta Road east and west of Humphries Road on approach to school. 2) Humphries Road north and south of Cabramatta Road on approach to school.	Pedestrian crossing signage on all approaches to pedestrian crossings. Pedestrian signage gives advice and warns drivers to slow down and look out for pedestrians.

3.3.2 Pedestrian Access

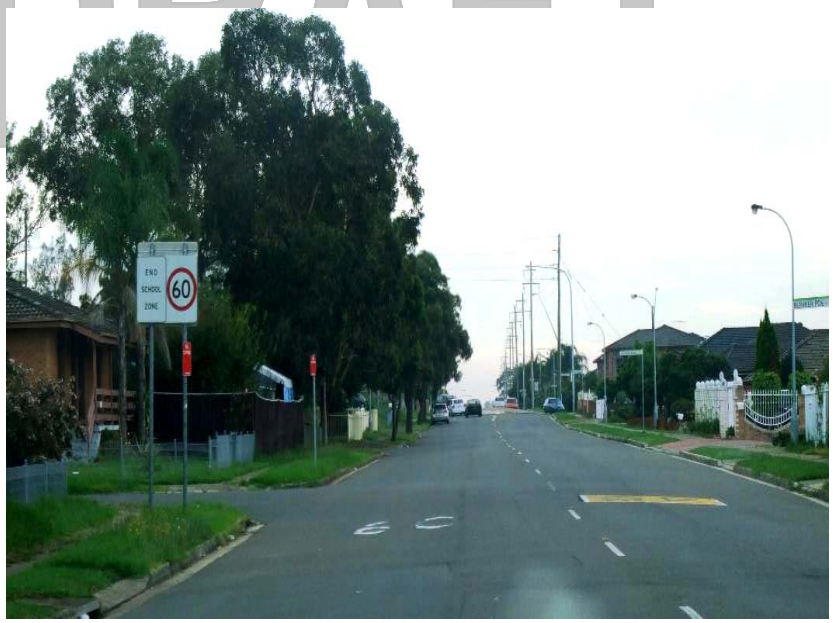
- **Figure 3-24 Pedestrian Crossing on Humphries Road**



Location(s)	Safety Measure(s)
1) Raised zebra crossing on Humphries Road near Mason Place with kerb extensions 2) Signalised pedestrian crossing at intersection of Humphries Road and Cabramatta Road.	Zebra crossing with kerb extensions Raised road pavement (speed hump) to reduce the vehicular speed. Raised concrete platforms with barricades at each end of the crossing and pedestrian refuge island in the centre of the road to protect pedestrians from vehicles and improve accessibility. Pedestrian crossing road signs on both sides of the road and in both directions to advise and warn drivers of the approaching pedestrian crossing.

- **Figure 3-25 Pedestrian Footpaths along Cabramatta Road**

- **Figure 3-26 Pedestrian Footpaths along Humphries Road**



Location(s)	Safety Measure(s)
1) Both sides of Cabramatta Road.	Footpath providing pedestrian links on both sides of Cabramatta Road extending from Elizabeth Drive to Pritchard Street.
2) Both sides of Humphries Road.	Footpath providing pedestrian links on both sides of Humphries Road extending from Edensor Road to Kenwin Avenue.

3.3.3 Student Drop-Off and Pick-Up

- **Figure 3-27 Student Drop-Off and Pick-Up on Humphries Road**

- **Figure 3-28 Student Drop-Off and Pick-Up on Cabramatta Road**

Location(s)	Safety Measure(s)
1) Humphries Road. 2) Cabramatta Road.	Parents or guardians park their vehicle along Humphries Road between Mason Place and Sandilands Road and also in adjacent streets in this vicinity. Parents or guardians meet their children at the school gates or wait for children at their vehicle. Some children walk to and from school unaccompanied by an adult.

3.4 Bonnyrigg Primary School

Bonnyrigg Primary school is located on Tarlington Parade opposite Bradfield Crescent. It is located within the development area.

3.4.1 Speed Limit Enforcement

- **Figure 3-29 Speed Limit Enforcement on Tarlington Parade**

Location(s)	Safety Measure(s)
1) Both sides of Tarlington Parade at start and end of the school zone area. 2) Bradfield Crescent	40km/h speed limit enforcements within the school zone area on Tarlington Parade. Signs on both sides of the road at either ends of the road (approaches to Bonnyrigg Avenue and Cabramatta Road intersections) 40 km/h sign painted on the road pavement in either directions at the entrances to the school zone area on Tarlington Parade and Bradfield Crescent.

- **Figure 3-30 Pedestrian Crossing Road Signs on Tarlington Parade**

Location(s)	Safety Measure(s)
Tarlington Parade (both approaches to the pedestrian crossing).	Pedestrian crossing and speed hump signage at the approaches to the pedestrian crossing (both directions of travel). These signs advise and warn drivers to slow down and look out for pedestrians.

3.4.2 Pedestrian Access

- **Figure 3-31 Pedestrian Crossing on Tarlington Parade**

Location(s)	Safety Measure(s)
Tarlington Parade.	Zebra crossing with kerb extensions Raised road pavement (speed hump) at the crossing to reduce the vehicular speed. Raised concrete platforms with barricades at each end of the crossing to protect and separate the pedestrians from approaching vehicles. Pedestrian crossing road signs on both sides of the road for both directions to advise and warn drivers of the approaching pedestrian crossing.

- **Figure 3-32 Pedestrian Footpaths on Tarlington Parade**

Location(s)	Safety Measure(s)
1) Tarlington Parade (both sides of road).	Footpath on north-east side of Tarlington Parade providing access from Cabramatta Road to Bonnyrigg Avenue. Footpath along south-west side of Tarlington Parade providing access from Cabramatta Road to 60m beyond west entrance to Bradfield Crescent.
2) Bradfield Crescent.	Footpath along full length of north side of Bradfield Crescent. Segmented footpath on south side of Bradfield Crescent.

4. Recommended Safety Requirements for Future Development

The adequacies of the existing safety measures in place with the four school zones were reviewed and our analysis indicates that most of the current measures are adequate. However, additional measures should be considered to enhance the safety for school children (under existing traffic volumes).

4.1 Recommended Safety Improvements for Existing Traffic Conditions

4.1.1 St John's Primary School

It is recommended that a pedestrian footpath be installed on the south side of Edensor Road to allow pedestrian access on both sides of the road and to discourage pedestrians from crossing away from the designated crossing point near Bunker road intersection.

Our site visit indicated that currently the crossing desire line extends further to the east towards Humpheries Road and west towards Melbourne Road. Hence, provision of crossing facilities such as pedestrian refuges should be investigated closer to these intersections to provide designated points for pedestrian crossing.

4.1.2 Bonnyrigg High School

Cabramatta Road at Bonnyrigg High School experiences heavy traffic flow. The distance between the signalised crossing at Elizabeth Drive and Tarlington Road is approximately 420m and between Tarlington Road and Humphries Road is approximately 450m. Some school children cross Cabramatta Road mid-block rather than walking some 400m to cross the road at the existing traffic signals. With heavy vehicles using this stretch of road this creates a high safety concern.

Hence, the provision for an upgrade of the current pedestrian crossing at Bonnyrigg High School on Cabramatta Road needs to be considered. To cater for the existing traffic volume it is recommended that a pedestrian refuge island or zebra crossing be considered.

Austroads Guidelines Part 6 indicate that pedestrian refuges may be considered for moderate volumes of crossing traffic and provides physical protection from vehicles. In terms of zebra crossings the Austroads Guidelines indicate that these are suitable for crossing two lanes two-way and low speed roads that have high volumes of traffic.

4.1.3 Our Lady of Mt. Carmel Primary School

The section of Cabramatta Road between Humphries Road and Meadows Road has no crossing facility except at the traffic signals at either ends of this section. As per section 4.1.2 above it is recommended that a crossing facilities (either signalised or non-signalised) in the midblock of this section of road be investigated.

4.1.4 Bonnyrigg Primary School

Placing a 'lollypop' person at the pedestrian crossing on Tarlington Road should be considered. A designated person operating during the school zone periods will help provide priority crossing for children and would also supervisor children crossing the road and ensure approaching vehicles stop for the children at this crossing point.

4.2 Recommended Safety Improvements for Future Traffic Volumes

The recommended safety improvements highlighted in this section are required due to background traffic growth along with the predicted additional traffic generated by the proposed Bonnyrigg development.

The proposal generated traffic along these sections of the roads were estimated to be in the range of 40 to approximately 400 additional vehicles over a peak hour period in the year 2020 when the final construction stage of the development would have been completed.

4.2.1 Bonnyrigg High School

- **Figure 4-1 Heavy Vehicles On Cabramatta Road**

A provision for an upgrade of the current pedestrian crossing at Bonnyrigg High School on Cabramatta Road is recommended with the increase in traffic in the future. Two options are suggested:

- Option 1: An additional signalised pedestrian crossing; and
- Option 2: Installation of a pedestrian barricade/fence along the median of Cabramatta Road.

As discussed in Section 4.1 Cabramatta Road at Bonnyrigg High School experiences heavy traffic flow and the distance between the signalised crossing at Elizabeth Drive and Tarlington Road is approximately 420m and between Tarlington Road and Humphries Road is approximately 450m. School children may cross mid block as opposed to walking some 400m to cross at the lights. With heavy vehicles using this stretch of road this create a high safety concern.

With an increase of additional vehicles in the future travelling on this section of Cabramatta Road, implementing additional measures for safety should be considered.

It is to be noted that under Option 1 installation of a pelican or puffin crossing could also be considered. These minimise delays to vehicles and provide reduced cycle time. The 'push button' traffic signals, pelican and puffins provide higher guarantee of priority control and can allow provision of audio and tactile treatments for all pedestrian user types. To enhance safety for cyclist, bicycle detector and hand rails may also be considered.

Option 2 would require an investigation into the constructability of installing a thin solid median along the section of Cabramatta Road outside the school in order to incorporate the barricade/fence.

Option 1is considered a more feasible option and further investigation into the detailed type of signalised crossing is recommended.

4.2.2 Our Lady of Mt. Carmel Primary School

There is a pedestrian crossing facility provided on Humpheries Road between Salecich Road and Cabramatta Road. However, there is no crossing facility provided at the start/end of school zone near Bunker Parade intersection and Salecich Place. The lack of such facility encourages school children to cross away from the designated crossing point and hence increases safety concerns. With the increase in traffic volumes in the future it is therefore recommended that the provision of additional crossing facility such as pedestrian refuge be investigated on Humphries Road between Bunker Parade and Salecich Place.

4.3 Apportionment of Background Traffic and Development Traffic

As stated in Section 2 above, the total increase in traffic including the background traffic growth and the predicted traffic generation of the development was considered to be in the order of 1.5% increase by 2010 and a 17% in the year 2020. The 17% increase in traffic is taken as an average increase over the entire study area.

The total traffic predicted to increase for particular school zone roads links in the study area is shown in Table 4-1 below.

- **Table 4-1 Development Traffic Vs Background Traffic Growth**

School	Year 2002 without Development	Year 2020 With Development +Background Traffic Growth	Year 2020 Development Traffic Only	Proportion of Traffic Contributed by Development
Bonnyrigg Primary	97	223	126	57%
Bonnyrigg High	590	685	95	14%
Our Lady of Mt. Carmel	366	521	154	30%
St Johns Primary	381	404	23	6%

Please note that the values indicated in Table 4-1 above are based on average values in the AM and PM peak periods. Where more than one road is defined within a school zone for a particular school we have taken the average volumes of these roads to calculate the values of columns two and three in the table (development and without development traffic volumes).

4.4 Summary

The existing safety measures at schools in the Bonnyrigg study area are considered to be adequate for the existing traffic conditions. A number of measures to further increase safety along these roads were recommended. Additional safety improvement measures were also recommended to further improve pedestrian safety associated with the increase in general and Bonnyrigg redevelopment traffic.

A summary of the number of recommended safety measures within each of the four school zones (three primary schools and the one high school) is illustrated in Figure 4-2 below.

Figure 4-2 Summary of Recommendations

It should also be noted that as this report does not consider detailed review of design and costing regarding the recommended measures a further reference to appropriate design and costing standards will need to be considered before any implementation of these recommended measures.

Appendix D Parking Occupancy Surveys

(Malabar, Stanhope Gardens, North Paramatta and Bonnyrigg)

File Note

Date	18 September 2008
Project No	IN90937
Subject	**Parking Occupancy Surveys - Malabar, Stanhope Gardens, North Parramatta and Bonnyrigg**

1. Introduction

Parking occupancy surveys were undertaken to establish existing parking supply and demand generated by the specific housing development types and help determine the expected parking demand in the proposed Bonnyrigg development area.

In addition to parking surveys undertaken at Bonnyrigg (Tarlington and Bunker Parade) surveys were conducted on the 22nd and 23rd April, 2008 and in the following locations:

- Malabar (area surrounding Bilga Crescent);
- Stanhope Gardens (area surrounding Somerset Street); and
- North Paramatta (Governors Way and Hunterford Crescent).

The sites are representative of proposed Bonnyrigg development. These surveys were conducted no earlier than 7:00pm to allow residents to have returned to their homes after work and represent full parking demand.

The following sections outline the results of the surveys at these four study locations.

2. Malabar (Southern End of Bilga Crescent)

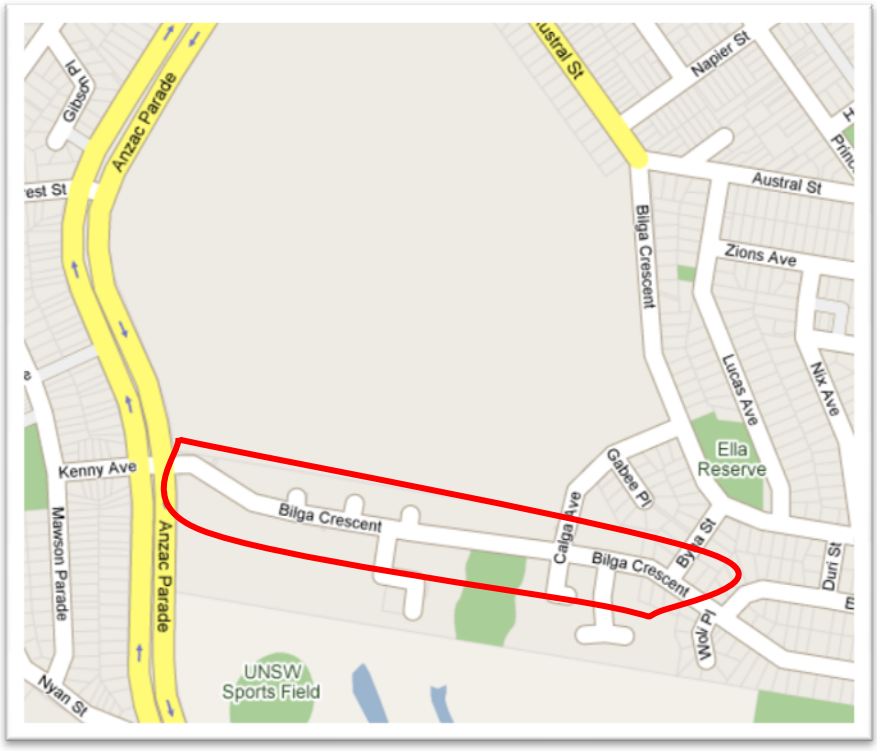
Figure 1 indicates the study area for the parking survey in Malabar study area.

The surveyed area included:

- Bilga Crescent;
- Wyee Place;
- Karoo Place and;
- Calga Avenue.

Malabar consists mainly of high rise apartments and town houses. A large number of the town houses have carports as their off-street parking area. There were a total ten visitor car parks in the study area. The high-rise units had off-street parking lots available for both residents and visitors to the site. The surveyed area was considered a lower income housing development. **Figure 2** and **Figure 3** below show the parking off-street and on-street parking in the study area in Malabar.

- **Figure 1 Study Area – Malabar**



- **Figure 2 Malabar Off-Street Parking Area**

- **Figure 3 Malabar On-Street Parking**

Table 1 shows the parking occupancy surveyed results for Malabar study area.

- **Table 1 Surveyed On-Street Parking Supply and Demand for Malabar Study Area**

Streets	On-Street			Off- Street Parking		
	Total Spaces	Total Occupied	% Occupied	Total Spaces	Total Occupied	% Occupied
Bilga Crescent*	228	92	40	279	153	55

*Includes the carparks on Calga Avenue, Wyee and Karoo Place.

Of the total 228 on-street parking available in the surveyed area only 40% were occupied and only 55% of the total off-street car parks were occupied during the surveyed period. This indicates that there is a surplus of parking spaces in the area.

2.1 Randwick Council Parking Requirements

Malabar falls under the Randwick local government area. **Table 2** below shows the standard and visitor parking requirement as stated in the Randwick Council's DCP (per residential housing development types).

- **Table 2 Randwick Council DCP Parking Requirements**

	Detached Housing	Medium Density	High Density
Resident's Parking	1/dwelling (2 or less bdrms) 2/dwelling (3+bdrms)	1.2/dwelling (2 bdrms) 2/dwelling (3+ bdrms)	
Visitor's Parking	Not Stated	1/ 2.5 dwellings	1/ 2.5 dwellings

It was estimated that there are approximately 250 dwellings in the study area. It was assumed that all dwellings in the area were either high or medium density type of housing. It is assumed that 70% of the dwellings have 1-2 bedrooms while the rest consist of 3+ bedrooms. The total parking was estimated as:

- 360 resident park spaces
- 100 visitor parking spaces

There are 279 residential parking spaces available in the study area whilst the Council DCP requires 360 spaces to be provided. There are 10 car spaces allocated for visitors whilst the Council DCP requires 100 car spaces for visitors.

Hence, there is a shortfall in the number of both residential and visitor car parking spaces.

However, we consider that despite the shortfall in the parking spaces, there is sufficient on-street parking in the area to accommodate both residential and visitor parking demands.

3. Stanhope Gardens (Somerset Street)

Figure 4 indicates the study area for the parking survey in Stanhope Gardens.

The surveyed area included:

- Somerset Street;
- Kendell Street;
- Darcy Street;
- Heywood Glen;
- Kentwell Crescent;
- Fletcher Street;
- Esher Street and;
- Access streets off Somerset Street (see **Figure 5** below).

Stanhope Gardens is a newly developed area. The development consists mainly of modern double-storey houses and town houses. All off-street parking consisted of either single or double garages. In many instances, garages were separated from the actual house and were located off separate access ways located behind or adjacent to the houses.

- **Figure 4 Study area – Stanhope Gardens**

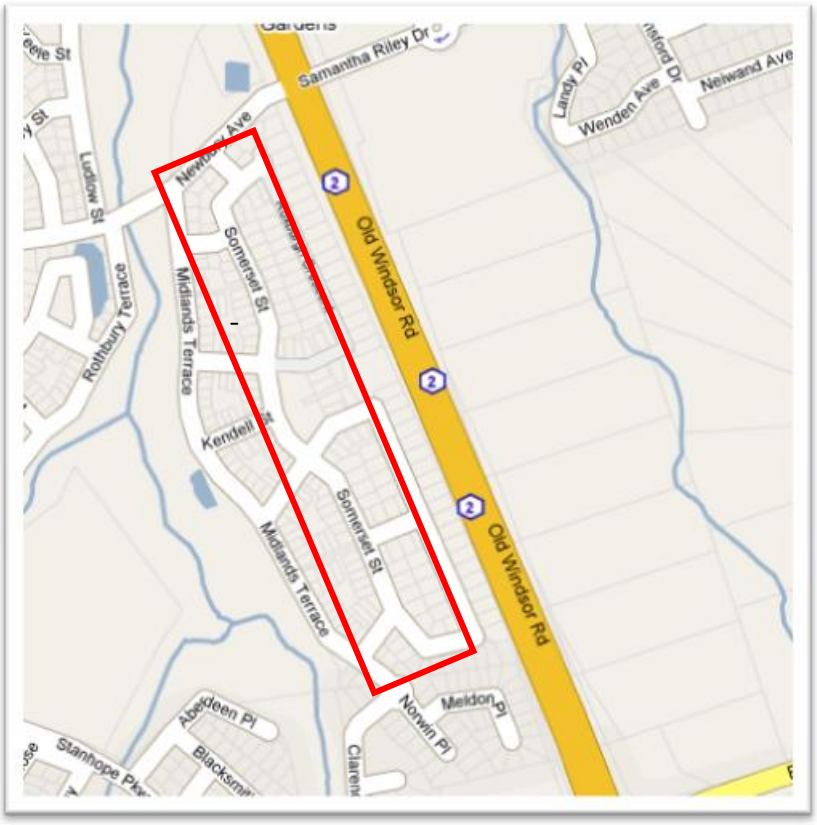


Table 3 indicates the supply and parking occupancy at Stanhope Gardens study area.

Figure 5, **Figure 6** and **Figure 7** below show the off-street and on-street parking in Stanhope Gardens study area.

- **Figure 5 Off-Street Parking Access Area**

- **Figure 6 On-Street Indented Parking Area**

- **Figure 7 On-Street Parking Area**

- **Table 3 Surveyed On-Street Parking Supply and Demand for Stanhope Gardens**

Streets	On Street Parking		
	Total Spaces	Total Occupied	% Occupied
Somerset Street	69	22	32
Kendell Street	22	2	9
Darcy Street	26	9	35
Heywood Glen	17	1	6
Kentwell Crescent	29	8	28
Fletcher Street	25	5	20
Esher Street	15	3	20
Dover Street	0	0	N/A
Trafford Street	17	4	24
Total/Average	**220**	**54**	**25**

Note that off-street parking occupancy was difficult to measure as the houses in the area have enclosed private garages. Hence off-street parking was not recorded. There were a total of 250 carparks on the property in the study area with approximately 50 vehicles parked in the driveways.

There were no specifically marked out visitor car spaces in the study area. Hence, it was assumed that the on-street parking was available for visitors to the area as well for the residents.

Only 54 of the total 220 on-street parking spaces (25%) were occupied in the study area. Hence there is sufficient on-street parking available to meet the demands in the area created by the residents and visitors in the area. In addition to parking on the road visitors were also observed parking in the driveways of the homes that they were visiting.

3.1 Blacktown City Council Parking Requirements

The Blacktown City Council provides a guideline in their DCP on the parking requirements per landuse. **Table 4** below indicates the standard and visitor parking requirement per residential housing development types

- **Table 4 Blacktown City Council DCP Parking Requirements**

	Dual Occupancy Housing	Integrated Housing	Medium Density	Residential Flat
Resident's Parking		1/dwelling (1-2 bedrooms) 2/dwelling (3+ bedrooms)		
Visitor's Parking	Not Stated	1/3.5 dwellings	1/ 2.5 dwellings	1/ 2.5 dwellings

It was assumed that 80% of that all houses in the study area have 3+ bedrooms with the remaining 20% 1-2 bedroom homes. Houses were classified as medium density. There were approximately 125 houses in the study area. Parking required was estimated as:

- 225 resident park spaces
- 50 visitor parking spaces

Based on the above calculated parking numbers, there adequate parking spaces provided for the residents (with 250 car park spaces available in the study area and only 225 required).

As noted above there are no specific car parks allocated for visitors in the study area. Therefore, it was assumed that visitors would park either on the driveways or on-street. The surveys show that there are a sufficient number of spaces available on the street to accommodate parking demand the visitor's vehicles.

4. North Parramatta (Hunterford subdivision -opposite King's School)

Figure 8 indicates the study area for the parking survey in Hunterford, North Parramatta.

The surveyed area included:

- Governors Way;
- Hunterford Crescent;
- Peppercorn Lane and;
- Ivy Lane.

Peppercorn Lane and Ivy Lane provide residential access to garages that are not accessed from either Hunterford Crescent or Governor Way. These access lanes provide pedestrian access as well as small areas for recreation use such as park benches, etc. (see **Figure 10** below).

This study area is comprised of newly built houses and townhouses in a tightly spaced suburban setting. A large number of off -street parking surveyed in this area were garages and driveways, with the exception of a basement parking space serving a cluster of townhouses. Some residences have a separated garage which is accessed through a lot located behind the houses.

- **Figure 8 Study area – North Paramatta**

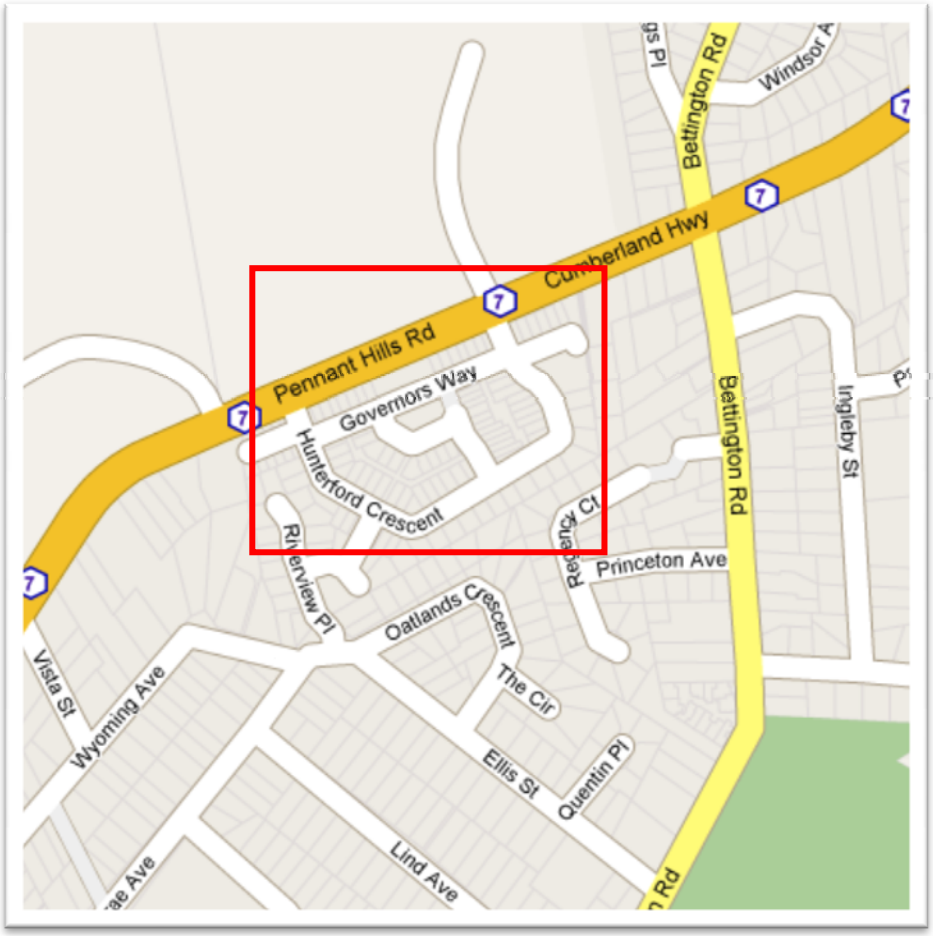


Figure 9, **Figure 10** and **Figure 11** show the parking areas in North Paramatta Study Area.

- **Figure 9 Off-Street Access to Parking**

- **Figure 10 Off-Street Parking Access Places**

- **Figure 11 On-Street Parking**

Table 5 shows the results of the parking occupancy surveys for North Paramatta study area.

- **Table 5 Surveyed On-Street Parking Supply and Demand for North Paramatta Study Area**

Streets	On Street Parking		
	Total Spaces	Total Occupied	% Occupied
Governors Way	17 (2 visitor parking)	10	59
Hunterford Crescent	70	26	37
Peppercorn Lane	10 (visitor parking)	7	70
Ivy Lane	0	0	N/A
The Mews	0	0	N/A
Total/Average	**97**	**43**	**55**

Table 5 shows that 55% of the total on-street car parks surveyed in the study area were occupied. It can therefore be concluded that there is sufficient on-street parking spaces available for residents and the visitors to the area.

A total of 200 off-street parking spaces are provided in the study area. A total number of 24 cars were parked in the driveways on the properties. In additional, there are approximately 27 off-street car parks available in a basement area for a group townhouses located on Governors Way. Of the 27 car spaces, seven were allocated to visitors. A total of 19 car spaces were available for the visitors to the study area.

Despite no parking signs along a section on Governors Way there are cars parking in these areas. There is however on-street parking available on other streets in the vicinity.

4.1 Paramatta Council Parking Requirements

Table 6 below shows the Paramatta Council's guideline as per their DCP regarding the parking requirements per residential housing types (residential and visitor parking).

- **Table 6 Paramatta Council DCP Parking Requirements**

	Dwelling Houses + Dual Occupancy Housing	Town Houses, Villas	Residential flats (NOT within 400m of train station)	Residential flats (within 400m of train station)
Resident's Parking	1 /dwelling (less than/equal to 125m^2) 2/dwelling greater than 125m^2)	1/unit (1-2 bedroom) 1.5/unit (3 bdrm) 2/unit (4+ bdrm)	1.25/2 bdrm unit 1.5/3 bdrm unit	1/1-2bdrm unit 2/3 bdrm unit
Visitor's Parking	0.25/dwelling	0.25/dwelling	0.25/dwelling	0.25/dwelling

There were approximately 100 houses in the study area with 80% assumed to be consisting of 3+ bedrooms with 20% less than or equal to two bedrooms. It was assumed that 80% of the houses in the area were townhouses while the rest were detached houses. Parking was estimated as:

- 140 resident park spaces
- 25 visitor parking spaces

There are adequate resident parking spaces provided for the residents (with 200 car park spaces available in the study area and only 140 required). Only 19 visitor parks are provided in the area. **Table 5** indicates there is more than sufficient on-street parking available for any visitors to the site.

5. Bonnyrigg (Tarlington Parade and Bunker Parade)

Figure 12 indicates the study area for the parking survey in Bonnyrigg.

The surveyed area included:

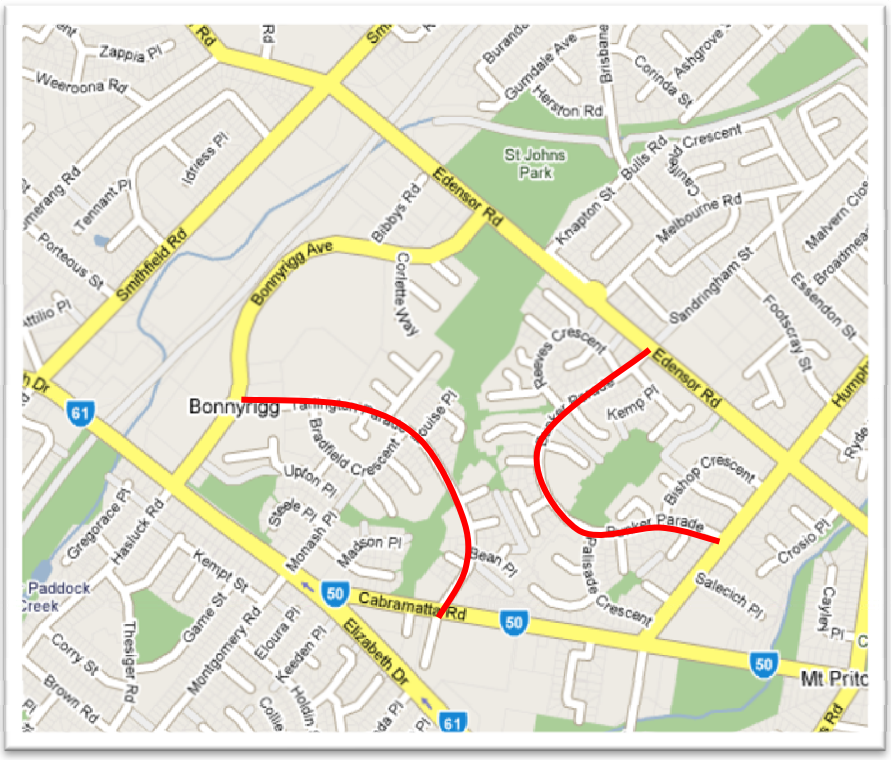
- Tarlington Parade;
- Bunker Parade and;
- Access roads off Tarlington and Bunker Parade

The area of investigation mainly comprised of detached houses with either single car ports or single separate garages allocated on properties. A large number of houses have wide lawn areas, where additional private vehicles belonging to a property or belonging to visitor(s) to the property were parked. Both Tarlington and Bunker Parade are wide roads which can easily accommodate on-street parking on either sides of the road.

There were approximately six access roads that adjoined with Bunker and Tarlington Parade and which provide access to the parking areas of several proprieties in the study area.

Off-street parking occupancy is difficult to survey with cars parked on lawns and behind closed property gates. A total of 254 off-street parking spaces were recorded from Tarlington Parade and Bunker Parade including the small side streets.

- **Figure 12 Study area – Bonnyrigg**



- **Figure 13 Off-Street Parking**

- **Figure 14 Off-Street Parking Access Area**

- **Figure 15 Off-Street Car Port Area**

- **Figure 16 On-Street Parking**

Table 7 indicates the parking occupancy surveyed results for Bonnyrigg study area.

- **Table 7 Surveyed On-Street Parking Supply and Demand for Bonnyrigg Study Area**

Streets	On Street Parking		
	Total Spaces	Total Occupied	% Occupied
Tarlington Parade + access roads	320	11	3
Bunker Parade +access roads	340	6	2
Total/Average	**660**	**17**	**3**

As **Table 5** above indicates only 3% of the total on-street car parks surveyed in the study area were occupied. Hence, it is considered that there more than sufficient on-street parking spaces available for the residents and the visitors to the area.

There are a total of 254 (106 on Tarlington Parade and 148 on Bunker Parade) off-street parking that is available in the study area. There are a total of 10 visitor carparks available in the surveyed area.

Despite the availability of parking on the roads the owners of the properties or the visitors preferred to park on the lawns of the house rather than on the street. Hence, a high number of cars were observed to be parked in the driveways and the lawns of the dwellings.

5.1 Fairfield Council Parking Requirements

The Bonnyrigg study area falls under the jurisdiction of Fairfield Council. **Table 6** below indicates the Fairfield Council's guideline as per their DCP regarding the parking requirements per residential housing types (residential and visitor parking).

- **Table 8 Paramatta Council DCP Parking Requirements**

	Dwelling Houses	Medium Density	High Density
Resident's Parking	1 /dwelling (1-2 bedroom) 1.5 -2/dwelling (3+ bedrooms)		
Visitor's Parking	0.25/dwelling		

5.2 Existing Dwellings

There were approximately 120 houses in the study area. It is assumed due that 80% of the houses in the area were 3+ bedroom detached houses while the rest were 1-2 bedroom detached houses. Parking supply was estimated as follows:

- 144-192 resident park spaces
- 30 visitor parking spaces

There are adequate resident parking spaces provided for the residents (with 254 car park spaces available in the study area and only a maximum of 192 required by the council). It is to be noted only 10 visitor parks are provided in the area. However, **Table 7** indicates there is more than sufficient on-street parking available for any visitors to the site.

6. Summary

The supply of on-street and off-street parking is generous at all four surveyed locations. Demand for parking at the four locations surveyed is about half the available supply. All four areas currently have a shortfall in visitor parking spaces but all sites have adequate on-street parking spaces available to accommodate both visitor and residential parking. It is unlikely that a slight restriction in parking requirements would adversely affect residential or visitor parking convenience.

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