## Document / Report Control Form

Project Name: **Traffic Impact Assessment for SDBP**

Project number: **3002100**

Report for: **BG&E**

## PREPARATION, REVIEW AND AUTHORISATION

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Abbreviations:

**AADT** - Annual Average Daily Traffic

**AUSTROADS** –the association of Australian and New Zealand road transport and traffic authorities

**ITE** - Institute of Transportation Engineers

**LOS** – Level of Service (Graded from A-F)

**RTA** – Roads and Traffic Authority of NSW – NSW State Road Authority

**SDBP** - Southern Distribution Business Park

**TIA** Traffic Impact Assessment

**VicRoads** – Victorian State Road Authority

# 1 INTRODUCTION

## 1.1 Background

The Southern Distribution Business Park (SDBP) is planned to be built to the south of the Goulburn Bypass section of the Hume Highway that connects Sydney to Melbourne. The expected land area is 269.19 hectares (Ha) with a building foot print of 131.54 Ha with a hardstand area of 70 Ha. The Gross Floor Area (GFA) of the development is expected to be 144.68 Ha. This development will generate and attract heavy goods vehicles as well as passenger vehicles for journey to work by employees. This chapter provides an estimate of the future traffic volume expected to be generated by the development and assesses the capability of the surrounding road network to accommodate this traffic. New works necessary to provide for access to the SDBP are identified.

The increase in traffic during operation of the SDBP will be a gradual process dependant on the timing of the development of particular facilities.

## 1.2 Methodology

The methodology for conducting a TIA for SDBP is depicted in Figure 1. It involves the following main tasks:

- Data Collection and Capacity Determination
- Forecast of Normal Growth in Traffic by type
- Determination of Generated Traffic by type
- Assessment of Future Expected Traffic Related Problems
- Identification & Assessment of Potential Problems, Mitigation Policies & Measures
- The following sections and sub-sections present in detail the TIA study for SDBP

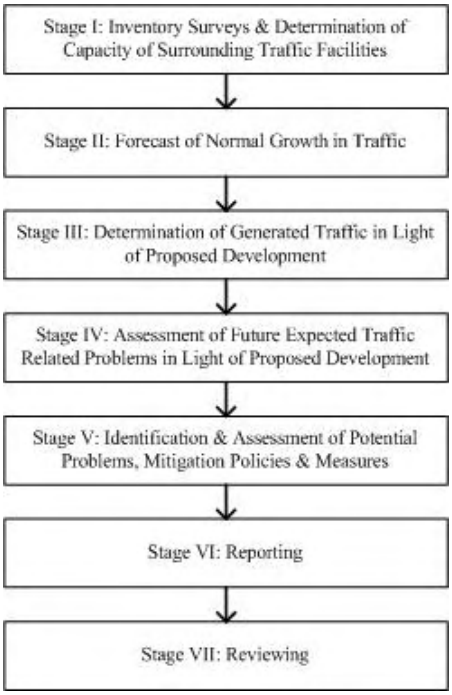


**Figure 1: Main Stages Involved in Conducting Traffic Impact Assessment for SDBP**

## 1.3 Data Collection and Scope

### 1.3.1 Base Road Network

The TIA process starts by identifying the location of the planned new development. Examining the site location acts as the basis for defining the study area as well as establishing the boundaries within which induced traffic impacts are assessed. Figure 2 shows the study area.

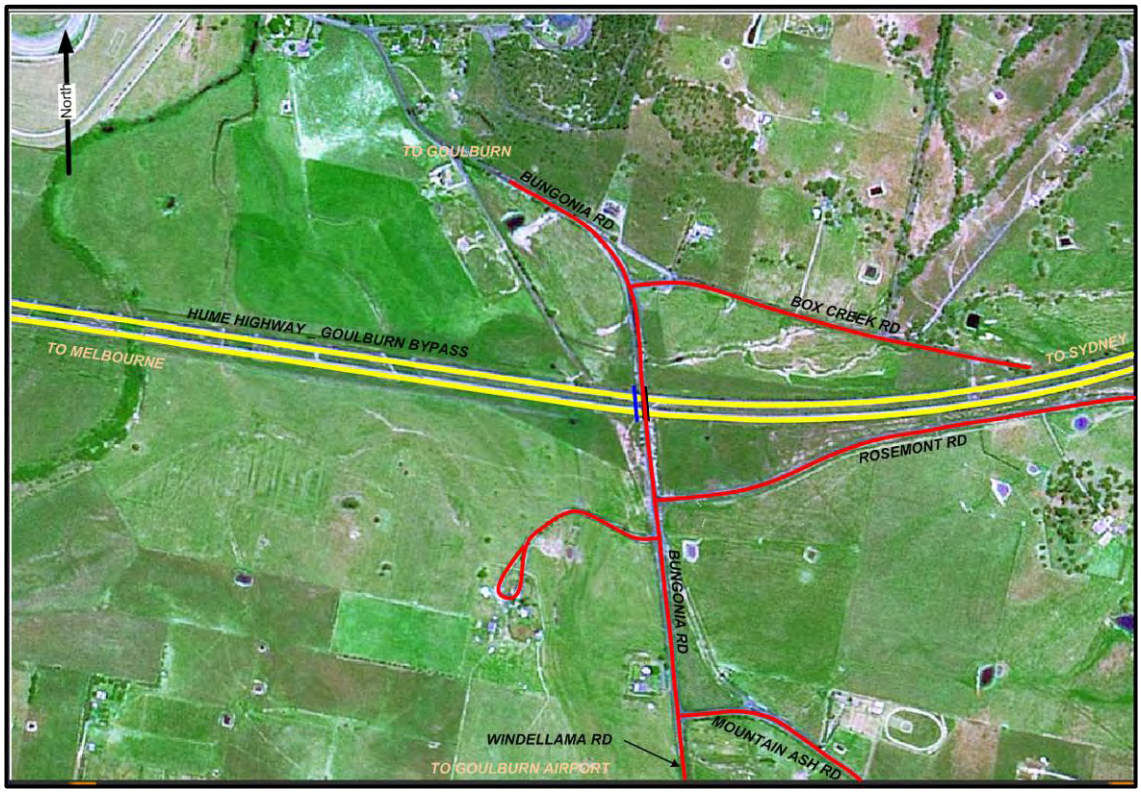


**Figure 2: Existing Roads**

The roads in the area are:

- **Hume Highway (H31)** – a limited access highway which links Sydney with Canberra and Melbourne. The speed limit is 110 km/h (trucks 100km/h) on the dual carriageways. The pavement is concrete.
- **Bungonia Road** – a local collector road that crosses the Hume Highway on an overpass and terminates at the Braidwood Road intersection in Goulburn. The pavement is generally 7.2–8.0 metres wide, light duty and 80 km/h alignment; Examination of recent crash data shows records of minor single vehicle accidents along Bungonia Road between Lansdowne Bridge and Sandy Hollow Road. The road pavement is constructed for low traffic volume, mostly passenger vehicle traffic, with no off road provision for cyclists or pedestrians.
- **Windellama Road** – a local collector road that intersects with Bungonia Road on the northern side of the site. The pavement is generally 7.2–8.0 metres wide, light duty and 80–100 km/h alignment.
- **Brisbane Grove Road** – a minor rural road linking Windellama Road with Braidwood Road. The pavement is generally 7.2 metres wide, light duty and 80 km/h alignment.
- **Rosemont Road** – a minor rural road intersecting with Bungonia Road on the southern side of the Hume Highway.

- **Rifle Range Road (Box Creek Road)** – a minor rural road intersecting with Bungonia Road on the northern side of the Hume Highway.
- **Mountain Ash Road** – a local collector road through the centre of the majority of the SDBP site, 7.2–8.0 metres wide, light duty pavement, 80–100km/h.
- **Braidwood Road** – a main road (MR 79) linking Goulburn to the Kings Highway via Tarago.
- **Barretts Lane** – a 1.2 kilometre lane, four metres wide, partly sealed and servicing three rural properties.

This assessment estimates traffic volumes on:

- Hume Highway Goulburn Bypass
- Bungonia Road
- Rosemont Road
- Windellama Road
- Mountain Ash Road

### 1.3.2 Data Collection

Data collection involved contacting several of the main stakeholders, including:

- Mariner supplied information about the employment of the SDBP, as well as any available information on travel patterns, traffic volumes, and heavy vehicle movements.
- RTA NSW data supplied included Annual Average Daily Traffic (AADT) counts, some hourly counts from the join between the Hume Highway and the Federal Highway, and a global percentage of heavy vehicles.
- The Goulburn Mulwarree Council supplied traffic volumes and travel pattern information for the local roads around the development.
- Local members of the project team were able to provide information about the local roads structure and speed limits and the employment patterns for the area.

# 2 FORECAST OF NORMAL GROWTH IN TRAFFIC

## 2.1 Traffic Growth Rate for Hume Highway

Historical data on the Hume highway was used to establish the yearly traffic growth rate on this road. This analysis is shown in Table 2-1. The table shows that traffic growth rate on Hume Highway is in the order of 2.3% p.a.

**Table 2-1: Hume Highway AADT**

| Hume Highway Goulburn Bypass | 1997 | 2000 | 2003 |
|---|---|---|---|
| Average Annual Daily Traffic | 18,464 | 19,747 | 21,123 |
| Yearly Growth Rate | NA | 2.32% | 2.32% |

The only hourly volumes available for a relevant section of the Hume Highway were for the merge between the Hume Highway and the Federal Highway, see Figure 3. The data were combined to represent the Hume Highway after this merge, and used to determine the most significant peak hour as well as to derive the peak hour factors in both directions of the highway.

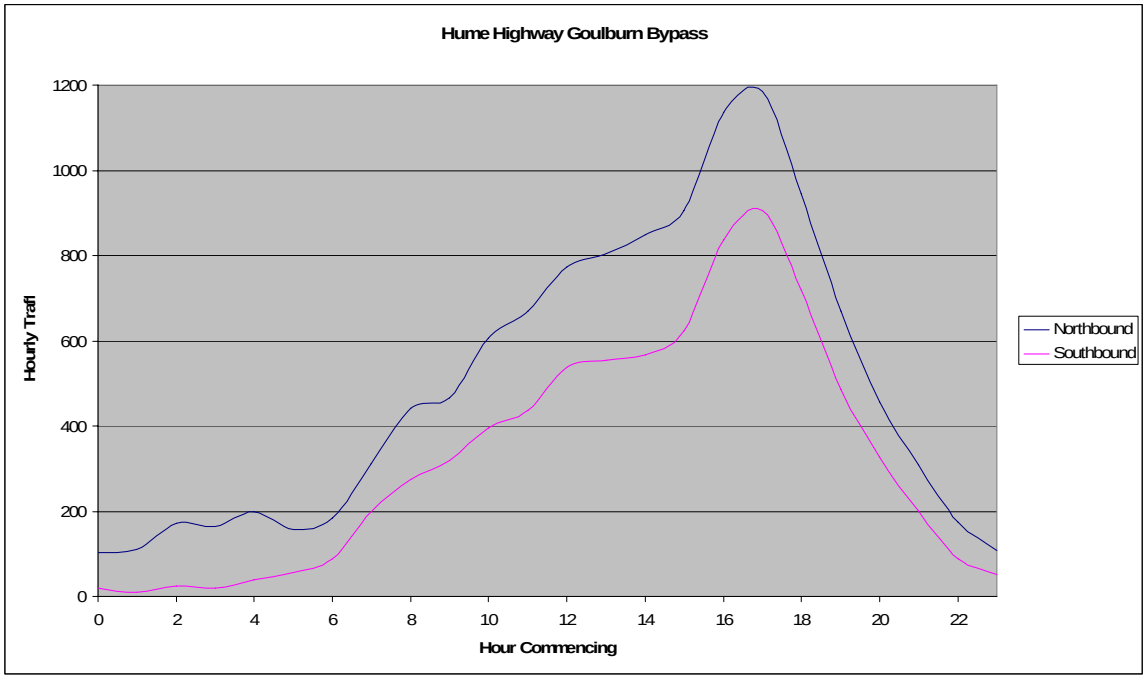


**Figure 3: Hume Highway Goulburn Bypass Daily Traffic**

- Northbound Peak Hour Factor = 9.95%
- Southbound Peak Hour Factor = 11.63%

The figure also shows that the highest peak hour is during the PM period starting at 5pm. The figure also shows that there is no definable AM peak.

## 2.2 Forecast of Future Traffic Volumes

Once growth rates are established in the previous step, simple forecast models are utilised in an effort to predict expected future levels of traffic. The future horizon year is determined to match the year when the project is expected to be fully developed and in operation. This is taken as 2021 as the development is expected to occur over 15 years.

Applying the traffic growth rate for Hume highway, it is expected that AADT would grow along this road to become 31,629 vehicles/day in the year 2021.

Since the hourly count are not for the exact location of the project site, they were factored using the AADT on the Goulburn Bypass to produce more appropriate flows for the area around the proposed interchange. According to 2003 RTA count the global percentage of heavy vehicles on the Hume Highway Goulburn Bypass was 22.8%. As this factor was only provided for one year it will be assumed to be consistent with future growth. Based on this data the future PM peak flows on the Hume Highway are as depicted in Table 2-2:

**Table 2-2: Hume Highway Goulburn Bypass Peak Volumes**

| PM Peak hour traffic | Light Vehicles | Heavy Vehicles |
|---|---|---|
| Northbound | 1,392 | 411 |
| Southbound | 1,063 | 314 |

As for the local roads, the only traffic data available near the development was a 2002 AADT count for Bungonia Road of 1805 vehicles. For lack of any relevant information and the fact that population growth in Goulburn is fairly small, this was assumed to be equivalent to 90 peak vehicles each direction in the design year on both Bungonia Road and Windellama Road applying a peak hour factor of 10%. Traffic volumes on Mountain Ash Road and Rosemont Drive Road were assumed as minimal i.e. in the range of 10 peak vehicles each direction based on subjective information from local consultants.

No allowance for Bungonia Road traffic diverting through the new interchange (for trips not originating or finishing in Goulburn) has been made due to the lack of data. These volumes are expected to be small proportion of a relatively small total volume, and are not considered to materially affect required intersection and ramp capacity.

# 3 FUTURE ROAD NETWORK

To allow the park to be accessed by heavy vehicles including multiple trailers (i.e. B-Double and B-Triple) it is necessary to construct a new interchange to allow these trucks to access the business park from the Hume Highway. The current Goulburn local road system is unsuitable for large numbers of heavy vehicles.

The major changes to the roads currently in place will involve:

- a new service interchange to provide full access to the Hume Highway through four ramps. The ramps are to connect with Mountain Ash Road at a new roundabout.
- realignment of Rosemont Drive to connect with this roundabout.
- a second new roundabout at the intersection of Bungonia Road, Mountain Ash Road, and Windellama Road
- minor roads within the development precincts.
- pedestrian and cycle path along Bungonia Road, linking with footpaths in the SDBP
- bus stops in the SDBP

The following sub-sections will discuss the geometric conceptual thinking involved in this proposed future road network changes.

## 3.1 Interchange

### 3.1.1 Interchange Spacing

Figure 4 indicates the location of the proposed interchange. The closest interchange is 4.5km away.

**Reference 1 Grade Separated Interchanges - A Design Guide NAASRA 1984**

Reference 1 recommends that interchanges be spaced at 1.5-2.0 km in urban areas and 5-8 km in rural areas. (Spacing may be reduced to suit specific circumstances). The location is considered acceptable, as it is sufficiently distant from the existing interchanges for weaving not to be an issue. Capacity is dependent on merge and diverge operations. Note that at the northern end of the Goulburn Bypass there is no southbound entry ramp. The RTA acquired sufficient land for the Goulburn Bypass to allow for possible future construction of a diamond interchange at Bungonia Road. Figure 4shows the proposed interchange location.

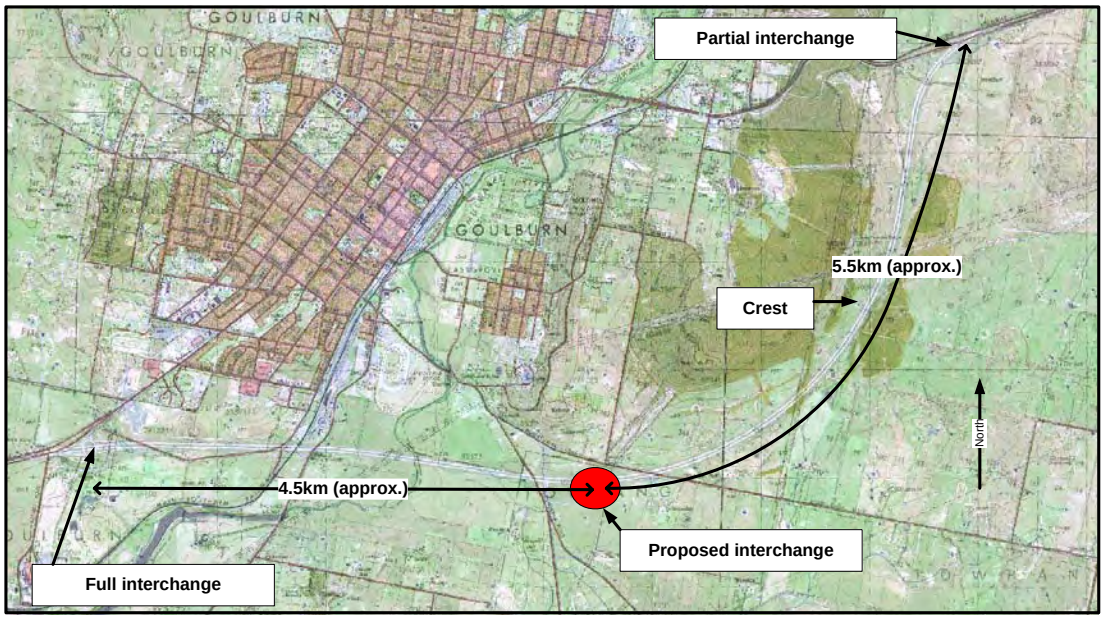


**Figure 4: Goulburn Bypass**

**Figure 5: Site of proposed interchange (looking west, Melbourne bound)**

### 3.1.2 Interchange Layout

10 options were considered for the service interchange, and the evaluation is included in Table 3-1. Sketch plans of the options are included in **Error! Reference source not found.**

**Table 3-1: Comparison of Options**

| Option | Description | Comment | Bungonia Rd local traffic only? | Action |
|---|---|---|---|---|
| 1 | Twin roundabout diamond | Small roundabouts are unsuited to B triple operation.<br>Truck speeds constrained by roundabouts, leading to low merge speeds and need for very long auxiliary lanes. | No | Abandon |
| 2 | Parclo A with truck stop | Truck stop (not required by RTA) | No | Abandon |
| 3 | Parclo A | Has bypass of central roundabout | No | 4 preferred to 3 |
| 4 | Parclo A<br>Relocate Rosemont Rd | Eliminates central roundabout<br>Noise issue | No | Modify to reduce noise as shown in 5 |
| 5 | Parclo A (similar to 4) | Has northern roundabout moved closer to Highway. Entry loop is larger radius than Option 7<br>Entry loop joins Highway before uphill section | No | Compare cost with 9<br>Compare environmental impact with 9.<br>Compare capacity with 9. |
| 6 | Trumpet B | Parclo B adds risk of trucks overturning if exit speed is excessive | Yes | Abandon |
| 7 | Trumpet A | Trumpet A requires trucks to begin uphill acceleration from 50km/h speed, and Highway is on upgrade<br>High cost for Sydney bound climbing lane | Yes | Abandon |
| 8 | Hybrid | Loop adds risk of trucks overturning if exit speed is excessive | Yes | Abandon |
| 9 | Semi-direct | No loops<br>Elegant solution<br>High capital cost due to curved bridges (sight distance widening required) | Yes | Compare cost with 5<br>Compare environmental impact with 5. Compare capacity with 5 |
| 10 | Elevated roundabout | Roundabout reduces entry speed for northbound trucks<br>Exit from Highway may be too steep to suit roundabout levels<br>Traffic pattern does not suit roundabout<br>Lower capacity than 9 | Yes | Abandon |

Option 9 (when compared with Option 5), is more expensive to construct, but in terms of traffic capacity, safety, highway entry speed, reinforcement of the road hierarchy, noise and visual impact, it is superior.

Accordingly, a semi-direct interchange (Option 9) as shown in Figure 6 is proposed.

Note that the Figure 6 noise walls/mounds are indicative only. For more detail of the actual noise mitigation measures required, see Noise Chapter.

The semi-direct option was selected as the preferred option as it provides a service interchange with the following desirable characteristics:

- safe exit ramp geometry to minimize the risk of vehicles overturning, particularly dangerous goods vehicles (no exit loops)
- relatively high speed entry ramps (no entry loops)
- direct access to the SDBP site
- indirect access to Goulburn (to encourage continued use of existing Goulburn Bypass interchanges for non SDBP travel)
- Bungonia Rd overpass not incorporated (retained for local traffic and Goulburn based SDBP employment trips)
- location minimises potential noise impact on dwellings (the eastbound exit ramp will shield residences from the existing through carriageways and the rest of the proposed ramps)
- location east of Bungonia Rd increases the distance from closest adjacent interchange
- roundabout as ramp terminal intersection control inhibits wrong way movement
- Airport traffic and some school bus routes do not mix with heavy vehicle movement (Bungonia Rd could have a load limit (buses excepted) to reinforce the road hierarchy)

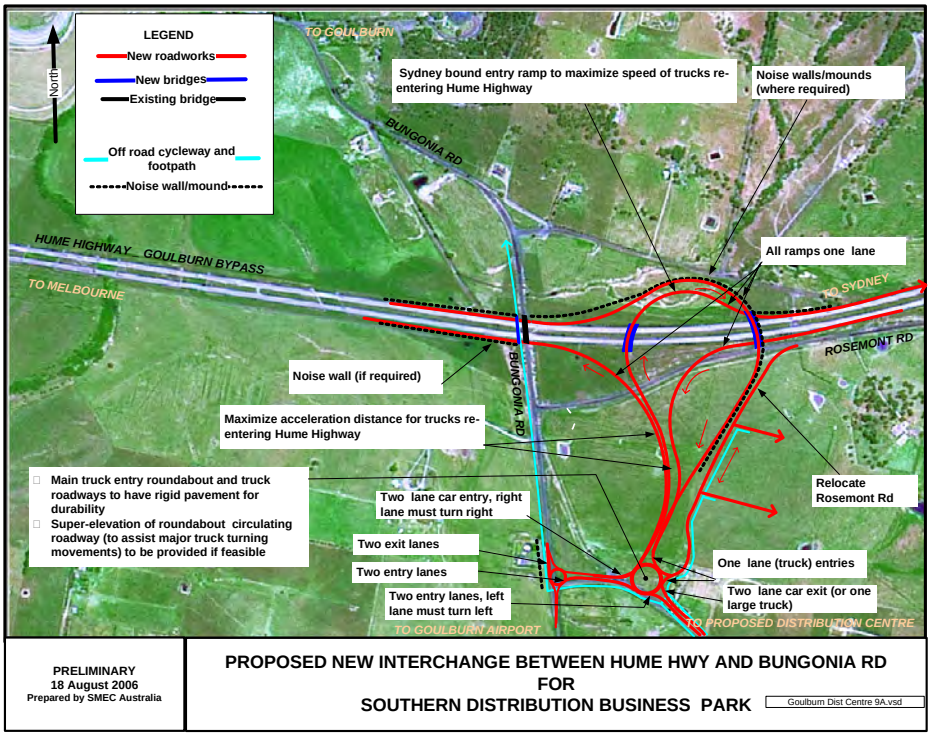


**Figure 6: Proposed Semi-direct interchange**

Figure 7 shows the preliminary plan and ramp profiles for the interchange.

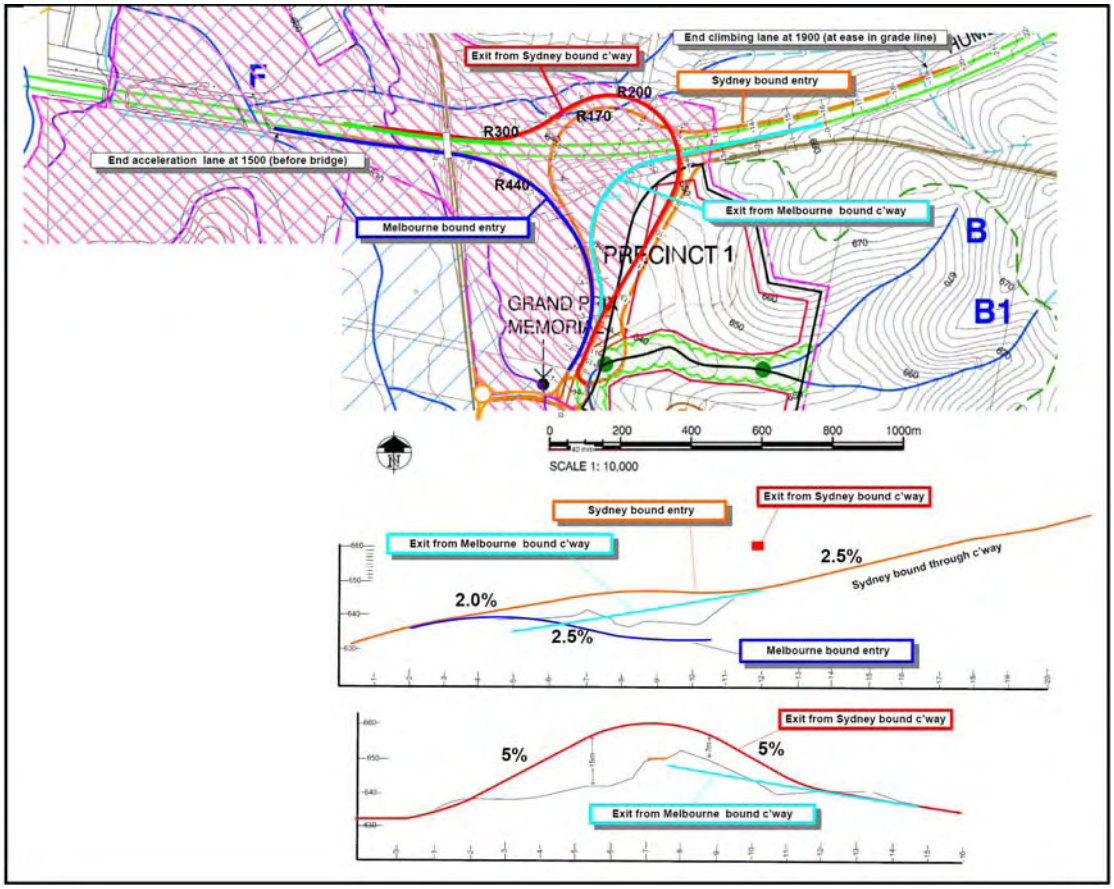


**Figure 7: Semi-direct Interchange Plan and Profiles (Preliminary)**

As shown on the profiles and in Figure 5, the Hume Highway is level west of Bungonia Rd, and climbs at about 2.5% in a north easterly direction towards Sydney. The gradient continues for over 3 km, although there is an ease in the grade at ramp chainage 1900 as shown in Figure 7.

The proposed interchange design provides generous auxiliary lanes for the entry ramps so that vehicles may merge safely.

**Reference 2 Geometric Design for Trucks AUSTROADS 2002**

Reference 2 points out "Unless the acceleration lane can be combined with a downgrade, the lengths of acceleration lane required for trucks to accelerate to the design speed of the through roadway are unrealistically long. Merging truck speed 10 to 20 km/h less than the through speed would not be expected to be unduly disruptive to traffic flow. Acceleration lane lengths based on the truck accelerating to such speeds are more realistic and achievable."

Sydney bound laden trucks would reduce speed to around 50 km/h as they climb towards the crest on the Highway. However, laden truck speeds are expected to be about 80 km/h next to the Sydney bound entry ramp, and fall to about 60 km/h by the proposed end of the auxiliary lane as shown in Figure 8. This provides a long length for trucks to adjust their position and safely merge, with the speed differential between laden trucks not exceeding 20 km/h. The practical location to end the auxiliary lane is at the ease in the gradient at about ramp chainage 1900.

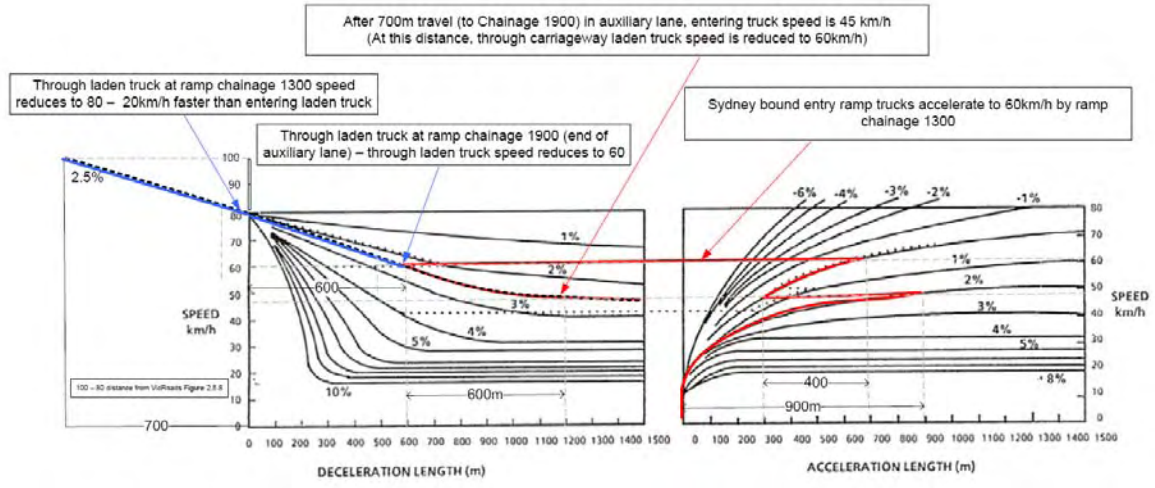


**Figure 8: Truck Speed on Sydney Bound Entry Ramp (RTA and VicRoads)**

As cars are expected to use the overtaking lane if trucks are present (either as through or entering vehicles) the speed differential considers truck speed, not car speed.

The Melbourne bound entry ramp is merging with truck traffic travelling at 100km/h, and Figure 9 shows that acceleration to about 85 km/h is possible for a laden truck. The practical location to end the auxiliary lane is just east of a floodway bridge. It is not practical for trucks to accelerate to 90km/h so that a speed differential of 20km/h is obtained for cars as well as trucks. Car traffic is expected to use the overtaking lane if trucks are entering.

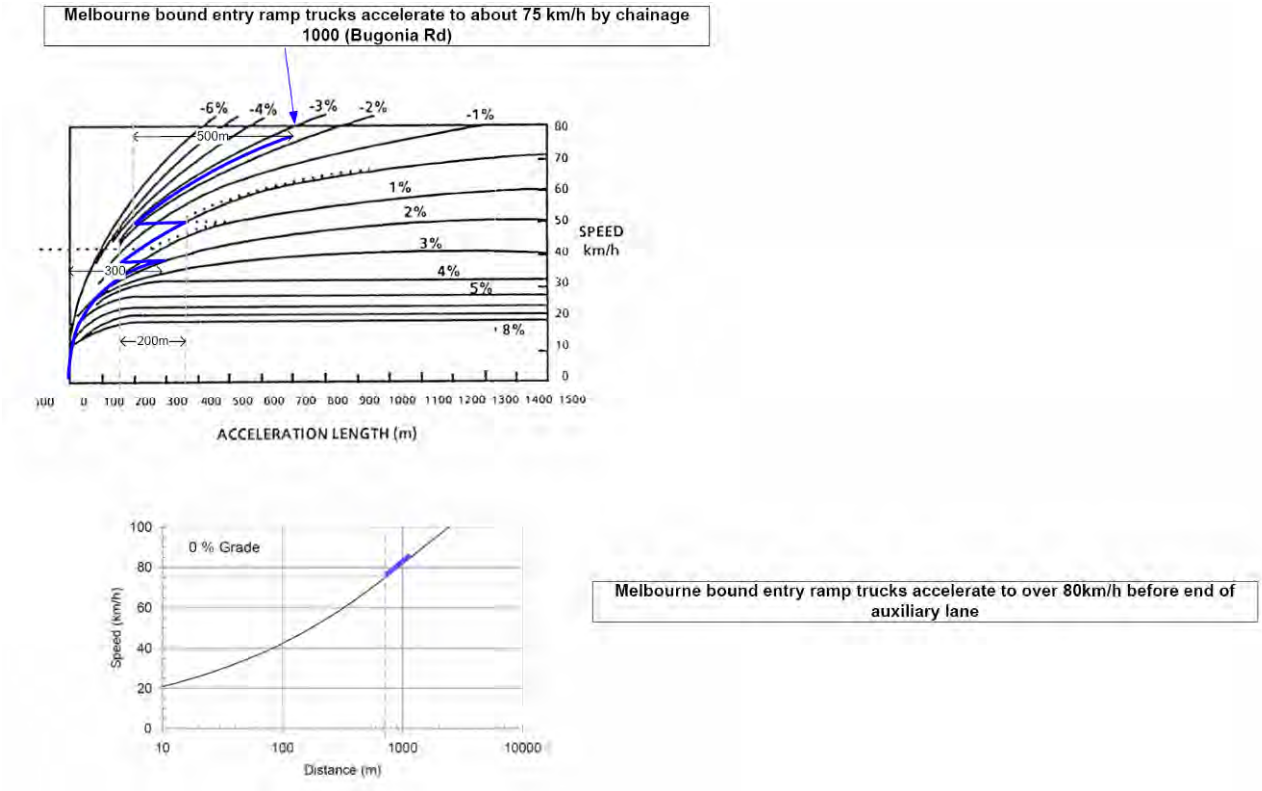


**Figure 9: Truck Speed on Melbourne Bound Entry Ramp (RTA and AUSTROADS)**

### 3.1.3 Bungonia Rd

The Bungonia Rd overbridge will require modification to convert the spill through abutments to near vertical abutments so that the west facing ramps can be accommodated, together with sight distance offsets needed to obtain SSD (westbound) and exit nose sight distance (eastbound).

A new footpath/cycle way bridge is proposed west of the existing Bungonia Road as the existing bridge has no footpath (6.8m between kerbs).

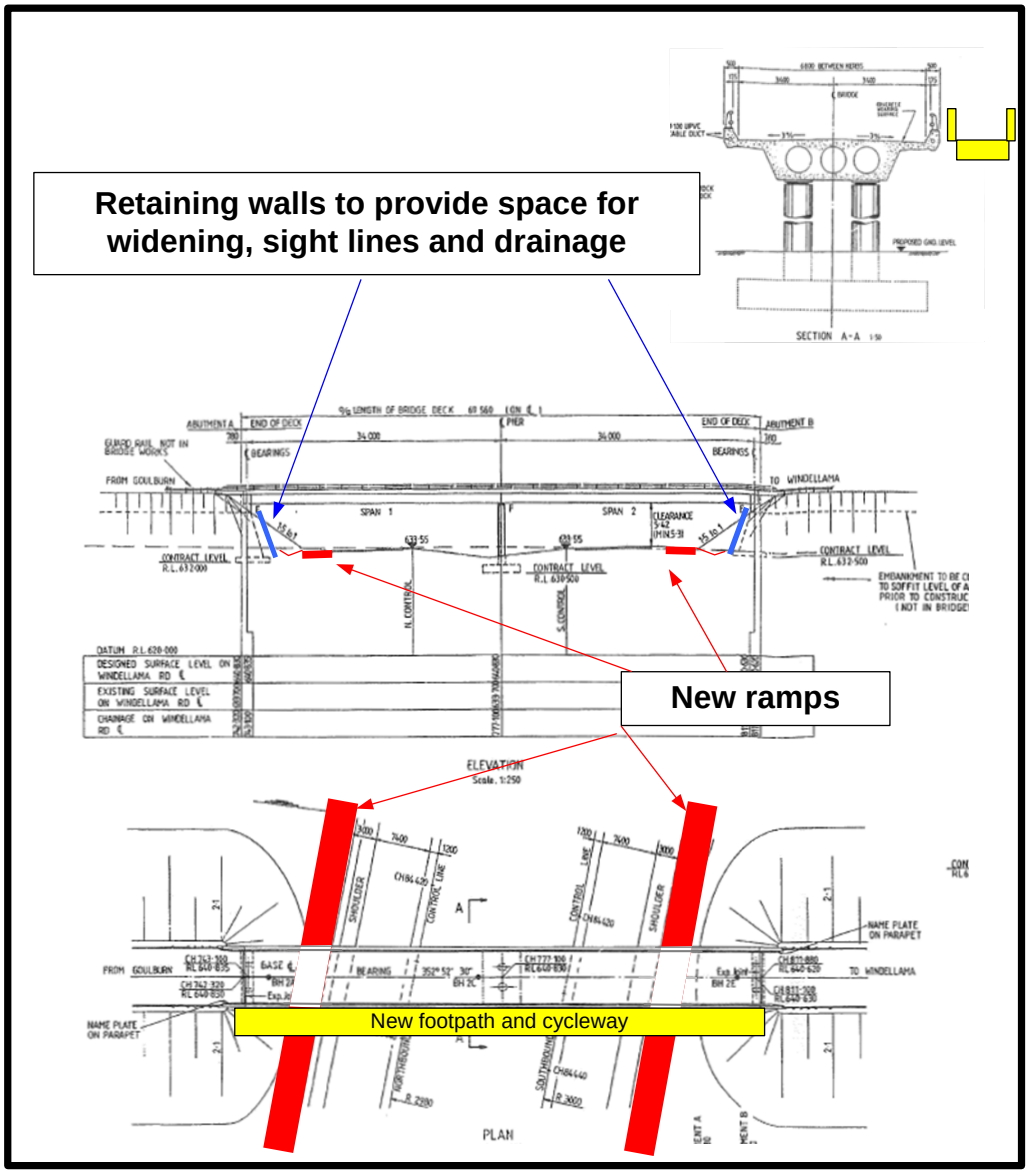


**Figure 10: Bungonia Rd Bridge Modifications**

### 3.1.4 Rosemont Rd

Rosemont Road is relocated to facilitate the interchange layout. Rosemont Rd has very low usage.

It is proposed to construct access roads to Precinct 1 that intersect with the relocated Rosemont Rd. No driveway access to Rosemont Rd is proposed.

### 3.1.5 Precinct Access Points

Precinct 1 will gain access from the relocated Rosemont Road, while Precincts 2-4 will connect to Mountain Ash Road. The intersections for these access points to Mountain Ash Road will be roundabouts. Intersections with Rosemont Road will be T junctions.

The capacity limit to the road system will be the roundabout where Rosemont Road and Mountain Ash Road meet the interchange ramps. This intersection will be controlled by a roundabout with a mixture of single lane and dual lane entries as annotated in Figure 6. Lane widths and lane allocations will be allocated so that truck movements will be single lane operations. This is adequate for traffic capacity, and the swept path requirements of B-double and B-triple trucks make two lanes of turning trucks impractical. The entries which serve journey to work trips will be two lane entries to ensure adequate capacity.

As detailed in Section 7, if traffic generation exceeds that generated b y warehouse development, it is likely that a signalised intersection will be required as shown in Figure 31 on page 39.

# 4 TRAFFIC GENERATED BY SDBP

This chapter deals with the SDBP being set up primarily as a warehouse centre. For traffic generation and analysis based on detailed land-use types for each precinct including industry, warehousing, road transport terminals, bulk stores and ancillary, please refer to Section 7.

## 4.1 Employment and Building Area

As mentioned in the beginning of the report that the Gross Floor Area is expected to be about 1,446,800 m². Low density broad acre development as proposed for the SDBP in Reference 3 is expected to have an employment density of 5 per acre (12 per hectare) of developable land. If this is applied to SDBP Land area of 263 hectares, 3,156 jobs can be expected as experienced in warehouse dominated developments in Sydney. Employment of 3,156 persons is eventually expected.

**Reference 3: Mariner Preliminary Report Appendix B Demand Feasibility and Economic Impact Logistics Bureau 2006**

Reference 4 gives average trips generated based on floor area for warehouses, industrial complexes and road transport terminals. For example, the trip generation for industry according to Reference 4 is 1 evening peak hour trips per 100m² of gross floor area (GFA). Applying this trip generation rate, a total floor space of 1,446,800 m² would generate 14468 vehicles/peak hour entering and leaving the complex (combined passenger and truck traffic). According to Reference 4 Volumes of this magnitude would be associated with a workforce of 39, 638. This is many times the anticipated employment level, and consequently a more realistic method of estimating trip generation for this site was sought. The method adopted addresses the generation of passenger trips separately from the generation of truck trips.

**Reference 4: Guide to Traffic Generating Developments RTA 2002**

## 4.2 Generation of Passenger Vehicles Trips

First principle estimation was performed for the passenger vehicles using the anticipated employment of 3,156 staff. As one third of these staff are shift workers spread of three shifts, then it could be expected that 2,104 regular staff and 351 shift works will be arriving in the same hour while 351 other shift workers will be leaving. Using a vehicle occupancy of 1.3 which is similar to Canberra, and a public transport factor of 90% which assumes a slightly less public transport usage than Canberra, this equates to 1,699 vehicles arriving in the morning and 243 leaving. The reverse applies for the evening peak.

An estimate of 4,370 vehicle trips per day was made for passenger vehicles, i.e. ~2,185 vehicles enter, and ~2,185 vehicles leave the facility, totalling 4,370. As one third of the workers will be shift workers, this is divided into 2104 workers trips on a 9 to 5 schedule, and 1,053 trips for shift workers spread over 3 shifts per day. There are an additional 875 ‘service’ trips per day.

To find a worst case scenario for passenger cars trips, it has been assumed that in the morning all 9-5 workers and one lot of shift workers will arrive in the same hour, while another group of shift workers are leaving along with the people making service trips. The reverse of this is used in the evening peak. The service trips have been split into in trips and out trips and spread over a standard 8 hour day.

## 4.3 Generation of Truck Trips

As a result of extensive literature review, an ITE trip generation table that is directly relevant to Australia was obtained from Reference 5 , and shown in Table 4-1.

**Reference 5 Truck Trip Generation Data Synthesis 298 NCHRP 2001**

**Table 4-1: ITE Trip Generation Rates**

DAILY TRUCK TRIP GENERATION RATES BY LAND USE (AUSTRALIA)

| Truck Trips Per 1,000 GSF Development Type | Courier Vans | Light Rigid Trucks | Heavy Rigid Trucks | Articulated Trucks | Total |
|---|---|---|---|---|---|
| Office | 1.9 | 0.4 | 0.0 | 0.2 | 2.5 |
| Retailing* | | | | | |
| Regional Center | 0.4 | 0.9 | 0.6 | 0.1 | 2.0 |
| Major Supermarket | 0.2 | 0.4 | 0.4 | 0.2 | 1.2 |
| Local Supermarket | 0.1 | 0.9 | 0.5 | 0.2 | 1.7 |
| Department Store | 0.2 | 0.5 | 0.9 | 0.1 | 1.7 |
| Other | 0.7 | 0.9 | 0.4 | 0.0 | 2.0 |
| Manufacturing | 0.1 | 0.1 | 0.1 | 0.2 | 0.5 |
| Warehouse | 0.1 | 0.0 | 0.2 | 0.2 | 0.5 |
| Light Industry & High Technology | 1.9 | 0.6 | 0.5 | 0.1 | 3.1 |
| Truck Depots | 0.9 | 0.9 | 1.4 | 3.7 | 6.9 |

Source: Ogden 1992 (as presented in ITE *Trip Generation Handbook).*
*Rate for retail is expressed in truck trips per 1,000 square feet of Gross Leasable Area.
Note: GSF = gross square feet.

The development area was assumed to be predominantly warehouse facilities and so the warehouse trip generation rate from Table 4-1 was used. Using the total area of 1,446,800m² or 15,573,226 Gross Square Feet (GSF) this gives:

- 1,557 Vans (Service Trips)
- 3,115 Heavy Rigid Trucks
- 3,115 Articulated Trucks
- 1,557 service trips and 6,230 heavy vehicle trips per day.

In estimating the peak hour truck movements it has been assumed that the freight trucks are spread over 24 hours to a pattern obtained from Reference 6 shown in Figure 11. However the trucks servicing the light industrial are spread over a standard working day. Results of applying such daily spread factors are shown in Table 4-2 and Table 4-3 . The vehicle trips were then distributed to the origins and destinations as discussed in the following section.

**Reference 6 Fatigue in Truck Crashes Monash University Research Centre Report 3, 1989**

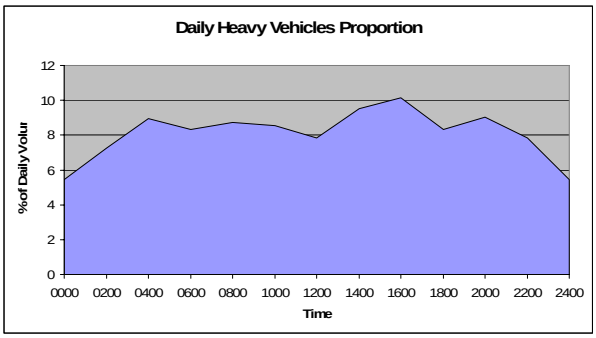


**Figure 11: Heavy Vehicle Daily Proportions**

**Table 4-2: AM Peak Development Volumes**

| AM Peak | Entering | | Leaving | |
|---|---|---|---|---|
| | Light | Heavy | Light | Heavy |
| 1st Principles Journey to Work (Passenger Traffic) | 1,699 | | 243 | |
| ITE truck volumes (excluding employees) | 97 | 139 | 97 | 139 |

**Table 4-3: PM Peak Development Volumes**

| PM Peak | Entering | | Leaving | |
|---|---|---|---|---|
| | Light | Heavy | Light | Heavy |
| 1st Principles Journey to Work | 243 | | 1,699 | |
| ITE truck volumes (excluding employees) | 97 | 148 | 97 | 148 |

## 4.4 Distribution of Generated Trips

According to the site plan the extent of building areas for each precinct are:

- Precinct 1 113,284.44 m² or 7.83% of total area.
- Precinct 2 335,946.96 m² or 23.22% of total area.
- Precinct 3 729,476.56 m² or 50.42% of total area.
- Precinct 4 268,092.04 m² or 18.53% of total area.

Using the relative area of each precinct to the total of all four, the productions and attractions were spread over the four precincts. The main effect this to the capacity analysis is for an intersection between Mountain Ash Road and Rosemont Road, as 7.83% of SDBP traffic will use Rosemont Road, while the remaining 92.17% will use Mountain Ash Road.

## 4.5 Assignment of Generated Trips

The distribution of the passenger car trips from the SDBP were estimated based on the size of Goulburn and other nearby communities.

Staff Trips:

- 79% of staff will come from Goulburn along Bungonia Road.
- 9% of staff will come from north of Goulburn via the Hume Highway.
- 9% of staff will come from south of Goulburn via the Hume Highway.
- 3% of staff will come from areas that would require them to use Windellama and Brisbane Grove Road.

Staff using Rosemont Road and Bungonia Road to the east/southeast of the development are expected to be minimal and will not interact with the intersections and sections of road being assessed.

A similar estimate was used to the service trips however it was expected that a greater proportion of these trips would be using the highway.

The Hume Highway service trips and heavy vehicle trips were split between north and south routes based on gravity modelling of major population centres. This used the population of major centres accessible from the Hume and listed in the SDBP Preliminary Design Report Vol 1. The result was that 53% of long distance highway traffic would travel to/from the south, while 47% of long distance highway traffic would travel to/from the north. It was assumed that all heavy vehicles are using the Hume Highway to get to/from the SDBP. The following is a summary of these conclusions.

Service Vehicles:

- 60% of staff will come from Goulburn along Bungonia Road.
- 19% of staff will come from north of Goulburn via the Hume Highway.
- 21% of staff will come from south of Goulburn via the Hume Highway.

Heavy Vehicles:

- 47% will come from north of Goulburn via the Hume Highway.
- 53% will come from south of Goulburn via the Hume Highway.

## 4.6 Volume Diagrams

The 1st Principle figures for the cars are combined with the heavy vehicle volumes derived from the ITE method. The light vehicles from the ITE method are also used to represent service trips. These are converted into AM and PM peak directional traffic volumes for the with and without SDBP scenarios as shown in Figure 12 to Figure 15.

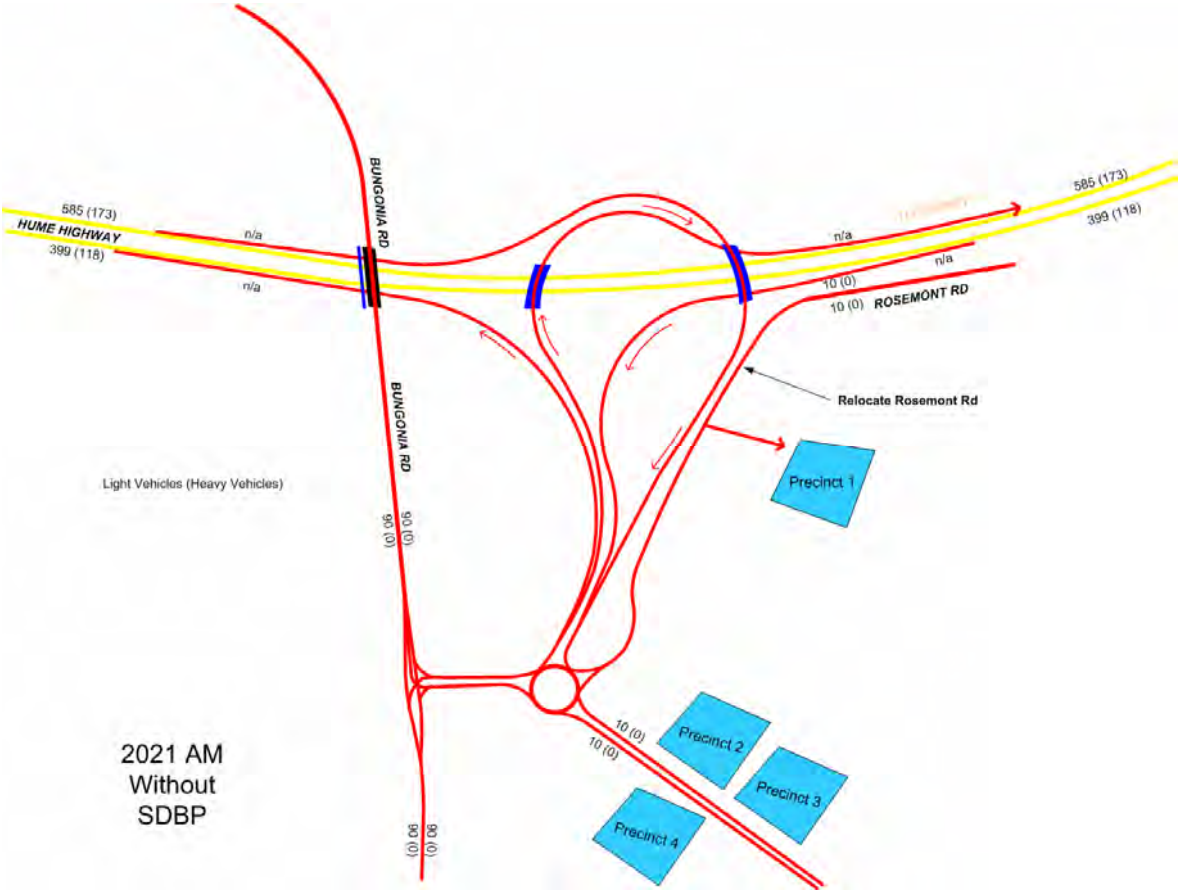


**Figure 12: Traffic Volumes (2021 AM) Without SDBP**


**Figure 13: Traffic Volumes (2021 AM) With SDBP**


**Figure 14: Traffic Volumes (2021 PM) Without SDBP**

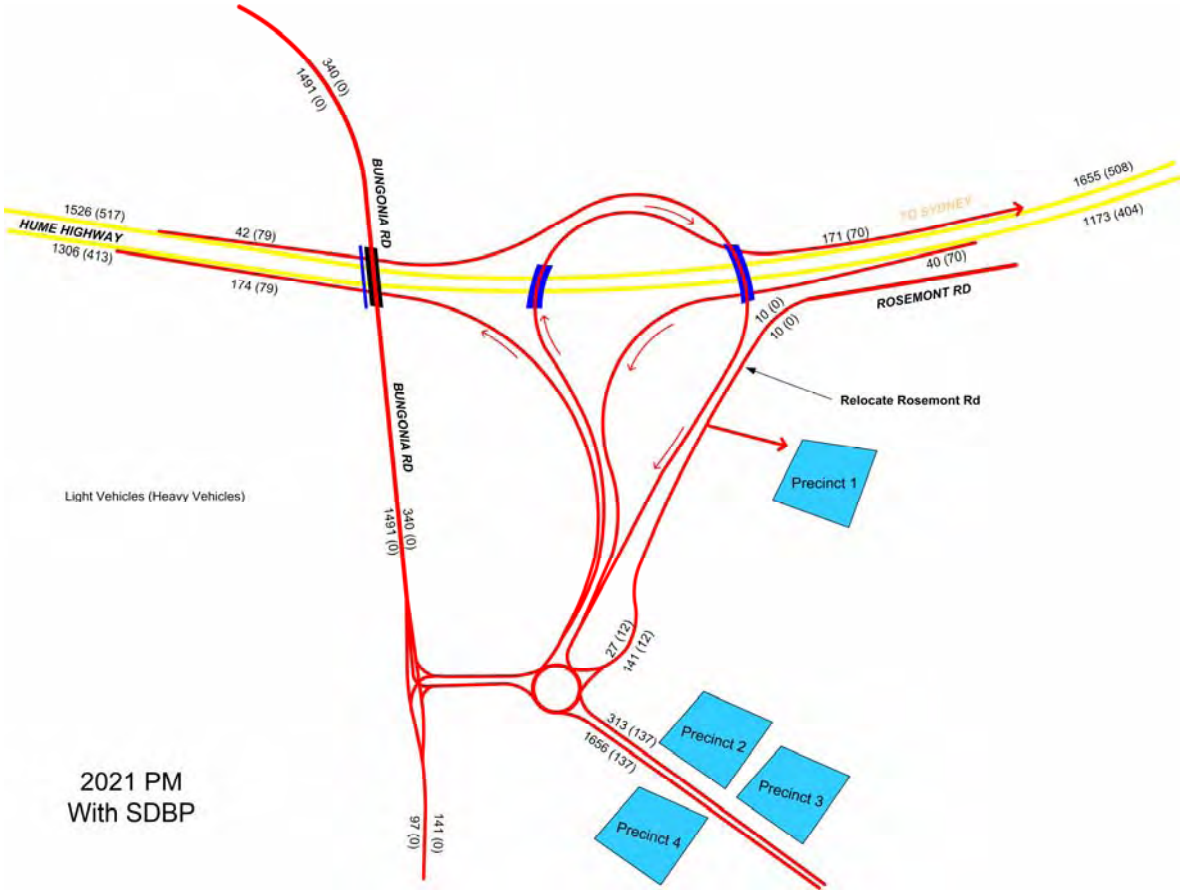


**Figure 15: Traffic Volumes (2021 PM) With SDBP**

# 5 ASSESSMENT OF IMPACT

## 5.1 Traffic Capacity

The main objective of this step is to identify and assess the scale of key traffic related problems in light of normal traffic growth as well as in light of normal and generated traffic growth. This is based on Level of Service (LOS) Analysis for all network facilities depicted in Figure 16. The LOS analyses were conducted using aaSIDRA software for the intersections and the Highway Capacity Manual (HCM) for road and highway facilities and manoeuvres.

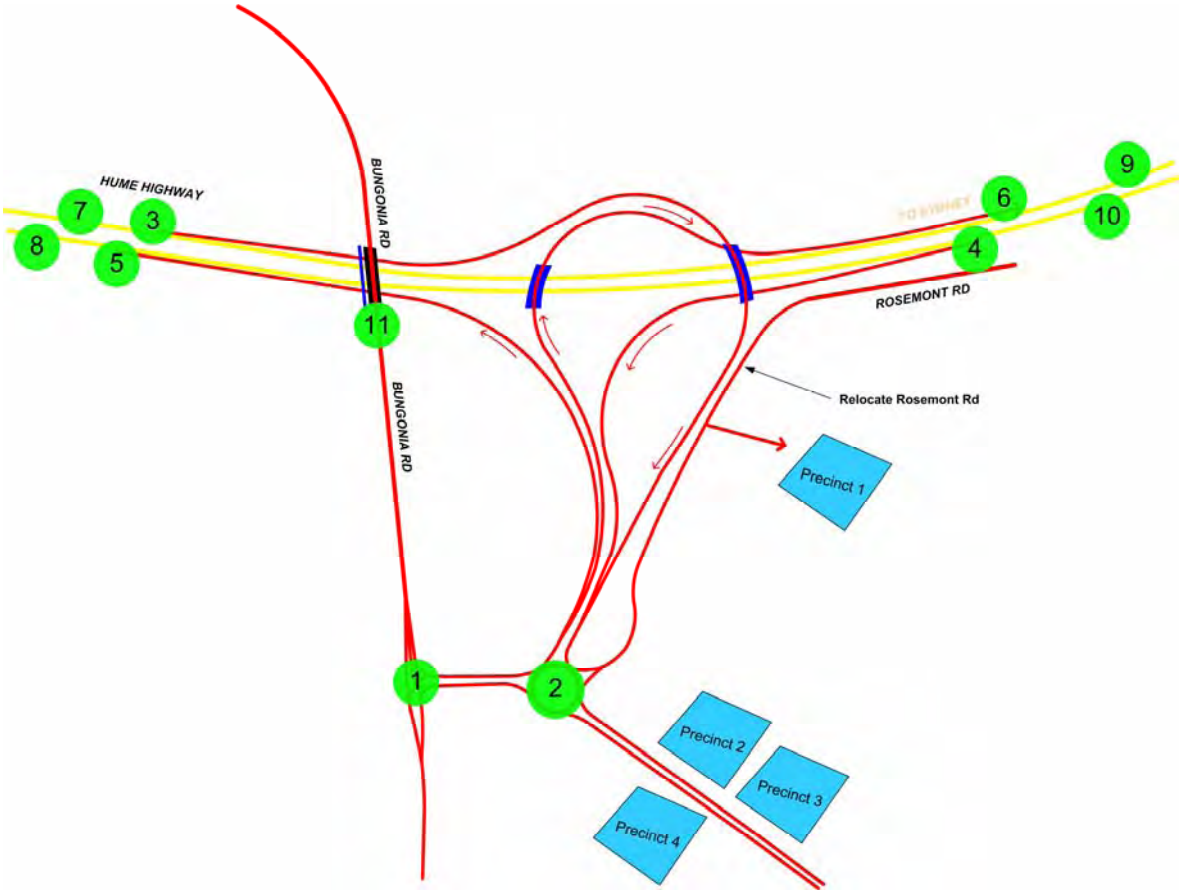


**Figure 16: LOS Analysis Locations**

Table 5-1 shows a comparison of road and intersection performance with and without the SDBP. The locations analysed are shown in Figure 16.

**Table 5-1: LOS Analysis Results**

| Location | Road/Intersection | Method | LOS Criteria | LOS (Without SDBP) | | LOS (With SDBP) | | Comment |
|---|---|---|---|---|---|---|---|---|
| | | | | AM | PM | AM | PM | |
| 1 | SDBP Access Roundabout (see Figure 17) | Roundabout | Delay | - | - | B | A | Highly Satisfactory |
| 2 | Bungonia Rd and Mountain Ash Rd (see Figure 18) | Giveway | Delay | A | A | F | F | Unacceptable, adopt roundabout |
| 2 | Bungonia Rd and Mountain Ash Rd (see Figure 19) | Roundabout | Delay | - | - | A | A | Highly Satisfactory |
| 3 | Hume Highway Diverge (Eastbound) | Diverge | Density | - | - | A | B | Highly Satisfactory |
| 4 | Hume Highway Diverge (Westbound) | Diverge | Density | - | - | A | A | Highly Satisfactory |
| 5 | Hume Highway Merge (Westbound) | Merge | Density | | | A | A | Highly Satisfactory |
| 6 | Hume Highway Merge (Eastbound) | Merge | Density | | | A | B | Highly Satisfactory |
| 7 | Hume Highway (Eastbound, West of SDBP) | Highway | Density | A | C | A | C | Acceptable |
| 8 | Hume Highway (Westbound, West of SDBP) | Highway | Density | A | B | A | B | Highly Satisfactory |
| 9 | Hume Highway (Eastbound, East of SDBP) | Highway | Density | A | C | A | C | Acceptable |
| 10 | Hume Highway (Westbound, East of SDBP) | Highway | Density | A | B | A | B | Highly Satisfactory |
| 11 | Bungonia Road Overpass (Northbound) | Highway | Density | A | A | A | D | Satisfactory Over Short Term |
| 11 | Bungonia Road Overpass (Southbound) | Highway | Density | A | A | D | A | Satisfactory Over Short Term |

As shown in Table 5-1, most LOS are within acceptable and satisfactory levels.

The only unacceptable LOS was for the Intersection of Bungonia Road and Mountain Ash Road being F in the case of a T junction with give-way control. This was then tested as a roundabout, where the LOS improved to B.

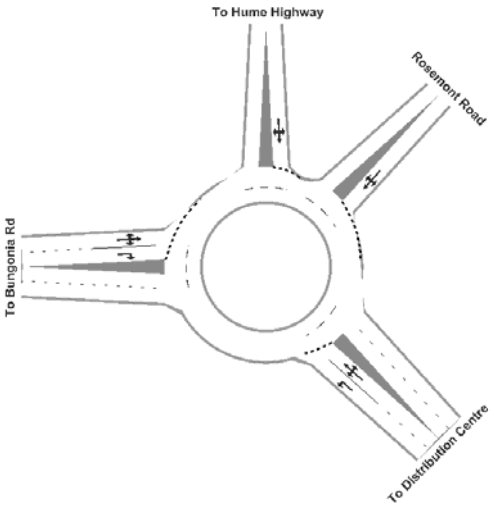


**Figure 17: Lane Numbers for Ramp Terminal Roundabout (LOS C/B)**

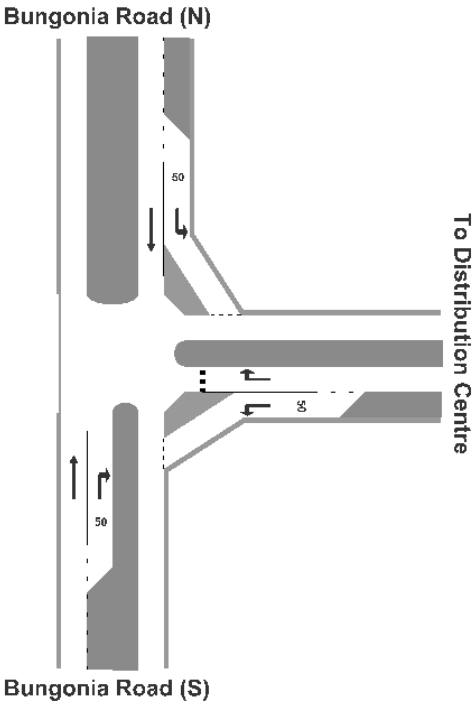


**Figure 18: Lane Numbers for Bungonia Rd T Junction Option (LOS F)**

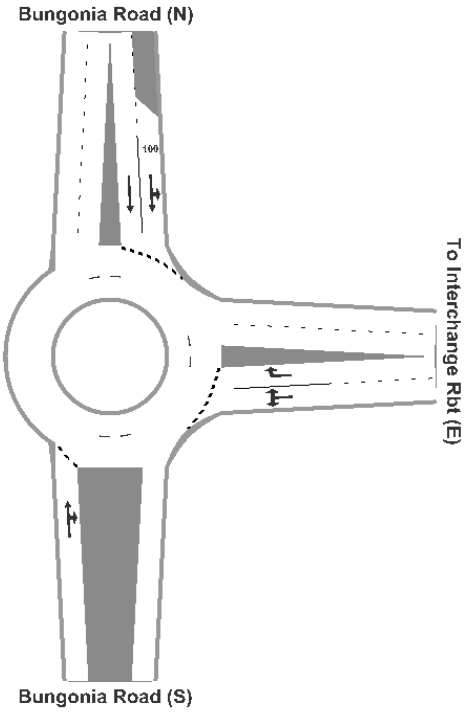


**Figure 19: Lane Numbers for Bungonia Rd Roundabout Option (LOS B)**

## 5.2 Traffic Impacts

The SDBP will significantly increase traffic volumes along Bungonia Road travelling between the SDBP and Goulburn. Because heavy vehicles are served by the Hume Highway, the majority of the vehicles on Bungonia Rd will be light vehicles. A load limit (buses excepted) could be introduced if found necessary. The volume of traffic is within the capacity of the mid block sections of Bungonia Rd.

The development will not significantly reduce LOS on the Hume Highway. The only unacceptable LOS was for the Intersection of Bungonia Road and Mountain Ash Road being F in the case of a T junction with give-way control. This was then tested as a roundabout, where the LOS improved to B. As part of the upgrading of the road, this intersection will require improvement from a giveway control to a roundabout.

## 5.3 New Works

SDBP will generate demand for the following traffic facilities and road works:

- construction of a service interchange with the Hume Highway with truck road ways constructed of rigid cement concrete between Mountain Ash Road and the Highway to ensure low maintenance and long life
- upgrading of 1.2 km Bungonia Road between Braidwood Road and the proposed interchange including:
- the replacement of the Lansdowne Bridge over the Mulwaree River by the Roads and Traffic Authority (scheduled to commence in the 06/07 financial year)
- the provision of an off road pedestrian and cycle path along Bungonia Road linking the SDBP to suitable facilities in Goulburn
- a pedestrian / cyclist bridge over the Hume Highway adjacent to the existing road bridge
- intersection improvements
- widening and strengthening of approximately two kilometres of Mountain Ash Road
- construction of a two roundabouts on Mountain Ash Road for the principal site access junctions.

- other site access junctions along Mountain Ash Road will also be roundabouts to control traffic speed so as to enhance intersection safety and provide safe pedestrian crossings
- bus stops along Mountain Ash road will be located adjacent to roundabouts, as these will provide safe pedestrian crossing opportunities across the splitter islands
- street lighting
- traffic regulatory and warning signs
- traffic direction signs
- provision of water quality measures as detailed in Water Supply and Quality Chapter
- provision of noise mitigating measures as detailed in Noise Chapter
- provision of landscape planting as detailed in Visual and Landscaping Chapter
- retention or relocation of the Grand Prix Memorial (subject to topographic survey and detailed design)

## 5.4 Construction Impacts

Extra traffic volumes generated by the development will occur:

- during construction of interchange traffic facilities and road works
- during drainage works
- during the infrastructure construction phase
- during building construction
- upon commissioning of each building

Around 30–60 employees will be employed daily during the 10 to 12 months during which the interchange is being constructed. Most of the construction staff traffic will consist of light vehicles emanating from the City of Goulburn and its vicinity. The existing road network has sufficient capacity for the additional vehicles.

The major transport tasks will be associated with construction of the proposed interchange with the Hume Highway. Delivery of equipment, materials and concrete to the site would require exit lanes adjacent to the existing overpass and most heavy vehicles would enter or leave via the Hume Highway. Speed restrictions would be necessary from time to time on the dual carriageway for about 10 to 12 months during construction. Heavy vehicle numbers should not exceed 100 per day.

Construction works on the interchange will result in minor traffic delays due to speed restrictions and brief closures to allow the erection of prefabricated bridge beams.

# 6 HIGH TRUCK VOLUME SCENARIO

This chapter utilises the data supplied on 10th November, 2006, detailing a possible land use matrix that would generate higher truck volumes. Table 6-1 shows the possible land areas to be developed for each land use.

**Table 6-1: Possible Land Use Matrix**

| Possible Land Use (Ha) | | | | | | |
|---|---|---|---|---|---|---|
| Precinct | Industry | Warehouse | Road transport Terminal | Bulk Store | Ancillary | Total |
| 1 | 3.5 | 4.2 | 4.2 | 1.4 | 0.71 | 14.01 |
| 2 | 4.47 | 12.03 | 2.98 | 7.5 | 2.98 | 29.96 |
| 3 | 11.28 | 31.11 | 15.04 | 15.04 | 2.7 | 75.17 |
| 4 | 7.66 | 5.11 | 5.11 | 6.38 | 1.28 | 25.54 |
| Total | 26.91 | 52.45 | 27.33 | 30.32 | 7.67 | 144.68 |

## 6.1 Employment and Building Area

As mentioned in the beginning of the report that the Gross Floor Area is expected to be about 1,446,800 m². Low density broad acre development as proposed for the SDBP in Reference 3 is expected to have an employment density of 5 per acre (12 per hectare) of developable land. If this is applied to SDBP Land area of 263 hectares, 3,156 jobs can be expected as experienced in warehouse dominated developments in Sydney. Employment of 3,156 persons is eventually expected.

## 6.2 Generation of Passenger Vehicles Trips

The passenger trips will not be changed as the employment figure remains unchanged.

## 6.3 Generation of Truck Trips

As a result of extensive literature review, an ITE trip generation table that is directly relevant to Australia was obtained from Reference 5, and is shown in Table 6-3.

In this scenario, land-use is divided as shown in Table 6-2. Industry areas are treated as Manufacturing, Bulk Store and Ancillary are treated as Warehouse and Road Transport Terminals are treated as Truck Depots to obtain trip generation rates as shown in Table 6-3.

**Table 6-2: Possible Land Use Matrix**

| Possible Land Use (Ha) | | | | | | |
|---|---|---|---|---|---|---|
| Precinct | Industry | Warehouse | Road transport Terminal | Bulk Store | Ancillary | Total |
| 1 | 3.5 | 4.2 | 4.2 | 1.4 | 0.71 | 14.01 |
| 2 | 4.47 | 12.03 | 2.98 | 7.5 | 2.98 | 29.96 |
| 3 | 11.28 | 31.11 | 15.04 | 15.04 | 2.7 | 75.17 |
| 4 | 7.66 | 5.11 | 5.11 | 6.38 | 1.28 | 25.54 |
| Total | 26.91 | 52.45 | 27.33 | 30.32 | 7.67 | 144.68 |

**Table 6-3: Trip Generation Rates (ITE)**

DAILY TRUCK TRIP GENERATION RATES BY LAND USE (AUSTRALIA)

| Truck Trips Per 1,000 GSF Development Type | Courier Vans | Light Rigid Trucks | Heavy Rigid Trucks | Articulated Trucks | Total |
|---|---|---|---|---|---|
| Office | 1.9 | 0.4 | 0.0 | 0.2 | 2.5 |
| Retailing* | | | | | |
| Regional Center | 0.4 | 0.9 | 0.6 | 0.1 | 2.0 |
| Major Supermarket | 0.2 | 0.4 | 0.4 | 0.2 | 1.2 |
| Local Supermarket | 0.1 | 0.9 | 0.5 | 0.2 | 1.7 |
| Department Store | 0.2 | 0.5 | 0.9 | 0.1 | 1.7 |
| Other | 0.7 | 0.9 | 0.4 | 0.0 | 2.0 |
| Manufacturing | 0.1 | 0.1 | 0.1 | 0.2 | 0.5 |
| Warehouse | 0.1 | 0.0 | 0.2 | 0.2 | 0.5 |
| Light Industry & High Technology | 1.9 | 0.6 | 0.5 | 0.1 | 3.1 |
| Truck Depots | 0.9 | 0.9 | 1.4 | 3.7 | 6.9 |

Source: Ogden 1992 (as presented in ITE *Trip Generation Handbook).*
*Rate for retail is expressed in truck trips per 1,000 square feet of Gross Leasable Area.
Note: GSF = gross square feet.

The passenger trips will not be changed as the employment figure remains unchanged. The new peak hour traffic volumes are shown in Table 6-4 and Table 6-5.

- 3,911 Vans (Service Trips)
- 2,937 Light Rigid Trucks
- 6,355 Heavy Rigid Trucks
- 13,411 Articulated Trucks
- 3,911 service trips and 22,703 heavy vehicle trips per day.

In estimating the peak hour truck movements it has been assumed that the freight trucks are spread over 24 hours to a pattern obtained from Reference 6 shown in Figure 20. However the trucks servicing the light industrial are spread over a standard working day. Results of applying such daily spread factors are shown in Table 6-4 and Table 6-5. The vehicle trips were then distributed to the origins and destinations as discussed in the following section.

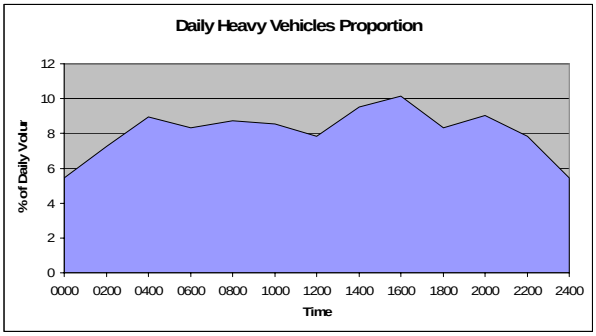


**Figure 20: Heavy Vehicle Daily Proportions**

**Table 6-4: AM Peak Development Volumes**

| AM Peak | Entering | | Leaving | |
|---|---|---|---|---|
| | Light | Heavy | Light | Heavy |
| 1st Principles Journey to Work (Passenger Traffic) | 1,699 | | 243 | |
| ITE truck volumes (excluding employees) | 244 | 625 | 244 | 625 |

**Table 6-5: PM Peak Development Volumes**

| PM Peak | Entering | | Leaving | |
|---|---|---|---|---|
| | Light | Heavy | Light | Heavy |
| 1st Principles Journey to Work | 243 | | 1,699 | |
| ITE truck volumes (excluding employees) | 244 | 655 | 244 | 655 |

## 6.4 Distribution of Generated Trips

According to the site plan the extent of building areas for each precinct are:

- Precinct 1 113,284.44 m² or 7.83% of total area.
- Precinct 2 335,946.96 m² or 23.22% of total area.
- Precinct 3 729,476.56 m² or 50.42% of total area.
- Precinct 4 268,092.04 m² or 18.53% of total area.

Using the relative area of each precinct to the total of all four, the productions and attractions were spread over the four precincts. The main effect this to the capacity analysis is for an intersection between Mountain Ash Road and Rosemont Road, as 7.83% of SDBP traffic will use Rosemont Road, while the remaining 92.17% will use Mountain Ash Road.

## 6.5 Assignment of Generated Trips

The distribution of the passenger car trips from the SDBP were estimated based on the size of Goulburn and other nearby communities.

Staff Trips:

- 79% of staff will come from Goulburn along Bungonia Road.
- 9% of staff will come from north of Goulburn via the Hume Highway.
- 9% of staff will come from south of Goulburn via the Hume Highway.
- 3% of staff will come from areas that would require them to use Windellama and Brisbane Grove Road.

A similar estimate was used to the service trips however it was expected that a greater proportion of these trips would be using the highway.

The Hume Highway service trips and heavy vehicle trips were split between north and south routes based on gravity modelling of major population centres. This used the population of major centres accessible from the Hume and listed in the SDBP Preliminary Design Report Vol 1. The result was that 53% of long distance highway traffic would travel to/from the south, while 47% of long distance highway traffic would travel to/from the north. It was assumed that all heavy vehicles are using the Hume Highway to get to/from the SDBP. The following is a summary of these conclusions.

Service Vehicles:

- 60% of staff will come from Goulburn along Bungonia Road.
- 19% of staff will come from north of Goulburn via the Hume Highway.
- 21% of staff will come from south of Goulburn via the Hume Highway.

Heavy Vehicles:

- 47% will come from north of Goulburn via the Hume Highway.
- 53% will come from south of Goulburn via the Hume Highway.

## 6.6 Volume Diagrams

The 1st Principle figures for the cars are combined with the heavy vehicle volumes derived from the ITE method. The light vehicles from the ITE method are also used to represent service trips. These are converted into AM and PM peak directional traffic volumes for the with and without SDBP scenarios as shown in Figure 12 to Figure 15.

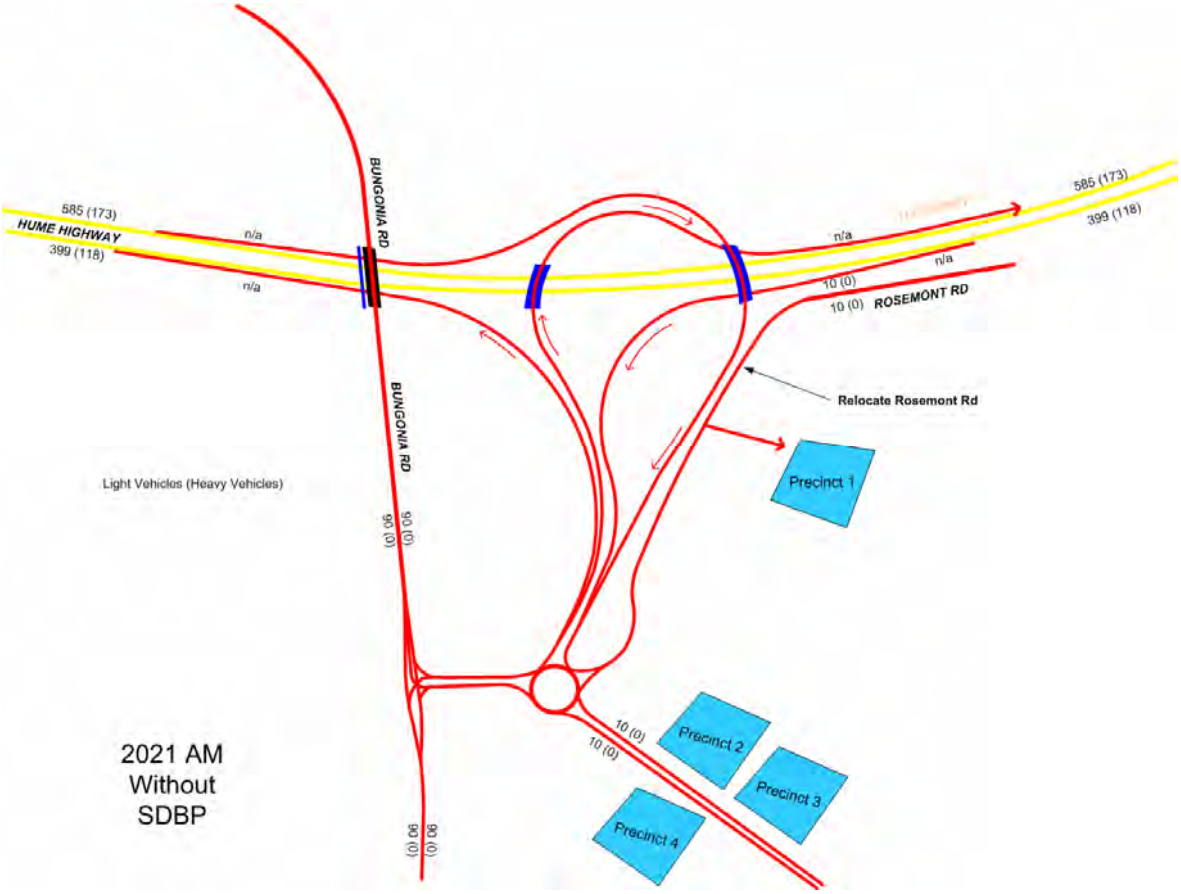


**Figure 21: Traffic Volumes (2021 AM) Without SDBP**


**Figure 22: Traffic Volumes (2021 AM) With SDBP**


**Figure 23: Traffic Volumes (2021 PM) Without SDBP**

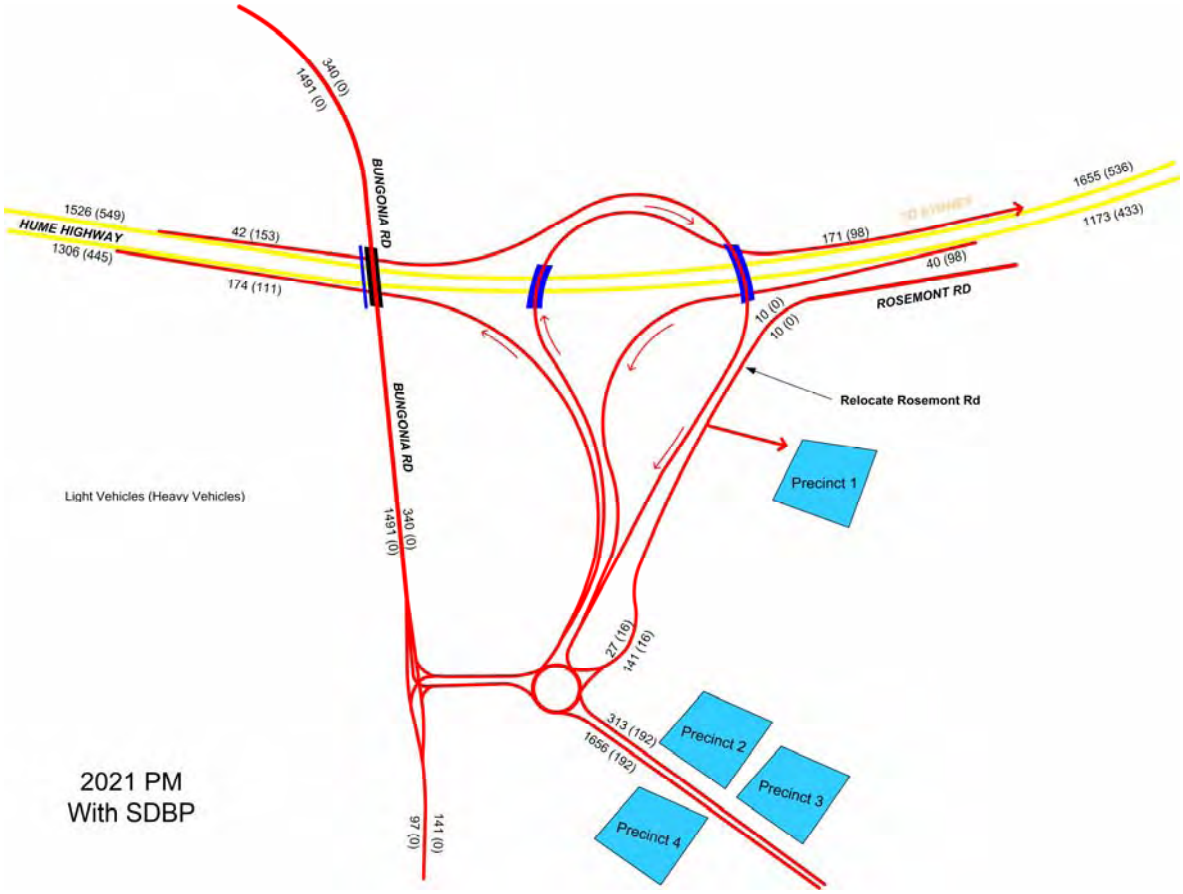


**Figure 24: Traffic Volumes (2021 PM) With SDBP**

# 7 ASSESSMENT OF IMPACT (HIGH TRUCK VOLUME)

## 7.1 Traffic Capacity

The main objective of this step is to identify and assess the scale of key traffic related problems in light of normal traffic growth as well as in light of normal and generated traffic growth. This is based on Level of Service (LOS) Analysis for all network facilities depicted in Figure 25. The LOS analyses were conducted using aaSIDRA software for the intersections and the Highway Capacity Manual (HCM) for road and highway facilities and manoeuvres. Table 7-1 shows a comparison of road and intersection performance with and without the SDBP. The locations analysed are shown in Figure 25.

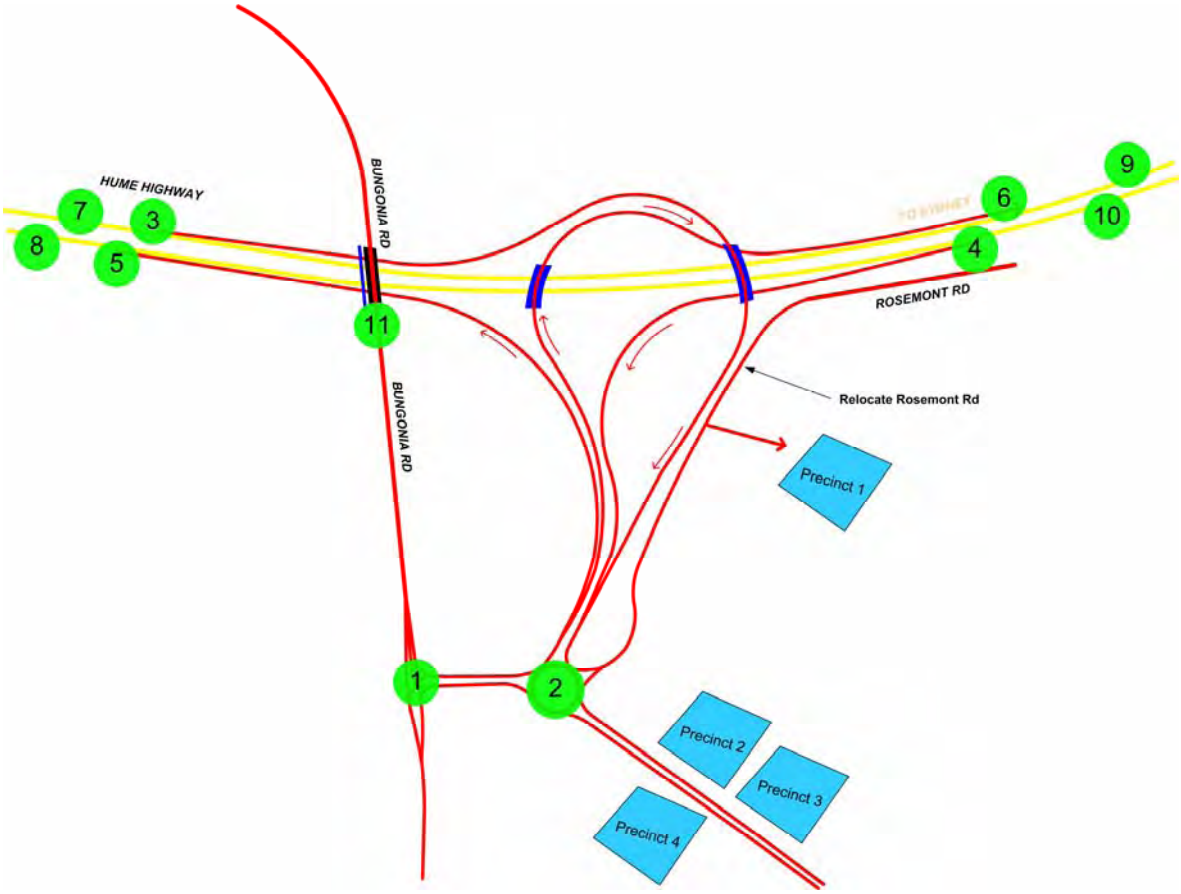


**Figure 25: LOS Analysis Locations**

**Table 7-1: LOS Analysis Results**

| Location | Road/Intersection | Method | LOS Criteria | LOS (Without SDBP) | | LOS (With SDBP) | | Comment |
|---|---|---|---|---|---|---|---|---|
| | | | | AM | PM | AM | PM | |
| 1 | SDBP Access Roundabout (see Figure 26) | Roundabout | Delay | - | - | F | F | Unacceptable, Adopt Signalised |
| 1 | SDBP Access (Signalised) (see Figure 27) | Signalised Intersection | Delay | - | - | D | D | Undesirable, Adopt Split T |
| 1 | SDBP (Split T) (see Figure 28) | Intersection | Delay | - | - | C | C | Acceptable |
| 2 | Bungonia Rd and Mountain Ash Rd (see Figure 29) | Giveway | Delay | A | A | F | F | Unacceptable, adopt roundabout |
| 2 | Bungonia Rd and Mountain Ash Rd (see Figure 30) | Roundabout | Delay | - | - | A | A | Highly Satisfactory |
| 3 | Hume Highway Diverge (Eastbound) | Diverge | Density | - | - | A | B | Highly Satisfactory |
| 4 | Hume Highway Diverge (Westbound) | Diverge | Density | - | - | A | B | Highly Satisfactory |
| 5 | Hume Highway Merge (Westbound) | Merge | Density | | | A | B | Highly Satisfactory |
| 6 | Hume Highway Merge (Eastbound) | Merge | Density | | | A | B | Highly Satisfactory |
| 7 | Hume Highway (Eastbound, West of SDBP) | Highway | Density | A | C | A | C | Acceptable |
| 8 | Hume Highway (Westbound, West of SDBP) | Highway | Density | A | B | A | B | Highly Satisfactory |
| 9 | Hume Highway (Eastbound, East of SDBP) | Highway | Density | A | C | A | C | Acceptable |
| 10 | Hume Highway (Westbound, East of SDBP) | Highway | Density | A | B | A | B | Highly Satisfactory |
| 11 | Bungonia Road Overpass (Northbound) | Highway | Density | A | A | A | D | Satisfactory Over Short Term |
| 11 | Bungonia Road Overpass (Southbound) | Highway | Density | A | A | D | A | Satisfactory Over Short Term |

As shown in Table 7-1, most LOS are within acceptable and satisfactory levels if suggested upgrades are implemented.

The LOS analysis has conservatively assumed that all of the SDBP truck traffic is in addition to the projected growth in the Hume Highway traffic (which assumed the observed growth rate will continue). As the impact on Highway LOS is marginal with this assumption, this simplistic approach is considered sufficient to demonstrate the acceptability of the project impact on Hume Highway. In reality, the traffic using the centre will partly be derived from similar warehousing located in Sydney being relocated to the SDBP site, resulting in lower merging volumes than assumed, as some of the SDBP traffic will be diverted trips from the Highway, rather than new trips. (i.e. the increase in ramp volume would have an associated reduction in through volume).

The approach adopted also has an element of "double counting" as the long term growth is driven by developments such as SDBP.

Other complexities not analysed include the possibility of truck depot facilities being included in SDBP. Higher ramp volumes would result, but this traffic would be largely diverted traffic, so that merging volumes would tend to be similar. If B-Triple trucks were to aggregate/disaggregate loads at the SDBP, effects would depend on the mix of truck types. This activity would be diverted traffic rather than new traffic.

The LOS analyses show that two intersections require improvement. The first is SDBP Access intersection which was first tested as a roundabout, producing a LOS F. This was then further tested as signalised producing an improvement in LOS but still D. Finally, it was tested as a Split T intersection where the LOS improved to C. The longest 95$^{th}$ percentile queue length for the internal roads in the Split T intersection was 97 metres. This means that the intersections should be built approximately 100 metres apart. The detailed movement summaries from aaSIDRA for this intersection are shown in **Error! Reference source not found.**. The other unacceptable LOS was for the Intersection of Bungonia Road and Mountain Ash Road being F in the case of a T junction with give-way control. This was then tested as a roundabout, where the LOS improved to B.

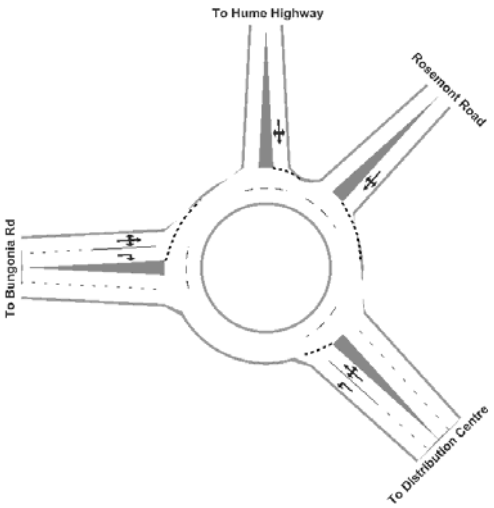


**Figure 26: Lane Numbers for Ramp Terminal Roundabout (LOS F)**

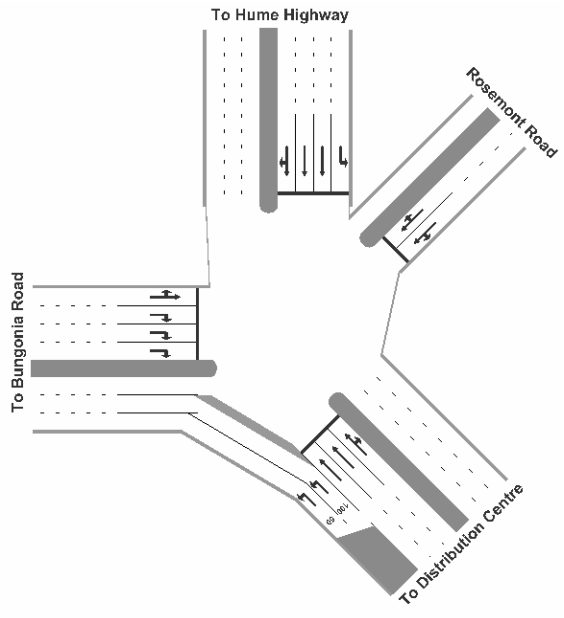


**Figure 27: Layout for Signalised Access to SDBP (LOS D)**

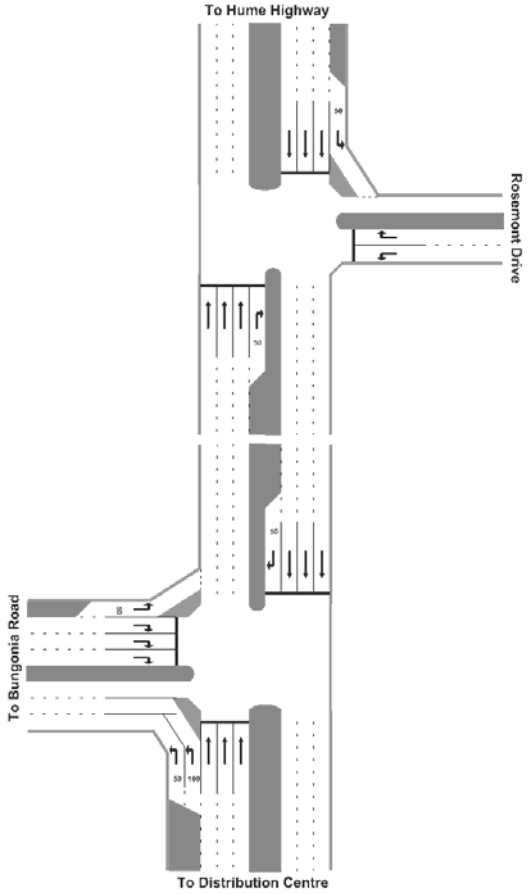


**Figure 28: Split-T Intersection (LOS C)**

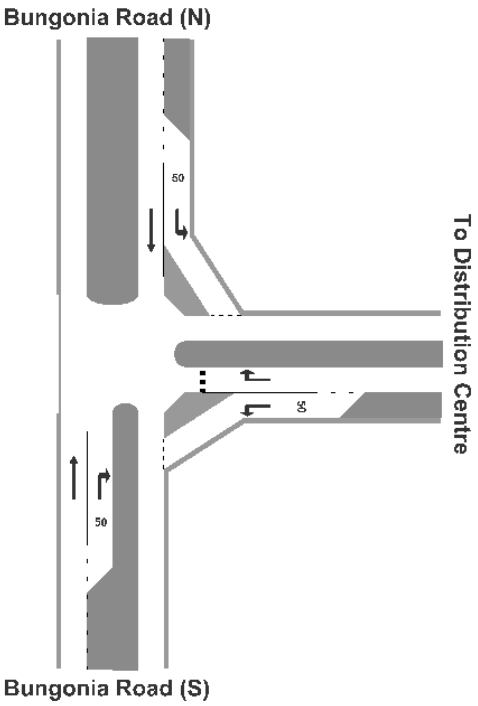


**Figure 29: Lane Numbers for Bungonia Rd T Junction Option (LOS F)**

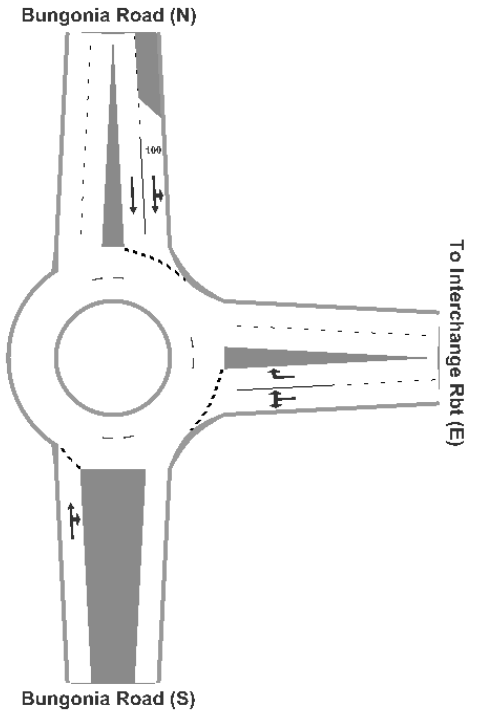


**Figure 30: Lane Numbers for Bungonia Rd Roundabout Option (LOS B)**

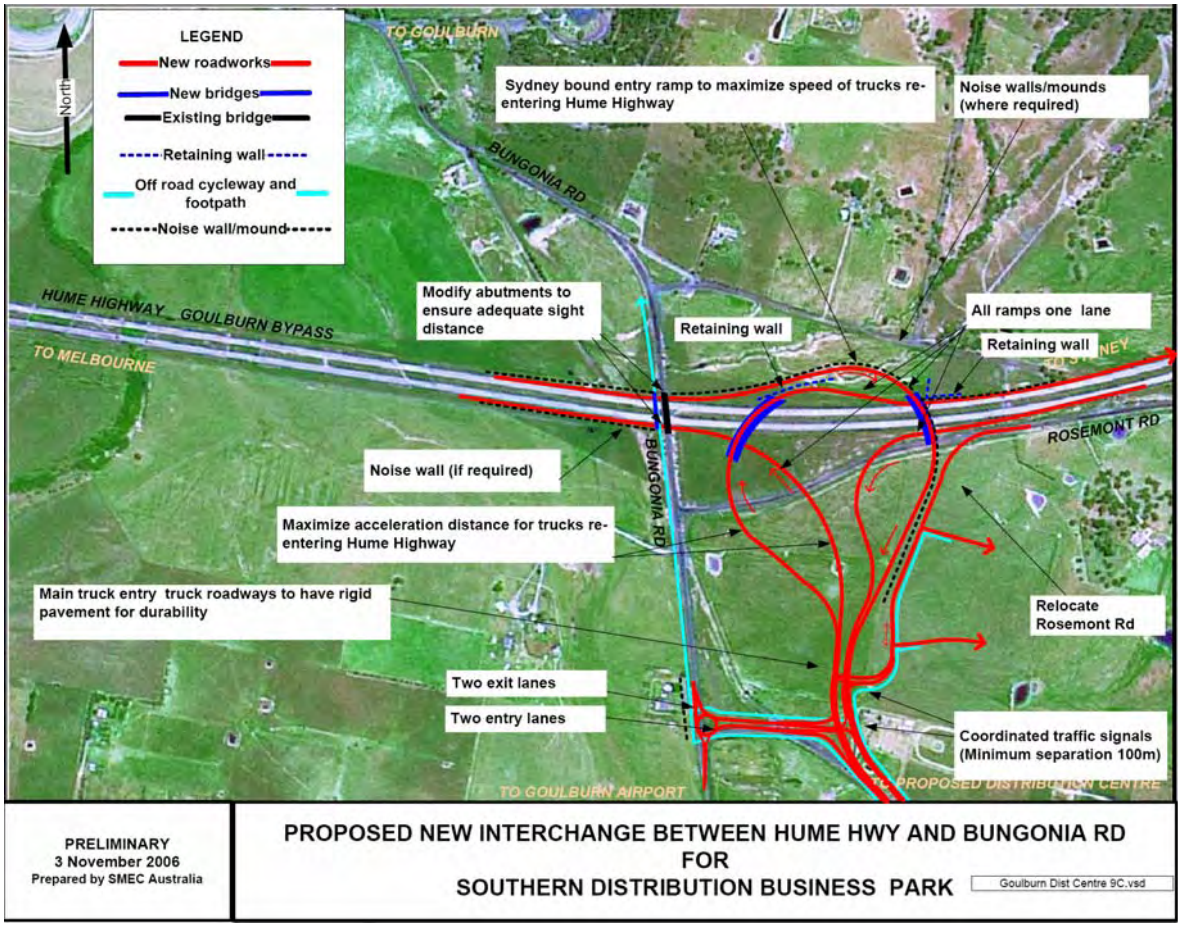


**Figure 31: Interchange Alternative with Traffic Signals**

Figure 31 shows the layout required to accommodate the high truck volume scenario. The layout also shows how land acquisition from a third party can be avoided. A minimum separation of 100m between the signalised intersections is proposed to provide for the estimated queue lengths.

Advanced detection of northbound trucks will increase Hume Highway entry speeds for those trucks receiving a green light compared with the roundabout controlled option shown in Figure 6.

## 7.2 Traffic Impacts

The SDBP will significantly increase traffic volumes along Bungonia Road travelling between the SDBP and Goulburn. Because heavy vehicles are served by the Hume Highway, the majority of the vehicles on Bungonia Rd will be light vehicles. A load limit (buses excepted) could be introduced if found necessary. The volume of traffic is within the capacity of the mid block sections of Bungonia Rd.

The development will not significantly reduce LOS on the Hume Highway. The intersection LOS analyses shows that two intersections require improvement. The first is SDBP Access intersection which was first tested as a roundabout, producing a LOS F. This was then further tested as signalised producing an improvement in LOS but still D. Finally, it was tested as a Split T intersection where the LOS improved to C. The other unacceptable LOS was for the Intersection of Bungonia Road and Mountain Ash Road being F in the case of a T junction with give-way control. This was then tested as a roundabout, where the LOS improved to B.

## 7.3 Bungonia Road

A detailed assessment of improvements that may be required along Bungonia Road has not been undertaken at this stage due to the lack of existing traffic data.

However, Figure 32 shows works that may be required, subject to further analysis.

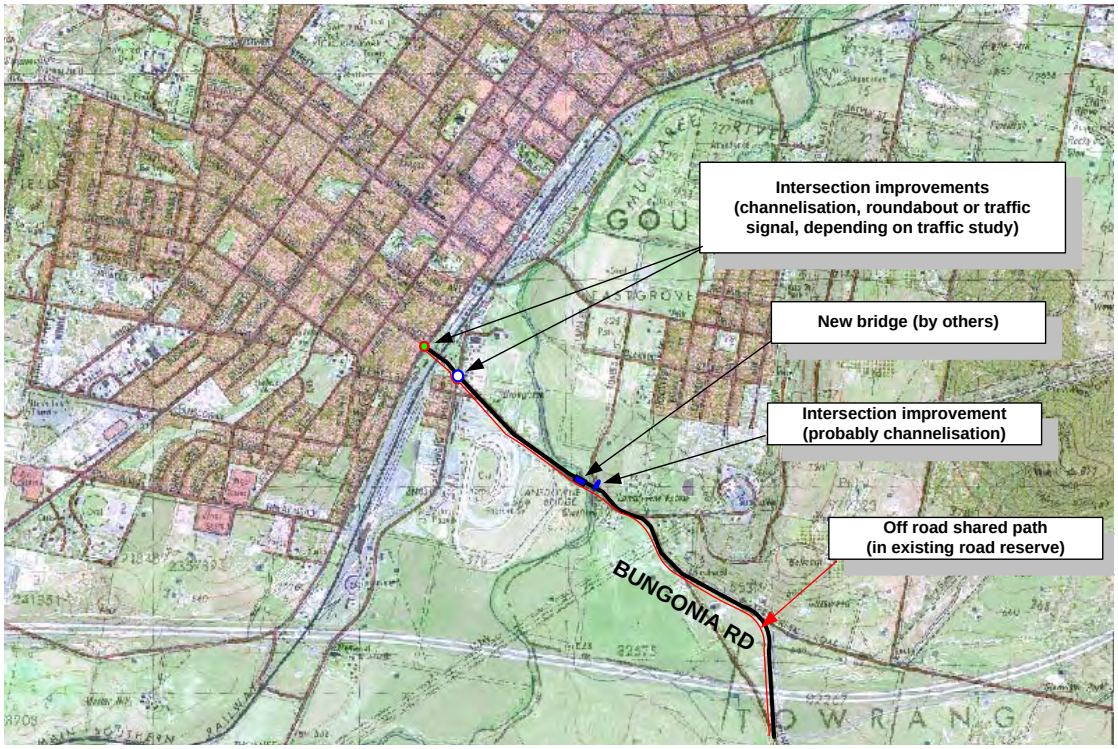


**Figure 32: Indicative Works along Bungonia Road**

## 7.4 New Works

SDBP will generate demand for the following traffic facilities and road works:

- construction of a service interchange with the Hume Highway with truck road ways constructed of rigid cement concrete between Mountain Ash Road and the Highway to ensure low maintenance and long life
- upgrading of 1.2 km Bungonia Road between Braidwood Road and the proposed interchange including:
- the replacement of the Lansdowne Bridge over the Mulwaree River by the Roads and Traffic Authority (scheduled to commence in the 06/07 financial year)
- the provision of an off road pedestrian and cycle path along Bungonia Road linking the SDBP to suitable facilities in Goulburn
- a pedestrian / cyclist bridge over the Hume Highway adjacent to the existing road bridge
- intersection improvements
- widening and strengthening of approximately two kilometres of Mountain Ash Road
- construction of a two roundabouts on Mountain Ash Road for the principal site access junctions (or one roundabout and a signalised junction for the high truck volume scenario).
- other site access junctions along Mountain Ash Road will also be roundabouts to control traffic speed so as to enhance intersection safety and provide safe pedestrian crossings
- bus stops along Mountain Ash road will be located adjacent to roundabouts, as these will provide safe pedestrian crossing opportunities across the splitter islands
- street lighting
- traffic regulatory and warning signs

- traffic direction signs
- provision of water quality measures as detailed in Water Supply and Quality Chapter
- provision of noise mitigating measures as detailed in Noise Chapter
- provision of landscape planting as detailed in Visual and Landscaping Chapter
- retention or relocation of the Grand Prix Memorial (subject to topographic survey and detailed design)

## 7.5 Construction Impacts

Extra traffic volumes generated by the development will occur:

- during construction of interchange traffic facilities and road works
- during drainage works
- during the infrastructure construction phase
- during building construction
- upon commissioning of each building

Around 30–60 employees will be employed daily during the 10 to 12 months during which the interchange is being constructed. Most of the construction staff traffic will consist of light vehicles emanating from the City of Goulburn and its vicinity. The existing road network has sufficient capacity for the additional vehicles.

The major transport tasks will be associated with construction of the proposed interchange with the Hume Highway. Delivery of equipment, materials and concrete to the site would require exit lanes adjacent to the existing overpass and most heavy vehicles would enter or leave via the Hume Highway. Speed restrictions would be necessary from time to time on the dual carriageway for about 10 to 12 months during construction. Heavy vehicle numbers should not exceed 100 per day.

Construction works on the interchange will result in minor traffic delays due to speed restrictions and brief closures to allow the erection of prefabricated bridge beams.

# 8 SAFETY

## 8.1 Interchange Safety

The access proposals have been developed based on traffic capacity analysis and the application of design features that maximize road safety.

In particular, the interchange concept is based on the following:

- Minimization of relative speeds between merging vehicles by providing long ramps before the merge and by continuing the entry ramp as an auxiliary lane as detailed in Section 3.1.2
- Provision of good sight distance to exit ramps and adequate deceleration opportunities to reduce speed before negotiating a lower radius horizontal curve

## 8.2 Intersection Safety

The intersections have been designed for safe operation by using roundabouts and traffic signals as necessary, depending on traffic volume.

## 8.3 Pedestrian and Cyclist Safety

An off road shared path between Goulburn and the site is proposed to provide for safe movement of cyclists and pedestrians. A new footpath is proposed adjacent to the existing Bungonia Road overpass of the Hume Highway as the existing bridge has no footpath. To minimize the conflict between pedestrians/cyclist and vehicles, the path is located on the southern/western side of the road.