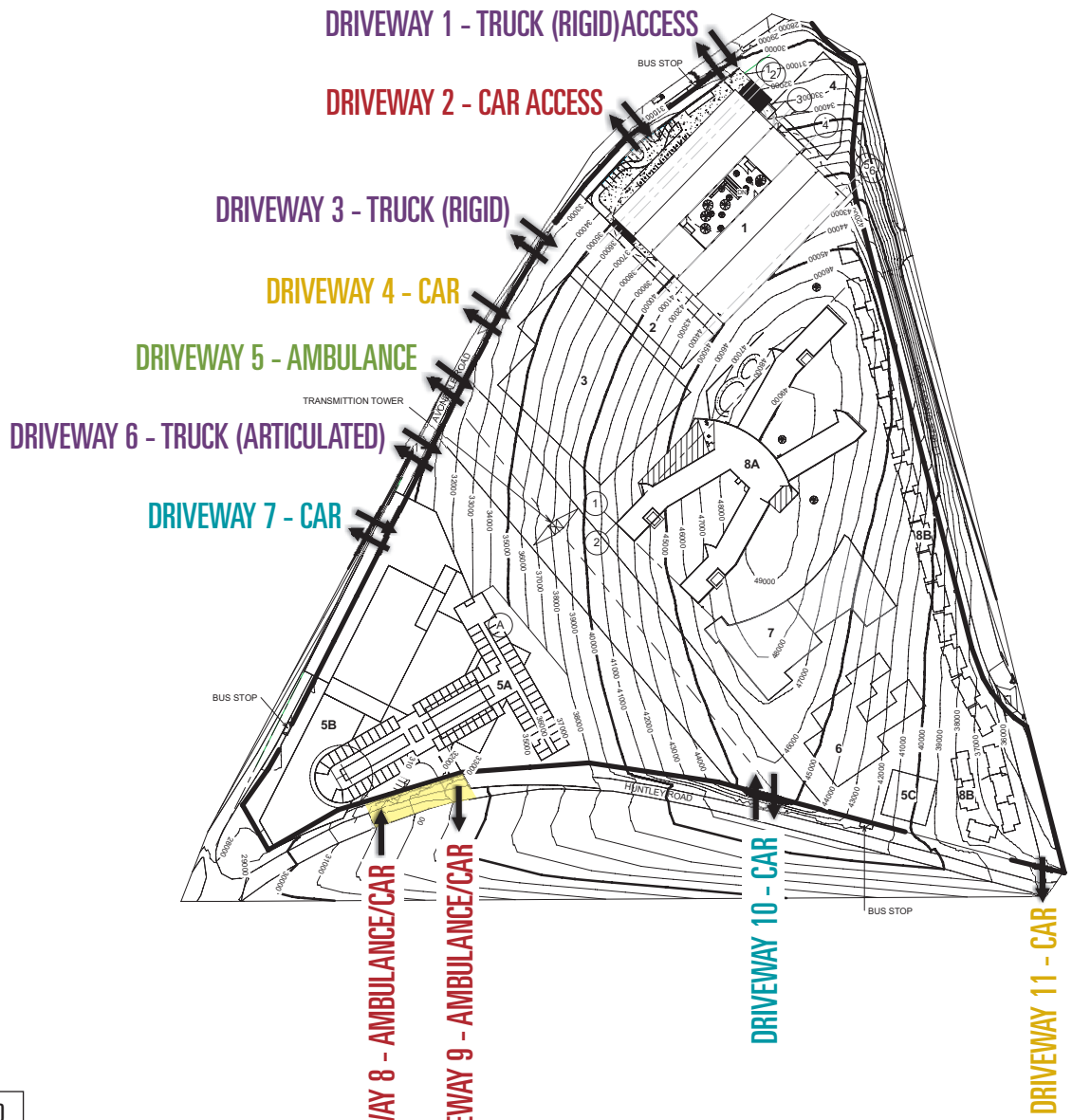

ACCESS CATEGORY FACILITY BASED ON AS2890

CATEGORY 1

CATEGORY 2

CATEGORY 3

CATEGORY 4

HRV & AV REQUIRED

Driveway Types and Locations

Date: 06.04.09 | Project No: FR108121

Figure No: 5.13

Cardno Eppell Olsen
Shaping the Future

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6.0 MODELLING

6.1 OBJECTIVE OF THE MODELLING

Traffic modelling has been undertaken utilising the Wollongong Shellharbour (WOLSH) TRACKS model. The TRACKS model developed for the Wollongong LGA and surrounding LGA's was used as the traffic model to determine the impacts of the development traffic generation on the surrounding road network and to provide input to the detailed intersection analysis.

6.2 BACKGROUND TO TRAFFIC MODELLING COMPLETED WITHIN THE STUDY AREA

6.2.1 TRACKS Model

A widespread TRACKS model was developed for Wollongong City Council and Shoalhaven Council to assess traffic volumes for existing and future conditions. The model is made up of 2001 and 2026 model horizons and considers measures such as new land release areas, major developments and road network changes including upgrades and new connections. The SIDRA intersection modelling undertaken is based upon the change and growth in traffic patterns shown in the TRACKS models for the earlier study years.

6.2.2 Issues with TRACKS Model

The following form the background to the model:

- Findings from the Growth Centres Commission study documented that the number of land releases initially predicted had been reduced and the revised number of land releases had not been updated in the TRACKS model for the year 2026;
- The expansion of the Dapto Mall had been factored into the 2026 model; and
- The Growth Centres Commission was commissioned by Wollongong City Council in 2008 to undertake a review of West Dapto Release Area planning, following revisions to the anticipated lot yields. The review included the LES, draft LEP, draft s.94 contributions plan, and the Draft Infrastructure Implementation Plan.
  Notable findings of the review include:
  - The West Dapto Transport Link (Fowlers Road Extension) is superfluous and does not represent value for money; and
  - Upgrades to Bong Bong Road, West Dapto Road and Shone Avenue would provide flood free access to/from West Dapto except in a 1 in 100 year flood incident.

The TRACKS model for the year 2026 included the Fowlers Road Extension which is on hold.

The intersections assessed in this report and the approach to the TRACKS Modelling has been undertaken based on discussions with Council and RTA officers. We also note that although some of the infrastructure upgrades have been considered to not represent value of money in the most recent Growth Centre Commission's review, detailed modelling on the merits of such infrastructure changes has yet to be carried out, and we have therefore included these upgrades in our future assessment as per Council's request and to be consistent with the TRACKS Model as adopted by Council and RTA.

6.3 MODELLING METHODOLOGY

6.3.1 Overview

The following modelling methodology is based on discussions with Council and RTA officers.

The requirements of the project requires that TRACKS modelling is undertaken for 2008, 2016 and 2026 time horizons. Since the WOLSH TRACKS model has a 2001 base year and 2026 forecast year, the required 2008 and 2016 forecast years had to be synthesized from the available models. Note that the 2016 model is based on the ultimate road network.

The synthesized 2008 model was subsequently compared to traffic count data to ensure that it is adequately replicating the present conditions.

Upon completion of the 2008 base model, 2016 and 2026 models were developed and run to establish baseline traffic flows without the proposed IIHP development in place. The demographic data for the proposed IIHP was subsequently added to the 2016 and 2026 base models in order to determine the demand and distribution of traffic generated by the IIHP.

6.3.2 2008 & 2016 Base Models

Both the 2008 and 2016 models have been developed from interpolating demographic data between 2001 and 2026 to arrive at demographic input datasets for the 2008 base year and 2016 forecast year. The network plots are provided in **Appendix B**.

Subsequently, 2008 traffic count data has been compared with the 2008 base year model to ensure that the base case model is adequately replicating current observed traffic flows on the network near the proposed IIHP site. A summary table of these comparisons is shown in **Table 6.1** and **Table 6.2**.

Table 6.1 AM Peak Comparison

Location	Between	Direction	TRACKS	Count	GEH
Cleveland Rd	Marshall St & Princes Hwy	EB	96	220	9.9
		WB	133	257	8.9
Avondale Rd	Marshall St & Princes Hwy	EB	242	187	3.8
		WB	104	103	0.1
	Oakhurst Close & Amaral Ave	EB	280	102	12.9
		WB	130	189	4.7
	Huntley Rd & Turnbull Cres	EB	6	29	5.5
		WB	2	20	5.4
Huntley Rd	Avondale Rd & Penrose Dr	EB	10	32	4.8
		WB	7	18	3.0
	Penrose Rd & Marshall Mt Rd	EB	105	111	0.5
		WB	86	49	4.4
	Marshall Mt Rd & Princes Hwy	EB	152	135	1.4
		WB	158	89	6.2
Marshall Mt Rd	Yallah Rd & Huntley Rd (North of Yallah Rd)	NB	41	45	0.6
		SB	43	38	0.8
	Yallah Rd & Huntley Rd (South of Huntley Rd)	NB	67	33	4.8
		SB	91	48	5.2
Princes Hwy	Huntley Rd & Mt Brown Rd	NB	811	625	6.9
		SB	789	585	7.8
	Kanahooka Rd & Huntley Rd	NB	879	771	3.8
		SB	548	616	2.8

Table 6.2 PM Peak Comparison

Location	Between	Direction	TRACKS	Count	GEH
Cleveland Rd	Marshall St & Princes Hwy	EB	60	181	11.0
		WB	51	129	8.2
Avondale Rd	Marshall St & Princes Hwy	EB	112	123	1.0
		WB	234	220	0.9
	Oakhurst Close & Amaral Ave	EB	162	210	3.5
		WB	267	136	9.2
	Huntley Rd & Turnbull Cres	EB	3	19	4.9
		WB	5	38	7.1
Huntley Rd	Avondale Rd & Penrose Dr	EB	10	23	3.2
		WB	11	20	2.2
	Penrose Rd & Marshall Mt Rd	EB	100	68	3.4
		WB	111	80	3.2
	Marshall Mt Rd & Princes Hwy	EB	112	87	2.5
		WB	135	105	2.7
Marshall Mt Rd	Yallah Rd & Huntley Rd (North of Yallah Rd)	NB	14	23	2.2
		SB	13	34	4.3
	Yallah Rd & Huntley Rd (South of Huntley Rd)	NB	24	26	0.3
		SB	35	36	0.2
Princes Hwy	Huntley Rd & Mt Brown Rd	NB	756	575	7.0
		SB	798	517	10.9
	Kanahooka Rd & Huntley Rd	NB	530	628	4.1
		SB	811	810	0.0

The **GEH Statistic** is a formula used in traffic engineering, traffic forecasting, and traffic modelling to compare two sets of traffic volumes. It is an empirical formula that has proven useful for a variety of traffic analysis purposes.

The formula for the "GEH Statistic" is:

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

Where M is the hourly traffic volume from the traffic model (or new count) and C is the real-world hourly traffic count (or the old count).

The use of GEH as an acceptance criterion for travel demand forecasting models is recognised in the UK Highways Agency's *Design Manual for Roads and Bridges* (DMRB), Volume 12, Section 2, and in other references.

For traffic modelling work in the "baseline" scenario, a GEH of less than 5.0 is considered a good match between the modelled and observed hourly volumes (flows of longer or shorter durations should be converted to hourly equivalents to use these thresholds). According to DMRB, 85% of the volumes in a traffic model should have a GEH less than 5.0. GEHs in the range of 5.0 to 10.0 may warrant investigation. If the GEH is greater than 10.0, there is a high probability that there is a problem with either the travel demand model or the data (this could be something as simple as a data entry error, or as complicated as a serious model calibration problem).

Table 6.1 and **Table 6.2** show that there is a good correlation between the observed traffic flows and the 2008 base case model and the model is therefore suitable for further testing of the proposed development.

6.3.3 2026 Base Model

The WOLSH TRACKS model has a 2026 forecast year base model. The 2026 base model contains the following changes to the road network within, or adjacent to, the study area:

- A four-lane Fowlers Road extension from Princes Highway to Cleveland Road, with a two-lane link to Fairwater Drive, Horsley;
- A two-lane link road extending from the Cleveland Road/Fowlers Road Extension intersection to Avondale Road;
- Severance of Avondale Road either side of the railway line;
- Two-lane link from Avondale Road/Huntley Road to the proposed Cleveland Village and Bong Bong Town Centre;
- Widening of Huntley Road to three lanes across the railway line;
- Widening of Princes Highway to four lanes south of Mount Brown Road;
- Provision of a third northbound lane on the F6 between Princes Highway and Emerson Road;
- North-facing ramps at the F6/Princes Highway interchange at Tallawarra; and
- F6 Extension to Oak Flats.

With the exception of the severance of Avondale Road and consequent provision of a link to Cleveland Road, the model is consistent with the road network depicted in the West Dapto Master Plan.

The F6 extension, as depicted in the Master Plan, involves a new route to the west of Yallah, however the model shows the extension utilising the existing alignment of Princes Highway between Tallawarra and Macquarie Rivulet.

6.3.4 Development Models

Four traffic zones have been utilised to represent the proposed IIHP site. This is due to the proposed site layout which indicates that the site is to be made up of four general precincts, each with its own access to the surrounding road network. Internally, these precincts are not connected to each other (for vehicular movements) and therefore can be represented as discrete areas. For this reason, four traffic zones have been utilised to represent the four precincts of the site. **Table 6.3** shows the precincts allocated for the four site zones.

Table 6.3 Site Zones by Precinct Stages

Site Zone	Precinct
A	1 to 4
B	5b
C	5a
D	5c, 6, 7, 8a and 8b

Additionally, the staging of the development construction means that only part of the full development yield would be online by 2016, with the remainder following between 2016 and 2026. For analyses purposes, it has been assumed that Precinct 1 has been constructed and generates traffic in 2008. **Table 6.4** shows the staging of the precincts and **Table 6.5** to **Table 6.7** shows the assumed demographic data for the four site zones at 2008, 2016 and 2026.

Table 6.4 Precinct Staging by Year

Year	Precincts Developed
2008-2016	1 to 4, 5a, 5b and 5c
2016-2026	6, 7, 8a and 8b

Table 6.5 2008 Demographic Data

Site Zone	Employment/ Household	Cars/Household	Household	TAFE/ Uni	School	Community	Retail	Finance	Manufacturing
A	0	0	0	6	0	153	14	92	0
B	0	0	0	0	0	0	0	0	0
C	0	0	0	0	0	0	0	0	0
D	0	0	0	0	0	0	0	0	0

Table 6.6 2016 Demographic Data

Site Zone	Employment/ Household	Cars/Household	Household	TAFE/ Uni	School	Community	Retail	Finance	Manufacturing
A	0	0	0	14	0	214	28	141	0
B	0	0	0	0	0	0	50	0	0
C	0	0	0	0	0	760	0	50	0
D	0	0	0	0	0	30	0	3	0

Table 6.7 2026 Demographic Data

Site Zone	Employment/ Household	Cars/Household	Household	TAFE/ Uni	School	Community	Retail	Finance	Manufacturing
A	0	0	0	14	0	214	28	141	0
B	0	0	0	0	0	0	50	0	0
C	0	0	0	0	0	760	0	50	0
D	0	0.3	50	90	0	122	0	10	0

The demand generated by the TRACKS model understated the trip generation determined from the RTA traffic generation guidelines. Therefore the demand matrix utilised in the 2016 and 2026 TRACKS models was modified in order to replicate the traffic generation determined from the RTA guidelines. This factoring process was undertaken through the TRACKS GROWTH module which balances the new row and column totals through an iterative process of adjusting the row and column totals for a given traffic zone. The overall traffic generation of the site by zones is detailed in **Table 6.8** below.

Table 6.8 Traffic Generation by Zone

Site Zone	AM		PM	
	IN	OUT	IN	OUT
A	342	86	157	301
B	170	42	131	280
C	164	41	73	136
D	108	27	29	112
Total	**784**	**196**	**390**	**829**

6.4 NETWORK MODELLING

TRACKS modelling has been undertaken for the six analysis scenarios:

- 2008 Base AM and PM Volumes;
- 2016 Base AM and PM Volumes;
- 2026 Base AM and PM Volumes;
- 2006 Base AM and PM Volumes with Development;
- 2016 Base AM and PM Volumes with Development; and
- 2026 Base AM and PM Volumes with Development.

The 2008 base AM and PM models represent the current road network. The 2026 AM and PM models represent an anticipated future road network adopted by the RTA in conjunction with Wollongong City Council, based on previous planning for the West Dapto Release Area. The 2016 model assumes the anticipated future road network as per the 2026 model.

6.5 INTERSECTION LAYOUTS

The following intersection layouts have been modelled in SIDRA for the 2008, 2016 and 2026 scenarios. It should be noted that for the 2016 and 2026 scenarios, several intersection layouts are altered. The three main reasons for this are:

- the proposed Fowlers Road extension (from Cleveland Road to Avondale Road);
- the closure of Avondale Road at the level railway crossing, and
- the introduction of a new link road which will connect Huntley Road, Avondale Road and Fowlers Road extension.

All intersection layouts are shown below. The future intersection layouts used in the SIDRA assessment are based on the intersection configurations as proposed in the WOLSH Model.

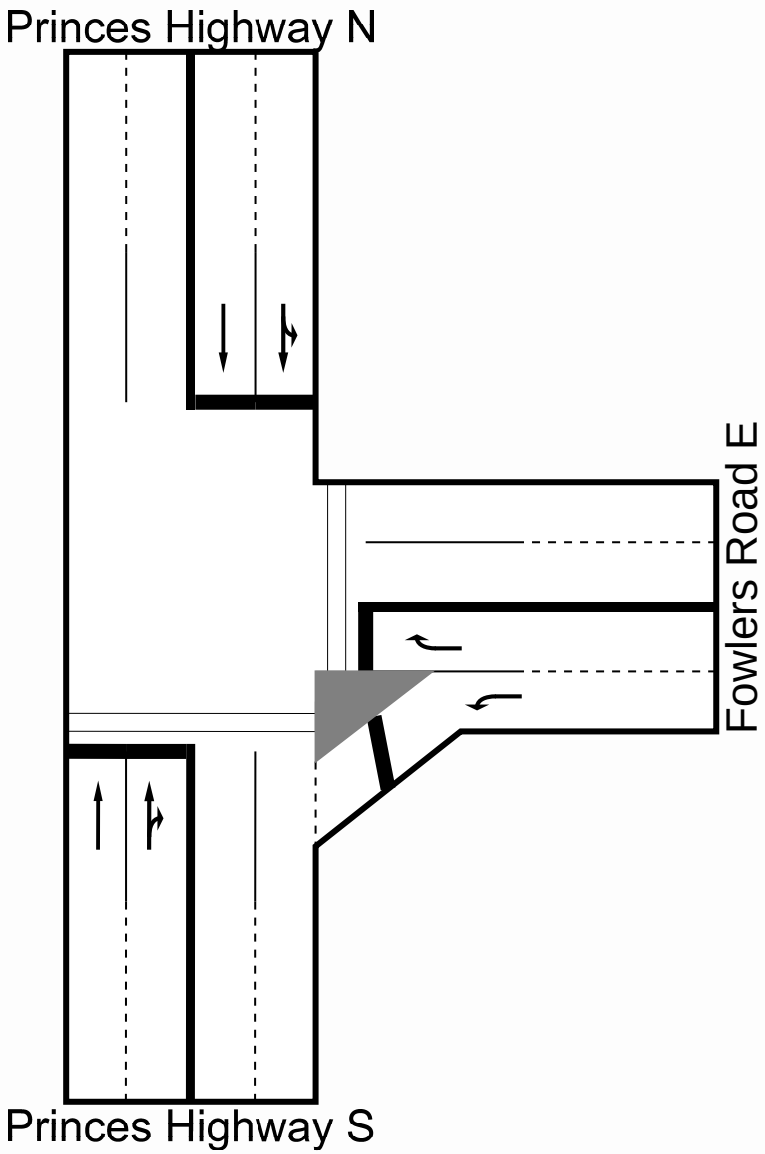
6.5.1 Princes Highway/Fowlers Road

2008 Layout

The intersection of Princes Highway with Fowlers Road is a signalised three way junction. The key features of the intersection are as follows:

- The Princes Highway northern approach consists of a shared through-left kerbside lane and a through median lane;
- The Princes Highway southern approach consists of through kerbside lane and a shared through-right median lane;
- The Fowlers Road approach consists of a left-turn signalised slip lane and a shared right-turn lane; and
- All departures consist of two lanes.

Figure 6.1 Princes Highway/Fowlers Road 2008 Intersection Layout

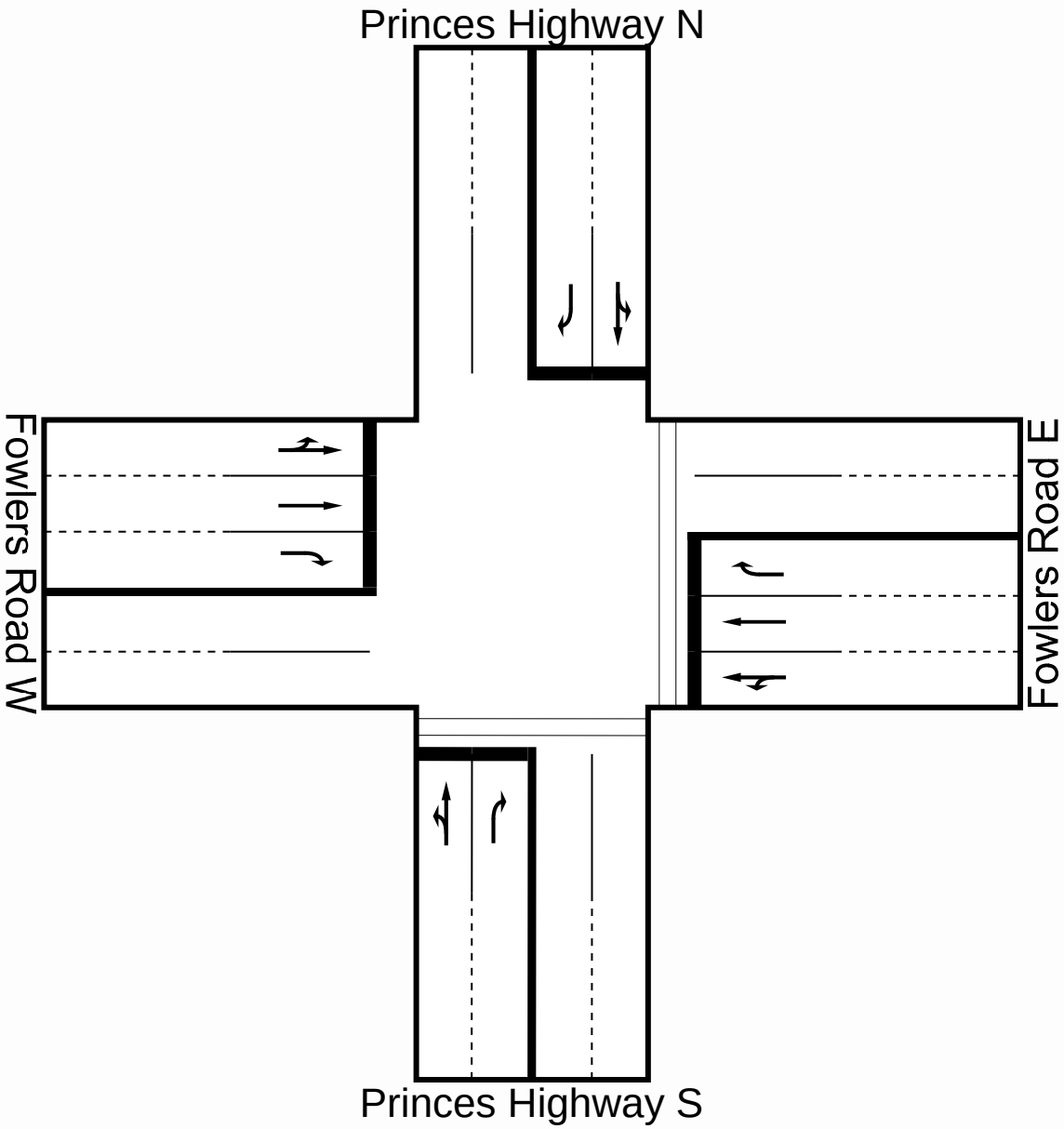


2016 and 2026 Layout

The intersection of Princes Highway with Fowlers Road is a signalised four leg junction. The key features of the intersection are as follows:

- The Princes Highway northern and southern approaches consist of a shared through-left kerbside lane and a shared right-turn median lane;
- The Fowlers Road eastern and western approaches consist of a shared through-left kerbside lane, a through lane and a right-turn median lane; and
- All departures consist of two lanes.

Figure 6.2 Princes Highway/Fowlers Road 2016 and 2026 Intersection Layout



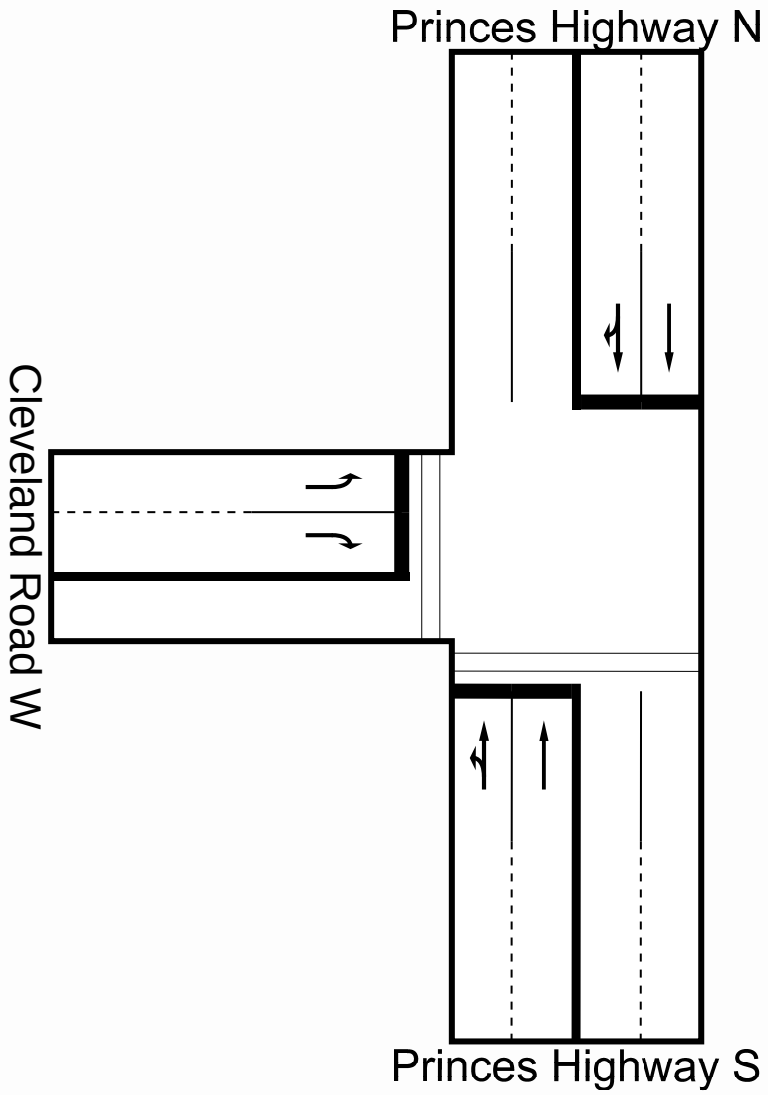
6.5.2 Princes Highway/Cleveland Road

2008 Layout

The intersection of Princes Highway with Cleveland Road is a signalised three leg junction. The key features of the intersection are as follows:

- The Princes Highway northern approach consists of a through kerbside lane and a shared through-right median lane;
- The Princes Highway southern approach consists of a shared through-left kerbside lane and a through median lane;
- The Cleveland Road approach consists of a left-turn kerbside lane and a right-turn median lane; and
- All departures consist of two lanes.

Figure 6.3 Princes Highway/Cleveland Road 2008 Intersection Layout

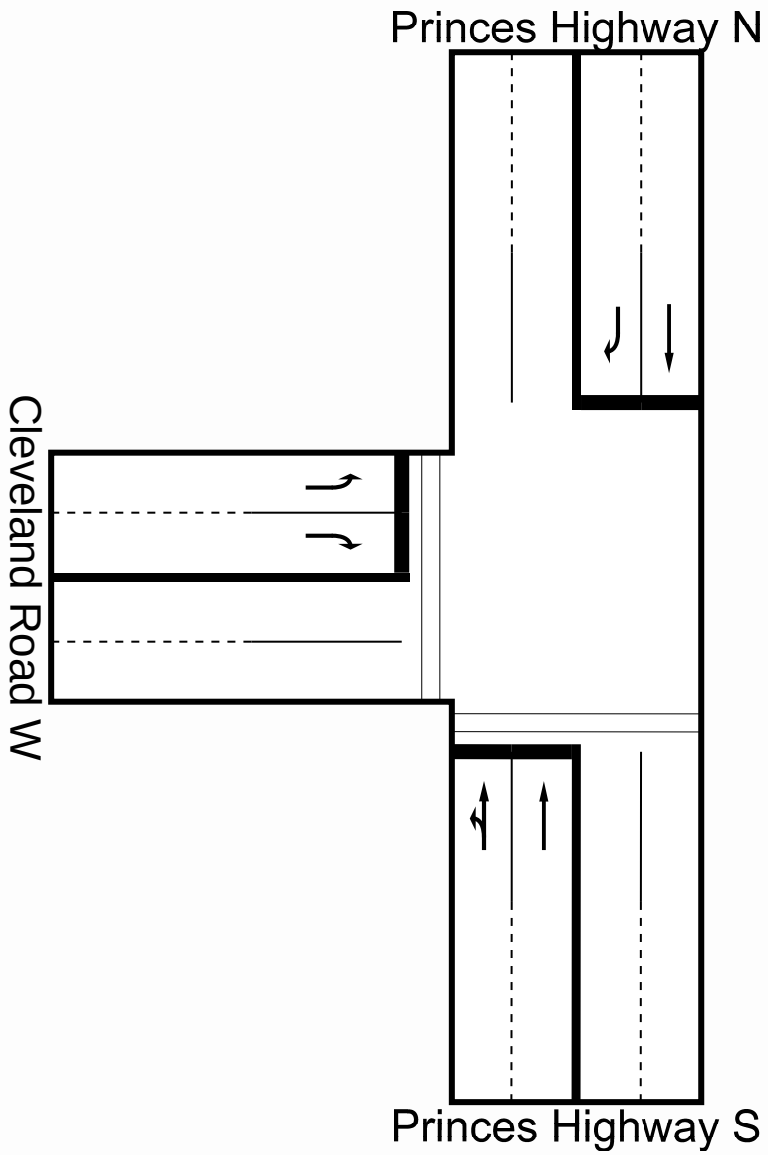


2016 and 2026 Layout

The intersection of Princes Highway with Cleveland Road is a signalised three leg junction. The key features of the intersection are as follows:

- The Princes Highway northern approach consists of a through kerbside lane and a right-turn median lane;
- The Princes Highway southern approach consists of a shared through-left kerbside lane and a through median lane;
- The Cleveland Road approach consists of a left-turn kerbside lane and a right-turn median lane; and
- All departures consist of two lanes.

Figure 6.4 Princes Highway/Cleveland Road 2016 and 2026 Intersection Layout

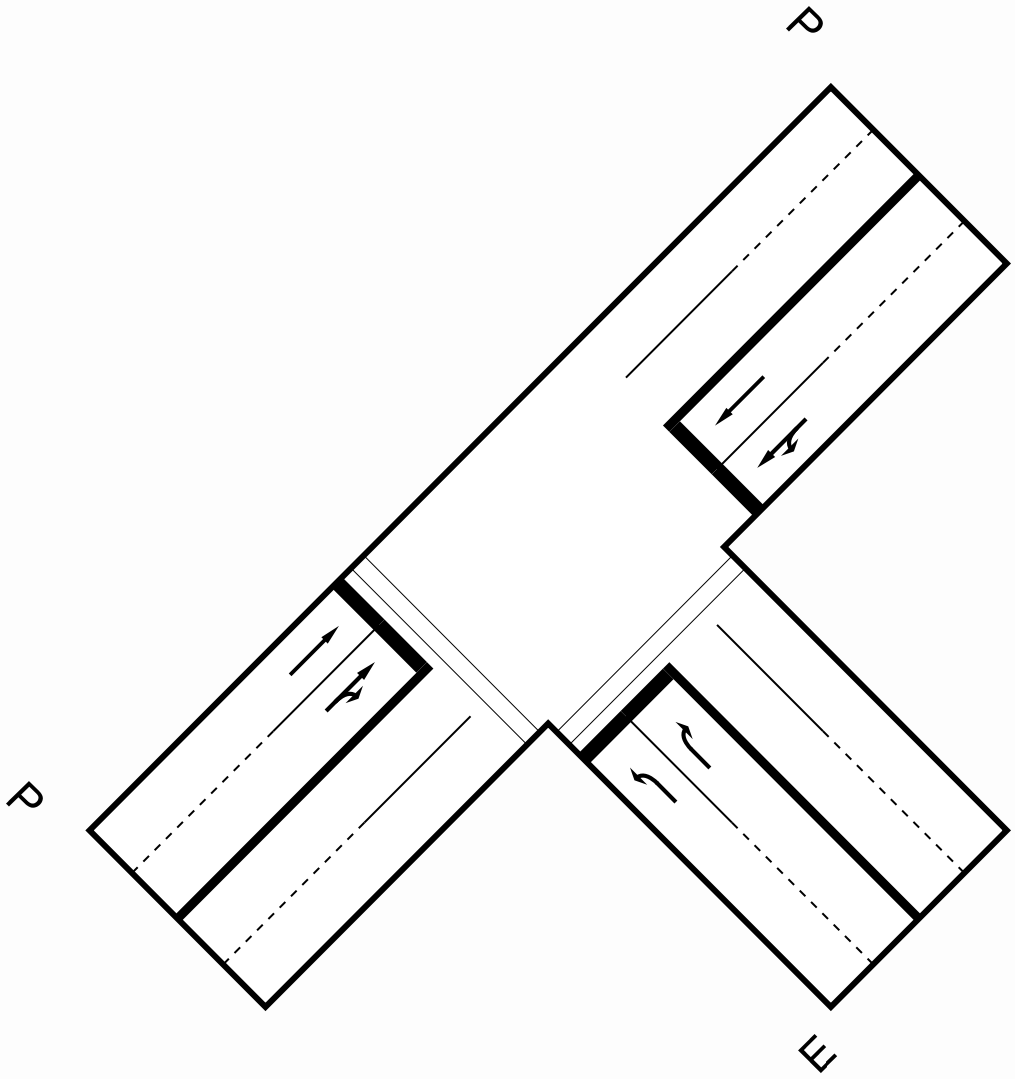


6.5.3 Princes Highway/Emerson Road

The intersection of Princes Highway with Emerson Road is a signalised three leg junction. The key features of the intersection are as follows:

- The Princes Highway north-eastern approach consists of a shared through-left kerbside lane and a through median lane;
- The Princes Highway south-western approach consists of a through kerbside lane and a shared through-right median lane;
- The Emerson Road approach consists of a left-turn kerbside lane and a right-turn median lane; and
- All departures consist of two lanes.

Figure 6.5 Princes Highway/Emerson Road Intersection Layout



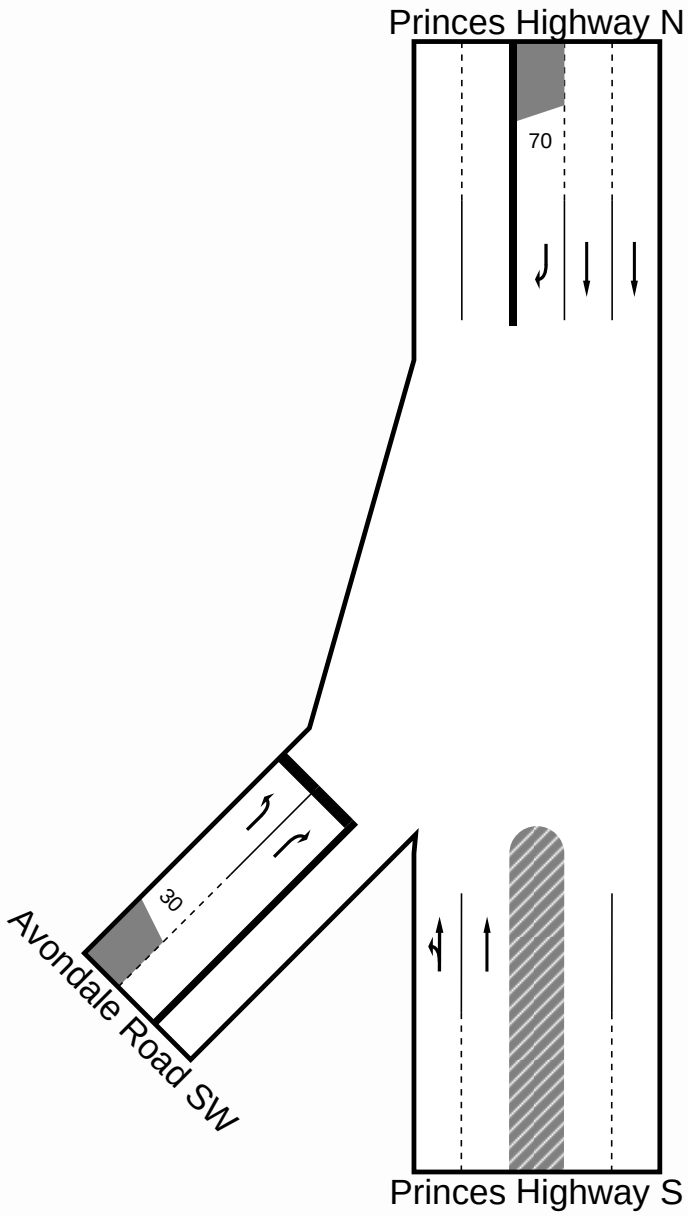
6.5.4 Princes Highway/Avondale Road

2008 Layout

The intersection of Princes Highway with Avondale Road is a three leg priority junction with traffic from Avondale Road needing to stop. The key features of the intersection are as follows:

- The Princes Highway northern approach consists of a through kerbside lane, a through lane and a short right-turn median lane (70m);
- The Princes Highway southern approach consists of a shared through-left kerbside lane and a through median lane;
- The Avondale Road approach consists of a short left-turn kerbside lane (30m) and a right-turn median lane controlled by a stop sign;
- The Princess Highway departures consist of two lanes; and
- The Avondale Road departure consists of one lane.

Figure 6.6 Princes Highway/Avondale Road 2008 Intersection Layout

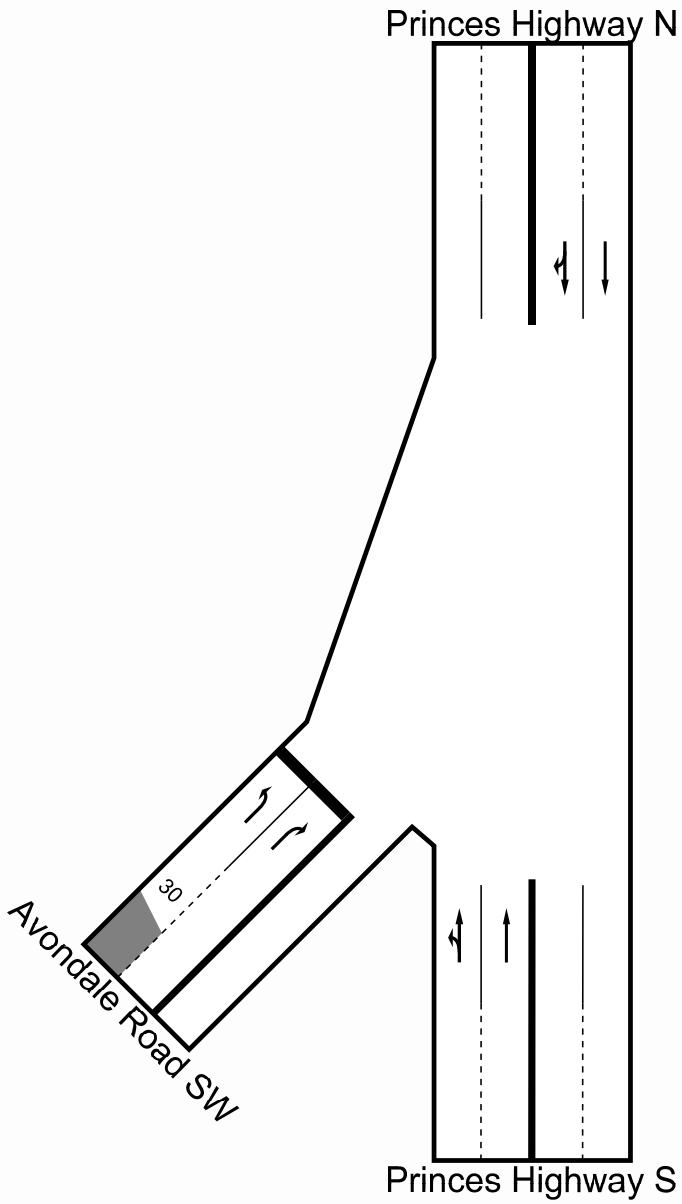


2016 and 2026 Layout

The intersection of Princes Highway with Avondale Road is a three leg priority junction with traffic from Avondale Road needing to stop. The key features of the intersection are as follows:

- The Princes Highway northern approach consists of a through kerbside lane and a shared through-right median lane;
- The Princes Highway southern approach consists of a shared through-left kerbside lane and a through median lane;
- The Avondale Road approach consists of a short left-turn kerbside lane (30m) and a right-turn median lane controlled by a stop sign;
- The Princess Highway departures consist of two lanes; and
- The Avondale Road departure consists of one lane.

Figure 6.7 Princes Highway/Avondale Road 2016 and 2026 Intersection Layout

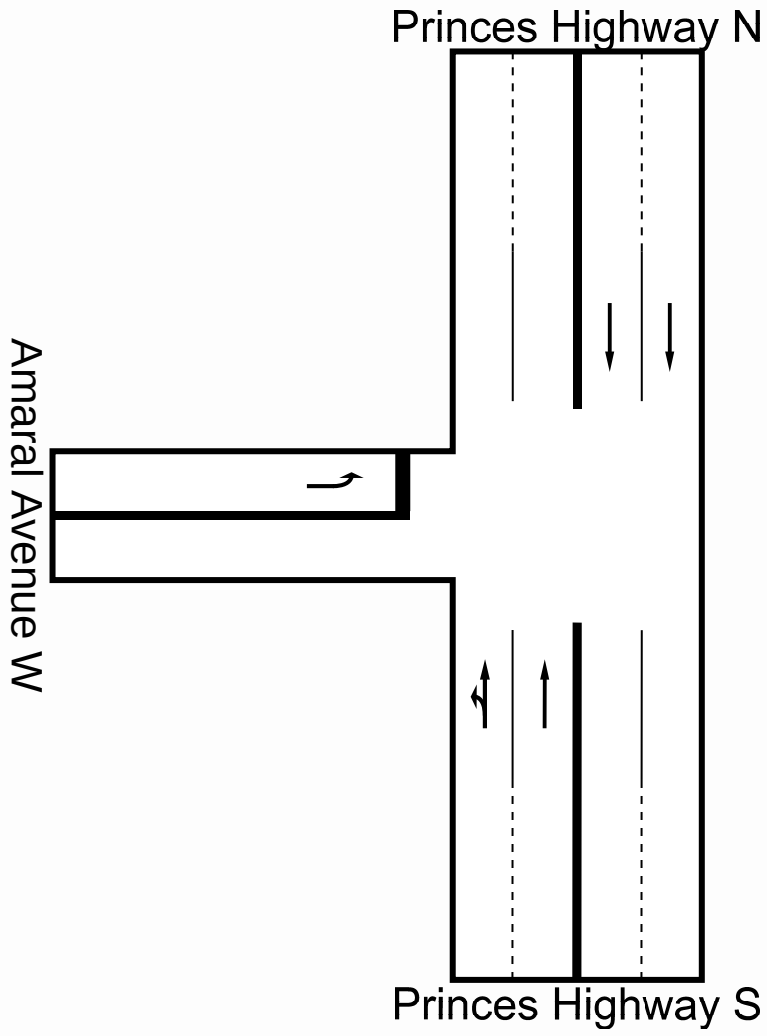


6.5.5 Princes Highway/Amaral Avenue

The intersection of Princes Highway with Amaral Avenue is a three leg priority junction with traffic from Amaral Avenue needing to stop. The key features of the intersection are as follows:

- The Princes Highway northern approach consists of a through kerbside lane and a through median lane;
- The Princes Highway southern approach consists of a shared through-left kerbside lane and a through median lane;
- The Amaral Avanue approach consists of a left-turn kerbside lane controlled by a stop sign;
- The Princess Highway departures consist of two lanes; and
- The Amaral Avenue departure consists of one lane.

Figure 6.8 Princes Highway/Amaral Avenue Intersection Layout



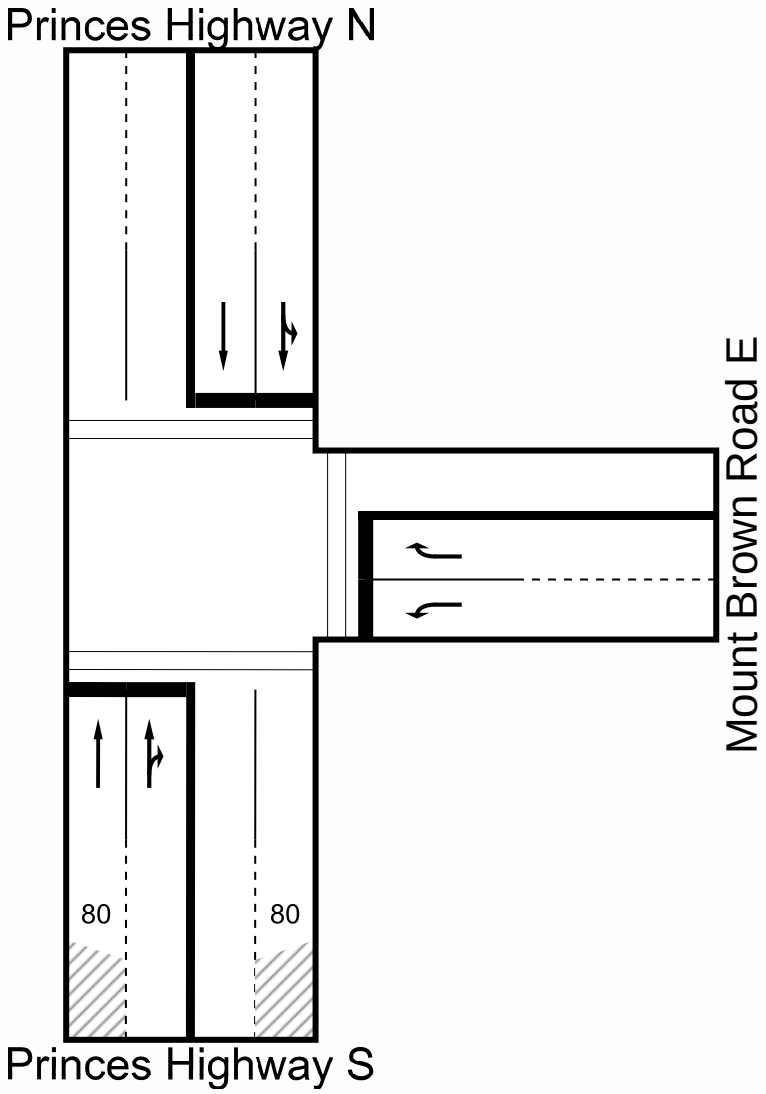
6.5.6 Princes Highway/Mt Brown Road

2008 Layout

The intersection of Princes Highway with Mount Brown Road is a signalised three leg junction. The key features of the intersection are as follows:

- The Princes Highway northern approach consists of a shared through-left kerbside lane and a through median lane;
- The Princes Highway southern approach consists of a short through kerbside lane (80m) and a shared through-right median lane;
- The Mount Brown Road approach consists of a left-turn kerbside lane and a right-turn median lane;
- The Princes Highway northern departure consists of two lanes;
- The Princes Highway southern departure consists of two lanes with the kerbside lane tapering to one lane; and
- The Mount Brown Road departure consists of one lane.

Figure 6.9 Princes Highway/Mt Brown Road 2008 Intersection Layout

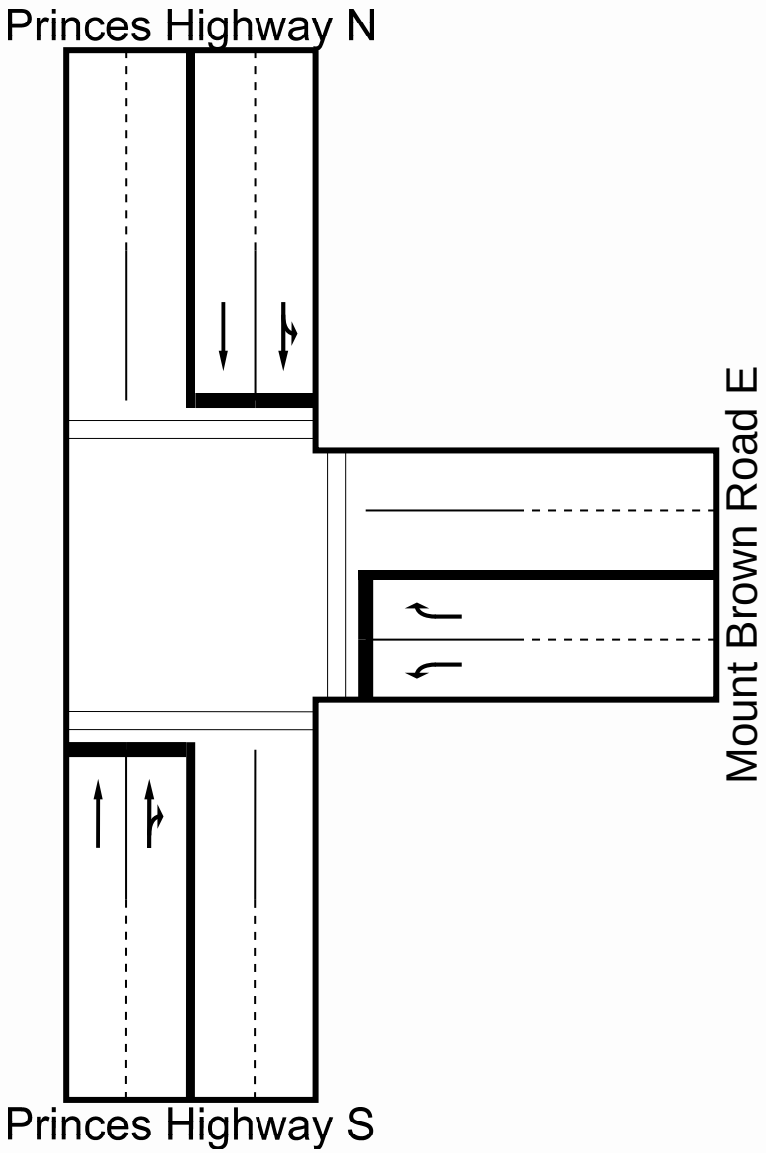


2016 and 2026 Layout

The intersection of Princes Highway with Mount Brown Road is a signalised three leg junction. The key features of the intersection are as follows:

- The Princes Highway northern approach consists of a shared through-left kerbside lane and a through median lane;
- The Princes Highway southern approach consists of a through kerbside lane and a shared through-right median lane;
- The Mount Brown Road approach consists of a left-turn kerbside lane and a right-turn median lane; and
- All departures consist of two lanes.

Figure 6.10 Princes Highway/Mt Brown Road 2016 and 2026 Intersection Layout



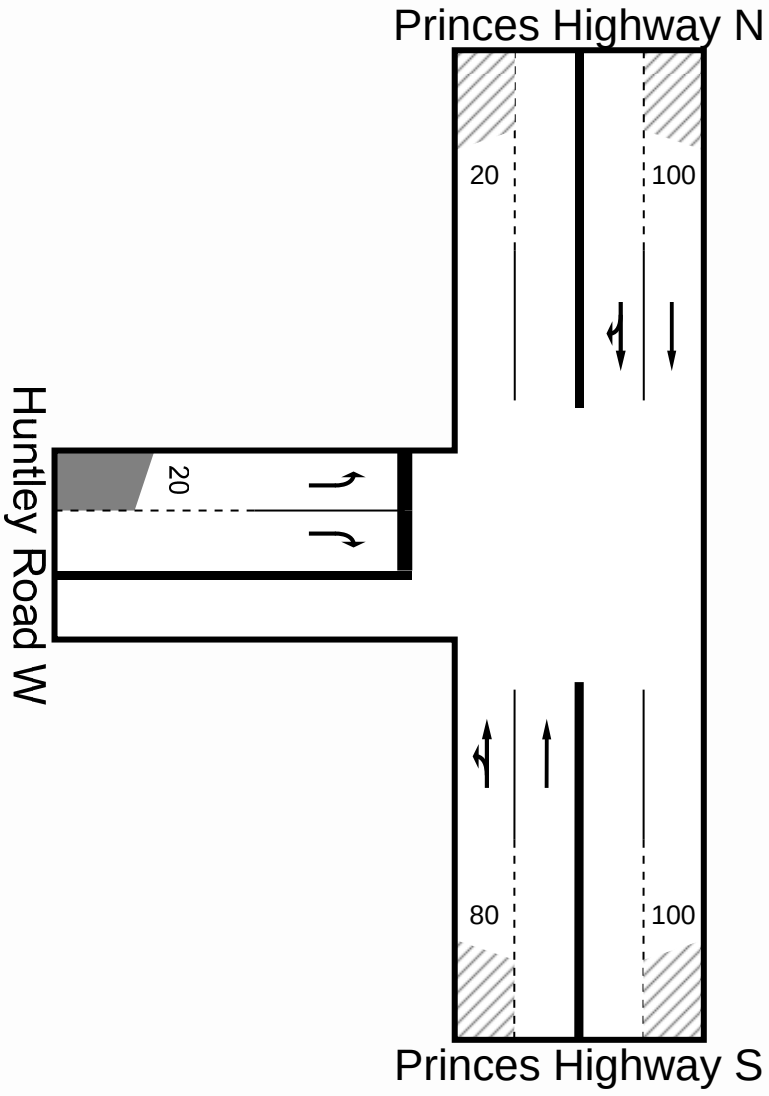
6.5.7 Princes Highway/Huntley Road

2008 Layout

The intersection of Princes Highway with Huntley Road is a three leg priority junction with traffic from Huntley Road needing to stop. The key features of the intersection are as follows:

- The Princes Highway northern approach consists of a short through kerbside lane (100m) and a shared through-right median lane;
- The Princes Highway southern approach consists of a short shared through-left kerbside lane (80m) and a through median lane;
- The Huntley Road approach consists of a short left-turn kerbside lane (20m) and a right-turn median lane controlled by a stop sign;
- The Princes Highway departures consist of two lanes with the kerbside lanes tapering to one lane; and
- The Huntley Road departure consists of one lane.

Figure 6.11 Princes Highway/Huntley Road 2008 Intersection Layout

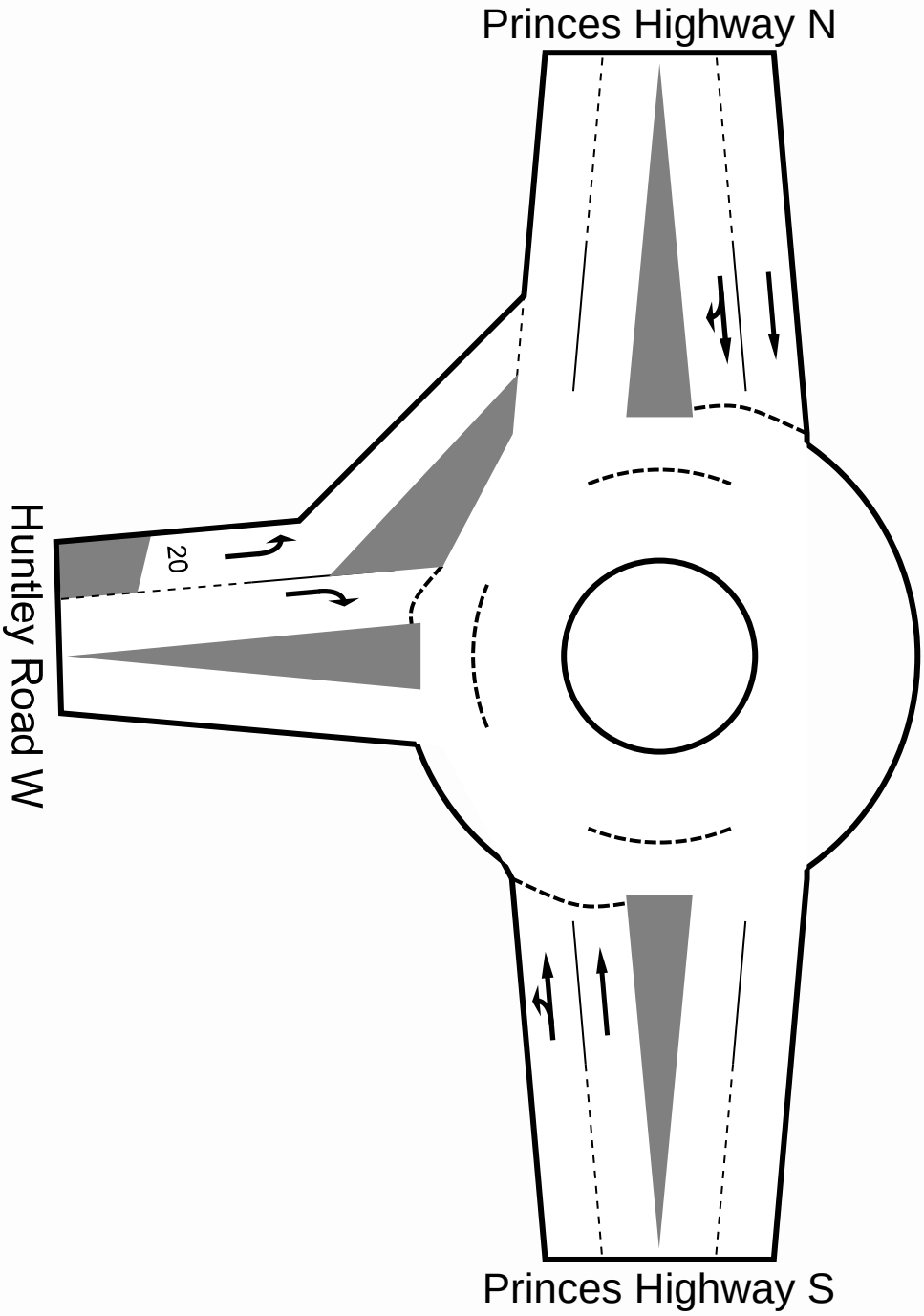


2016 and 2026 Layout

The intersection of Princes Highway with Huntley Road is a three-leg roundabout with two circulating lanes. The key features of the roundabout are:

- The Princes Highway northern approach consists of a through kerbside lane and a shared through-right median lane;
- The Princes Highway southern approach consists of a left-turn kerbside lane and a through median lane;
- The Huntley Road approach consists of a short left-turn slip lane (20m) and a right-turn median lane;
- The Princes Highway northern and southern departures consist of two lanes; and
- The Huntley Road departure consists of one lane.

Figure 6.12 Princes Highway/Huntley Road 2016 and 2026 Intersection Layout



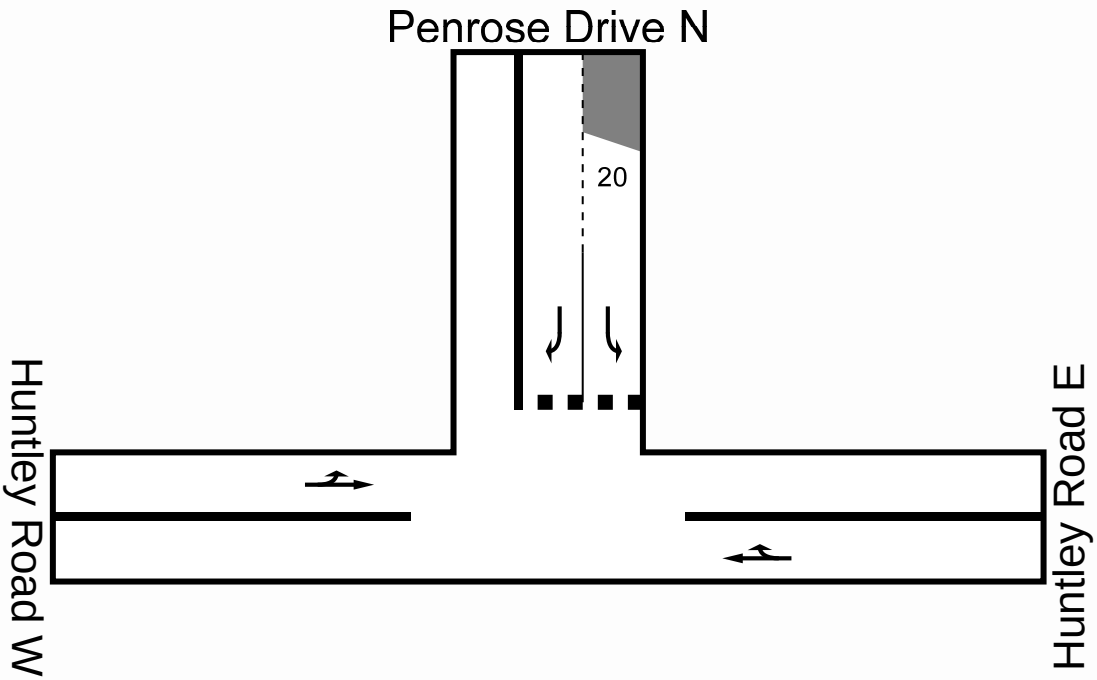
6.5.8 Huntley Road/Penrose Drive

2008 Layout

The intersection of Huntley Road with Penrose Drive is a three leg priority junction with traffic from Penrose Drive needing to give way. The key features of the intersection are as follows:

- The Huntley Road eastern approach consists of a shared through-right kerbside lane;
- The Huntley Road western approach consists of a shared through-left kerbside lane;
- The Penrose Drive approach consists of a short left-turn kerbside lane (20m) and a right-turn median lane controlled by a give way sign; and
- All departures consist of one lane.

Figure 6.13 Huntley Road/Penrose Drive 2008 Intersection Layout

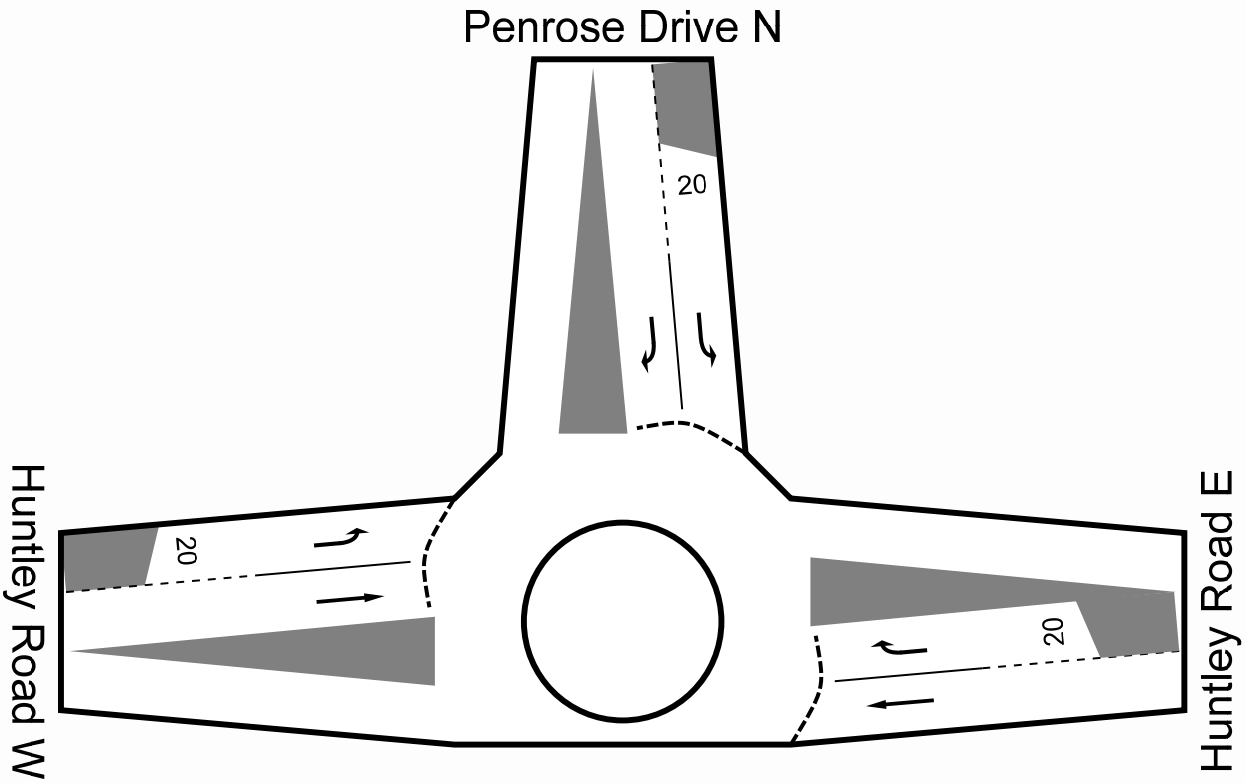


2016 and 2026 Layout

The intersection of Huntley Road with Penrose Drive is a three-leg roundabout with one circulating lane. The key features of the roundabout are:

- The Huntley Road eastern approach consists of a through kerbside lane and a short right-turn median lane (20m);
- The Huntley Road western approach consists of a short left-turn kerbside lane (20m) and a through median lane;
- The Penrose Drive approach consists of a short left-turn kerbside lane (20m) and a right-turn median lane; and
- All departures consist of one lane.

Figure 6.14 Huntley Road/Penrose Drive 2016 and 2026 Intersection Layout



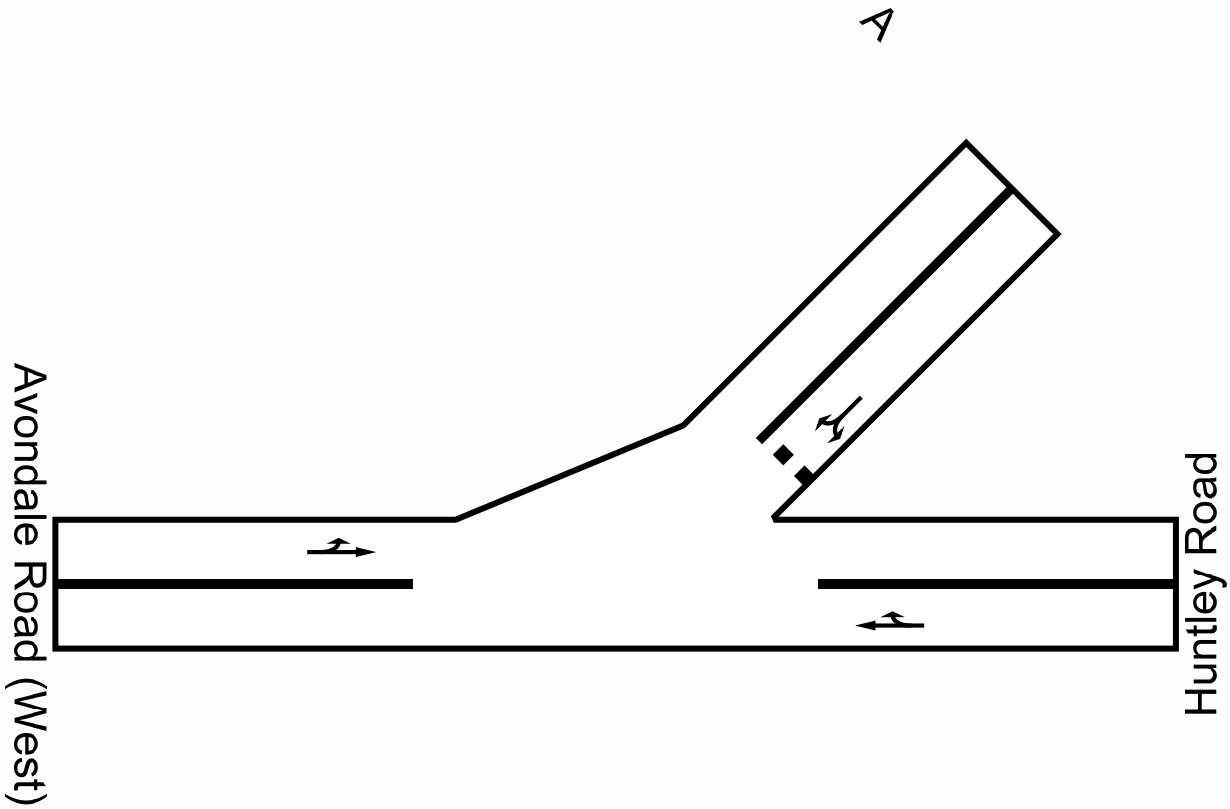
6.5.9 Huntley Road/Avondale Road

2008 Layout

The intersection of Huntley Road with Avondale Road is a three leg priority junction with traffic from Avondale Road north needing to give way. The key features of the intersection are as follows:

- The Avondale Road northern approach consists of a shared left-right kerbside lane controlled by a give way sign;
- The Avondale Road western approach consists of a shared through-left kerbside lane;
- The Huntley Road approach consists of a shared through-right kerbside lane; and
- All departures consist of one lane.

Figure 6.15 Huntley Road/Avondale Road 2008 Intersection Layout

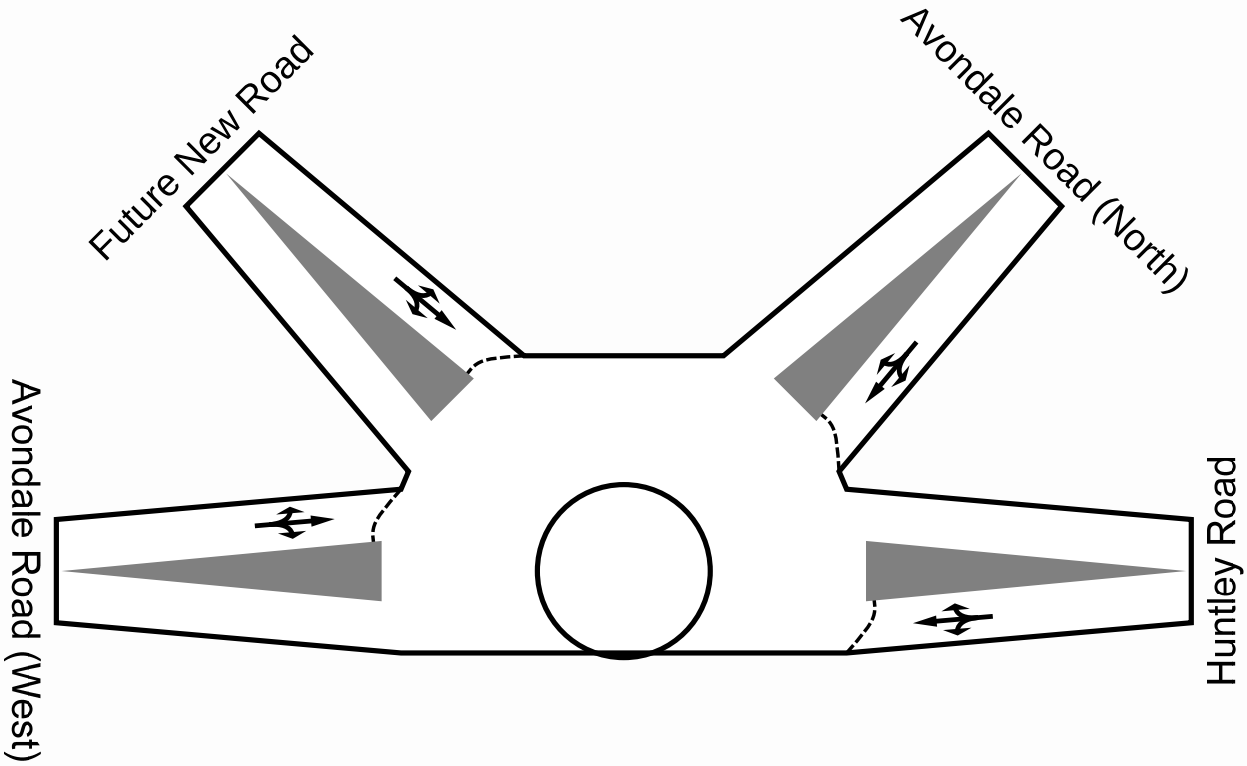


2016 and 2026 Layout

The intersection of Huntley Road with Penrose Drive is a four-leg roundabout with one circulating lane. The key features of the roundabout are:

- The Huntley Road approach consists of a shared through-right kerbside;
- The Avondale Road northern approach consists of a shared left-right kerbside lane;
- The Future New Road approach consists of a shared left-right kerbside lane;
- The Avondale Road western approach consists of a shared through-left kerbside lane; and
- All departures consist of one lane.

Figure 6.16 Huntley Road/Avondale Road 2016 and 2026 Intersection Layout



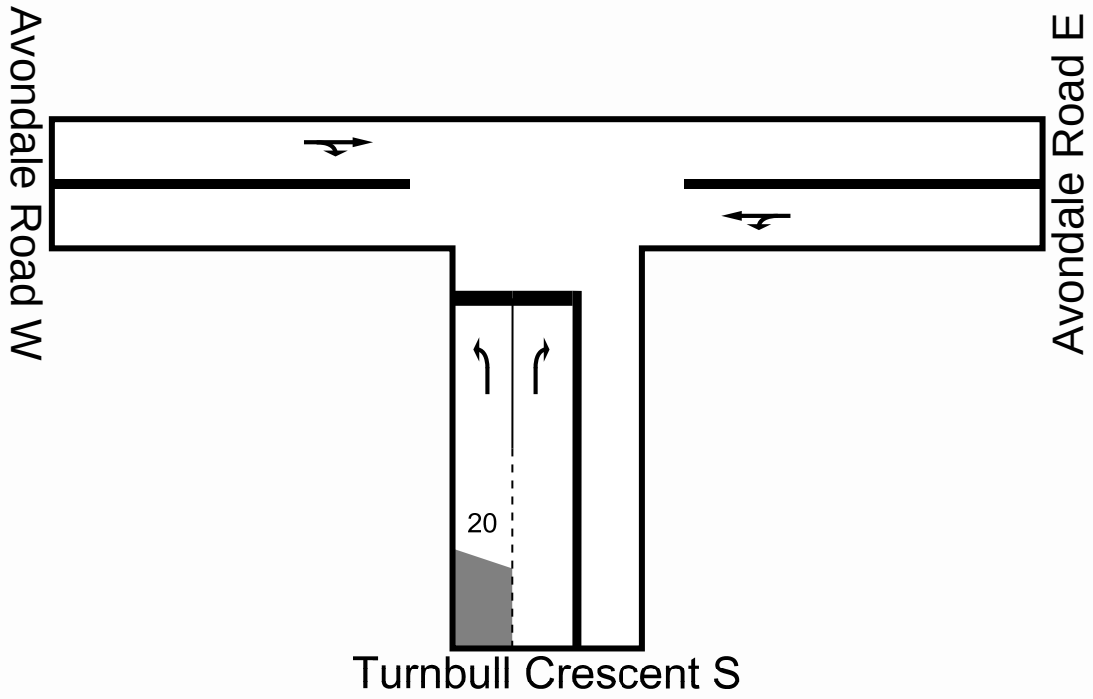
6.5.10 Avondale Road/Turnbull Crescent

2008 Layout

The intersection of Avondale Road with Turnbull Crescent is a three leg priority junction with traffic from Turnbull Crescent needing to stop. The key features of the intersection are as follows:

- The Avondale Road eastern approach consists of a shared through-left kerbside lane;
- The Avondale Road western approach consists of a shared through-right kerbside lane;
- The Turnbull Crescent approach consists of a short left kerbside lane (20m) and a right-turn median lane controlled by a stop sign; and
- All departures consist of one lane.

Figure 6.17 Avondale Road/Turnbull Crescent 2008 Intersection Layout

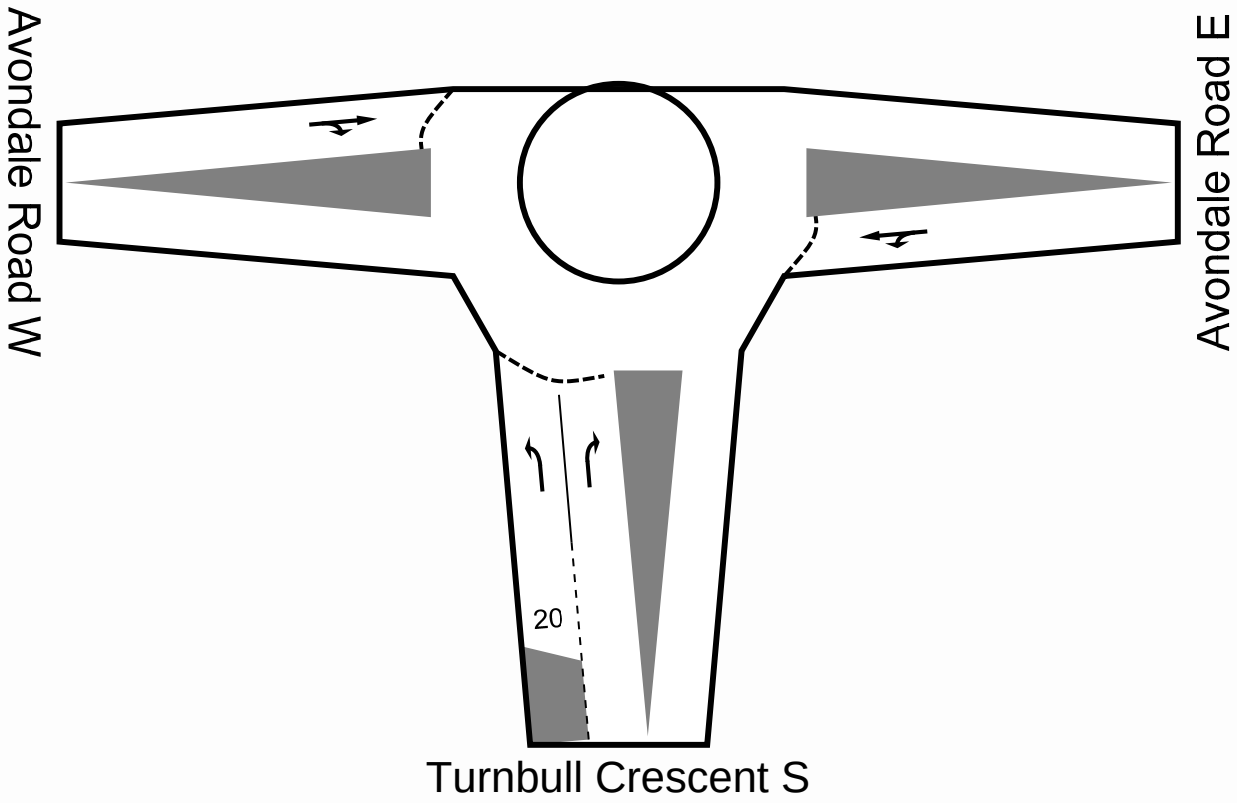


2016 and 2026 Layout

The intersection of Avondale Road with Turnbull Crescent is a three-leg roundabout with one circulating lane. The key features of the roundabout are:

- The Avondale Road eastern approach consists of a shared through-left kerbside lane;
- The Avondale Road western approach consists of a shared through-right kerbside lane;
- The Turnbull Crescent approach consists of a short left-turn kerbside lane (20m) and a right-turn median lane; and
- All departures consist of one lane.

Figure 6.18 Avondale Road/Turnbull Crescent 2016 and 2026 Intersection Layout



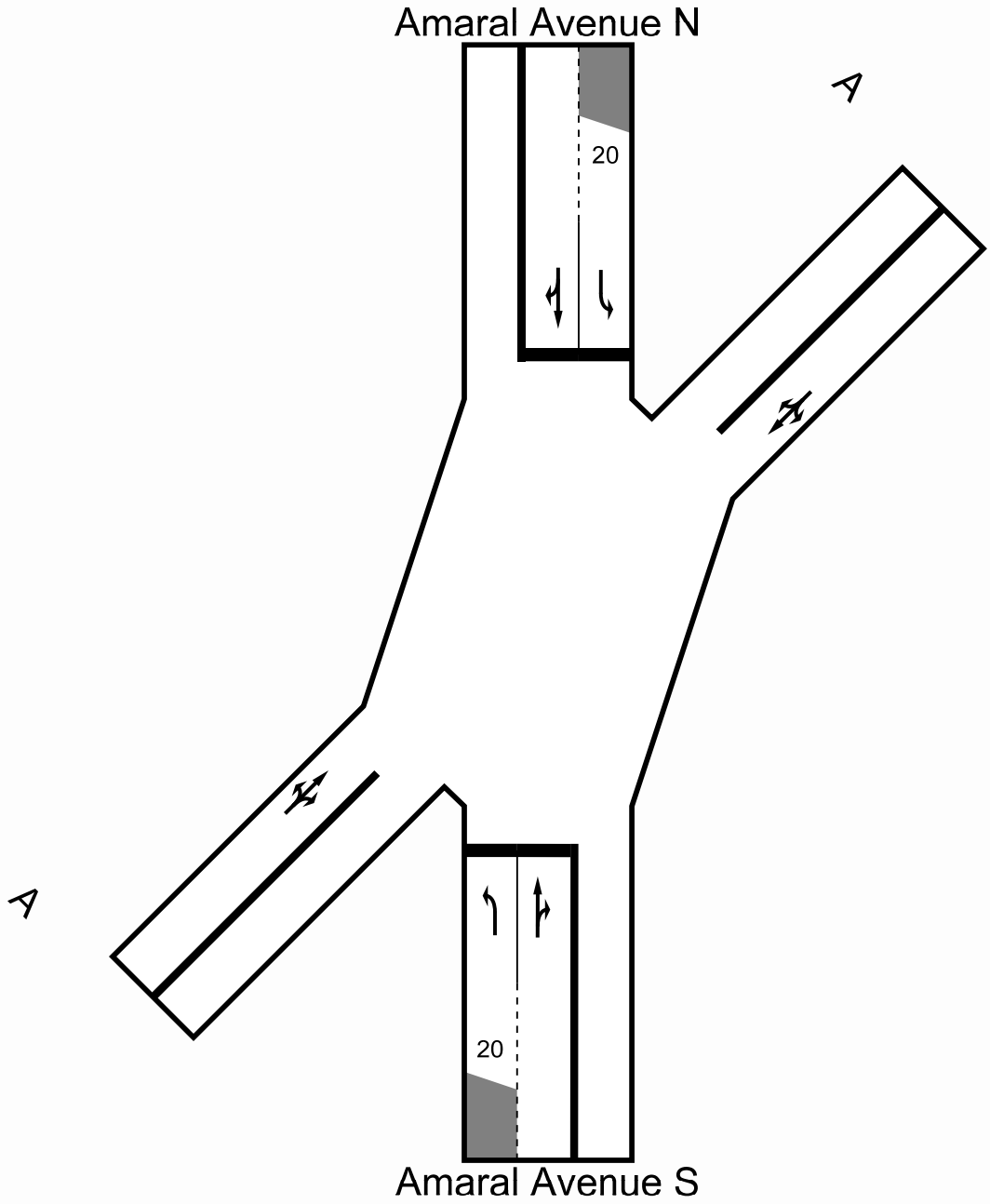
6.5.11 Avondale Road/Amaral Avenue/Marshall Street

2008 Layout

The intersection of Avondale Road with Amaral Avenue is a four leg priority junction with traffic from Amaral Avenue needing to stop. The key features of the intersection are as follows:

- The Avondale Road north-eastern and south-western approaches consist of a shared left-through-right kerbside lane;
- The Amaral Avenue northern and southern approaches consist of a short left-turn kerbside lane (20m) and a shared through-right median lane controlled by a stop sign; and
- All departures consist of one lane.

Figure 6.19 Avondale Road/Amaral Avenue/Marshall Street 2008 Intersection Layout

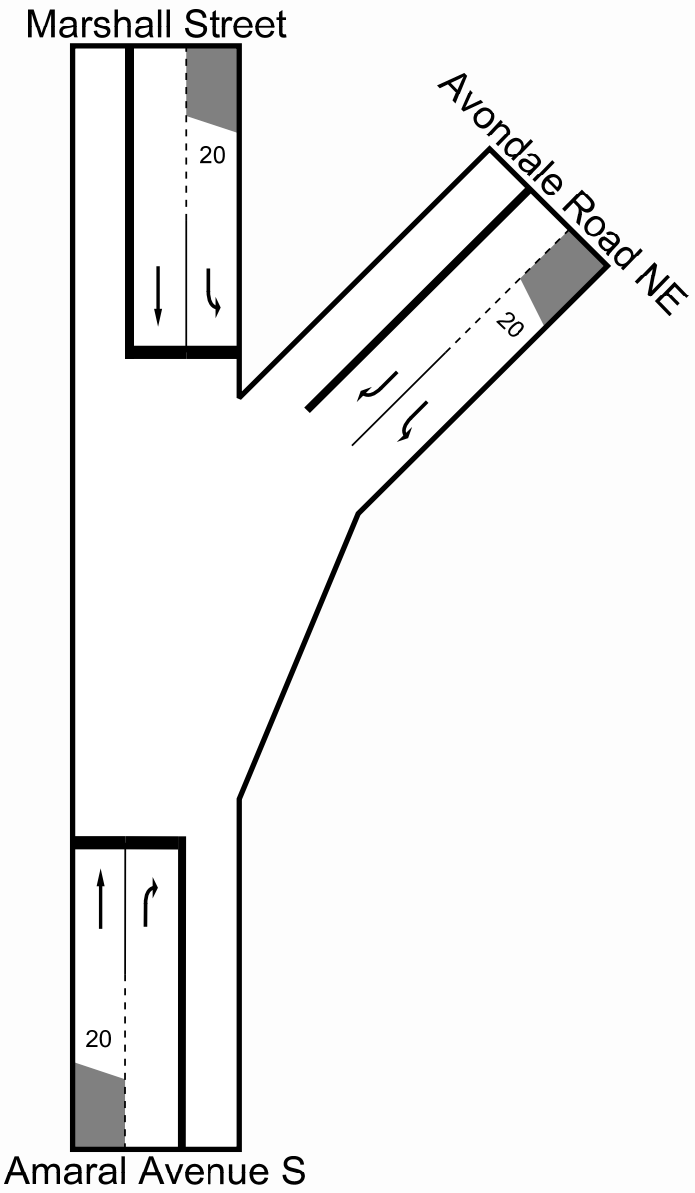


2016 and 2026 Layout

The intersection of Avondale Road with Amaral Avenue is a three leg priority junction with traffic from Amaral Avenue and Marshall Street needing to stop. Avondale Road will become closed at the level railway crossing. The key features of the intersection are as follows:

- The Avondale Road north-eastern approach consist of a short left-turn kerbside lane (20m) and a right-turn median lane;
- The Amaral Avenue approach consist of a short through kerbside lane (20m) and a right-turn median lane controlled by a stop sign;
- The Marshall Street approach consists of a short right-turn kerbside lane (20m) and a through median lane controlled by a stop sign; and
- All departures consist of one lane.

Figure 6.20 Avondale Road/Amaral Avenue/Marshall Street 2016 and 2026 Intersection Layout

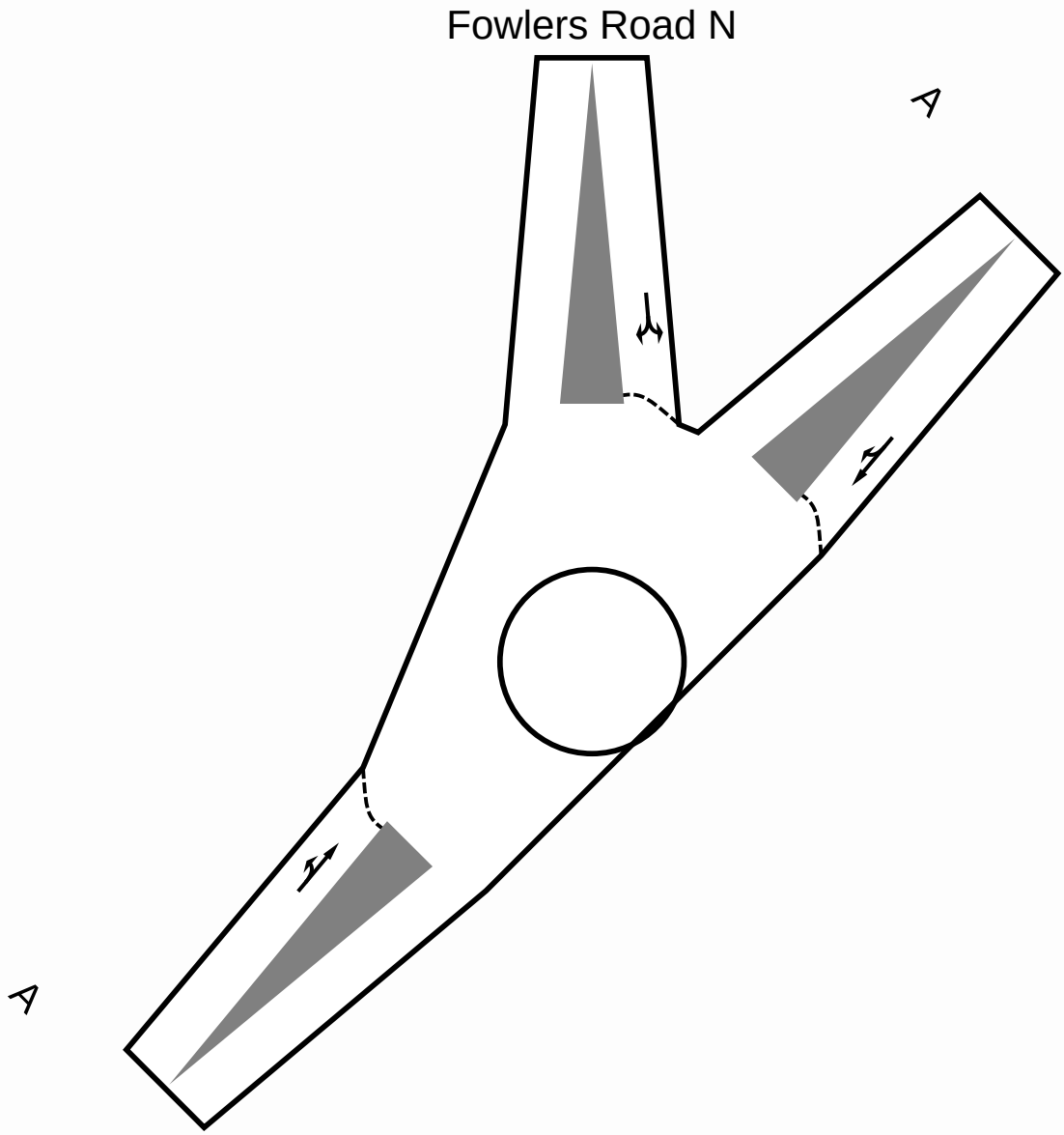


6.5.12 Fowlers Road Ext/Avondale Road

The intersection of Fowlers Road Ext with Avondale Road is a three-leg roundabout with one circulating lane. The key features of the roundabout are:

- The Fowlers Road approach consists of a shared left-right kerbside lane;
- The Avondale Road north-eastern approach consists of a shared through-right kerbside lane;
- The Avondale Road south-western approach consists of a shared through-left kerbside lane; and
- All departures consist of one lane.

Figure 6.21 Fowlers Road Ext/Avondale Road Intersection Layout



6.6 SIDRA INTERSECTION ANALYSIS

Intersection modelling was completed using SIDRA to determine intersection performance and operation for the 2008, 2016 and 2026 base traffic peaks and base plus development traffic peaks. The following scenarios were assessed;

- 2008 Base;
- 2016 Base;
- 2026 Base;
- 2008 Base plus development traffic;
- 2016 Base plus development traffic; and
- 2026 Base plus development traffic.

6.6.1 Intersection Performance

The existing intersection operating performance was assessed using the SIDRA software package to determine the Degree of Saturation (DS), Average Delay (AVD in seconds) and LoS at each intersection. The SIDRA program provides LoS Criteria Tables for various intersection types. The key indicator of intersection performance is LoS, where results are placed on a continuum from 'A' to 'F', as shown in **Table 6.9**.

Table 6.9 Intersection Level of Service

LoS	Traffic Signal / Roundabout	Give Way / Stop Sign / T-Junction control
A	Good operation	Good operation
B	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	Satisfactory	Satisfactory, but accident study required
D	Operating near capacity	Near capacity & accident study required
E	At capacity, at signals incidents will cause excessive delays.	At capacity, requires other control mode
F	Unsatisfactory and requires additional capacity, Roundabouts require other control mode	At capacity, requires other control mode

The Average Vehicle Delay (AVD) provides a measure of the operational performance of an intersection as indicated below, which relates AVD to LOS. The AVD's should be taken as a guide only as longer delays could be tolerated in some locations (i.e. inner city conditions) and on some roads (i.e. minor side street intersecting with a major arterial route). For traffic signals, the average delay over all movements should be taken. For roundabouts and priority control intersections (sign control) the critical movement for LoS assessment should be that movement with the highest average delay.

Table 6.10 Intersection Average Delay (AVD)

LoS	Average Delay per Vehicles (seconds/vehicle)
A	Less than 14
B	15 to 28
C	29 to 42
D	43 to 56
E	57 to 70
F	>70

The degree of saturation (DS) is another measure of the operational performance of individual intersections. For intersections controlled by traffic signals both queue length and delay increase rapidly as DS approaches 1. It is usual to attempt to keep DS to less than 0.9. Degrees of Saturation in the order of 0.7 generally represent satisfactory intersection operation. When DS exceed 0.9 queues can be anticipated.

Intersection modelling has been completed using the SIDRA intersection modelling program. The 2008 base case scenarios for both the AM and PM peaks have been assessed as part of this study. The modelled volumes have been derived from the TRACKS model and reassigned into SIDRA.

The intersections were analysed to determine the operating characteristics under the existing traffic conditions with existing traffic volumes. The intersections were analysed using the existing intersection layout. The analysis results are presented in the following sections.

A summary of the operating performance of critical intersections within the study area are presented in **Table 6.11** to **Table 6.16** below. The detailed SIDRA outputs are provided in **Appendix C**.

6.6.2 2008 Base

Table 6.11 2008 Base - Intersection Operation

Intersection	2008 AM Peak			2008 PM Peak		
	Degree of Saturation	Delays (s)	Level of Service	Degree of Saturation	Delays (s)	Level of Service
Princes Highway/ Fowlers Road	0.776	15.1	B	0.638	15.6	B
Princes Highway/ Cleveland Road	0.489	15.0	B	0.544	15.8	B
Princes Highway/ Emerson Road	0.588	15.2	B	0.608	12.4	A
Princes Highway/ Avondale Road	0.029	106.0	F	0.036	>120	F
Princes Highway/ Amaral Avenue	0.002	16.6	B	0.002	15.3	B
Princes Highway/ Mt Brown Road	0.495	11.6	A	0.562	12.4	B
Princes Highway/ Huntley Road	>1.000	>120	F	>1.000	>120	F
Huntley Road/ Penrose Drive	0.001	8.8	A	0.001	8.9	A
Huntley Road/ Avondale Road	0.004	9.3	A	0.006	9.3	A
Avondale Road/ Turnbull Crescent	0.245	10.9	A	0.153	11.2	A
Avondale Road/ Amaral Avenue/Marshall Street	0.003	12.8	A	0.003	12.8	A

* Average delay is calculated for the worst movement for priority controlled intersections

The intersection of Princess Highway with Avondale Road operates at a LoS F, with excessive delays of 106.0 seconds and greater than 120 seconds for the AM and PM peak periods, respectively. The heavy delays are experienced by the right-turn movement from the Avondale Road approach onto the Princes Highway. The volumes for this right turn movement are minimal and therefore this intersection operates within capacity.

The intersection of Princess Highway with Huntley Road operates at a LoS F, with excessive delays of greater than 120 seconds for both the AM and PM peak periods. The heavy delays are experienced by the right-turn movement from the Huntley Road approach onto the Princes Highway.

All other intersections are operating at a satisfactory LoS.

6.6.3 2016 Base

Table 6.12 2016 Base - Intersection Operation

Intersection	2016 AM Peak			2016 PM Peak		
	Degree of Saturation	Delays (s)	Level of Service	Degree of Saturation	Delays (s)	Level of Service
Princes Highway/ Fowlers Road	0.963	79.3	F	0.967	77.5	F
Princes Highway/ Fowlers Road UPGRADED	0.843	27.6	B	0.839	27.3	B
Princes Highway/ Cleveland Road	0.584	15.6	B	0.803	15.9	B
Princes Highway/ Emerson Road	0.461	15.0	B	0.666	17.9	B
Princes Highway/ Avondale Road	0.011	49.8	D	0.016	66.4	E
Princes Highway/ Amaral Avenue	0.002	16.6	B	0.002	14.3	A
Princes Highway/ Mt Brown Road	0.485	14.3	A	0.600	15.1	B
Princes Highway/ Huntley Road	0.925	39.3	C	0.780	24.3	B
Huntley Road/ Penrose Drive	0.099	15.8	B	0.108	14.8	B
Huntley Road/ Avondale Road	0.478	19.2	B	0.643	16.7	B
Avondale Road/ Turnbull Crescent	0.081	11.0	A	0.132	11.0	A
Avondale Road/ Amaral Avenue/Marshall Street	0.001	11.6	A	0.001	11.6	A
Fowlers Road Ext/ Avondale Road	0.247	13.4	A	0.139	14.4	A

* Average delay is calculated for the worst movement for priority controlled intersections

The intersection of Princess Highway with Fowlers Road operates at a LoS F, with excessive delays of 79.3 seconds and 77.5 seconds for the AM peak and PM peak periods, respectively. Heavy delays are experienced across all the movements within the intersection. These heavy delays were minimised with the upgrade of the intersection which is further discussed in **Section 6.7**. The LoS of the intersection was improved to a B, with less significant delays of 27.6 seconds and 17.3 seconds for the AM peak and PM peak periods, respectively.

The intersection of Princess Highway with Avondale Road operates at a LoS D and E, with excessive delays of 49.8 seconds and 66.4 seconds for the AM and PM peaks, respectively. The heavy delays are experienced by the right-turn movements from the Avondale Road approach onto the Princes Highway. The volumes for this right turn movement are minimal and therefore this intersection operates within capacity.

All other intersections are operating at a satisfactory LoS.

6.6.4 2026 Base

Table 6.13 2026 Base - Intersection Operation

Intersection	2026 AM Peak			2026 PM Peak		
	Degree of Saturation	Delays (s)	Level of Service	Degree of Saturation	Delays (s)	Level of Service
Princes Highway/ Fowlers Road	>1.000	>120	F	>1.000	>120	F
Princes Highway/ Fowlers Road **UPGRADED**	0.893	35.5	C	>1.000	46.5	D
Princes Highway/ Cleveland Road	0.685	17.1	B	0.841	16.5	B
Princes Highway/ Emerson Road	0.605	17.2	B	0.768	19.5	B
Princes Highway/ Avondale Road	0.024	91.4	F	0.038	>120	F
Princes Highway/ Amaral Avenue	0.003	19.6	B	0.002	16.0	B
Princes Highway/ Mt Brown Road	0.610	15.2	B	0.722	16.7	B
Princes Highway/ Huntley Road	>1.000	>120	F	>1.000	>120	F
Princes Highway/ Huntley Road **SIGNALISED**	0.894	37.7	C	0.917	50.4	D
Huntley Road/ Penrose Drive	0.225	19.6	B	0.186	17.1	B
Huntley Road/ Avondale Road	>1.000	>120	F	>1.000	>120	F
Huntley Road/ Avondale Road **SIGNALISED**	>1.000	29.6	C	>1.000	52.6	D
Avondale Road/ Turnbull Crescent	0.103	11.0	A	0.139	11.0	A
Avondale Road/ Amaral Avenue/Marshall Street	0.001	11.6	A	0.001	11.6	A
Fowlers Road Ext/ Avondale Road	0.292	14.1	A	0.185	16.2	B

* Average delay is calculated for the worst movement for priority controlled intersections

The intersection of Princess Highway with Fowlers Road operates at a LoS F, with excessive delays of greater than 120 seconds for both the AM peak and PM peak periods. Heavy delays are experienced across all the movements within the intersection. These heavy delays were minimised with the upgrade of the intersection which is further discussed in **Section 6.7**. The LoS of the intersection was improved to a C and D, with less significant delays of 35.5 seconds and 46.5 seconds for the AM peak and PM peak periods, respectively.

The intersection of Princess Highway with Avondale Road operates at a LoS F, with excessive delays of 91.4 seconds and greater than 120 seconds for the AM and PM peak periods, respectively. The heavy delays are experienced by the right-turn movements from the Avondale approach onto the Princes Highway. The volumes for this right turn movement are minimal and therefore this intersection operates within capacity.

The intersection of Princess Highway with Huntley Road operates at a LoS F, with excessive delays of greater than 120 seconds for both the AM and PM peak periods. The heavy delays are experienced by the right-turn movements from the

Huntley Road approach onto the Princes Highway. These heavy delays were minimised with the signalisation of the intersection which is further discussed in **Section 6.7**. The LoS of the intersection was improved to a C and D, with less significant delays of 37.7 seconds and 50.4 seconds for the AM peak and PM peak periods, respectively.

The intersection of Huntley Road with Avondale Road operates at a LoS F, with excessive delays of greater than 120 seconds for both the AM peak and PM peak periods. The heavy delays in the AM peak period are experienced by all movements on the New Future Road approach and the Avondale Road western approach. The heavy delays in the PM peak period are experienced by all movements on the Huntley Road approach and the Avondale Road northern approach. These heavy delays were minimised with the signalisation of the intersection which is further discussed in **Section 6.7**. The LoS of the intersection was improved to a C and D, with less significant delays of 29.6 seconds and 52.3 seconds for the AM peak and PM peak periods, respectively.

All other intersections are operating at a satisfactory LoS.

6.6.5 2008 Base plus Development

Table 6.14 2008 Base plus Development - Intersection Operation

Intersection	2008 AM Peak			2008 PM Peak		
	Degree of Saturation	Delays (s)	Level of Service	Degree of Saturation	Delays (s)	Level of Service
Princes Highway/ Fowlers Road	0.784	15.2	B	0.749	16.2	B
Princes Highway/ Cleveland Road	0.428	10.1	A	0.544	16.2	B
Princes Highway/ Emerson Road	0.554	13.5	A	0.635	12.5	A
Princes Highway/ Avondale Road	0.029	107.9	F	0.037	>120	F
Princes Highway/ Amaral Avenue	0.002	16.6	B	0.002	15.2	B
Princes Highway/ Mt Brown Road	0.496	11.6	A	0.561	12.4	A
Princes Highway/ Huntley Road	>1.000	>120	F	>1.000	>120	F
Huntley Road/ Penrose Drive	0.001	8.8	A	0.001	9.0	A
Huntley Road/ Avondale Road	0.005	9.3	A	0.007	9.3	A
Avondale Road/ Turnbull Crescent	0.001	11.0	A	0.166	11.7	A
Avondale Road/ Amaral Avenue/Marshall Street	0.005	16.1	B	0.003	13.1	A

* Average delay is calculated for the worst movement for priority controlled intersections

The intersection of Princess Highway with Avondale Road operates at a LoS F, with excessive delays of 107.9 seconds and greater than 120 seconds for the AM and PM peak periods, respectively. The heavy delays are experienced by the

right-turn movement from the Avondale Road approach onto the Princes Highway. The volumes for this right turn movement are minimal and therefore this intersection operates within capacity.

The intersection of Princess Highway with Huntley Road operates at a LoS F, with excessive delays of greater than 120 seconds for both the AM and PM peak periods. The heavy delays are experienced by the right-turn movement from the Huntley Road approach onto the Princes Highway.

All other intersections are operating at a satisfactory LoS.

6.6.6 2016 Base plus Development

Table 6.15 2016 Base plus Development - Intersection Operation

Intersection	2016 AM Peak			2016 PM Peak		
	Degree of Saturation	Delays (s)	Level of Service	Degree of Saturation	Delays (s)	Level of Service
Princes Highway/ Fowlers Road	>1.000	95.0	F	>1.000	>120	F
Princes Highway/ Fowlers Road **UPGRADED**	0.899	44.8	D	0.912	44.0	D
Princes Highway/ Cleveland Road	0.594	15.6	B	0.823	17.0	B
Princes Highway/ Emerson Road	0.468	16.5	B	0.686	18.1	B
Princes Highway/ Avondale Road	0.012	52.3	D	0.022	85.1	F
Princes Highway/ Amaral Avenue	0.002	16.7	B	0.024	50.5	D
Princes Highway/ Mt Brown Road	0.489	14.2	A	0.624	15.3	B
Princes Highway/ Huntley Road	0.934	41.3	C	0.899	36.1	C
Huntley Road/ Penrose Drive	0.101	16.0	B	0.130	16.3	B
Huntley Road/ Avondale Road	0.500	20.2	B	0.794	21.1	B
Avondale Road/ Turnbull Crescent	0.077	11.0	A	0.128	11.0	A
Avondale Road/ Amaral Avenue/Marshall Street	0.001	11.6	A	0.001	11.6	A
Fowlers Road Ext/ Avondale Road	0.420	21.8	B	0.171	17.3	B

* Average delay is calculated for the worst movement for priority controlled intersections

The intersection of Princess Highway with Fowlers Road operates at a LoS F, with excessive delays of 95.0 seconds and greater than 120 seconds for the AM peak and PM peak periods, respectively. Heavy delays are experienced across all the movements within the intersection. These heavy delays were minimised with the upgrade of the intersection which is further discussed in **Section 6.7**. The LoS of the intersection was improved to a D, with less significant delays of 44.8 seconds and 44.0 seconds for the AM peak and PM peak periods, respectively.

The intersection of Princess Highway with Avondale Road operates at a LoS D and F, with excessive delays of 52.3 seconds and 85.1 seconds for the AM and PM peaks, respectively. The heavy delays are experienced by the right-turn

movement from the Avondale Road approach onto the Princes Highway. The volumes for this right turn movement are minimal and therefore this intersection operates within capacity.

The intersection of Princess Highway with Amaral Avenue operates at a LoS B and D, with excessive delays of 50.5 seconds in the PM peak period. The heavy delays are experienced by the left-turn movement from the Amaral Avenue approach onto the Princes Highway.

All other intersections are operating at a satisfactory LoS.

6.6.7 2026 Base plus Development

Table 6.16 2026 Base plus Development - Intersection Operation

Intersection	2026 AM Peak			2026 PM Peak		
	Degree of Saturation	Delays (s)	Level of Service	Degree of Saturation	Delays (s)	Level of Service
Princes Highway/ Fowlers Road	>1.000	>120	F	>1.000	>120	F
Princes Highway/ Fowlers Road **UPGRADED**	0.893	31.4	C	>1.000	>120	F
Princes Highway/ Cleveland Road	0.698	17.4	B	0.886	20.3	B
Princes Highway/ Emerson Road	0.626	17.1	B	0.822	21.2	B
Princes Highway/ Avondale Road	0.031	114.7	F	0.083	>120	F
Princes Highway/ Amaral Avenue	0.003	19.9	B	0.003	19.7	B
Princes Highway/ Mt Brown Road	0.642	15.9	B	0.759	18.2	B
Princes Highway/ Huntley Road	>1.000	>120	F	>1.000	>120	F
Princes Highway/ Huntley Road **SIGNALISED**	0.821	28.1	B	>1.000	>120	F
Huntley Road/ Penrose Drive	0.264	21.6	B	0.554	26.4	B
Huntley Road/ Avondale Road	>1.000	>120	F	>1.000	>120	F
Huntley Road/ Avondale Road **SIGNALISED**	0.862	26.0	B	>1.000	>120	F
Avondale Road/ Turnbull Crescent	0.099	11.0	A	0.133	11.0	A
Avondale Road/ Amaral Avenue/Marshall Street	0.001	11.6	A	0.001	11.6	A
Fowlers Road Ext/ Avondale Road	0.541	30.1	C	0.230	20.8	B

* Average delay is calculated for the worst movement for priority controlled intersections

The intersection of Princess Highway with Fowlers Road operates at a LoS F, with excessive delays of greater than 120 seconds for both the AM peak and PM peak periods. Heavy delays are experienced across all the movements within the intersection. These heavy delays were minimised in the AM peak period with the upgrade of the intersection. The LoS of the intersection was improved to a C, with less significant delays of 31.4 seconds for the AM. These reductions in delays were not seen in the PM peak period.

The intersection of Princess Highway with Avondale Road operates at a LoS F, with excessive delays of 114.7 seconds and greater than 120 seconds for the AM and PM peak periods, respectively. The heavy delays are experienced by the right-turn movements from the Avondale approach onto the Princes Highway. The volumes for this right turn movement are minimal and therefore this intersection operates within capacity.

The intersection of Princess Highway with Huntley Road operates at a LoS F, with excessive delays of greater than 120 seconds for both the AM and PM peak periods. The heavy delays are experienced by the right-turn movements from the Huntley Road approach onto the Princes Highway and the left-turn movements from the Princes Highway southern approach onto Huntley Road. These heavy delays were minimised in the AM peak period with the signalisation of the intersection. The LoS of the intersection was improved to a B, with less significant delays of 28.1 seconds for the AM. These reductions in delays were not seen in the PM peak period. See **Section 6.7** for further details.

The intersection of Huntley Road with Avondale Road operates at a LoS F, with excessive delays of greater than 120 seconds for both the AM peak and PM peak periods. The heavy delays in the AM peak period are experienced by all movements on the New Future Road approach and the Avondale Road western approach. The heavy delays in the PM peak period are experienced by all movements on the Huntley Road approach and the Avondale Road northern approach. These heavy delays were minimised in the AM peak period with the signalisation of the intersection. The LoS of the intersection was improved to a B, with less significant delays of 26.0 seconds for the AM. These reductions in delays were not seen in the PM peak period. See Section 6.7 for further details.

All other intersections are operating at a satisfactory LoS.

6.7 MITIGATION MEASURES

The following intersection upgrades will be required to accommodate increased traffic volumes. The traffic modelling indicates the following intersections will require upgrading based on the 2008, 2016 or 2026 TRACKS base models.

2008 Traffic Volumes

The intersection of Princes Highway and Huntley Road operates at a LoS F as the right-turn movement from Huntley Road into Princes Highway experiences significant delays during the 2008 AM and PM peaks. This intersection will require upgrading regardless of any future traffic generated by this development or other developments in the area.

The 2016 and 2026 TRACKS base models show that this intersection will be upgraded to a roundabout intersection.

2016 Traffic Volumes

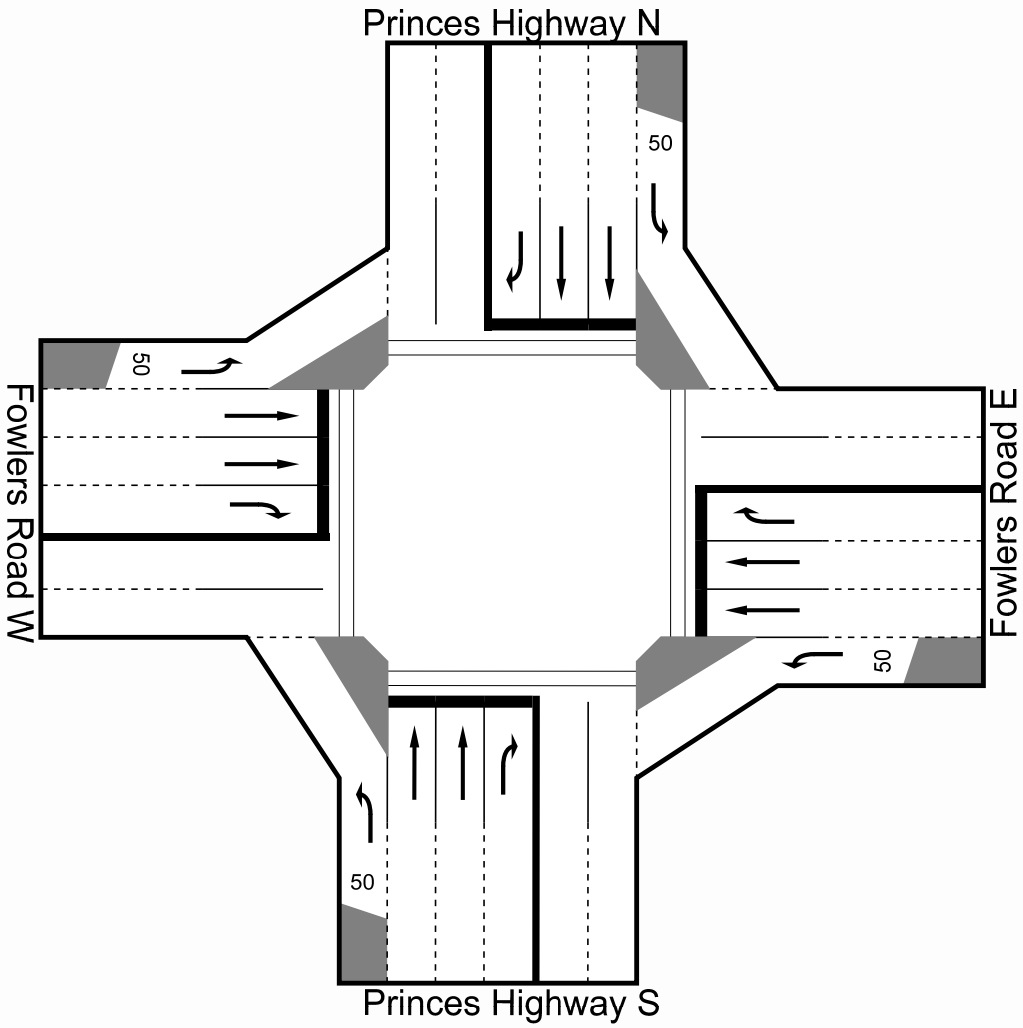
The intersection of Princes Highway and Fowlers Road operates at an overall LoS F in the 2016 AM and PM peaks when upgraded to a four way signalised intersection. This intersection will require further upgrades to accommodate increased traffic volumes. This intersection will require upgrading regardless of any future traffic generated by this development or other developments in the area.

2026 Traffic Volumes

The intersection of Princes Highway and Fowlers Road operates at an overall LoS F in the 2026 AM and PM peaks when upgraded to a four way signalised intersection. This intersection will require further upgrades to accommodate

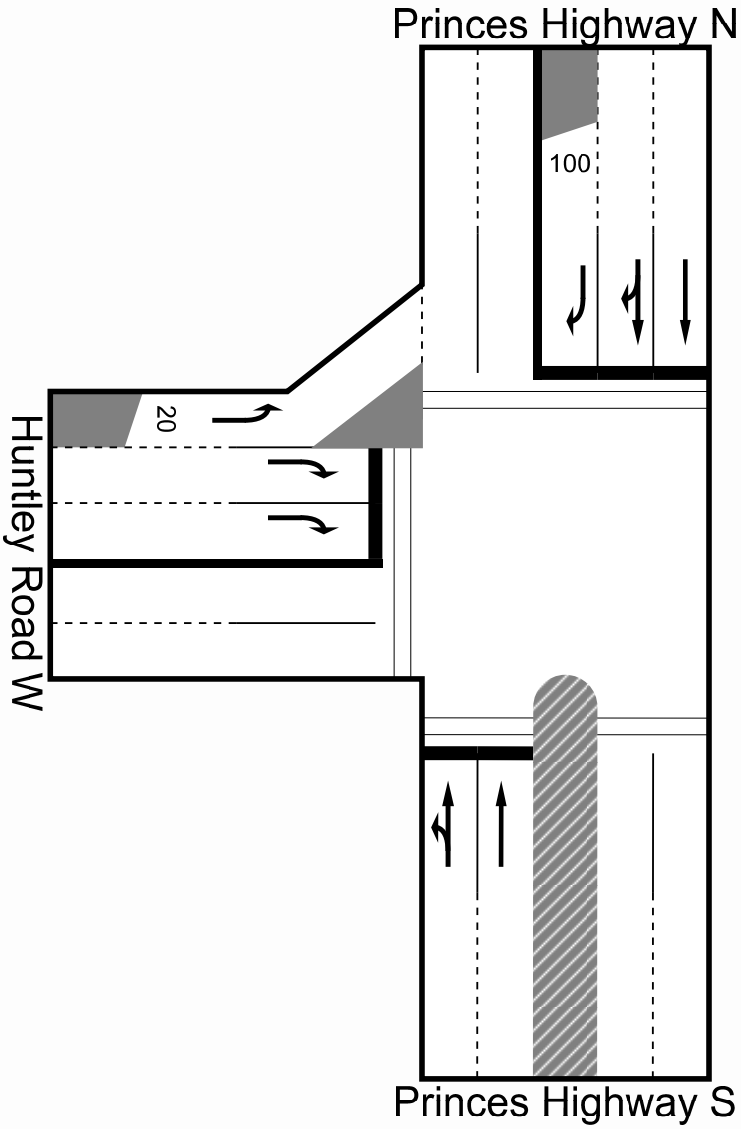
increased traffic volumes. This intersection will require upgrading regardless of any future traffic generated by this development or other developments in the area. **Figure 6.22** shows the upgraded layout.

Figure 6.22 Fowlers Road/Princes Highway Intersection Layout - UPGRADED



The intersection of Princes Highway and Huntley Road operates at a LoS F as the right-turn movement from Huntley Road into Princes Highway experiences significant delays during the 2026 AM and PM peaks with a roundabout intersection. It recommended that this intersection become signalised. This intersection will require upgrading regardless of any future traffic generated by this development or other developments in the area. **Figure 6.23** shows the layout of this intersection with upgrades and traffic signal operation.

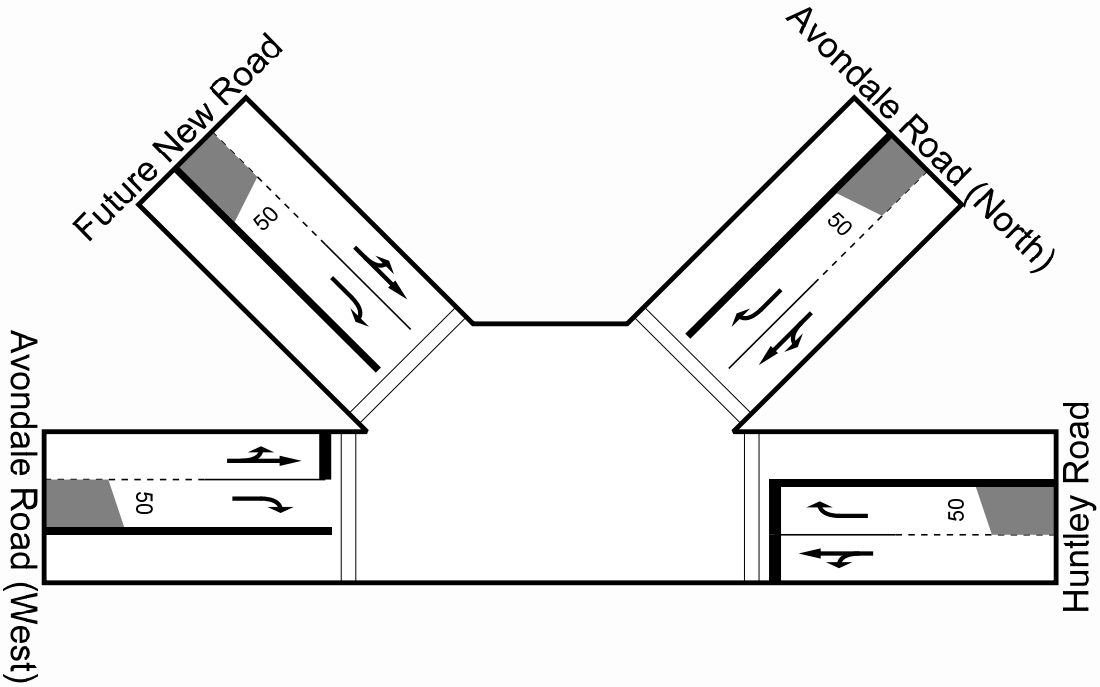
Figure 6.23 Huntley Road/Princes Highway Intersection Layout - SIGNALISED



The intersection of Huntley Road, Avondale Road and the Future New Road operates at a LoS F with significant delays during the 2026 AM and PM peaks with a roundabout intersection. It recommended that this intersection become signalised. This intersection will require upgrading regardless of any future traffic generated by this development or other developments in the area.

Figure 6.24 shows the layout of this intersection with upgrades and traffic signal operation.

Figure 6.24 Huntley Road/Avondale Road/Future New Road Intersection Layout - SIGNALISED



7.0 IMPACT ASSESSMENT

7.1 INTRODUCTION

This section reports on the likely transport impacts arising from the evaluation of the development and staging of the site. This section includes the assessment of impacts based on private vehicle and public transport modelling (refer **Section 6**), as well as qualitative input for the active modes of walking and cycling.

The modelling task summarised in **Section 6** provided a means to test the impact of the development of the IIHP development. The modelling considers the mode split (including freight) of generated trips for the following time frames:

- 2008 Base
  - Base week day AM/PM and
  - Base week day AM/PM plus Stage 1 of the development;
- 2016 Scenario 1 'Business as Usual' - this is an assessment as per the future road network, with current public transport service levels:
  - Base week day AM/PM and
  - Base week day AM/PM plus Stages 1-5 of the development;
- 2026 Scenario 1 'Business as Usual':
  - Base week day AM/PM and
  - Base week day AM/PM plus full development.
- 2026 Scenario 2 State Plan target of 25% Journey to Work (JTW) by public transport at full development stage (2026) – this assessment would require considerable additional public transport services to the site and upgraded Active Transport facilities:
  - 2026 Base week day AM/PM and
  - 2026 Base week day AM/PM plus full development.

7.2 PUBLIC TRANSPORT IMPACTS

Government policy places a strong emphasis on improving the sustainability of travel patterns and transport networks. Reducing the dependence on the private vehicle, particularly for journey to work trips, is an important step towards improving the sustainability and economic viability of the transport network as a whole.

As part of the preparation of this TMAP, the Ministry of Transport specifically requested that the following matters be addressed:

- Estimate of the likely modal split (including freight) of trips generated by the IIHP development under a 'business as usual scenario';
- Assess the likely impacts of generated trips based on the likely modal split on existing transport infrastructure, land uses and urban environment;
- Develop a package of measures to meet the State Plan target of 25% Journey to Work Trips by public transport at full development; and
- Assess the likely impacts of generated trips based on the higher modal split to public tansport

The following analysis has been undertaken for a full development scenario in the future year of 2026. This year has been selected for consistency with the TRACKS model, and for full development.

7.2.1 Scenario 1 'Business as Usual'

An analysis of the latest available (2006) journey to work data for the Dapto/Penrose area was undertaken in Section 4.0. The results indicate that the area is presently extremely dependent on the car for travelling to and from work. For JTW trips with a destination in the Dapto/Penrose area, public transport has a mode share of only 1.3%, whilst for JTW trips originating in the Dapto/Penrose area, public transport has a mode share of 4.2%.

The low public transport patronage for JTW trips reflects the current state of the public transport network in Dapto and across the wider Illawarra region. Section 3.3 identified that service frequency and operating hours are restricted, bus routes are indirect and that the present fare structure discourages intermodal and intra-modal transfers. The dispersed trip origin and destination combinations and the low density residential development make it very difficult to provide a suitable LoS for public transport to make services attractive to those with choice of travel mode. Current public transport services do not meet the needs of the population.

At present, the only freight carried by rail to/from the Dapto area is bulk materials, such as coal (e.g. to/from Wongawilli) and steel (e.g. to/from Tubemakers Siding at Kembla Grange). Whilst a container service operates to and from Bomaderry, there are no intermodal transfer points in the Dapto area to facilitate delivery or receipt of general freight traffic. Historically, rail carriage of less than container load (LCL) freight has been actively discouraged as part of the reform and modernisation of the rail network. The nature of freight being transported to/from the IIHP site would mean that it will occur in trucks and delivery vehicles on the existing road network.

Under this 'business as usual' scenario it has been assumed that:

- No changes are made to the ticketing structure of public transport services;
- No changes are made to the present operating hours and approximate service frequencies;
- No changes are made to the general layout of the bus network;
- Bus routes 33 and 43 have been re-routed via Avondale and Huntley Roads, instead of via Penrose Drive, to serve the IIHP site;
- As the West Dapto Urban Release Area is developed, bus routes are introduced with operating hours, service frequency and directness characteristics similar to existing routes; and
- All freight and service deliveries to the site will be by road.

The proportional growth in public transport trips (but not mode share) may require some small amplification to current service levels in order to provide sufficient capacity to cater for extra trips. The analysis of the trips generated by the development of the IIHP indicates that it would generate 27 trips inbound during the AM Peak and 7 trips outbound and 12 trips inbound and 29 trips outbound during the PM Peak.

The additional trips generated will require some additional bus services to provide sufficient capacity. Whilst service increases will generally result in additional demand, any such service amplifications are likely to be small, irregular, demand-lead and thus unlikely to provide the increase in service levels required to attract significant mode shift.

Under this 'business as usual' scenario, it is likely that public transport mode share will generally remain constant, due to the relatively low LoS. Few users are likely to be attracted to public transport, as an alternative to the motor vehicle.

Consequently, the private vehicle will continue to be the dominant transport mode for the IIHP site and the Dapto area under this scenario, requiring the road network to be upgraded to handle the vehicle trips generated by the IIHP site. Aside from traffic congestion issues discussed in Section 6.0, those without access to a private vehicle will be restricted in their options and times of travel to access the IIHP.

Given the types of deliveries that would be generated by the IIHP it would be expected that they would occur via road freight.

7.2.2 Scenario 2 '25% Public Transport Mode Share'

The State Plan, Chapter 3 – Delivering Better Services,
Priority S6: Increasing Share of peak hour journeys on a safe and reliable public transport system.

Target – *"Increase the proportion of total journeys to work by public transport in the Sydney Metropolitan region to 25 per cent by 2016 (currently 20-22 per cent)."*

The New South Wales State Plan sets a mode share target of 25% of JTW trips by public transport in the Sydney Metropolitan Area. The Ministry of Transport has requested that a package of measures be developed to support this target for the IIHP site. Network planning to support a mode share of 25% to public transport needs to focus on providing a base service of sufficient standard to attract choice users first of all.

The target of 25% mode share to public transport for JTW at full development is a substantial increase on the current mode share for public transport in the Illawarra. When considered in the light of the State Plan target and the existing percentage of JTW by public transport for the Sydney Metropolitan region, this equates to a mode shift of 3-5% to public transport from the existing situation. As highlighted in the assessment of the existing journey to work data outlined in Section 4.0 the share of public transport to and from the Dapto area is substantially lower than for the Sydney Metropolitan Region.

A review of 2006 JTW data for the Wollongong and Shellharbour Council areas indicates a mode share to public transport (bus and train) of 4% and 2% respectively. JTW figures for the Dapto area are less than this at 1.3% (as a destination) and 4.2% (as an origin).

Information from the Ministry of Transport's Transport Data Centre indicates that, of the regional centres within the Sydney Metropolitan Area (Parramatta, Penrith, Liverpool and Campbelltown) only Parramatta has attained a 25% mode share to public transport for JTW at this time[1]. Parramatta is serviced by both rail and bus with a major transport interchange also being provided. It is serviced by approximately 26 trains per hour in the AM peak and 45 separate bus routes.

This LoS is not practicable in the Wollongong region and indicates that a figure of 25% mode share to public transport for JTW is unlikely to be achieved other than in those areas where a comprehensive and extensive transport system is able to be provided, such as regional centres in the Sydney Metropolitan area.

In this regard, it would require the duplication of the South Coast Rail line to provide the opportunity for an increased frequency of train services, the implementation of the proposed Huntley Station and the provision of a significant number of bus routes in the Illawarra region as a whole.

A more realistic goal for the proposed development would be a mode share shift of 3-5% of the projected JTW trips, representing a doubling of the existing mode share.

As an example, under the current mode share for the Dapto area (1.3% for public transport) the proposed Health Precinct would generate 33 trips in the AM peak and 41 trips in the PM Peak at full development (2026), with a daily number of trips of approximately 250. Under a 25% mode share scenario these volumes would increase to 564 in the

[1] Transport Data Centre – Transfigures, December 2008; Employment and Commuting in Sydney's Centres, 1996 - 2006

AM Peak and 712 in the PM Peak. These volumes would require 12-14 buses operating in the peak periods, or a bus every 4-5 minutes, not allowing for the concentration of arrivals and departures to coincide with work start and finish times.

An assessment of the future public transport trips for the development using a mode shift of 4% for JTW, giving a total public transport mode share of 5.3% indicates that the AM Peak trips would be 120 (96-inbound, 24-outbound) and the PM Peak trips 151 (45-inbound, 106-outbound).

The nature of the urban form of the Dapto and greater Illawarra areas, results in dispersed trip origins and destinations which are difficult to serve by public transport. Public transport in the Dapto area is characterised by circuitous bus routes with corresponding long travel times, low service frequency, short operating hours, and a limited range of possible origin/destination combinations) which make it a less attractive option than driving.

The present low public transport mode split shows that existing services do not meet the travel needs of the population.

The IIHP development will employ a wide range of staff in varying roles. Shift workers, such as cleaners, retail workers, and possibly nurses would be more likely to choose public transport over the private vehicle due to lower car ownership and availability. However, shift workers typically start and finish work outside of the traditional peak travel periods, when public transport services are generally of lower quality (i.e. frequency, express running, range of services operating) than in the peak periods. Additionally, travel times for private vehicle trips during these periods are often reduced and consequently public transport needs to provide a higher LoS in order to attract choice users. The likely dispersed trip origins associated with JTW trips requires comprehensive network coverage.

Whilst the primary aim is to increase the public transport mode share of JTW trips, the public transport network will undoubtedly serve more than just these trips. It is not possible to design a network that solely caters for a 25% JTW mode share – other trips will inevitably be attracted to a network which provides the LoS required to reach 25% JTW trips. Similarly, JTW trips are often combined with other trips – such as shopping, sport and recreation activities – and the public transport network must provide the opportunity for such multi-purpose trips to be undertaken, in order for a choice user to prefer public transport over the private vehicle.

The present public transport network in the Dapto area is uncoordinated and particularly confusing to unfamiliar users due to inadequate bus service information. There is little integration between bus and rail services, causing significant inefficiencies in the network which result in reduced service levels. A review of the bus network is required, taking into account the proposed residential developments in the area and using the rail line and the Wollongong-Shellharbour strategic bus corridor as the basis. These could be supplemented with regional and local bus services to ensure the adequate provision of public transport options for future residents and employees.

The development of an overall effective public transport system will need to be undertaken by the bus operator(s), in conjunction with Railcorp and the Ministry of Transport. However, the new network should be designed with the following principles in mind:

- An easily understood and simplified route structure, from the user perspective. The present route structure is confusing, with irregular diversions and circuitous one-way loops, which is intimidating for unfamiliar users. The route structure should be completely redesigned in the form of a grid, modified to suit local and regional trip generators and travel desire lines.
- Improved levels of service, including a base service frequency of 2 services per hour, and 3 services per hour in peak periods.
- Maximising return on investment. The rail line, which functions as a transport spine in the Dapto area, is underutilised, particularly for local trips. The high fixed investment is providing little return due to poor service

frequency and an absence of integration with the bus network, which relegates its use to mainly long distance commuter trips. The population distribution of the Illawarra region also makes it difficult for the rail line to serve local trips. The provision of a railway station at Huntley Road would increase the attractiveness of rail services as a mode of transport to/from the IIHP site and reduce the distance between the site and the nearest rail service.

- High service frequency on all routes. Adequately serving dispersed origin and destination combinations requires comprehensive network coverage. It is difficult to provide comprehensive network coverage efficiently without the use of intermodal and intramodal transfers. These transfers need to incur minimal time penalty to the user.
- An integrated fare structure which does not penalise users for transferring between services or modes. A review of fare structure needs to be implemented, potentially as part of the integrated ticketing project, where transfers are not penalised, in order to encourage full use of the network.

It is understood that significant changes in the urban form and development of the Dapto area will be undertaken over the next 20 years with the gradual development of the West Dapto Release Area, and that it will consequently be difficult to establish a full public transport network until development of the release area has reached an advanced stage. However, the NSW government must ensure that an attractive public transport network is provided from the beginning of these developments to encourage new residents to develop good transport habits. The government should be aware that in the absence of an attractive public transport network, as described previously, people will continue to drive, particularly in these new release areas. Early provision of bus links between the IIHP site and Bong Bong Town Centre, Horsley and other parts of the West Dapto Release Area should be undertaken. If these links are not initially required for private vehicle traffic, then the opportunity exists to provide them, at least initially, as bus-only links and further reinforce the attractiveness of public transport services.

In order to encourage increased mode share to public transport it is proposed that the following measures should be implemented to better serve the IIHP site:

- Once construction of the IIHP site commences, bus routes 33 and 43 should be re-routed via Avondale and Huntley Roads, instead of via Penrose Drive. Bus stops should be provided along the southern side of Avondale Road and the northern side of Huntley Road;
- With the commencement of operations of the first stage of the IIHP site, bus routes 37 and 57 should be re-routed from Princes Highway via Avondale and Huntley Roads, with service frequency of, at least, 20 minutes during peak periods and 30 minutes at other times of the day. The re-routing of the trunk route via the IIHP site is justified, given the significant trip generation of the site and the small (estimated to be approximately 4 minutes) diversion required; and
- Avondale Road railway crossing should remain open to bus traffic until the link between Avondale and Cleveland Roads (referred to as Fowlers Road extension in this report) has been opened to traffic. The closure of Avondale Road to bus traffic without an alternative route, would significantly reduce the accessibility of the IIHP site, imposing an undesirable situation where buses would either have to travel the loop via Cleveland Road, Avondale Road and Huntley Road, or travelling on a loop service that both enters and exits the area via Huntley Road.

7.2.3 Site-specific Public Transport Infrastructure

Bus stops to serve the IIHP site should be provided, as a minimum, at the following locations:

- Huntley Road at the eastern boundary of the site, adjacent to the entrance to the residential accommodation;
- Huntley Road adjacent to the main hospital entrance;
- Avondale Road, immediately to the north of its junction with Huntley Road; and
- Avondale Road, approximately 80-100 metres from the intersection with Turnbull Crescent.

While Avondale Road remains open to bus traffic, bus stops should be provided on Avondale Road along the northern boundary of the site at approximately 600 metre intervals. Once Avondale Road is closed, these stops can be removed as bus services will travel via Fowlers Road Extension.

All bus stops should be provided with shelter, seating, details of the routes that serve the stop, a timetable and a public transport network map tailored to suit the stop location.

7.2.4 Conclusions

The above analysis concludes that the existing public transport network does not meet the needs of the present population.

This 'business as usual' scenario adopts the current public transport mode share for JTW. This results in a low volume of additional patronage, proportionate to the additional trips generated by the IIHP site, but does not achieve the State Government's objectives of reducing car dependence and increasing the sustainability of the transport network. Diversion of the present route 33 and 43 bus services to serve the site will be required, as will bus links to the West Dapto Urban Release Area as it develops.

Given the low starting point, both from JTW mode share and service provision perspectives, a mode share target of 25% JTW trips by public transport, would require significant change and investment over the long term. A more realistic goal for JTW would be a mode share of approximately 5% to public transport.

The bus network needs to be enhanced in order to increase the number of potential trip origin and destination combinations, improve travel flexibility and redundancy, improve travel time and integrate seamlessly with rail services. Similarly, rail services need to be increased to complement and seamlessly integrated with the bus network. It must be noted that these works are required to support the JTW mode share target for the IIHP site, however these works are required regardless of whether the IIHP development proceeds, in order to increase JTW mode share in the Illawarra region as a whole.

Construction of the proposed Huntley Railway Station, in conjunction with an upgrade of rail service frequency, would increase the attractiveness of the public transport network, not only for journeys to and from the IIHP site but also for other trips. The directness of the rail service, and the limited stops, would produce time savings compared to journeys by bus for trips to/from destinations such as Wollongong and Shellharbour. The proposed Huntley station is located within the walking catchment of the IIHP site and, for less mobile travellers, easy bus-rail interchange could be provided on Huntley Road. The provision of a station at this location would also facilitate faster interchange between bus and rail services than could be achieved at Dapto, for trips to/from areas south of Emerson Road.

An integrated fare structure needs to be implemented to promote seamless intermodal and intra-modal transfers, facilitating the frequent modified grid network and the maximum number of potential origin and destination combinations.

7.3 INTERNAL ACTIVE TRANSPORT IMPACTS

7.3.1 Analysis

The nature of the development necessarily involves significant numbers of vulnerable pedestrians including disabled, aged, and children. The built environment will therefore need to comply with the Australian Standard AS1428.4:2002 *Design for Access and Mobility* which addresses walkways, ramps, landings, handrails and grabrails, signage and tactile indicators.

Additionally the site will need to design the vehicular/pedestrian environment to the highest level of internal road safety. This will require that all pedestrian footpaths and walkways are exclusively for pedestrian and wheelchair traffic. The use of shared paths for pedestrians and bicycles are not appropriate for a hospital site along the main access routes, such as those between the site and adjacent road network and to key health service buildings.

Within a hospital setting, the width of the internal network of footpaths needs to accommodate pedestrians with various disabilities as follows to comply with AS 1428.2:

- Ambulant disability – 1000mm
- Wheelchair user – 1200mm
- Wheelchair and pram – 1500mm
- Two wheelchairs – 1800mm.

Based on the above, the standard for pedestrian footpaths on site should be 1800mm.

The AUSTROADS *Guide to Traffic Engineering Practice – Pedestrians (Part 13)* discusses design guidelines for pedestrians. The table below lists some common mitigating requirements for pedestrian planning which should guide the design of pedestrian facilities on-site.

Table 7.1 Some Key Requirements for Special Needs Groups

Key Requirement	Special Needs Group			
	Impaired Vision	Impaired Hearing	Mobility Impaired	Children
(a) contrast / delineation between footpath & road edge or nature strip	✔		✔	
(b) tactile tiles on kerb ramps	✔			
(c) clear path of travel on foot path	✔		✔	
(d) good street lighting	✔		✔	✔
(e) clear view of oncoming traffic from kerbside		✔		
(f) longer crossing times	✔		✔	
(g) audible pedestrian signals	✔		✔	
(h) kerb ramps	✔		✔	
(i) smooth even paving surface	✔		✔	
(j) clear view for oncoming drivers to kerbside at crossing points	✔		✔	✔
(k) guidance to safe crossing points with fencing				✔

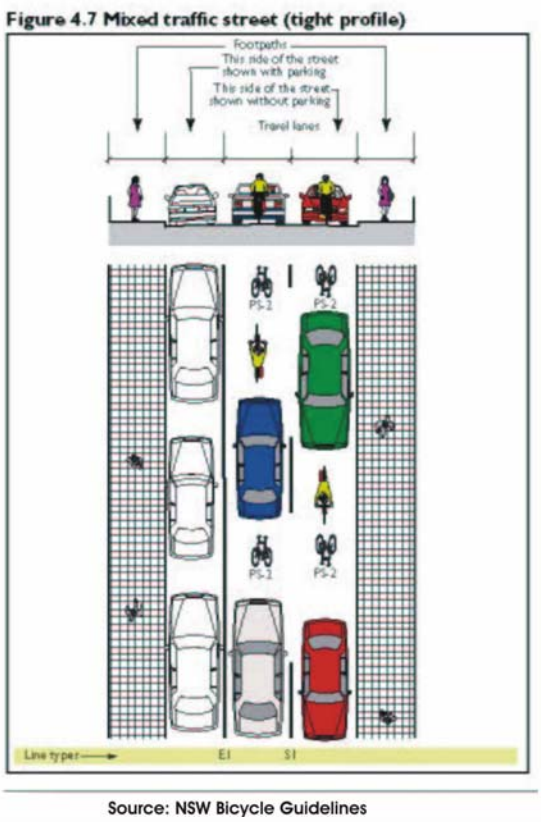
One of the key issues in an existing hospital campus, is the need for legibility of the hospital layout to the pedestrian searching for the most direct route to access various services/buildings. The advantage of a green field development is that the external and internal pedestrian flow environment can be coordinated and designed to best practice standards and guidelines in keeping with the end user. One way of achieving this is to clearly sign pedestrian and cyclist trip ends at all entries to the site and at critical decision points throughout the site to ensure seamless movement throughout the site by pedestrians and cyclists.

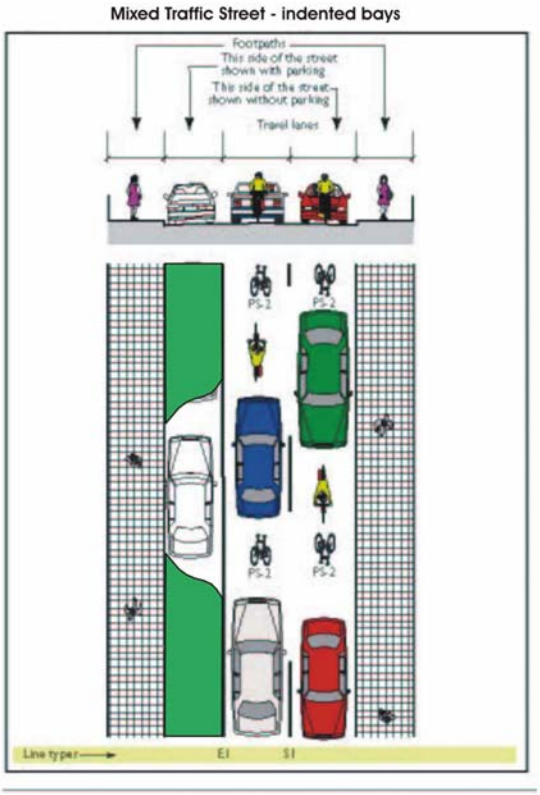
The road system within the site should have a speed limit of 20km/hr, appropriately signed at all entry points from the public road system with the regulatory 20km/hr speed signs. The most appropriate slowing device for light vehicles in a hospital environment is a raised threshold or speed hump within the road alignment.

Kerb side parking is not recommended as pedestrian/car visibility is reduced where cars are parked; indented car parking bays may be appropriate where drop off/pick up facilities are required.

The design of internal roads needs to accommodate bicycles as well, where in a 20km/hr speed environment, bicycles are able to travel with cars in safety. The appropriate road layouts are illustrated in Figure 7.1.

Figure 7.1 Examples of Appropriate Internal Road Layouts





Source: NSW Bicycle Guidelines

Shared Zones of 10km/hr can be designated on short links. In a hospital environment, these are most appropriate away from patient or the disabled movement corridors. The RTA *Shared Zone Guidelines* (1987) state that:

> 'The basic premise of a Shared Traffic Zone is that pedestrians have equal rights to motor vehicles in a specified area…..The design of the vehicular path should aim at physically achieving the travel speed of 10km/h by the use of sharp turns, speed humps and threshold treatments. Straight stretches of more than 25 metres without treatment should be avoided.'

The photographs below illustrate that the design materials of such environments are important in designating a shared space which varies from a normal road space dedicated only to vehicles.

Photograph 7.1 Example of Shared Zones

Photograph 7.2 Example of Shared Zones

The development site should be designed so that loading docks and/or ambulance bays are separated from the pedestrian and cyclist movement areas. This can be achieved by direct dedicated access for these vehicles from the external public road system.

The bicycle parking requirements are discussed in Section 5.5. While commuter bicycle facilities are best accommodated in the car parks, end of trip bike racks for short term visitor parking can be located as near to the entrance of buildings as possible. The visitor bicycle parking should desirably be under cover and with minimal conflict with pedestrian flows. Well-positioned signs should direct cyclists to all visitor bicycle parking, and bicycle parking facilities should be included on relevant visitor maps. For bicycle commuters, shower facilities, changing rooms and lockers for helmet and cycling gear should be available within easy reach of the main commuter bicycle parking area.

7.3.2 Conclusions

The following conclusions refer to onsite requirements which equitably address the active transport (walking and cycling) needs:

- The Australian Standard AS1428.4:2002 *Design for Access and Mobility* should guide the key disability design components of the site;
- Footpaths and crossing facilities should be designed to a higher standard accommodating mobility impaired pedestrians and children;
- A low speed road environment should be established for the site and reinforced with built slowing devices;
- Shared movement areas such as Shared Zones are not appropriate where mobility impaired pedestrians prevail;
- Light vehicle and bicycle traffic can share the low speed road space;
- Onsite pedestrian and cyclist trip ends should be clearly signed throughout the site.

A recommended package of works based on these conclusions is presented in Section 8.3.

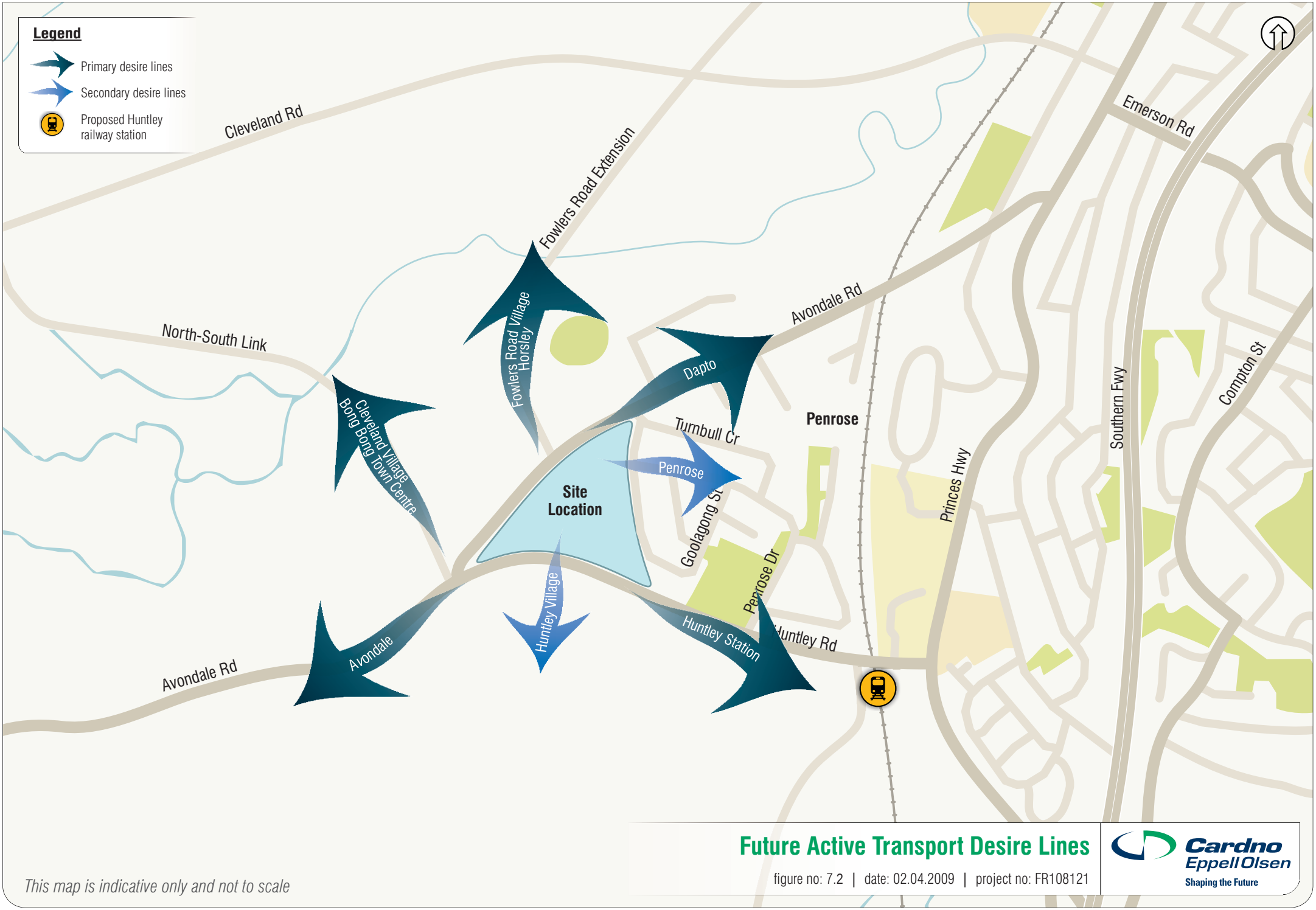
7.4 EXTERNAL ACTIVE TRANSPORT IMPACTS

7.4.1 Analysis

An analysis of the present walking and catchments was undertaken in Section 3.4. The analysis showed that the residential suburb of Penrose is entirely within the walking catchment of the IIHP site, and that a large portion of the southern Dapto residential area is within a 30 minute walk of the site. Whilst the majority of the Dapto residential areas, including Koonawarra and Horsley, are within a 30 minute bicycle ride from the site, it was identified that routes to Cleveland and Horsley were indirect due to the layout of the road network to the west of the railway line.

When the IIHP site reaches full development, it is anticipated that Stages 1 to 4 of the West Dapto Urban Release Area will also be nearing full development. The development of the release area to the north and west of the site will not only provide more dwellings within the existing active transport catchments, but also create new desire lines and the need for new links to expand the catchments.

The most important active transport desire line is likely to be between the IIHP site and the proposed Huntley Railway Station, with both pedestrians and cyclists accessing the rail network. Dapto Town Centre, as the closest sub-regional centre, will also be a strong desire line for cyclists. Until Huntley Station is constructed, Avondale Road will function as the primary cycling route to and from the IIHP site. Huntley and Penrose villages are located close by the IIHP site and it is anticipated that there will be strong pedestrian desire lines for movement between the site and the adjacent medium-density commercial and residential area. Avondale, Cleveland, Fowlers Road villages and Penrose are all likely to act as dormitories for workers and visitors to the site. These desire lines are shown in **Figure 7.2**.



Future Active Transport Desire Lines

figure no: 7.2 | date: 02.04.2009 | project no: FR108121

Cardno Eppell Olsen
Shaping the Future

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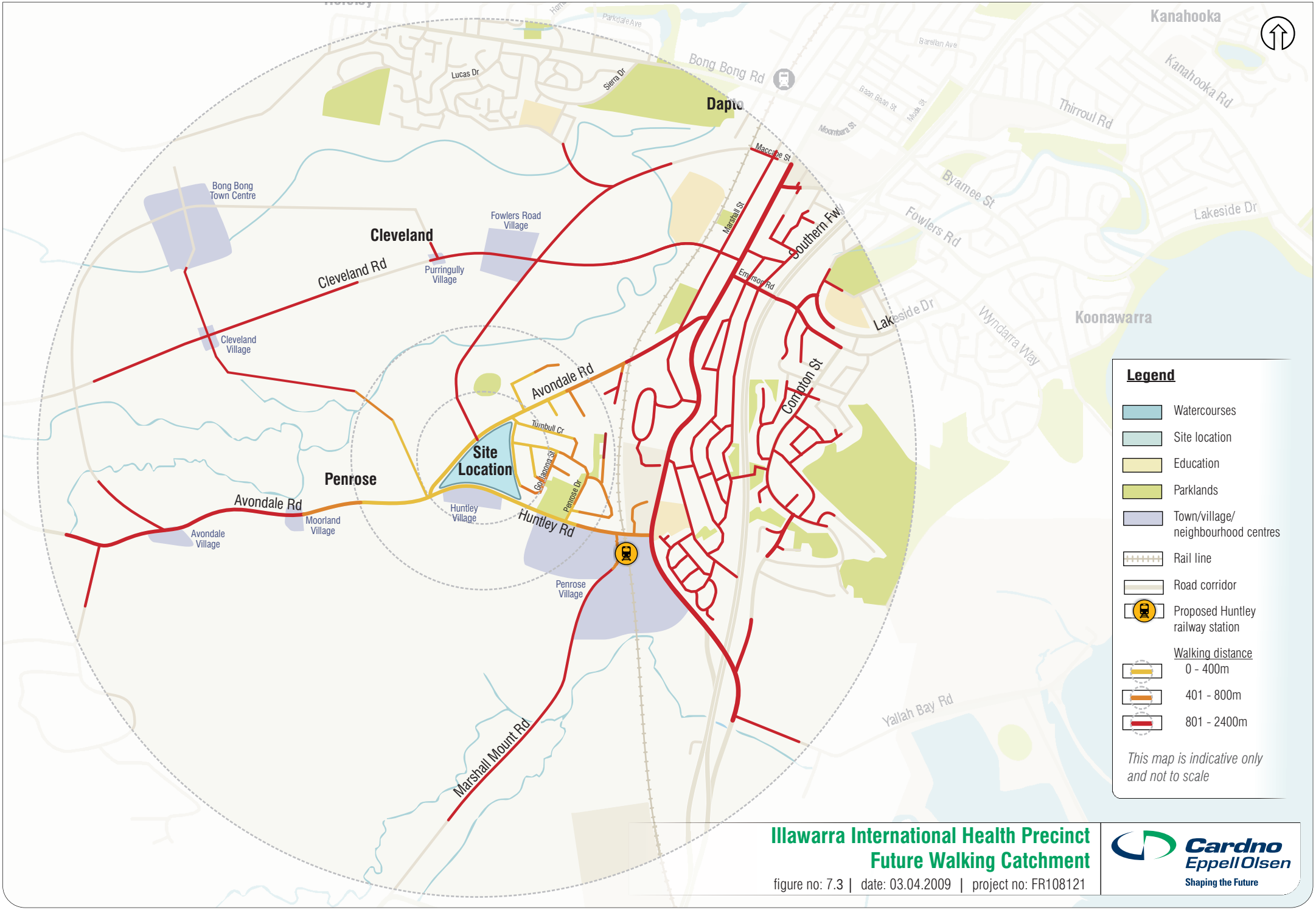
The future road network adopted for the purposes of this TMAP was developed from the West Dapto Master Plan and the 2026 WOLSH TRACKS model, representing forward planning undertaken jointly by the RTA and WCC. The future road network is detailed in **Section 6.6.3**. Assessment of the future active transport catchments was undertaken based on the availability of the additional road links included in the future road network, however the model and the Master Plan only provide firm details on the location of the primary movement corridors (i.e. sub-arterial and major collector roads) and consequently details of the local street layouts within the release area have not been shown. It has also been assumed that pedestrian and bicycle access has been retained across the railway line at the site of the present

The results of the assessment are presented in **Figure 7.3** and **Figure 7.4**.



Illawarra International Health Precinct
Future Walking Catchment

figure no: 7.3 | date: 03.04.2009 | project no: FR108121

Cardno Eppell Olsen
Shaping the Future

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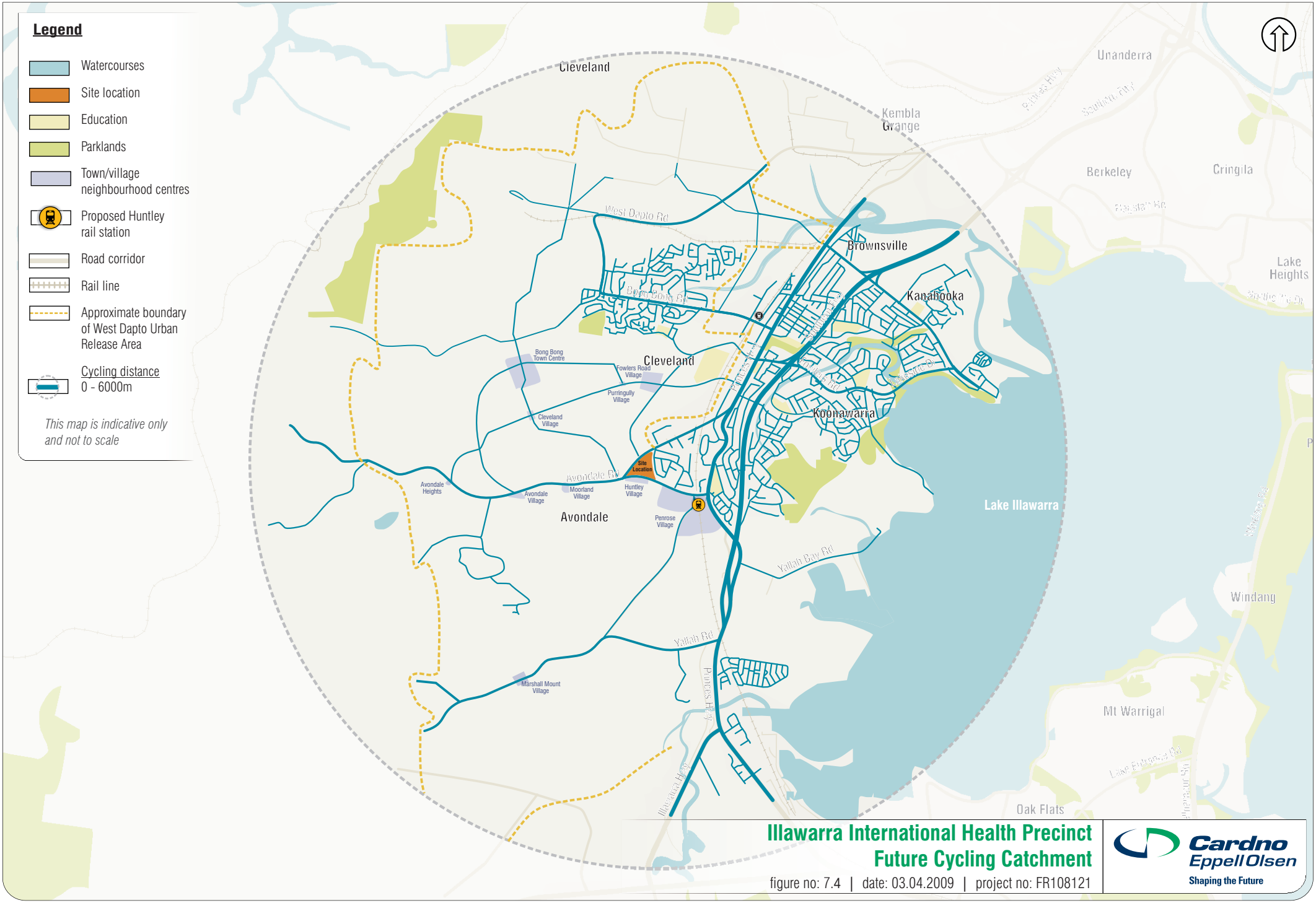

C:\CK Shared Artwork Folder\SYDNEY\FR108121_maps & figures108121 Cycling Catchment.cdr

Figure 7.3 shows that the additional road links presented in the future road network increase the walking catchment of the IIHP site. The proposed Huntley Railway Station is located within the walking catchment of the site, as are Huntley and Penrose villages. The future development nodes of Fowlers Road Village, Purringully Village, Cleveland Village, Moorland Village and Avondale Village are all located within a 30 minute walk of the IIHP site, whilst Bong Bong Town Centre is located just beyond the 30 minute catchment.

Linear residential development along the Avondale Road corridor is well catered for, however additional pedestrian links on the northern side of Mullet Creek could expand the walking catchment to include additional areas along the Cleveland Road corridor. These links would be considered during the precinct planning process for the Cleveland area.

Figure 7.4 shows that the additional road links presented in the future road network increase the cycling catchment of the IIHP site by providing good penetration into the future development areas such as Cleveland, which are presently poorly served. Horsley is also brought closer to the IIHP site by the provision of the Fowlers Road Extension. It has been assumed that pedestrian and cyclist access across the rail line has been retained at Avondale Road and consequently this route remains the preferred cycling route to/from Dapto Town Centre, linking with the regional cycleway at Marshall Street and Amaral Avenue. **Figure 7.4** also shows that the vast majority of the West Dapto Urban Release area will be within the 6 kilometre cycle catchment of the IIHP site and the provision of cycling links through the residential areas will further improve the catchment. Such links will be considered as part of the precinct planning process.

To provide for safe pedestrian and cyclist movements across Avondale, Huntley and Fowlers Roads, major intersections adjacent to the IIHP site should be signalised. Additionally, footpaths should be provided on both sides of the primary movement corridors, with a shared path on at least one side. These measures will reduce the barrier effect caused by major roads.

7.4.2 Conclusions

The following conclusions have been drawn from the analysis of the future active transport desire lines and catchments:

- Direct pedestrian and cycle links should be provided between the site and adjacent road network to maximise permeability and consequently catchment area;
- Provision should be made for pedestrians and cyclists travelling between the site and the Huntley Railway Station;
- Access for pedestrians and cyclists should be retained at the Avondale Road level crossing;
- Cyclist facilities should be provided along Avondale Road and Marshall Street to serve as the major connection to/from Dapto Sub-Regional Centre and to maximise permeability across the railway line;
- The primary movement corridors in the West Dapto Urban Release Area should provide off-road facilities to cater for pedestrians and cyclists;
- Major intersections adjacent to the IIHP site should be signalised to provide safe crossing opportunities for pedestrians and reduce the barrier effect of these roads; and
- Pedestrian crossing facilities should be provided to cater for the desire line between the hospital entrance and future development located on the southern side of Huntley Road.

A recommended package of works based on these conclusions is presented in **Section 8.2**.

7.5 TRAVEL DEMAND MANAGEMENT

7.5.1 Introduction

Travel Demand Management is a tool for reducing the demand for private vehicle travel. Providing an environment that encourages sustainable transport is beneficial if it is used, ranging from good health of employees to reduced traffic on the surrounding area and results in less of a dependence on single occupancy car use.

Importance placed on sustainable transport in a workplace encourages employees to use such services and can reduce the travel time and cost for those who partake. It reduces the demand for on-site parking, which reduces congestion resulting in faster access to the facilities of the site.

A Travel Plan is a framework developed as a package of measures aimed mainly at changing travel habits of a place in order to provide an environment which encourages more sustainable travel patterns. All Travel Plans, if set up appropriately with a coordinated strategy, will have measurable outcomes.

7.5.2 Range of Options

Potential elements for inclusion in a travel plan at the IIHP include:

- setting up a car pooling scheme;
- improving the local pedestrian environment;
- providing cycle facilities;
- negotiating improved bus services; and
- charging for car parking.

The options suitable for the IIHP include promotion of sustainable transport such as walking, cycling, carpooling and public transport. Measures to discourage driving to the Precinct alone should also be used; such as charging for parking.

Carpooling

Carpooling is an initiative pursued by the New South Wales State Government to reduce car dependency and improve air quality in accordance with the *NSW State Plan.*

Proposed strategies include a guaranteed ride home and parking/petrol/car maintenance discount to urge more staff to car pool. Designated free parking areas or petrol vouchers can be offered to staff that participate in a car pooling scheme. Other potential issues that should be considered with car pooling include:

- participants require a guaranteed ride home (e.g. if they have to work late and they miss their ride, they receive a free taxi ride);
- the pooling service takes people to where they want to go;
- the service needs to be reliable (e.g. on time, regular, informed if any changes);
- social interactions should be managed to avoid potential conflict (e.g. smoking, non-smoking, radio stations etc.);
- provide alternative travel for use during the day if necessary (e.g. shuttle service if not in walking distance to shops).

Walking

Walking is a healthy mode of transport that does not cause a negative impact on the environment. Walking to work is an option that promotes good health to staff and improves moral and productivity.

The current pedestrian infrastructure is lacking, with footpaths not located near the precinct. An upgrade to the pedestrian network on the surrounding area would provide a safer and more efficient means for staff and visitors for travel. Providing information can encourage staff and visitors to walk to the IIHP site. Information that encourages walking includes:

- walking maps;
- healthy lifestyle information;
- journey planners;
- local access maps (showing community facilities, cycleways, and public transport information);
- public transport timetables (and encourage walking from the nearby facilities).

Cycling

Cycling is another alternative to driving that is environmentally friendly and healthier. Cycling is relatively cheap and easy.

Cycleways are provided on the Princess Highway and are proposed to be extended north. The surrounding roads to the Precinct are not heavily used and would not require specific cycling facilities. To encourage cycling the following information that can be provided:

- cycling maps;
- healthy lifestyle information;
- journey planners;
- information on bicycle care and maintenance;
- local access maps (showing community facilities, cycleways, and public transport information);
- public transport timetables (trains and buses that provide bicycle transport).

On-site bicycle parking facilities help enable people to safely store their bicycle on-site. Bicycle racks and rails provide a place for riders to lock their bikes using their own locks. They are best arranged in groups or clusters situated near buildings that have on-site security. Another alternative that provides greater security are bicycle enclosures. These can be rooms or compounds that are locked that should be fitted with a roof for greater security and weather protection. The most secure way for riders to store their bicycles are bicycle lockers. These restrict access to one user and typically allow room for helmets and other cycling gear. This alternative is most suitable for staff that would most likely be storing their bicycle all day.

Public Transport

Public transport caters for large groups of people travelling to a destination and for this reason has less impact on the environment than single occupancy vehicle transport.

There are bus routes and railway lines that are in close proximity to the Precinct, however currently no bus or rail services directly serve the IIHP site. Therefore people must walk from Avondale Road near Turnbull Crescent, cycle or catch a taxi to continue to the Precinct. The use of public transport with a conjunction with walking or cycling to the site can be encouraged by providing journey planners which outline public transport timetables and walking and cycling maps so people can plan their journey to reach their destination on time. Improvements to the public transport network are proposed in Section 7.2 to enhance the LoS provided to the IIHP site.