



PORT of TOWNSVILLE
Nexus North Queensland

Appendix M Traffic Impact Assessment

Townsville Marine Precinct Project
Environmental Impact Statement





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- A Queue Length Calculation
- B SIDRA 3.2 Results



1. Traffic Impact Analysis

1.1 Introduction

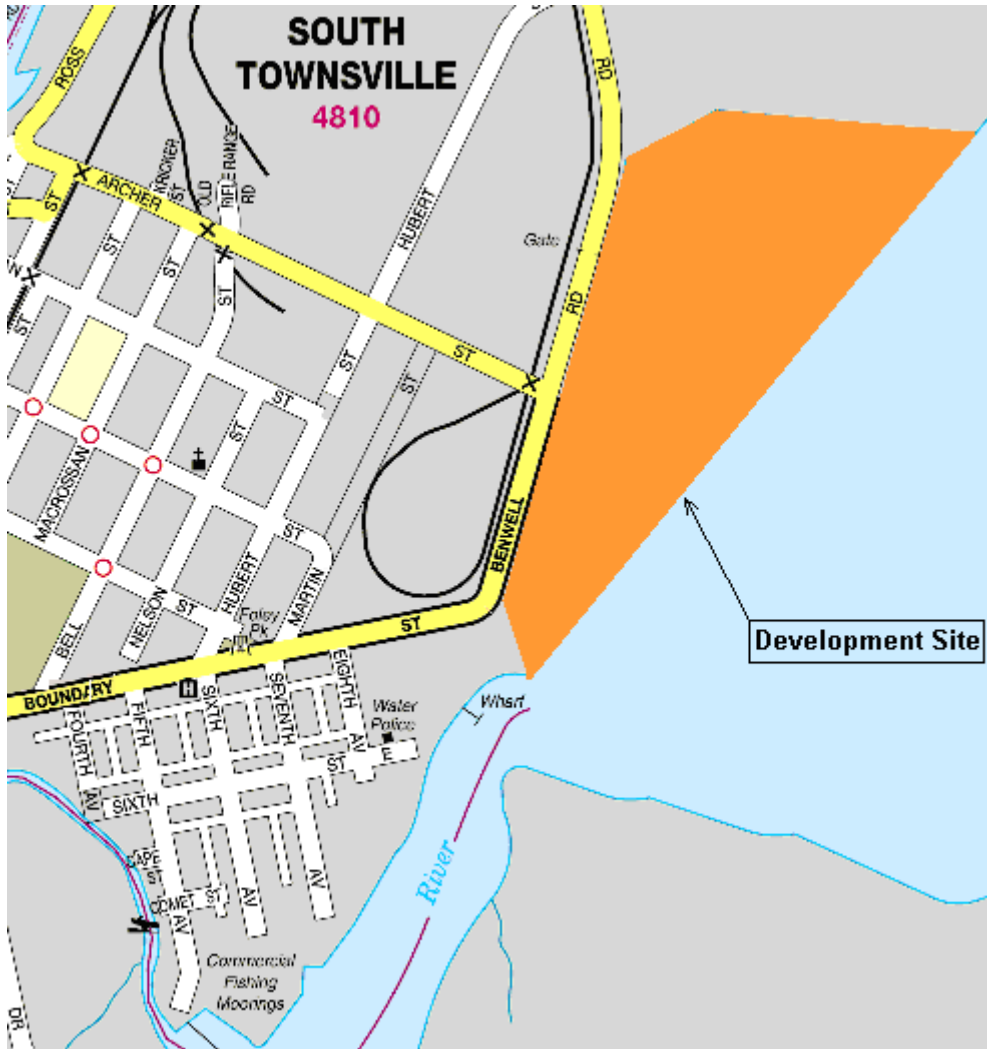
GHD Pty Ltd (GHD) has been commissioned by the Port of Townsville Pty Ltd to undertake a Traffic Impact Assessment (TIA) for the Marine Precincts port expansion consisting of mostly marine related light industry uses located on the eastern side of the Port of Townsville on Benwell Road. This assessment has been prepared to support an Environmental Impact Statement (EIS) for the proposed development.

The proposed development comprises of three stages with the following opening schedule:

- ▶ Stage 1 – 2011;
- ▶ Stage 2 – 2015; and,
- ▶ Stage 3 - 2017.

A locality plan is provided in Figure 1. This figure also highlights the intersections which have been considered in this analysis as agreed in consultation with Council and Department of Main Roads (DMR).

Figure 1 Development Site Locality Plan



(Source: Australian Regional Cities and Towns UBD 3.0)

Access to the development is proposed at two locations on Benwell Road. The overall site is approximately 34 hectares including 7 hectares of water. Based on preliminary drawings of the site prepared by Maunsell, the proposed development consists of approximately 18.8 hectares of trip generating area spread over 20 lots.

1.2 Existing Context

1.2.1 Road Network Details

It is intended that the first stage of the development will not be operational until the Eastern Access Road project is complete. It is understood that the construction of the Eastern Access Road across the Ross River is scheduled for completion in 2011. The development will be assessed during construction with the new road connection. The preliminary site layout which shows the relationship between the location of the Eastern Access Road and the proposed development is shown in Figure 2.

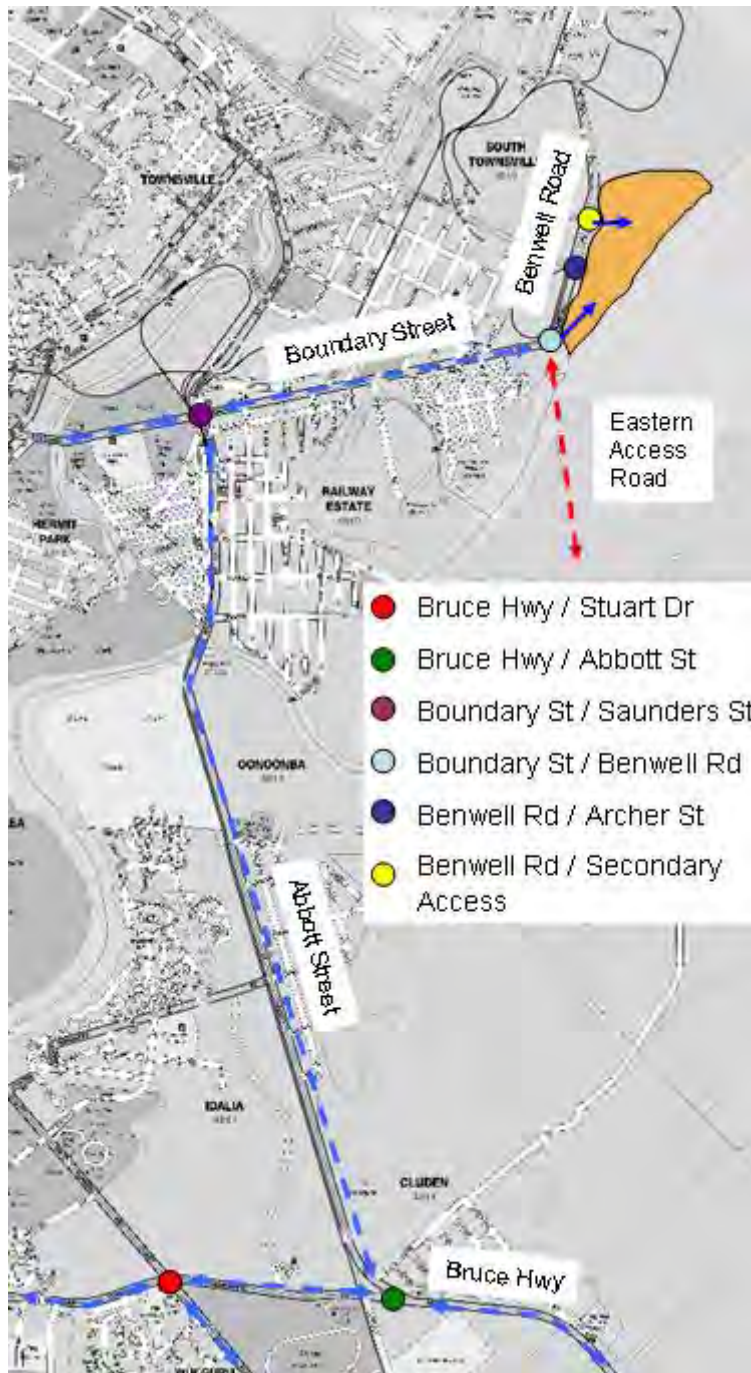
Figure 2 Indicative Site Layout and Eastern Access Road Corridor



(Port of Townsville – Townsville Marine Industries & Rec. Boating Precinct, Preliminary – 25 January 2008 – Maunsell)

The primary routes for haulage of construction materials and for operations are highlighted in Figure 3.

Figure 3 Intersection Location and Indicative Road Network Assignment



1.2.2 Surrounding Land Uses

The proposed development is located on the eastern side of the Port of Townsville on the north bank of the Ross River. The developed land directly to the southwest is classed as light industrial. It is understood that some tenants within this area will move into the proposed development. This light industrial area is proposed to be redeveloped into for residential uses. On the western side of the development residential land uses are found along with light industrial and rail yards. The Port of



Townsville's main berths are found to the north of the development including other industrial land uses associated with the port.

1.2.3 Background Traffic

Growth rates used for this assessment have been adopted from the *Townsville Port Access Road Traffic Assessment* produced by Maunsell. These are identified in Table 1.

Table 1 Background Traffic Growth Rates

| Stuart Drive | Bruce Highway | Abbott Street | Boundary Street | Saunders Street |
|--------------|---------------|---------------|-----------------|-----------------|
| 6% p.a. | 9% p.a. | 5%* p.a. | 4% p.a. | 5%* p.a. |

*Indicates that no growth rate provided and a nominal 5% p.a. has been assumed.

The growth rate for all roads in the vicinity of the port has been assumed at 7% p.a. Roads around the port relevant to the potential traffic related impacts of this development include:

- Benwell Road;
- Archer Street; and
- Eastern Access Road.

Figure 4, Figure 5, Figure 6 and Figure 7 show a summary of the traffic counts sourced from the Department of Main Roads.

Figure 4 2008 Observed Traffic Counts for the Boundary Street / Saunders Street Intersection

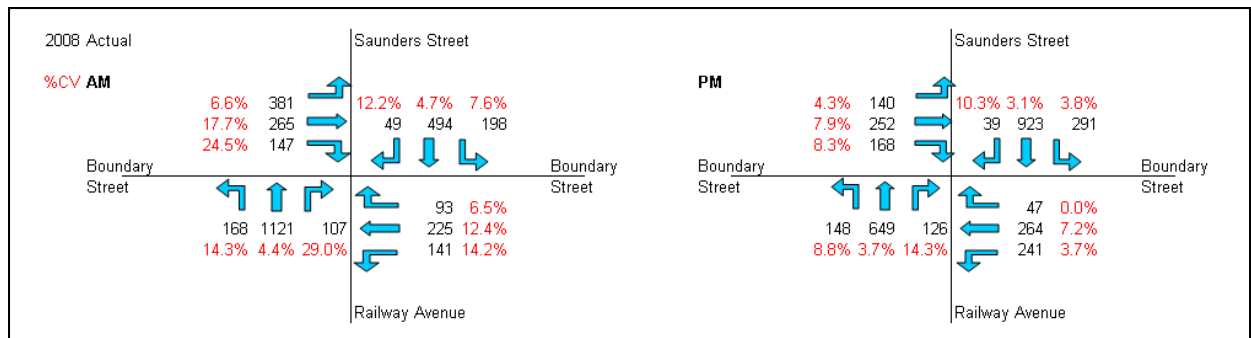


Figure 5 2006 Observed Traffic Counts for the Bruce Hwy / Abbott Street Intersection

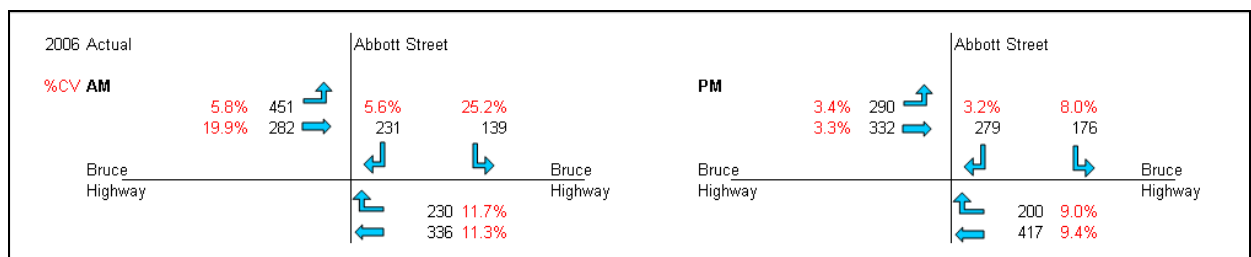




Figure 6 2006 Observed Traffic Counts for the Bruce Hwy / Stuart Drive Intersection

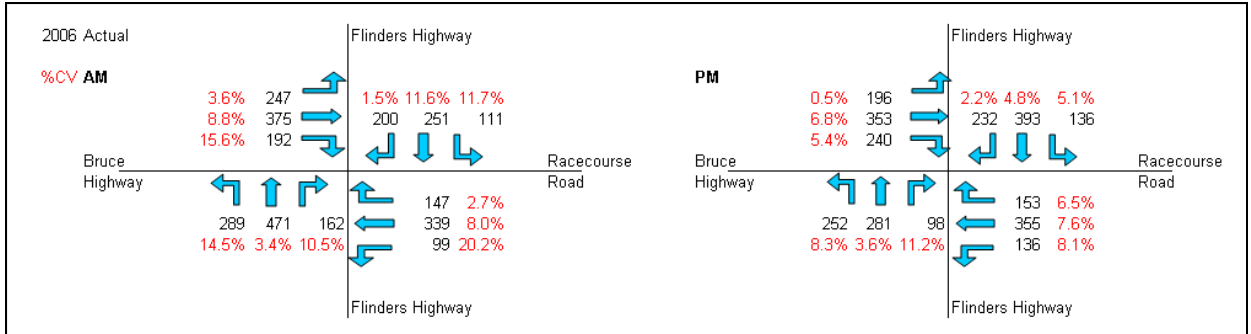


Figure 7 Observed Two-Way Counts for Benwell Road and Archer Street and Modelled Volumes for the Eastern Access Road

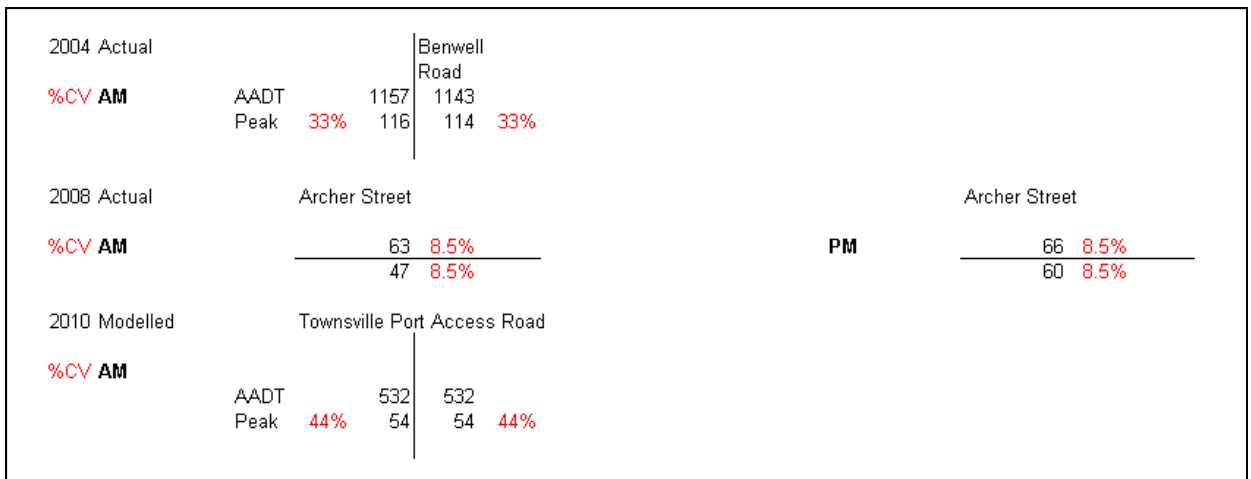
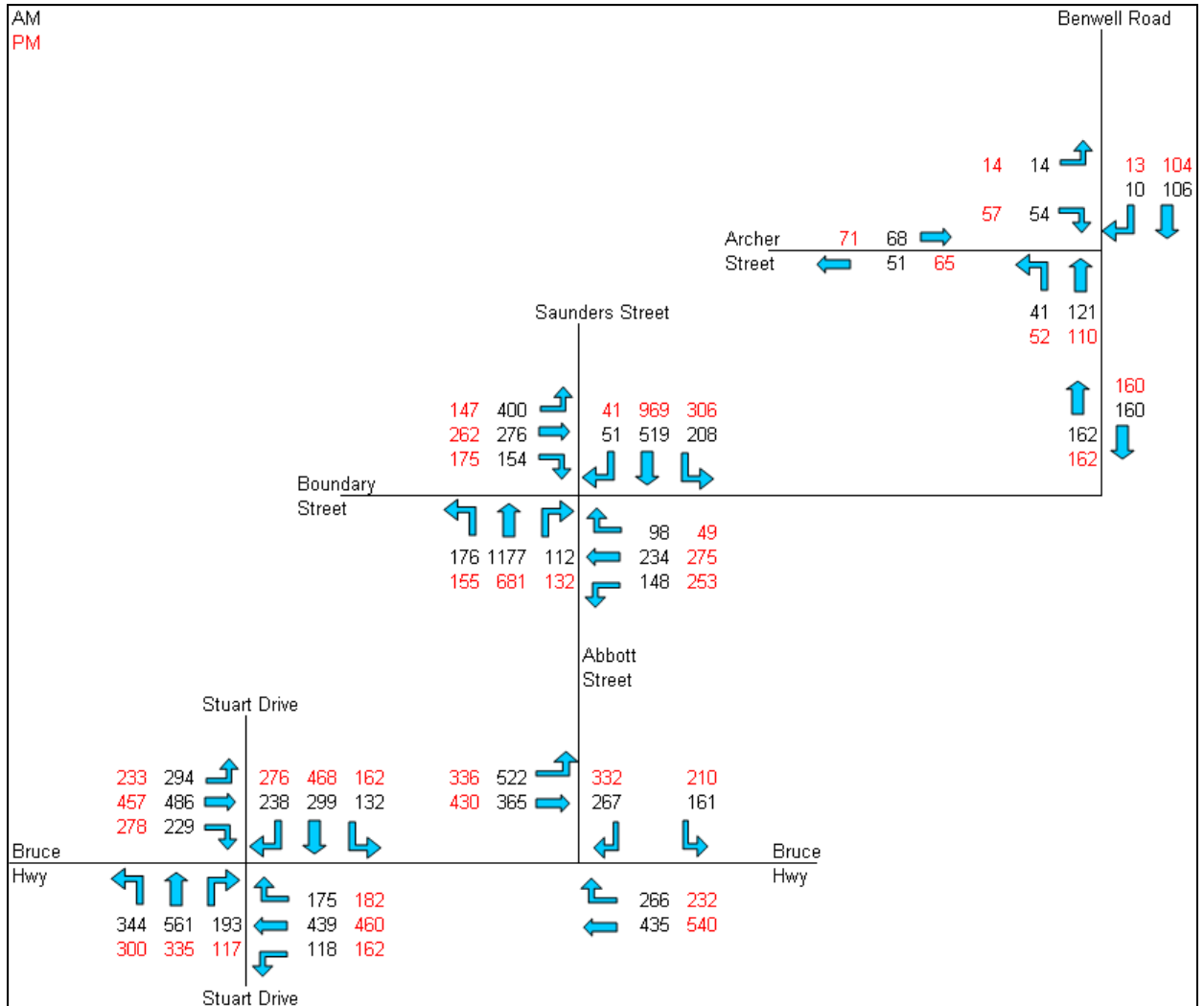


Figure 8 shows the design traffic volumes used for the 2009 background analysis that have been factored up from their respective years of observation to 2009 using the growth rates provided in Table 1.



Figure 8 2009 Background Traffic Volumes Grown from Traffic Counts



1.3 Proposed Development

1.3.1 Development Profile

The proposed development is an industrial reclaim consisting of approximately 18.8 hectares of trip generating land. The development will be constructed in three separate stages with the opening of the first stage to correspond to the completion of the Eastern Access Road scheduled for late 2011.

The analysis has been undertaken for the completion of all three stages with an anticipated opening year of 2017 as well as the 10 year horizon analysis of 2027. Further analysis has been undertaken for 2011 to understand the impact construction traffic will have on intersections within Townsville.

1.3.2 Site Access

The site currently has frontage to Benwell Road. By late 2011, the site frontage will be primarily to the Eastern Access Road and interaction with Boundary Road. The development plan provided by Maunsell



shows the marine precincts proposed access to the external road network via two new intersections to the site frontage located:

- ▶ A three-way intersection with Eastern Access Road to the north of Archer Street; and,
- ▶ A four way intersection with Boundary Street/Eastern Access Road.

1.3.3 Construction Traffic Generation

Table 2 shows the additional traffic due to project construction expected on the external road network. It has been assumed that all construction workers will arrive in the adjacent road network corresponding AM peak and will depart in the PM peak whilst heavy vehicles from the quarry will operate at 8 vehicles per hour in both directions between 6:00am and 6:00pm. The daily peak in construction workforce during the entire period of construction is expected to be 100 workers on-site at any point in time.

Table 2 Additional Traffic due to Construction

| Construction Workers | Vehicle Occupancy | Heavy Vehicles | Total Vehicles AM | | Total Vehicles PM | |
|----------------------|-------------------|----------------|-------------------|-----|-------------------|-----|
| | | | In | Out | In | Out |
| 100 | 1.5 | 8 | 75 | 8 | 8 | 75 |

1.3.4 Construction Traffic Splits and Distribution

The haulage route for construction traffic associated with Stage 1 is likely to impact the following intersections prior to the completion of the Eastern Access Road:

- ▶ Bruce Highway/Stuart Drive;
- ▶ Bruce Highway/Abbott Street; and
- ▶ Boundary Street/Saunders Street.

The assumed directional split for the construction workers is shown in Figure 9. Also shown is the number of heavy vehicles movements through the network. Figure 10 and Figure 11 show the volumes used in the analysis for without and with construction traffic respectively.



Figure 9 Assumed Directional Splits for Construction Traffic

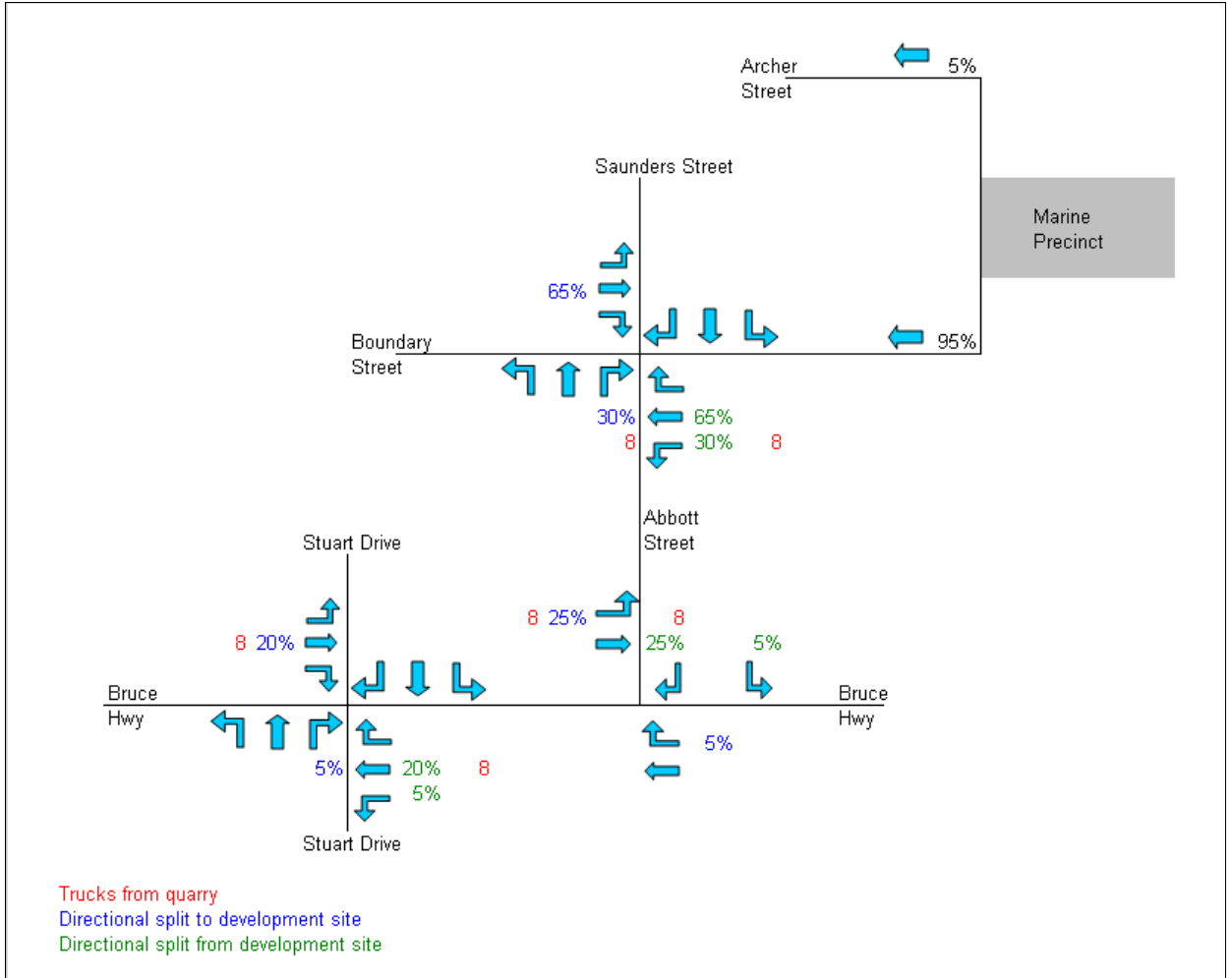




Figure 10 2011 Volumes Without Construction Traffic

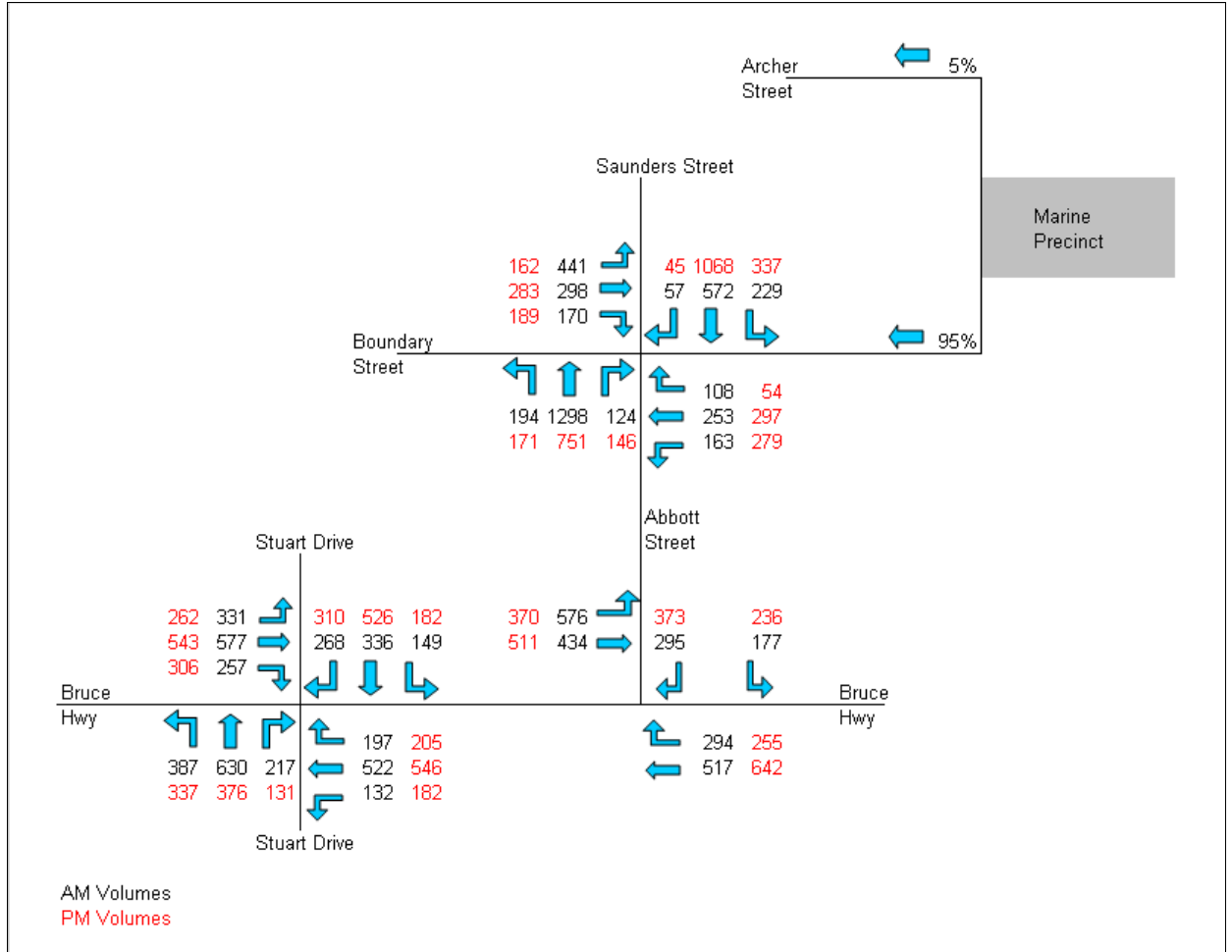
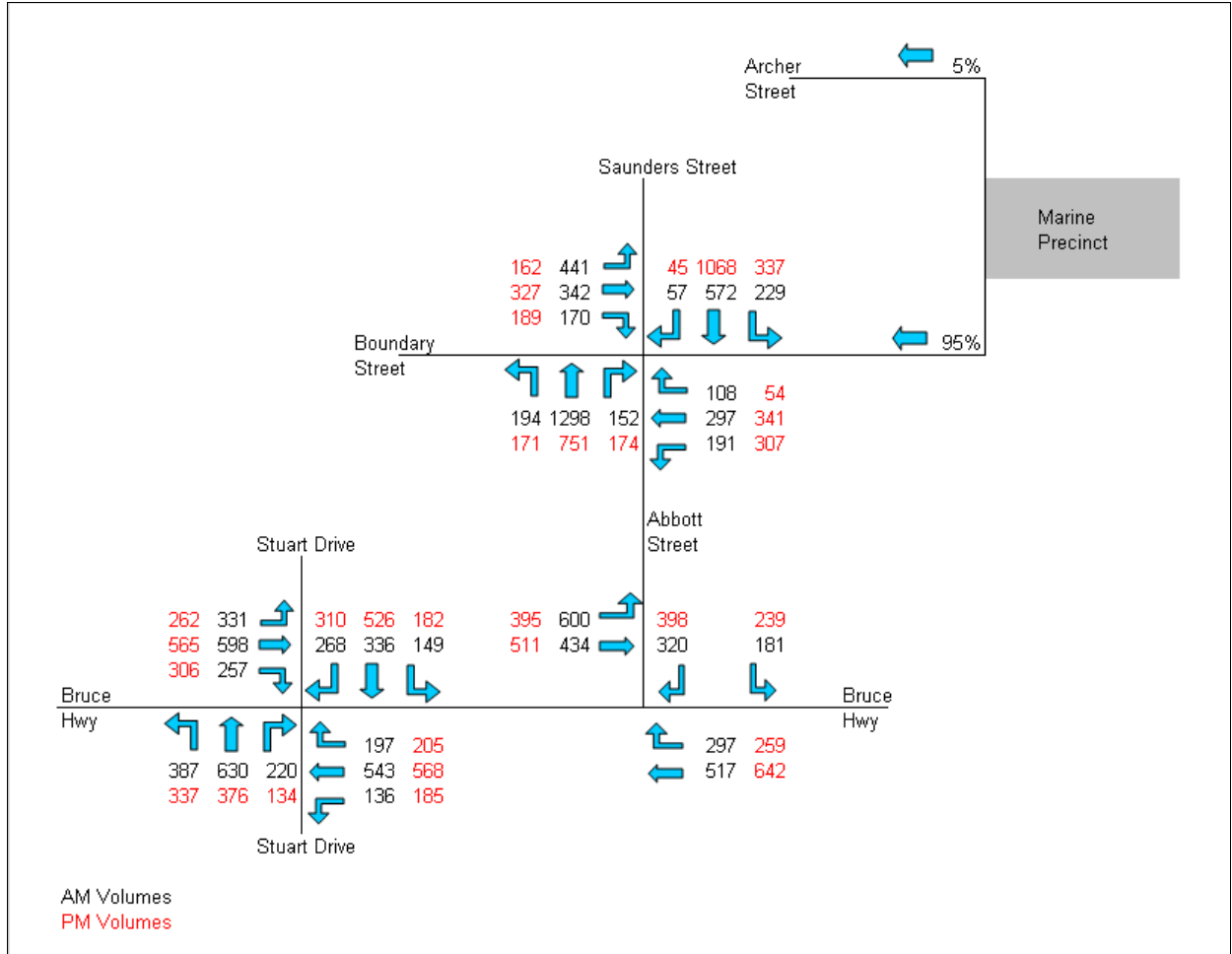




Figure 11 2011 Volumes With Construction Traffic



1.3.5 Operational Traffic Generation

Table 3 is a summary of the range of peak hour and daily trip generation rates for industrial land uses. The generation rates are sourced from the *Design for Subdivisional Streetworks by Queensland Streets*.

Table 3 Range of Trip Generation Rates for Industrial Land Uses

| | Peak Rate (per 100m ²) | Daily Rate (per 100m ²) | Source |
|-----------------|------------------------------------|-------------------------------------|--------|
| Factories | 1.0 | 5 | RTA |
| Large Factories | N/A | 4-5 | QT |
| Warehouses | 0.5 | 4 | RTA |
| Warehouses | 1.1 | N/A | BCC |
| Light Industry | 0.9 | 9 | QT |



The Light Industry land use was the most appropriate land use type and has been used to estimate the number of trips generated by the development of the site as shown in Table 4. The rates are based on Gross Floor Area (GFA) and *Design for Subdivisional Streetworks* stipulates that for light industry, typically 45% of the site area is GFA. The site area for the marine precincts is approximately 18.8 hectares with 45% of this being 8.46 hectares.

Table 4 Light Industrial Trip Generation Rates

| Area (GFA) m ² | Trip Generation Rate (per 100m ²) | Trips Generated (Two-way) | |
|---------------------------|---|---------------------------|-------|
| | | Peak Hour | Daily |
| 84,600 | 0.9 trips per peak 9 trips per day | 762 | 7,620 |

1.3.6 Operational Traffic Splits and Distribution

The directional split, shown in Table 5, for the AM and PM peak hour periods for the development traffic has been adopted from the “*Institute of Transportation Engineers – Trip Generation 7th Edition*”.

Table 5 Development Traffic Directional Splits

| Direction | OUT | IN |
|-------------------------------|-----------------|-----------------|
| AM Peak Hour Light Industrial | 17% (130 Trips) | 83% (632 Trips) |
| PM Peak Hour Light Industrial | 79% (602 Trips) | 21% (160 Trips) |

Note: Number of trips has been rounded up.

The assumed trip distributions as a percentage for the development and surrounding roads are shown in Figure 12. The development traffic movements have been assigned to the road network, largely guided by turning splits from observed traffic counts and modelled traffic volumes from the Maunsell report for the Eastern Access Road. Figure 13, Figure 14, Figure 15 and Figure 16 show the design traffic volumes for 2017 and 2027 with and without development scenarios.



Figure 12 Assumed Distributions for Marine Precinct Traffic

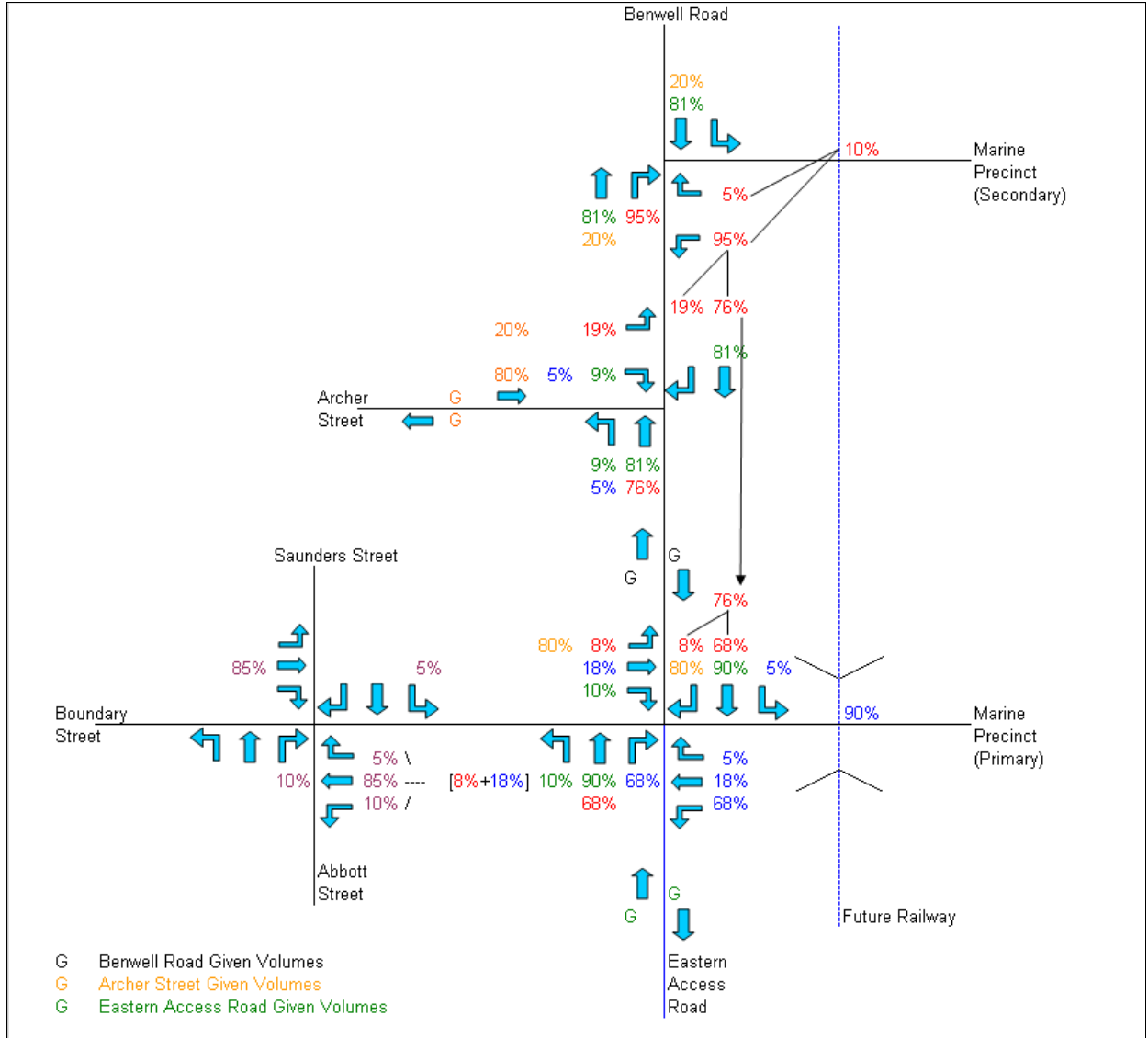




Figure 13 2017 Traffic Volumes with Development Traffic

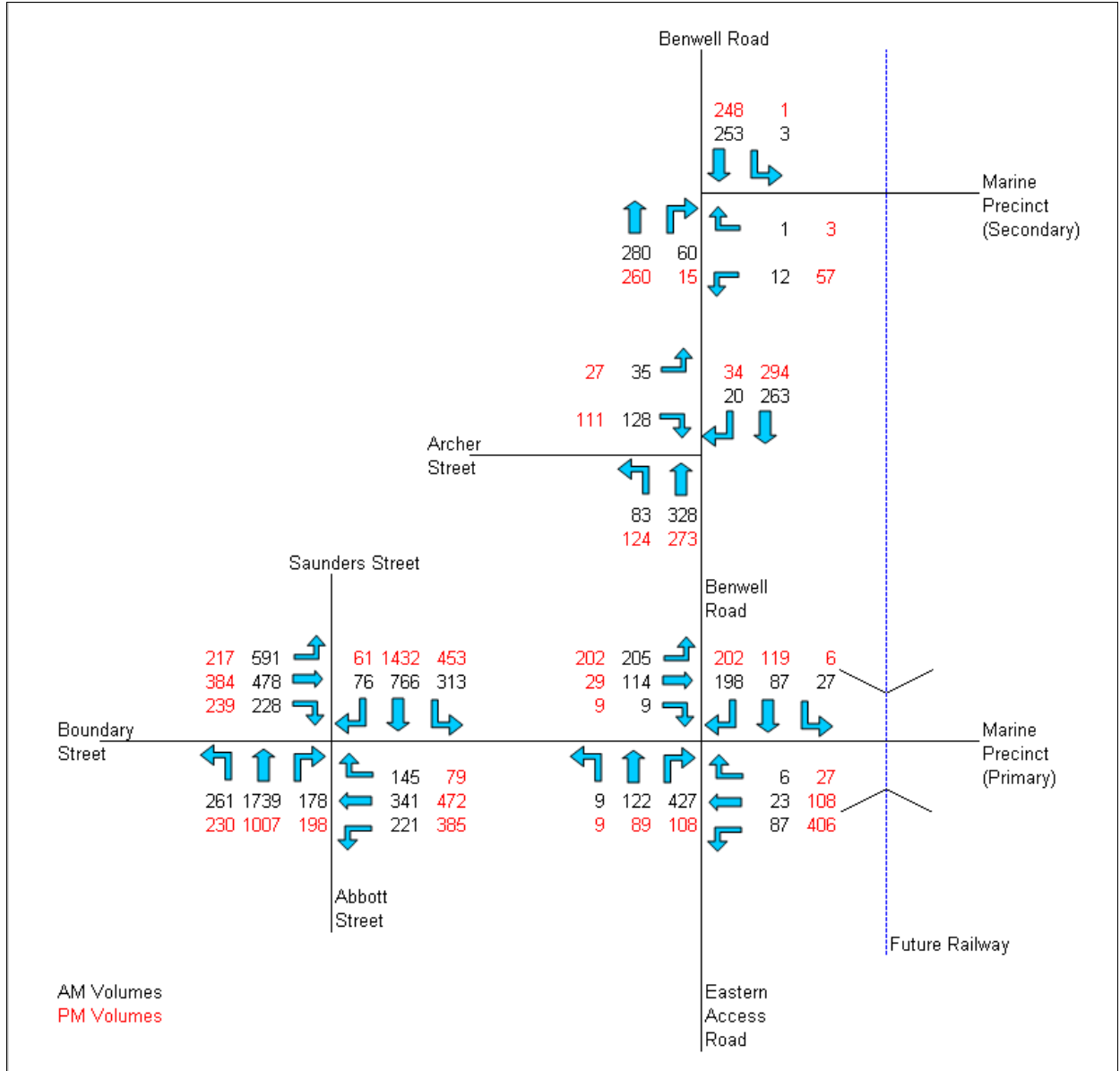




Figure 14 2017 Traffic Volumes without Development Traffic

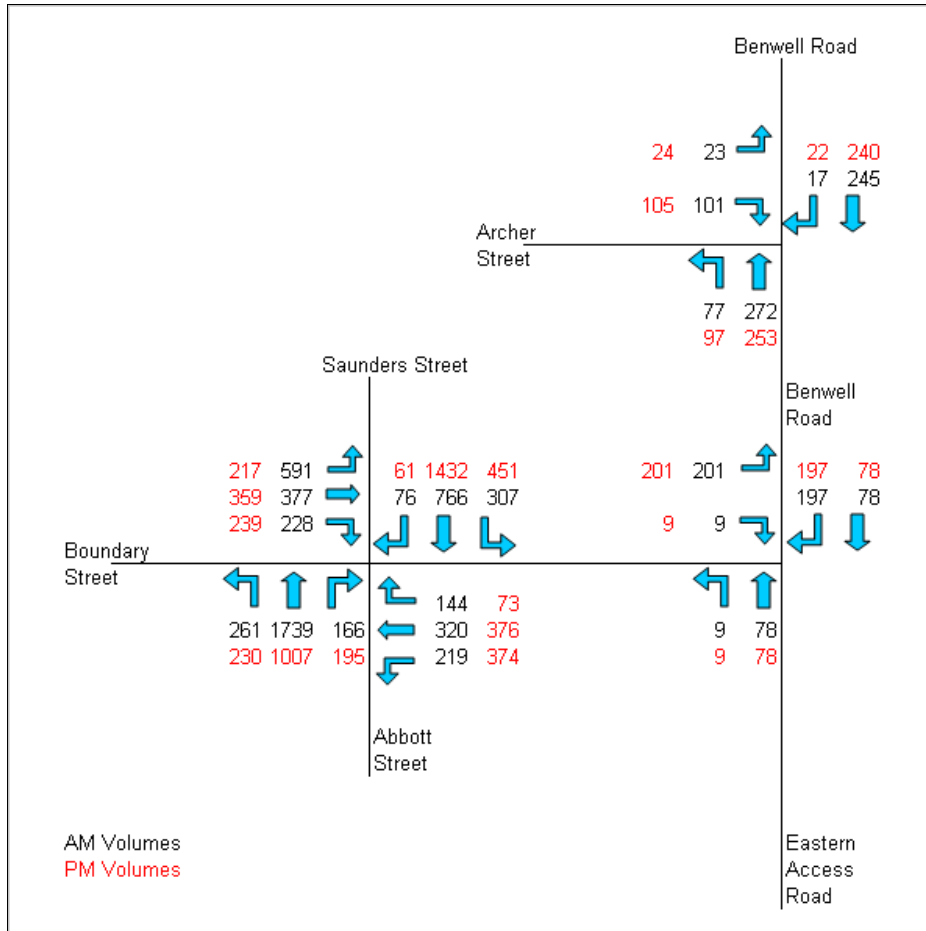




Figure 15 2027 Traffic Volumes with Development Traffic

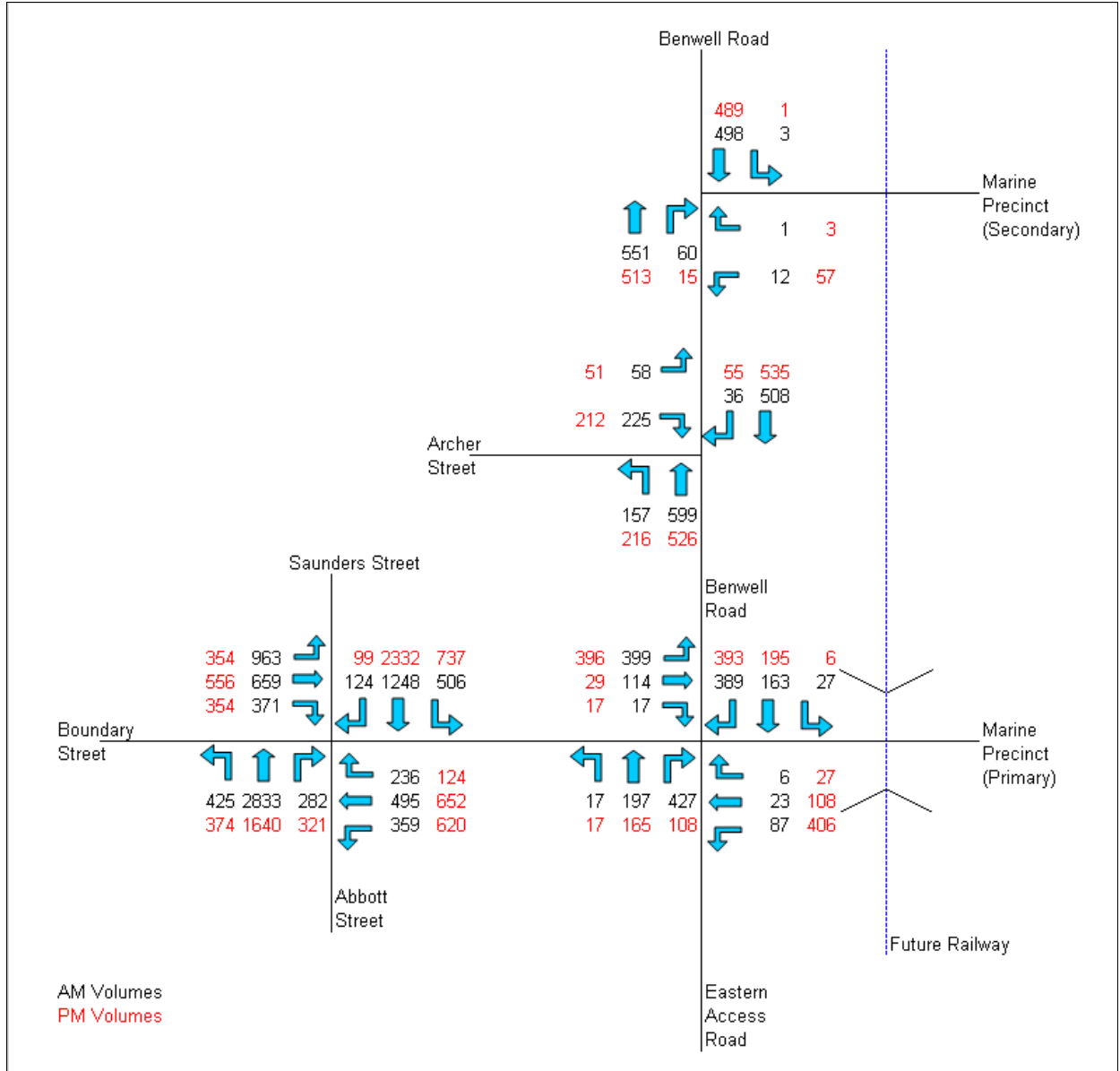




Figure 16 2027 Traffic Volumes without Development Traffic

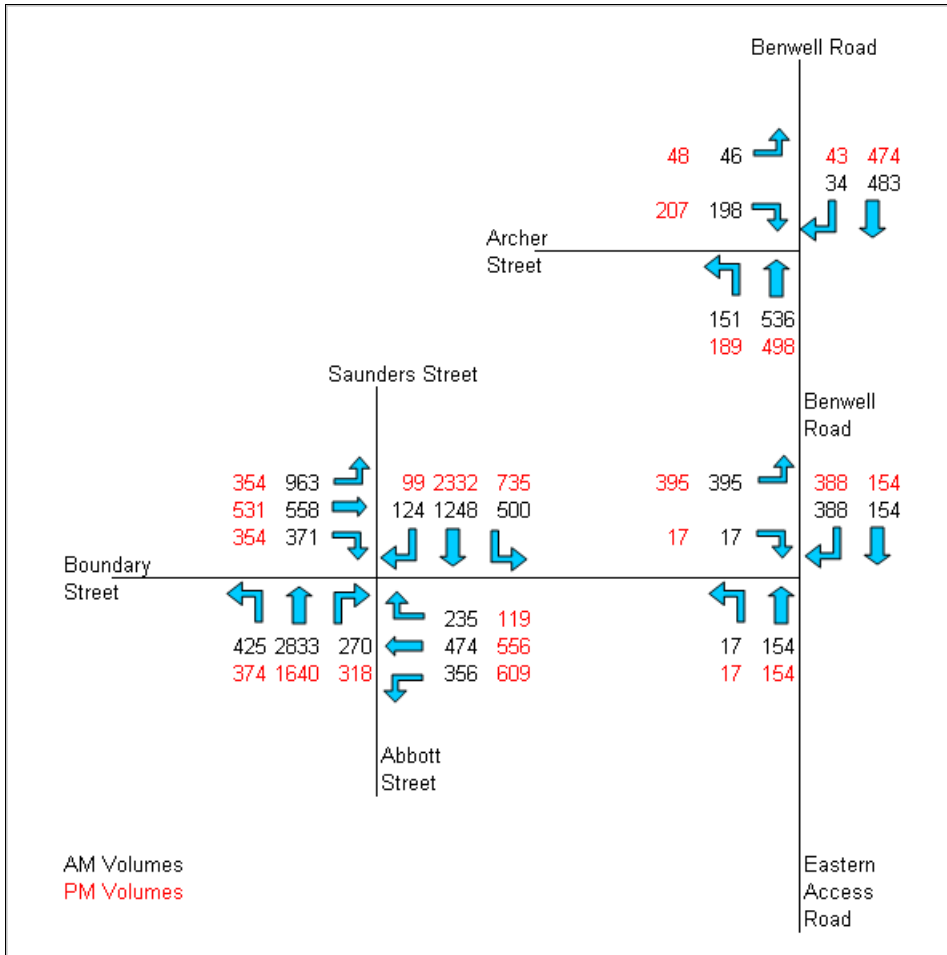


Table 6 highlights the percentage contribution of project construction and operational traffic on the existing road network based on traffic volumes.

Table 6 Contribution of Development Traffic to Intersections

| Scenario | | Bruce Hwy / Stuart Dr | Bruce Hwy / Abbott St | Boundary St / Saunders St | Boundary St / Benwell Rd | Benwell Rd / Archer St |
|------------------------|---------------|-----------------------|-----------------------|---------------------------|--------------------------|------------------------|
| 2011 With Construction | Background | 4001 | 2292 | 3907 | N/A | N/A |
| | AM Additional | 50 | 56 | 143 | N/A | N/A |
| | % Addition | 1% | 2% | 4% | N/A | N/A |
| | Background | 3908 | 2387 | 3784 | N/A | N/A |
| | PM Additional | 50 | 56 | 143 | N/A | N/A |
| | % Addition | 1% | 2% | 4% | N/A | N/A |



| Scenario | | | Bruce Hwy / Stuart Dr | Bruce Hwy / Abbott St | Boundary St / Saunders St | Boundary St / Benwell Rd | Benwell Rd / Archer St |
|-----------------------|----|------------|-----------------------|-----------------------|---------------------------|--------------------------|------------------------|
| 2017 With Development | AM | Background | N/A | N/A | 5195 | 572 | 736 |
| | | Additional | N/A | N/A | 143 | 742 | 121 |
| | | % Addition | N/A | N/A | 3% | 130% | 16% |
| | PM | Background | N/A | N/A | 5013 | 572 | 742 |
| | | Additional | N/A | N/A | 143 | 742 | 121 |
| | | % Addition | N/A | N/A | 3% | 130% | 16% |
| 2027 With Development | AM | Background | N/A | N/A | 8358 | 1125 | 1447 |
| | | Additional | N/A | N/A | 143 | 742 | 136 |
| | | % Addition | N/A | N/A | 2% | 66% | 9% |
| | PM | Background | N/A | N/A | 8021 | 1125 | 1459 |
| | | Additional | N/A | N/A | 143 | 742 | 136 |
| | | % Addition | N/A | N/A | 2% | 66% | 9% |

Table 6 highlights that the contribution of development traffic is less than 5% for the following intersections:

- ▶ Bruce Highway/Stuart Drive;
- ▶ Bruce Highway/Abbott Street; and,
- ▶ Boundary Street/Saunders Street.

Under general guidelines presented in DMR's Guide for Assessment of Road Impacts of Development (GARID), the traffic generated by the development does not trigger the need for assessment of the impacts at these intersections. For the purpose of completeness in this assessment, these intersections have been assessed.

1.4 Northern Access Rail Crossing

The rail crossing on the northern access to the marine precinct was analysed to determine likely queue lengths produced by vehicles accessing the site. Heavy vehicle composition has been assumed as the same as traffic on Benwell Road according to the 2004 classified traffic count which highlights a %CV of 33% on Benwell Road in both directions. This count has a distribution of commercial vehicles as follows:

- ▶ 10% - 13 metres in length;
- ▶ 15% - 19 metres in length; and
- ▶ 8% - 37 metres in length.

These lengths are according to classifications as stipulated in the Road Planning and Design Manual.



The time the boom gates are expected to be down per hour is 3 minutes. This has been utilised as per the Maunsell Townsville Port Access Road Traffic Assessment Report. Based on the number of vehicles generated by the site and the in and out splits given by the *ITE: Trip Generation Manual*, the longest queues will take place during the morning when vehicles are entering the site and evening when vehicles are exiting. Based on a 90/10 split between the two access points, this resulted in 63 vehicles entering the site in the morning and 60 exiting in the evening resulting in the predicted queue lengths shown in Table 7. The calculations used to find the expected average queue lengths can be found in Appendix A and have been based on random arrivals of vehicles during the peak hour.

Table 7 Expected Average Queue Lengths at Northern Access Rail Crossing

| | Max Number of Vehicles | Expected Average Queue Length (m) |
|----------|------------------------|-----------------------------------|
| Entering | 63 | 37.2 |
| Exiting | 60 | 35.4 |

This analysis demonstrates that provision for queuing of approximately 40m should be made on both approaches to the rail crossing so as to minimise the likelihood of queue spillback to adjacent roads.

1.5 Intersection Analysis

1.5.1 Overview

The analysis of the intersections expected to be impacted directly by the construction and operational traffic has been undertaken using SIDRA Intersection 3.2 for existing traffic, construction traffic and future with and without development conditions following the planning guidelines stipulated in Section 13.4.4 of the *DMR Road Planning and Design Manual, 2011* is the anticipated year that construction traffic will have the greatest impact on the road network which is prior to the completion of the Eastern Access Road. After 2011, construction traffic for stages 2 and 3 is assumed to use the EAR for trips to and from the Marine Precincts and will have a lesser impact on the adjacent road network. 2017 is the anticipated year of opening and 2027 has been used to assess the 10-year traffic horizon.

Signalised intersections were analysed with SIDRA 3.2 optimising cycle times between 60 and 120 seconds for existing and future scenarios.

Table 8 below shows the scenarios that have been analysed at each of the intersections. Intersections have only been analysed against the scenarios that are required and applicable.

Table 8 Intersection Scenario Summary

| Scenarios | Bruce Hwy / Stuart Drive | Bruce Hwy / Abbott St | Boundary St / Saunders St | Boundary St / Benwell Rd | Benwell Rd / Archer St | Benwell Rd / Secondary |
|-------------------|--------------------------|-----------------------|---------------------------|--------------------------|------------------------|------------------------|
| Section in Report | 1.5.2 | 1.5.3 | 1.5.4 | 1.5.5 | 1.5.6 | 1.5.7 |



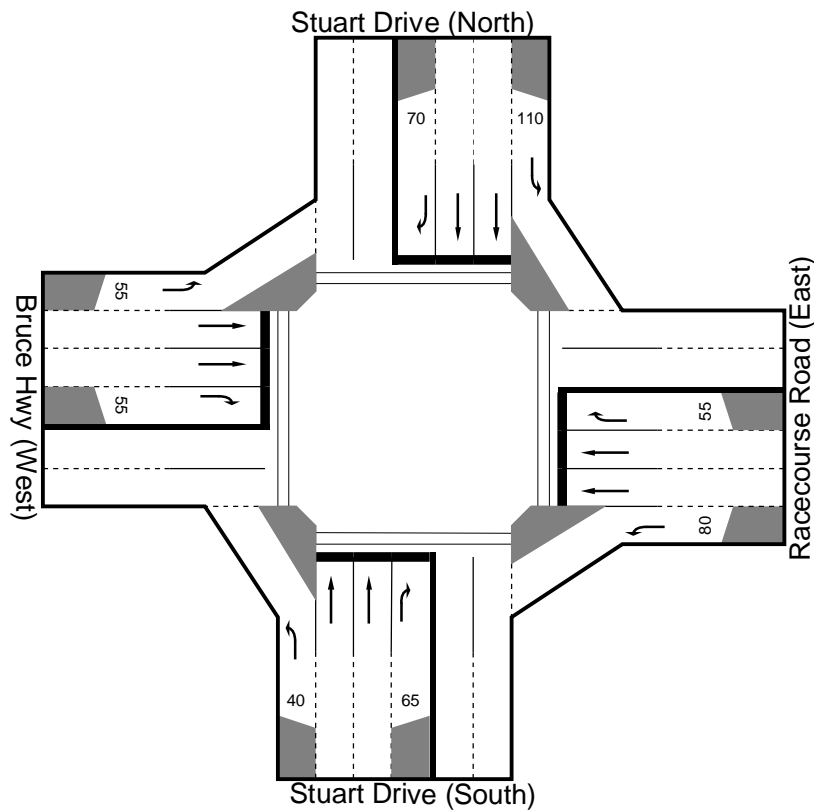
| Scenarios | Bruce Hwy / Stuart Drive | Bruce Hwy / Abbott St | Boundary St / Saunders St | Boundary St / Benwell Rd | Benwell Rd / Archer St | Benwell Rd / Secondary |
|---------------------------|--------------------------|-----------------------|---------------------------|--------------------------|------------------------|------------------------|
| 2009 Existing | ✓ | ✓ | ✓ | | ✓ | |
| 2011 Without Construction | ✓ | ✓ | ✓ | | | |
| 2011 With Construction | ✓ | ✓ | ✓ | | | |
| 2017 Without Development | | | ✓ | ✓ | ✓ | |
| 2017 With Development | | | ✓ | ✓ | ✓ | ✓ |
| 2027 Without Development | | | ✓ | ✓ | ✓ | |
| 2027 With Development | | | ✓ | ✓ | ✓ | ✓ |

1.5.2 Bruce Highway / Stuart Drive

It should be noted that traffic generated by the development contributed less than 5% of the total intersection volumes and therefore does not trigger the need for assessment of this intersection. However, it is considered herein for completeness.

The current layout used for the analysis of the Bruce Highway / Stuart Drive intersection is shown conceptually in Figure 17. The intersection is a four-leg signalised intersection with pedestrian crossings provided on all legs.

Figure 17 Intersection Layout: Bruce Highway / Stuart Drive



Background Traffic – 2009

Figure 18 and Figure 19 show the phasing summary based on an 80 second cycle time. The results of the analysis for the 2009 background traffic scenario are presented in Table 9. The results indicate the following:

- ▶ An overall minimum LOS C is achieved under peak traffic conditions;
- ▶ The degree of saturation is below the desirable practical absorption capacity of 0.9 for signalised intersections for all movements other than the right turns;
- ▶ Queue lengths are within acceptable limits and don't encroach on neighbouring intersections. Queue lengths on the northern and western approaches for the right turn movements exceed the turn slot; and,
- ▶ Average delays are less than 32 seconds for movements other than right turns which all exceed 45 seconds in both peaks.



Figure 18 2009 AM Phasing Summary

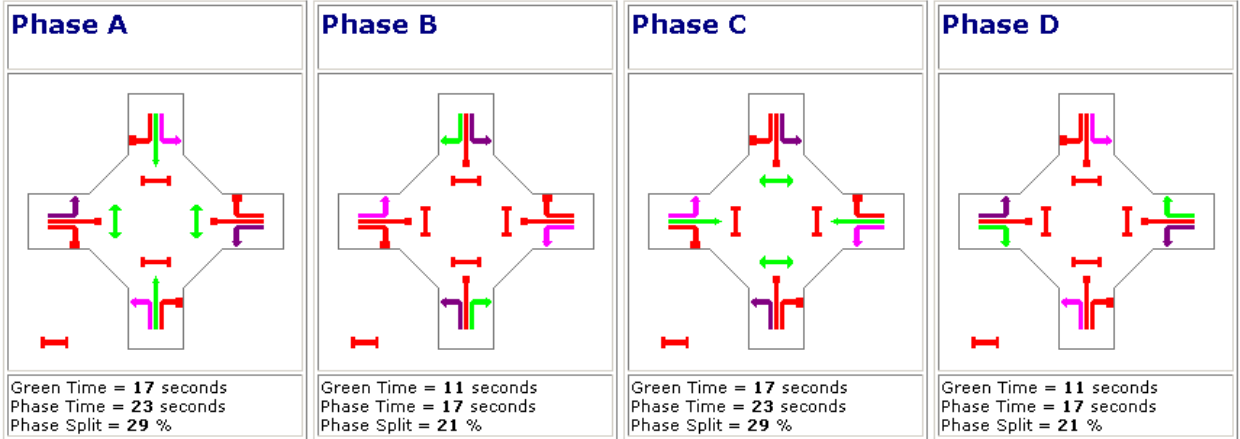


Figure 19 2009 PM Phasing Summary

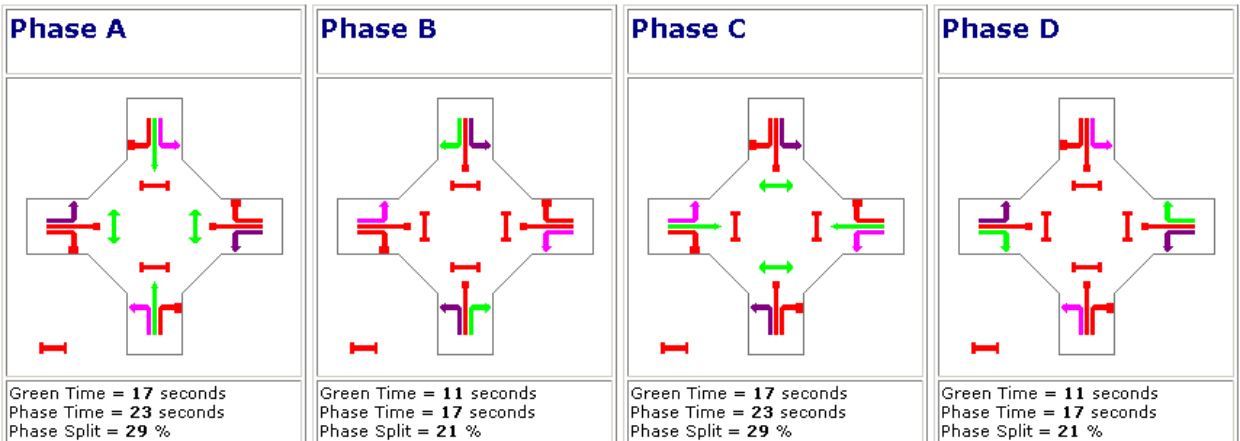




Table 9 Bruce Hwy / Stuart Drive - 2009 Background

| AM Peak (2009) | | | | | |
|-------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Stuart Drive (South) | | | | | |
| Left | 344 | 0.738 | 18.1 | LOS B | 65 |
| Through | 561 | 0.692 | 33.1 | LOS C | 88 |
| Right | 193 | 0.812 | 50.8 | LOS D | 76 |
| Approach Total | 1098 | 0.812 | 31.5 | LOS C | 88 |
| Racecourse Road (East) | | | | | |
| Left | 118 | 0.168 | 12.7 | LOS A | 17 |
| Through | 439 | 0.557 | 31.2 | LOS C | 72 |
| Right | 175 | 0.699 | 46.6 | LOS D | 63 |
| Approach Total | 732 | 0.699 | 31.9 | LOS C | 72 |
| Stuart Drive (North) | | | | | |
| Left | 132 | 0.152 | 13.1 | LOS A | 19 |
| Through | 299 | 0.388 | 29.9 | LOS C | 52 |
| Right | 238 | 0.943 | 67.5 | LOS E | 100 |
| Approach Total | 669 | 0.943 | 40.0 | LOS C | 100 |
| Bruce Hwy (West) | | | | | |
| Left | 294 | 0.454 | 13.4 | LOS A | 41 |
| Through | 486 | 0.620 | 31.8 | LOS C | 79 |
| Right | 229 | 0.997 | 63.1 | LOS E | 102 |
| Approach Total | 1009 | 0.997 | 33.5 | LOS C | 102 |
| All Vehicles | 3508 | 0.997 | 33.8 | LOS C | 102 |

| PM Peak (2009) | | | | | |
|-------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Stuart Drive (South) | | | | | |
| Left | 300 | 0.628 | 14.2 | LOS A | 46 |
| Through | 335 | 0.414 | 30.0 | LOS C | 54 |
| Right | 117 | 0.494 | 44.5 | LOS D | 46 |
| Approach Total | 752 | 0.628 | 26.0 | LOS B | 54 |
| Racecourse Road (East) | | | | | |
| Left | 162 | 0.225 | 13.9 | LOS A | 25 |
| Through | 460 | 0.583 | 31.4 | LOS C | 75 |
| Right | 182 | 0.746 | 48.0 | LOS D | 68 |
| Approach Total | 804 | 0.746 | 31.6 | LOS C | 75 |
| Stuart Drive (North) | | | | | |
| Left | 162 | 0.166 | 11.6 | LOS A | 19 |
| Through | 468 | 0.614 | 31.6 | LOS C | 77 |
| Right | 276 | 1.000# | 90.8 | LOS F | 122 |
| Approach Total | 906 | 1.000 | 44.5 | LOS D | 122 |
| Bruce Hwy (West) | | | | | |
| Left | 233 | 0.311 | 11.4 | LOS A | 25 |
| Through | 457 | 0.618 | 31.7 | LOS C | 79 |
| Right | 278 | 1.000# | 64.0 | LOS E | 100 |
| Approach Total | 968 | 1.000 | 35.0 | LOS C | 100 |
| All Vehicles | 3430 | 1.000 | 34.7 | LOS C | 122 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

Without Construction Traffic – 2011

Figure 20 and Figure 21 show the phasing summary based on an 80 second cycle time. The results of the analysis for the 2011 without construction traffic scenario are presented in Table 10. The results indicate the following:

- ▶ An overall minimum LOS C would be achieved under peak traffic conditions;

- ▶ The degree of saturation is below the practical absorption capacity of 0.9 for signalised intersections for all movements other than the right turns;
- ▶ Queue lengths are within acceptable limits and don't encroach on neighbouring intersections. Queue lengths on the northern and western approaches for the right turn movements exceed the turn slot in both peaks; and
- ▶ Average delays are less than 36 seconds for movements other than right turns which all exceed 45 seconds in both peaks.

Figure 20 2011 AM Phasing Summary

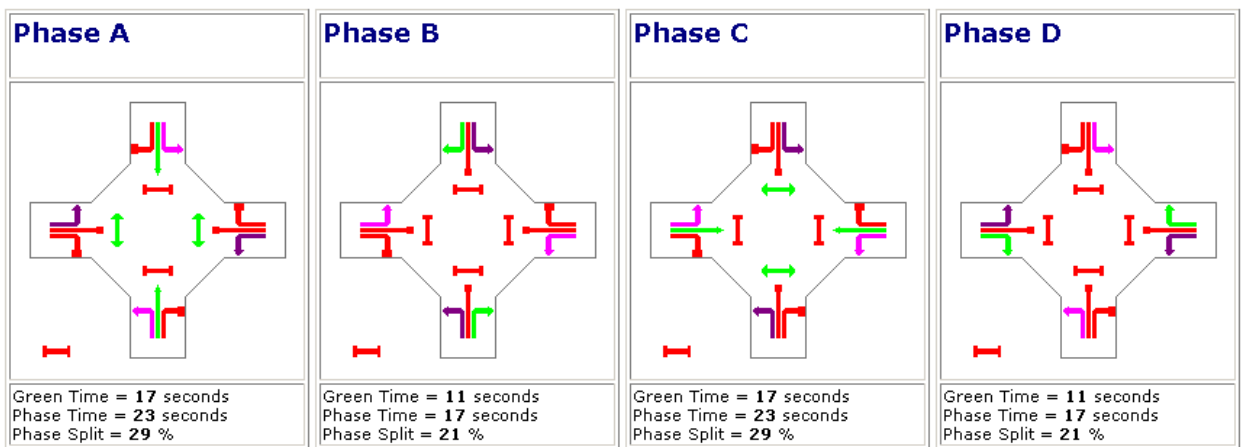


Figure 21 2011 PM Phasing Summary

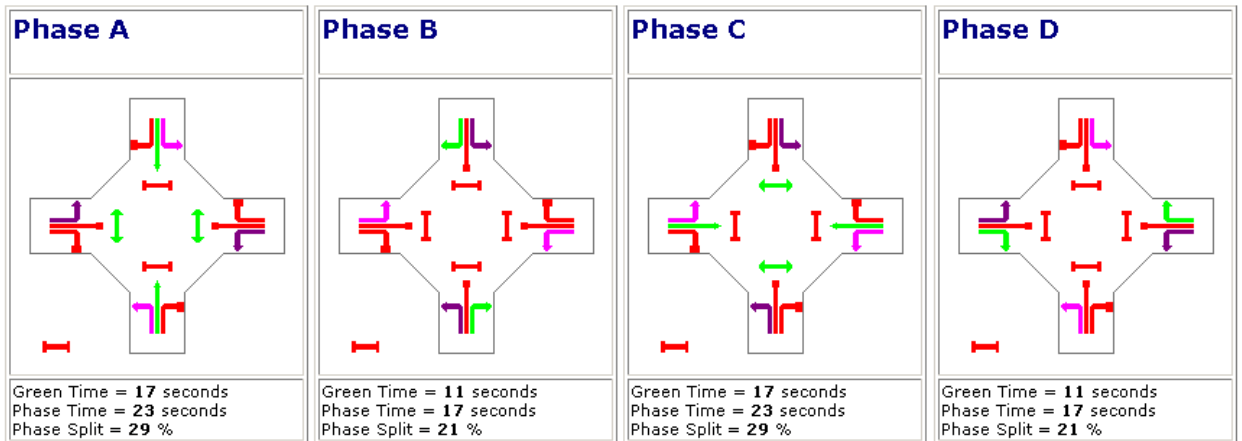




Table 10 Bruce Hwy / Stuart Drive – 2011 Without Construction Traffic

| AM Peak (2011) | | | | | |
|-------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Stuart Drive (South) | | | | | |
| Left | 387 | 0.894 | 20.4 | LOS B | 78 |
| Through | 630 | 0.777 | 35.9 | LOS C | 102 |
| Right | 217 | 0.914 | 61.0 | LOS E | 94 |
| Approach Total | 1234 | 0.914 | 35.5 | LOS C | 102 |
| Racecourse Road (East) | | | | | |
| Left | 132 | 0.192 | 13.1 | LOS A | 20 |
| Through | 522 | 0.663 | 32.6 | LOS C | 85 |
| Right | 197 | 0.785 | 49.1 | LOS D | 71 |
| Approach Total | 851 | 0.785 | 33.4 | LOS C | 85 |
| Stuart Drive (North) | | | | | |
| Left | 149 | 0.184 | 14.8 | LOS B | 25 |
| Through | 336 | 0.456 | 30.4 | LOS C | 60 |
| Right | 268 | 1.000# | 90.9 | LOS F | 122 |
| Approach Total | 753 | 1.000 | 47.6 | LOS D | 122 |
| Bruce Hwy (West) | | | | | |
| Left | 331 | 0.552 | 14.6 | LOS B | 50 |
| Through | 577 | 0.775 | 36.0 | LOS C | 103 |
| Right | 257 | 1.000# | 63.0 | LOS E | 102 |
| Approach Total | 1165 | 1.000 | 35.2 | LOS C | 103 |
| All Vehicles | 4003 | 1.000 | 37.2 | LOS C | 122 |

| PM Peak (2011) | | | | | |
|-------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Stuart Drive (South) | | | | | |
| Left | 337 | 0.742 | 19.2 | LOS B | 65 |
| Through | 376 | 0.465 | 30.4 | LOS C | 60 |
| Right | 131 | 0.555 | 44.9 | LOS D | 51 |
| Approach Total | 844 | 0.742 | 28.2 | LOS B | 65 |
| Racecourse Road (East) | | | | | |
| Left | 182 | 0.262 | 14.8 | LOS B | 30 |
| Through | 546 | 0.691 | 33.2 | LOS C | 89 |
| Right | 205 | 0.839 | 52.1 | LOS D | 79 |
| Approach Total | 933 | 0.839 | 33.8 | LOS C | 89 |
| Stuart Drive (North) | | | | | |
| Left | 182 | 0.194 | 12.7 | LOS A | 24 |
| Through | 526 | 0.730 | 34.2 | LOS C | 94 |
| Right | 310 | 1.000# | 90.8 | LOS F | 122 |
| Approach Total | 1018 | 1.000 | 44.3 | LOS D | 122 |
| Bruce Hwy (West) | | | | | |
| Left | 262 | 0.380 | 12.2 | LOS A | 32 |
| Through | 543 | 0.764 | 35.5 | LOS C | 101 |
| Right | 306 | 1.000# | 63.9 | LOS E | 100 |
| Approach Total | 1111 | 1.000 | 36.3 | LOS C | 101 |
| All Vehicles | 3906 | 1.000 | 36.0 | LOS C | 122 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

With Construction Traffic – 2011

Figure 22 and Figure 23 show the phasing summary based on a 90 second and 80 second cycle time in AM and PM peaks respectively. The results indicate that while the intersection is operating near capacity without construction traffic, the addition of construction traffic has a negligible impact on the intersection. As shown in Table 11 the results indicate the following:

- ▶ An overall minimum LOS C would be achieved under peak traffic conditions;
- ▶ The degree of saturation is below the practical absorption capacity of 0.9 for signalised intersections for all movements in the PM peak other than the right turns. The left turn movement on the southern approach exceed the practical degree of saturation in the AM peak;
- ▶ Queue lengths are within acceptable limits and don't encroach on neighbouring intersections. Queue lengths on the northern and western approaches for the right turn movements exceed the turn slot in both peaks; and
- ▶ Average delays are less than 37 seconds for movements other than right turns which all exceed 47 seconds in both peaks.

Figure 22 2011 AM Phasing Summary

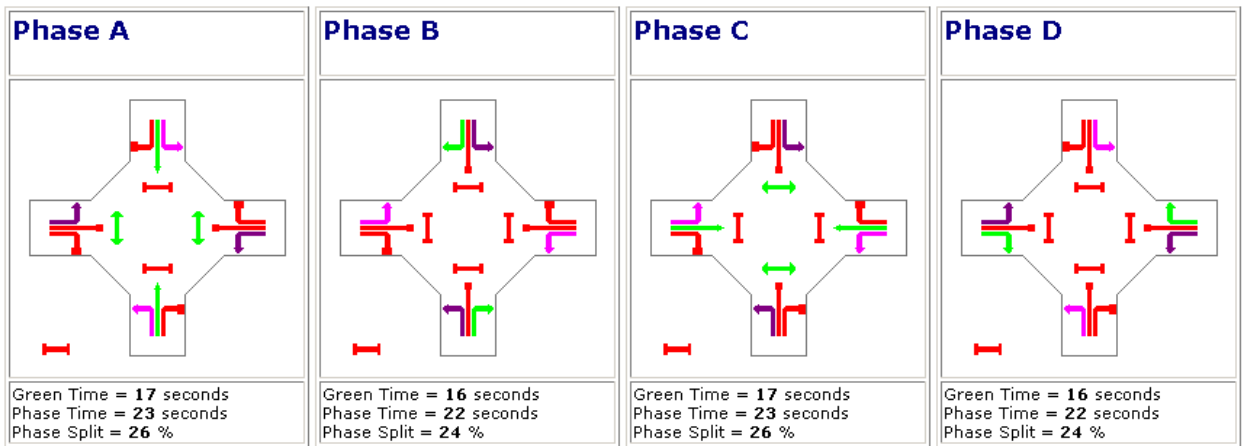


Figure 23 2011 PM Phasing Summary

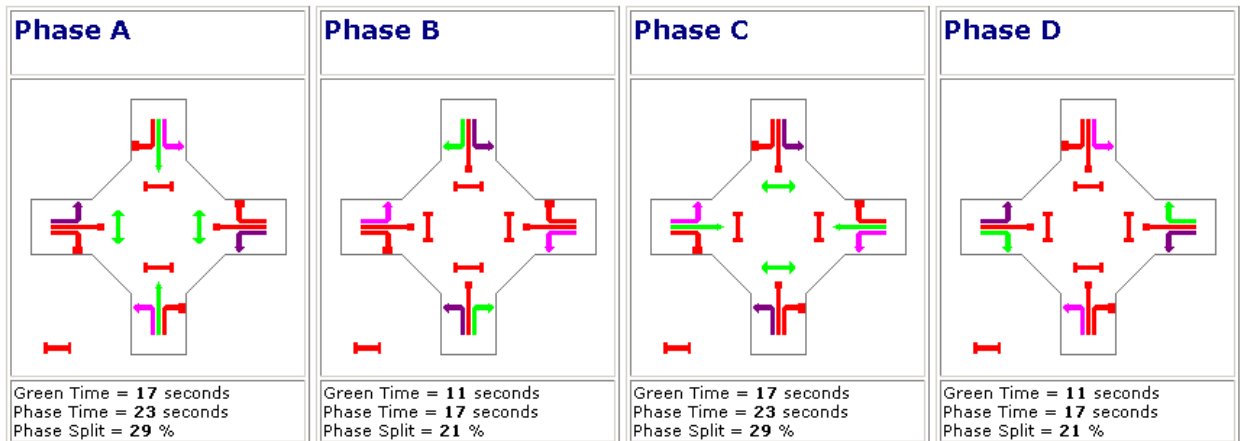




Table 11 Bruce Hwy / Stuart Drive – 2011 With Construction Traffic

| AM Peak (2011) | | | | | |
|-------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Stuart Drive (South) | | | | | |
| Left | 387 | 0.954 | 18.7 | LOS B | 78 |
| Through | 630 | 0.874 | 48.5 | LOS D | 122 |
| Right | 220 | 0.716 | 48.8 | LOS D | 87 |
| Approach Total | 1237 | 0.954 | 39.2 | LOS C | 122 |
| Racecourse Road (East) | | | | | |
| Left | 136 | 0.208 | 13.5 | LOS A | 23 |
| Through | 543 | 0.775 | 41.5 | LOS C | 103 |
| Right | 197 | 0.694 | 47.2 | LOS D | 72 |
| Approach Total | 876 | 0.775 | 38.4 | LOS C | 103 |
| Stuart Drive (North) | | | | | |
| Left | 149 | 0.186 | 14.7 | LOS B | 27 |
| Through | 336 | 0.491 | 36.1 | LOS C | 65 |
| Right | 268 | 0.820 | 52.7 | LOS D | 100 |
| Approach Total | 753 | 0.820 | 37.8 | LOS C | 100 |
| Bruce Hwy (West) | | | | | |
| Left | 331 | 0.570 | 14.9 | LOS B | 54 |
| Through | 598 | 0.858 | 47.1 | LOS D | 121 |
| Right | 257 | 0.865 | 57.6 | LOS E | 114 |
| Approach Total | 1186 | 0.865 | 40.4 | LOS C | 121 |
| All Vehicles | 4052 | 0.954 | 39.1 | LOS C | 122 |

| PM Peak (2011) | | | | | |
|-------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Stuart Drive (South) | | | | | |
| Left | 337 | 0.756 | 20.6 | LOS B | 68 |
| Through | 630 | 0.778 | 36.0 | LOS C | 102 |
| Right | 220 | 0.931 | 65.1 | LOS E | 99 |
| Approach Total | 1187 | 0.931 | 37.0 | LOS C | 102 |
| Racecourse Road (East) | | | | | |
| Left | 185 | 0.266 | 14.8 | LOS B | 31 |
| Through | 568 | 0.719 | 34.0 | LOS C | 93 |
| Right | 205 | 0.839 | 52.1 | LOS D | 79 |
| Approach Total | 958 | 0.839 | 34.1 | LOS C | 93 |
| Stuart Drive (North) | | | | | |
| Left | 182 | 0.215 | 14.7 | LOS B | 29 |
| Through | 526 | 0.730 | 34.2 | LOS C | 94 |
| Right | 310 | 1.000# | 90.8 | LOS F | 122 |
| Approach Total | 1018 | 1.000 | 44.7 | LOS D | 122 |
| Bruce Hwy (West) | | | | | |
| Left | 262 | 0.435 | 14.5 | LOS B | 39 |
| Through | 565 | 0.791 | 36.7 | LOS C | 105 |
| Right | 306 | 1.000# | 63.9 | LOS E | 100 |
| Approach Total | 1133 | 1.000 | 37.5 | LOS C | 105 |
| All Vehicles | 4296 | 1.000 | 38.3 | LOS C | 122 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

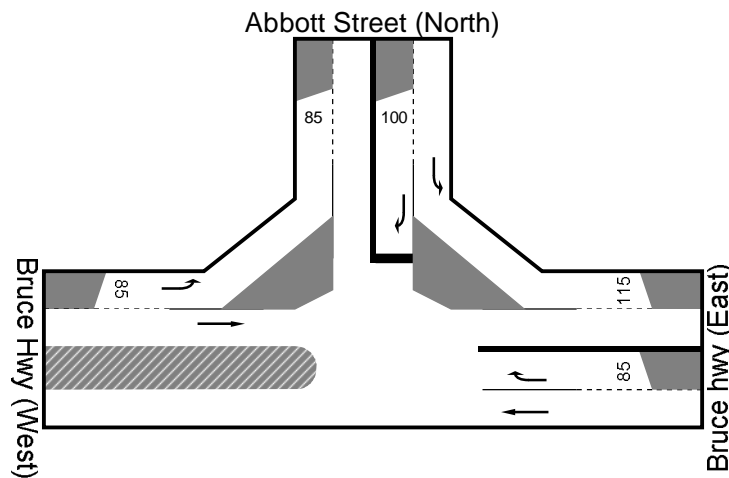
The impact of the development generated traffic by DMR guidelines is not considered to be significant on the intersection.

1.5.3 Bruce Highway / Abbott Street

It should be noted that traffic generated by the proposed development contributed less than 5% of the total intersection volumes and therefore does not trigger the need for assessment of this intersection. However, it is considered herein for completeness.

The layout used for the analysis of the Bruce Highway / Abbott Street intersection is shown in Figure 24. The intersection is a three-leg priority controlled junction with approaches from the East and West having priority.

Figure 24 Intersection Layout: Bruce Highway / Abbott Street



Background Traffic – 2009

The results of the analysis for the 2009 background traffic scenario are presented in Table 12. The results indicate the following:

- ▶ An overall minimum LOS A is achieved under peak traffic conditions;
- ▶ The degree of saturation is below the practical absorption capacity of 0.8 for unsignalised intersections for all movements;
- ▶ Queue lengths are within acceptable limits and don't encroach on neighbouring intersections; and
- ▶ Average delays are less than 17 seconds for all movements in both peaks.



Table 12 Bruce Hwy / Abbott Street – 2009 Background

| AM Peak (2009) | | | | | |
|------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Bruce Hwy (East) | | | | | |
| Through | 435 | 0.239 | 0.0 | LOS A | 0 |
| Right | 266 | 0.320 | 11.8 | LOS A | 15 |
| Approach Total | 701 | 0.320 | 4.5 | LOS A | 15 |
| Abbott Street (North) | | | | | |
| Left | 161 | 0.102 | 8.3 | LOS A# | 3# |
| Right | 267 | 0.382 | 16.9 | LOS B | 10 |
| Approach Total | 428 | 0.382 | 13.6 | LOS A | 10 |
| Bruce Hwy (West) | | | | | |
| Left | 522 | 0.293 | 7.8 | LOS B# | 9# |
| Through | 365 | 0.211 | 0.0 | LOS A | 0 |
| Approach Total | 887 | 0.293 | 4.6 | LOS A | |
| All Vehicles | 2286 | 0.382 | 6.8 | N/A | 15 |

| PM Peak (2009) | | | | | |
|------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Bruce Hwy (East) | | | | | |
| Through | 435 | 0.237 | 0.0 | LOS A | 0 |
| Right | 266 | 0.287 | 10.8 | LOS A | 12 |
| Approach Total | 701 | 0.287 | 4.1 | LOS A | 12 |
| Abbott Street (North) | | | | | |
| Left | 161 | 0.092 | 7.8 | LOS A# | 3# |
| Right | 267 | 0.360 | 13.7 | LOS A | 9 |
| Approach Total | 428 | 0.360 | 11.5 | LOS A | 9 |
| Bruce Hwy (West) | | | | | |
| Left | 522 | 0.288 | 7.7 | LOS B# | 9# |
| Through | 365 | 0.191 | 0.0 | LOS A | 0 |
| Approach Total | 887 | 0.288 | 4.5 | LOS A | |
| All Vehicles | 2283 | 0.360 | 6.3 | N/A | 12 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

Without Construction Traffic – 2011

The results of the analysis for the 2011 without construction traffic scenario are presented in Table 13. The results indicate the following:

- ▶ An overall minimum LOS A would be achieved under peak traffic conditions;
- ▶ The degree of saturation is below the practical absorption capacity of 0.8 for unsignalised intersections for all movements;
- ▶ Queue lengths are within acceptable limits and don't encroach on neighbouring intersections; and
- ▶ Average delays are less than 15 seconds for all movements in both peaks.



Table 13 Bruce Hwy / Abbott Street – 2011 Without Construction Traffic

| AM Peak (2011) | | | | | |
|------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Bruce Hwy (East) | | | | | |
| Through | 517 | 0.285 | 0.0 | LOS A | 0 |
| Right | 294 | 0.396 | 13.3 | LOS A | 21 |
| Approach Total | 811 | 0.396 | 4.8 | LOS A | 21 |
| Abbott Street (North) | | | | | |
| Left | 177 | 0.113 | 8.3 | LOS A# | 4# |
| Right | 295 | 0.351 | 14.8 | LOS B | 13 |
| Approach Total | 472 | 0.351 | 12.4 | LOS A | 13 |
| Bruce Hwy (West) | | | | | |
| Left | 576 | 0.323 | 7.8 | LOS B# | 10# |
| Through | 434 | 0.251 | 0.0 | LOS A | 0 |
| Approach Total | 1010 | 0.323 | 4.4 | LOS A | |
| All Vehicles | 2588 | 0.396 | 6.6 | N/A | 21 |

| PM Peak (2011) | | | | | |
|------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Bruce Hwy (East) | | | | | |
| Through | 642 | 0.349 | 0.0 | LOS A | 0 |
| Right | 255 | 0.336 | 12.6 | LOS A | 16 |
| Approach Total | 897 | 0.349 | 3.6 | LOS A | 16 |
| Abbott Street (North) | | | | | |
| Left | 236 | 0.134 | 7.8 | LOS A# | 4# |
| Right | 373 | 0.522 | 14.8 | LOS B | 17 |
| Approach Total | 609 | 0.523 | 12.1 | LOS A | 17 |
| Bruce Hwy (West) | | | | | |
| Left | 370 | 0.204 | 7.7 | LOS A# | 6# |
| Through | 511 | 0.268 | 0.0 | LOS A | 0 |
| Approach Total | 881 | 0.268 | 3.2 | LOS A | |
| All Vehicles | 2760 | 0.522 | 6.3 | N/A | 17 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

With Construction Traffic – 2011

The results indicate that the existing intersection layout and control will continue to operate satisfactorily in 2011 with the addition of construction related traffic. As presented in Table 14, the results indicate the following:

- ▶ An overall minimum LOS A would be achieved under peak traffic conditions;
- ▶ The degree of saturation is below the practical absorption capacity of 0.8 for unsignalised intersections for all movements;
- ▶ Queue lengths are within acceptable limits and do not encroach on neighbouring intersections; and
- ▶ Average delays are less than 16 seconds for all movements in both peaks.



Table 14 Bruce Hwy / Abbott Street – 2011 With Construction Traffic

| AM Peak (2011) | | | | | |
|------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Bruce Hwy (East) | | | | | |
| Through | 517 | 0.285 | 0.0 | LOS A | 0 |
| Right | 297 | 0.401 | 13.3 | LOS A | 22 |
| Approach Total | 814 | 0.401 | 4.9 | LOS A | 22 |
| Abbott Street (North) | | | | | |
| Left | 181 | 0.115 | 8.3 | LOS A# | 4# |
| Right | 320 | 0.510 | 15.7 | LOS B | 16 |
| Approach Total | 501 | 0.510 | 13.0 | LOS A | 16 |
| Bruce Hwy (West) | | | | | |
| Left | 600 | 0.337 | 7.8 | LOS B# | 11# |
| Through | 434 | 0.251 | 0.0 | LOS A | 0 |
| Approach Total | 1034 | 0.337 | 4.5 | LOS A | |
| All Vehicles | 2669 | 0.510 | 6.9 | N/A | 22 |

| PM Peak (2011) | | | | | |
|------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Bruce Hwy (East) | | | | | |
| Through | 642 | 0.349 | 0.0 | LOS A | 0 |
| Right | 259 | 0.341 | 12.6 | LOS A | 16 |
| Approach Total | 901 | 0.349 | 3.6 | LOS A | 16 |
| Abbott Street (North) | | | | | |
| Left | 239 | 0.136 | 7.8 | LOS A# | 4# |
| Right | 398 | 0.564 | 15.1 | LOS B | 19 |
| Approach Total | 637 | 0.564 | 12.4 | LOS A | 19 |
| Bruce Hwy (West) | | | | | |
| Left | 395 | 0.218 | 7.7 | LOS A# | 7# |
| Through | 511 | 0.268 | 0.0 | LOS A | 0 |
| Approach Total | 906 | 0.268 | 3.4 | LOS A | |
| All Vehicles | 2842 | 0.564 | 6.4 | N/A | 19 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

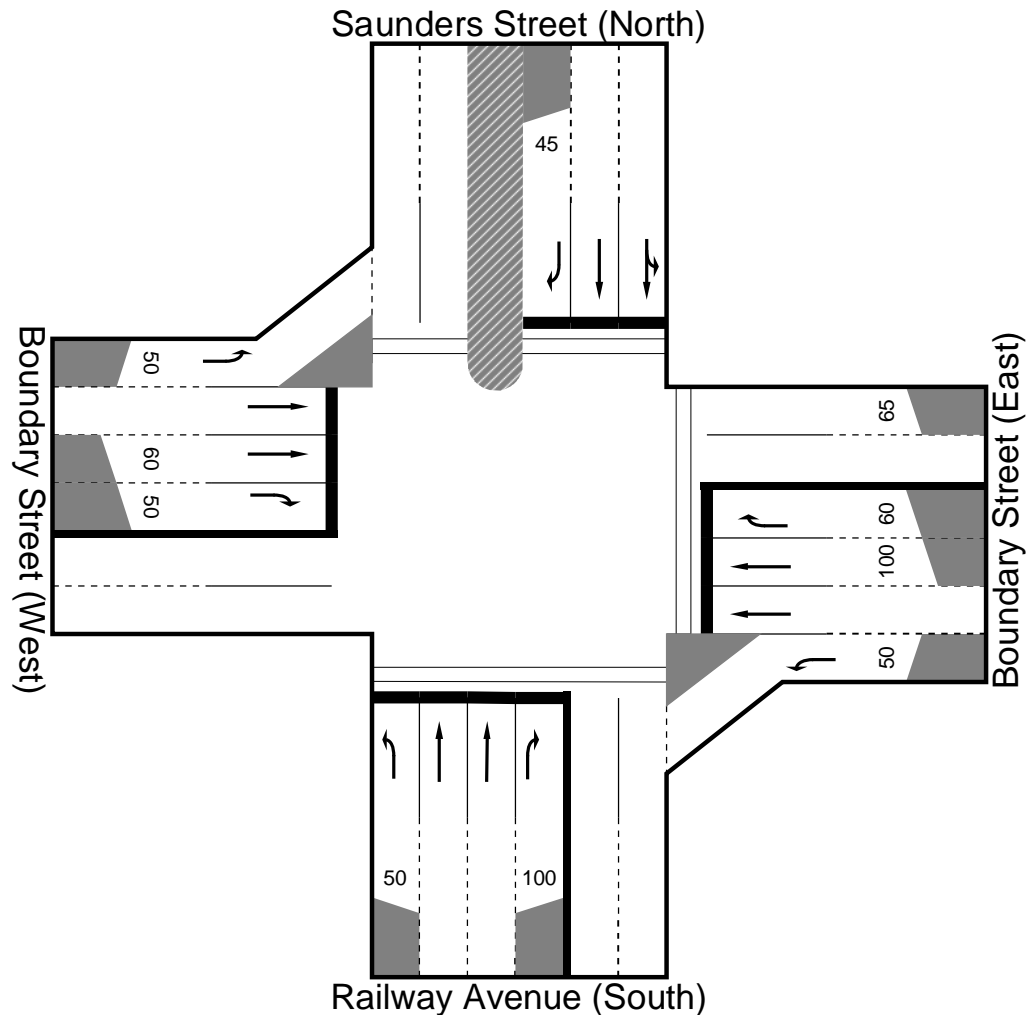
The impact of the development generated traffic by DMR guidelines is not considered to be significant on the intersection.

1.5.4 Boundary Street / Saunders Street

It should be noted that traffic generated by the development contributed less than 5% of the total intersection volumes and therefore does not trigger the need for assessment of this intersection. However, it is considered herein for completeness.

The layout used for the analysis of the Boundary Street / Saunders Street intersection is shown in Figure 25. The intersection is a four-leg signalised intersection with the major traffic movement being north-south.

Figure 25 Boundary Street / Saunders Street Intersection Layout



Background Traffic 2009

Figure 26 and Figure 27 show the phasing summary based on a 100 second and 110 second cycle time in AM and PM peaks respectively. The results of the analysis for the 2009 background traffic scenario are shown in Table 15. The results indicate the following:

- ▶ An overall minimum LOS C is achieved under peak traffic conditions;
- ▶ The overall degree of saturation is above the practical absorption capacity of 0.9 for signalised intersections;
- ▶ Queue lengths are within acceptable limits and do not encroach on neighbouring intersections; and
- ▶ Average delays for approaches are less than 40 seconds in the AM peak and less than 52 seconds in the PM peak. Right turn movements are the worst affected with at least 55 second delays.



Figure 26 2009 AM Phasing Summary

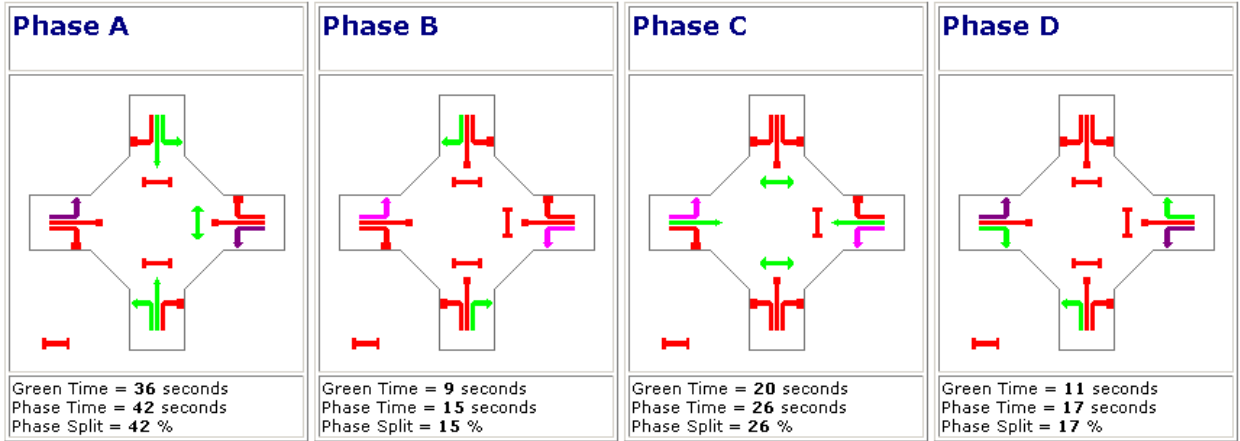


Figure 27 2009 PM Phasing Summary

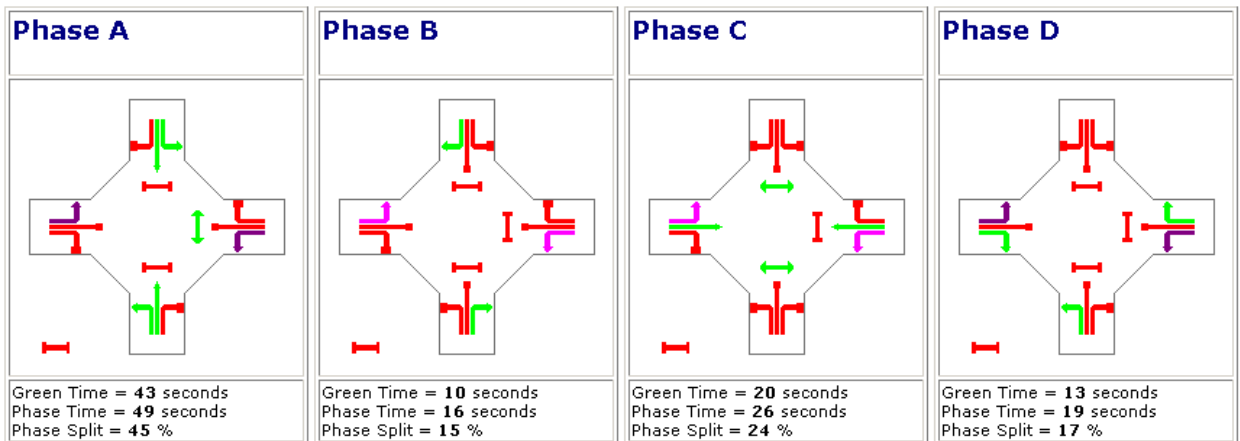




Table 15 Boundary Street / Saunders Street – 2009 Background

| AM Peak (2009) | | | | | |
|--------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Railway Avenue (South) | | | | | |
| Left | 176 | 0.488 | 21.8 | LOS B | 47 |
| Through | 1177 | 0.862 | 40.3 | LOS C | 222 |
| Right | 112 | 0.807 | 64.7 | LOS E | 67 |
| Approach Total | 1465 | 0.862 | 39.9 | LOS C | 222 |
| Boundary Street (East) | | | | | |
| Left | 148 | 0.341 | 15.0 | LOS B | 29 |
| Through | 234 | 0.324 | 37.5 | LOS C | 51 |
| Right | 98 | 0.501 | 55.6 | LOS D | 46 |
| Approach Total | 480 | 0.501 | 34.3 | LOS C | 51 |
| Saunders Street (North) | | | | | |
| Left | 208 | 0.576 | 38.5 | LOS C | 110 |
| Through | 519 | 0.576 | 28.4 | LOS B | 121 |
| Right | 51 | 0.331 | 56.8 | LOS E | 27 |
| Approach Total | 778 | 0.576 | 33.0 | LOS C | 121 |
| Boundary Street (West) | | | | | |
| Left | 400 | 0.979 | 21.7 | LOS B | 93 |
| Through | 276 | 0.680 | 39.3 | LOS C | 78 |
| Right | 154 | 0.887 | 69.3 | LOS E | 89 |
| Approach Total | 830 | 0.979 | 36.4 | LOS C | 93 |
| All Vehicles | 3553 | 0.979 | 36.8 | LOS C | 222 |

| PM Peak (2009) | | | | | |
|--------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Railway Avenue (South) | | | | | |
| Left | 155 | 0.419 | 20.7 | LOS B | 40 |
| Through | 681 | 0.457 | 26.6 | LOS B | 107 |
| Right | 132 | 0.862 | 72.0 | LOS F | 77 |
| Approach Total | 968 | 0.862 | 31.8 | LOS C | 107 |
| Boundary Street (East) | | | | | |
| Left | 253 | 0.755 | 30.2 | LOS C | 77 |
| Through | 275 | 0.406 | 43.6 | LOS D | 62 |
| Right | 49 | 0.223 | 56.7 | LOS E | 25 |
| Approach Total | 577 | 0.755 | 38.8 | LOS C | 77 |
| Saunders Street (North) | | | | | |
| Left | 306 | 0.901 | 58.8 | LOS E | 266 |
| Through | 969 | 0.901 | 48.6 | LOS D | 291 |
| Right | 41 | 0.260 | 60.7 | LOS E | 24 |
| Approach Total | 1316 | 0.901 | 51.4 | LOS D | 291 |
| Boundary Street (West) | | | | | |
| Left | 147 | 0.256 | 11.2 | LOS A | 20 |
| Through | 262 | 0.665 | 44.2 | LOS D | 75 |
| Right | 175 | 0.846 | 68.2 | LOS E | 90 |
| Approach Total | 584 | 0.846 | 43.1 | LOS D | 90 |
| All Vehicles | 3445 | 0.901 | 42.4 | LOS C | 291 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

Without Construction Traffic – 2011

Figure 28 and Figure 29 show the phasing summary based on a 100 second and 110 second cycle time in AM and PM peaks respectively. The results of the analysis for the 2011 without construction traffic scenario suggest that in 2011 the intersection will fail without additional traffic. The results shown in Table 16 indicate the following:

- ▶ An overall minimum LOS D would be achieved under peak traffic conditions which is acceptable;
- ▶ The overall degree of saturation is above the practical absorption capacity of 0.9 for signalised intersections;
- ▶ Queue lengths are within acceptable limits and don't encroach on neighbouring intersections; and
- ▶ Average delays for approaches are more than 46 seconds with delays of more than 40 seconds experienced on major movements.

Figure 28 2011 AM Phasing Summary

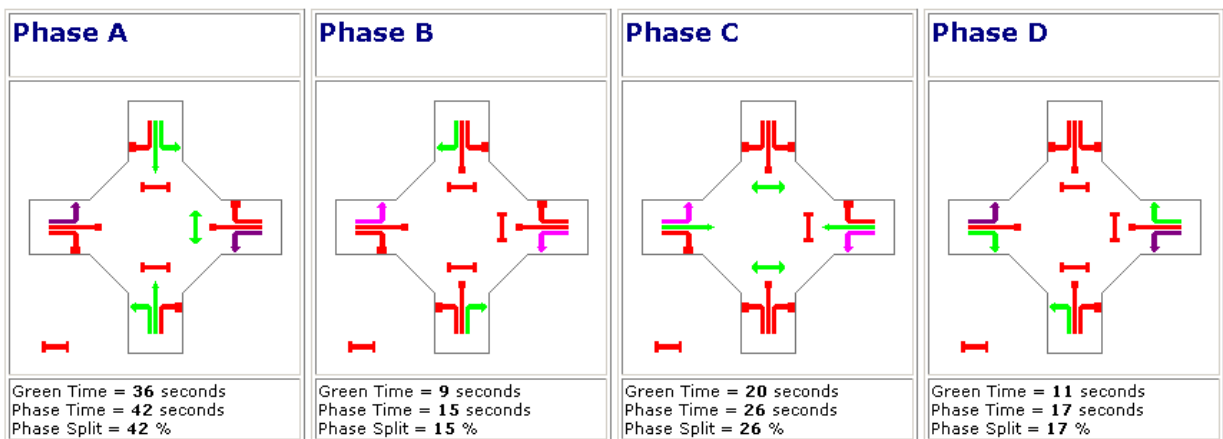


Figure 29 2011 PM Phasing Summary

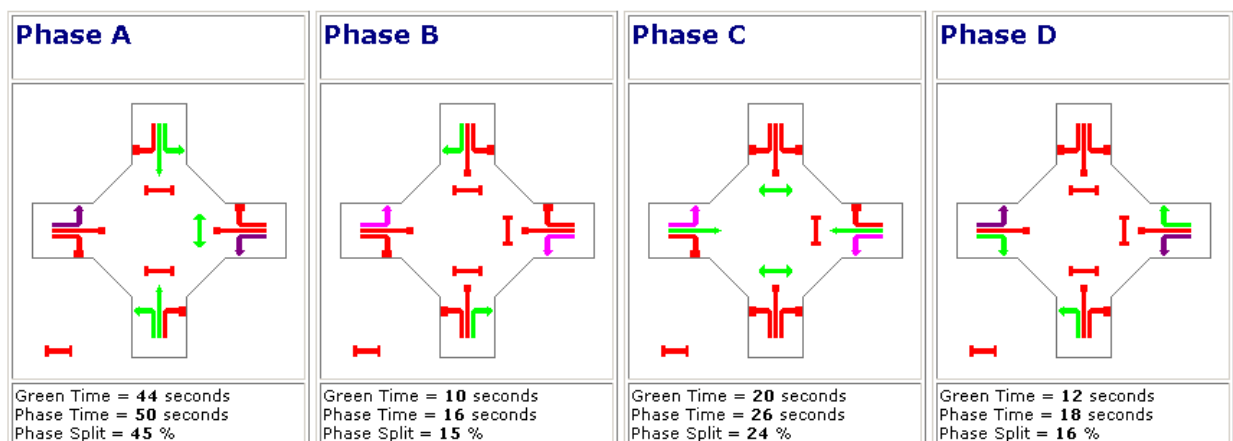




Table 16 Boundary Street / Saunders Street – 2011 Without Construction

| AM Peak (2011) | | | | | |
|--------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Railway Avenue (South) | | | | | |
| Left | 194 | 0.539 | 22.0 | LOS B | 51 |
| Through | 1298 | 0.951 | 65.0 | LOS E | 318 |
| Right | 124 | 0.896 | 71.8 | LOS F | 78 |
| Approach Total | 1616 | 0.951 | 60.3 | LOS E | 318 |
| Boundary Street (East) | | | | | |
| Left | 163 | 0.401 | 16.4 | LOS B | 35 |
| Through | 253 | 0.350 | 37.7 | LOS C | 54 |
| Right | 108 | 0.553 | 55.9 | LOS D | 50 |
| Approach Total | 524 | 0.553 | 34.8 | LOS C | 54 |
| Saunders Street (North) | | | | | |
| Left | 229 | 0.635 | 39.3 | LOS C | 122 |
| Through | 572 | 0.635 | 29.2 | LOS C | 134 |
| Right | 57 | 0.371 | 57.1 | LOS E | 30 |
| Approach Total | 858 | 0.634 | 33.7 | LOS C | 134 |
| Boundary Street (West) | | | | | |
| Left | 441 | 1.000# | 23.0 | LOS B | 93 |
| Through | 298 | 0.876 | 46.7 | LOS D | 110 |
| Right | 170 | 0.979 | 68.5 | LOS E | 95 |
| Approach Total | 909 | 1.000 | 40.8 | LOS C | 110 |
| All Vehicles | 3907 | 1.000 | 46.5 | LOS D | 318 |

| PM Peak (2011) | | | | | |
|--------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Railway Avenue (South) | | | | | |
| Left | 171 | 0.461 | 20.8 | LOS B | 44 |
| Through | 751 | 0.493 | 26.4 | LOS B | 117 |
| Right | 146 | 0.954 | 89.8 | LOS F | 94 |
| Approach Total | 1068 | 0.954 | 34.2 | LOS C | 117 |
| Boundary Street (East) | | | | | |
| Left | 279 | 0.892 | 36.9 | LOS C | 93 |
| Through | 297 | 0.438 | 43.9 | LOS D | 66 |
| Right | 54 | 0.267 | 58.1 | LOS E | 27 |
| Approach Total | 630 | 0.892 | 42.0 | LOS C | 93 |
| Saunders Street (North) | | | | | |
| Left | 337 | 0.969 | 88.2 | LOS F | 378 |
| Through | 1068 | 0.969 | 78.1 | LOS F | 417 |
| Right | 45 | 0.288 | 60.9 | LOS E | 26 |
| Approach Total | 1450 | 0.969 | 79.9 | LOS F | 417 |
| Boundary Street (West) | | | | | |
| Left | 162 | 0.300 | 11.8 | LOS A | 24 |
| Through | 283 | 0.717 | 45.2 | LOS D | 82 |
| Right | 189 | 0.989 | 65.7 | LOS E | 93 |
| Approach Total | 634 | 0.989 | 42.8 | LOS D | 93 |
| All Vehicles | 3782 | 0.989 | 54.4 | LOS D | 417 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

With Construction Traffic – 2011

Figure 30 and Figure 31 show the phasing summary based on a 100 second and 110 second cycle time in AM and PM peaks respectively. The results indicate that while the intersection isn't operating satisfactorily, when compared to the analysis without construction traffic, it is suggested that the

additional traffic doesn't significantly increase the adverse effects. The results of the 2011 with construction traffic scenario are presented in Table 17 and indicate the following:

- ▶ An overall minimum LOS D and LOS E would be achieved in AM and PM peaks respectively;
- ▶ The overall degree of saturation is above the practical absorption capacity of 0.9 for both peaks;
- ▶ Queue lengths are within acceptable limits and don't encroach on neighbouring intersections. Queue lengths exceed left and right turn slots in both peaks; and
- ▶ Average delays for approaches are more than 36 seconds in both peaks.

Figure 30 2011 AM Phasing Summary

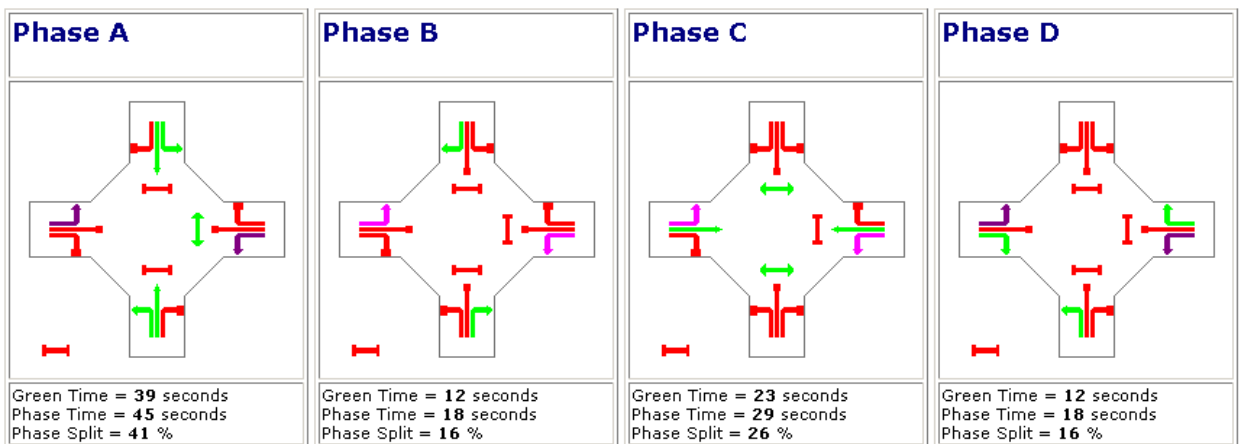


Figure 31 2011 PM Phasing Summary

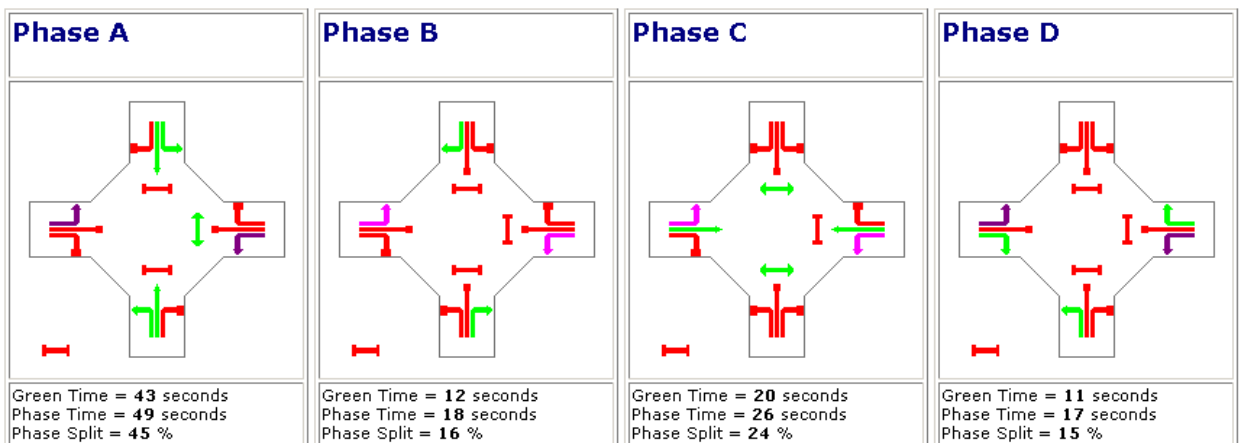




Table 17 Boundary Street / Saunders Street – 2011 With Construction

| AM Peak (2011) | | | | | |
|--------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Railway Avenue (South) | | | | | |
| Left | 194 | 0.592 | 24.0 | LOS B | 57 |
| Through | 1298 | 0.965 | 77.6 | LOS F | 364 |
| Right | 152 | 0.905 | 77.8 | LOS F | 100 |
| Approach Total | 1644 | 0.966 | 71.3 | LOS F | 364 |
| Boundary Street (East) | | | | | |
| Left | 191 | 0.493 | 17.0 | LOS B | 44 |
| Through | 297 | 0.394 | 40.9 | LOS C | 67 |
| Right | 108 | 0.558 | 60.6 | LOS E | 54 |
| Approach Total | 596 | 0.558 | 36.8 | LOS C | 67 |
| Saunders Street (North) | | | | | |
| Left | 229 | 0.641 | 42.5 | LOS D | 133 |
| Through | 572 | 0.641 | 32.4 | LOS C | 146 |
| Right | 57 | 0.306 | 58.9 | LOS E | 32 |
| Approach Total | 858 | 0.641 | 36.9 | LOS C | 146 |
| Boundary Street (West) | | | | | |
| Left | 441 | 1.000# | 23.6 | LOS B | 93 |
| Through | 342 | 1.000# | 43.0 | LOS D | 110 |
| Right | 170 | 0.987 | 64.5 | LOS E | 96 |
| Approach Total | 953 | 1.000 | 39.5 | LOS C | 110 |
| All Vehicles | 4051 | 1.000 | 51.5 | LOS D | 364 |

| PM Peak (2011) | | | | | |
|--------------------------------|----------------------|--------------|--------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Railway Avenue (South) | | | | | |
| Left | 171 | 0.476 | 21.8 | LOS B | 46 |
| Through | 751 | 0.505 | 27.2 | LOS B | 118 |
| Right | 174 | 0.947 | 87.1 | LOS F | 107 |
| Approach Total | 1096 | 0.947 | 35.9 | LOS C | 118 |
| Boundary Street (East) | | | | | |
| Left | 307 | 0.968 | 31.7 | LOS C | 93 |
| Through | 341 | 0.504 | 44.5 | LOS D | 75 |
| Right | 54 | 0.291 | 59.4 | LOS E | 28 |
| Approach Total | 702 | 0.968 | 40.1 | LOS C | 93 |
| Saunders Street (North) | | | | | |
| Left | 337 | 0.992 | 109.0 | LOS F | 424 |
| Through | 1068 | 0.992 | 98.9 | LOS F | 471 |
| Right | 45 | 0.240 | 58.3 | LOS E | 25 |
| Approach Total | 1450 | 0.992 | 100.0 | LOS F | 471 |
| Boundary Street (West) | | | | | |
| Left | 162 | 0.298 | 11.8 | LOS A | 24 |
| Through | 327 | 0.866 | 51.9 | LOS D | 106 |
| Right | 189 | 1.000# | 74.9 | LOS F | 93 |
| Approach Total | 678 | 1.000 | 48.3 | LOS D | 106 |
| All Vehicles | 3926 | 1.000 | 62.5 | LOS E | 471 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

Without Development Traffic – 2017

Figure 32 and Figure 33 show the phasing summary based on a 100 second and 120 second cycle time in AM and PM peaks respectively. The results of the analysis for the 2017 without development traffic scenario are presented in Table 18 and suggest the intersection will fail without additional traffic in 2017.



A potential mitigation solution is discussed in the conclusion of this report. The results indicate the following:

- ▶ An overall minimum LOS F would be achieved under peak traffic conditions;
- ▶ The degree of saturation is well above the practical absorption capacity of 0.9 for signalised intersections for all movements with an overall degree of saturation of 1.288 and 1.124 for the AM and PM peaks respectively;
- ▶ Queue lengths on the northern and southern approaches are predicted to be more than a kilometre long. This is unlikely due to driver behaviour however, it will need to be addressed; and
- ▶ Average delays are expected to be well over two minutes in both peaks.

Figure 32 2017 AM Phasing Summary

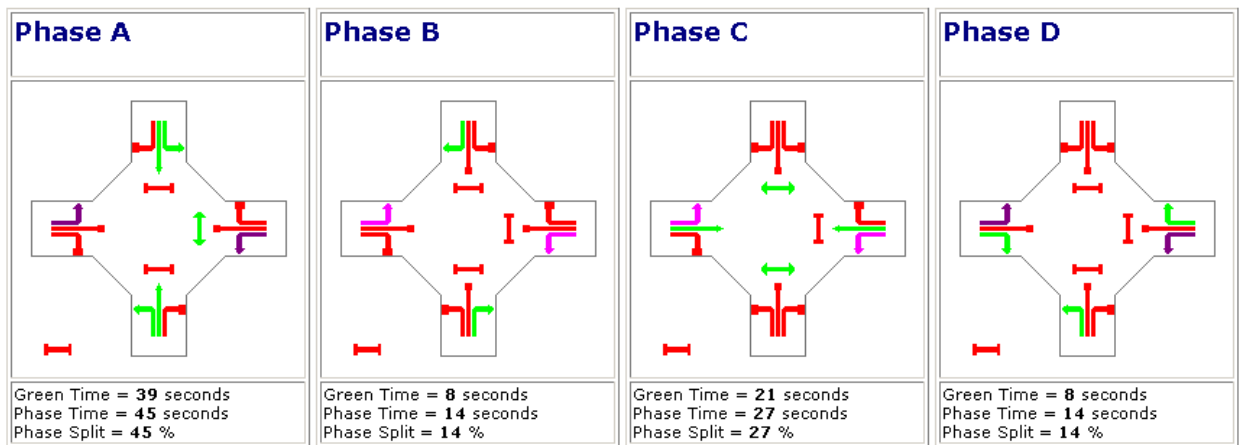


Figure 33 2017 PM Phasing Summary

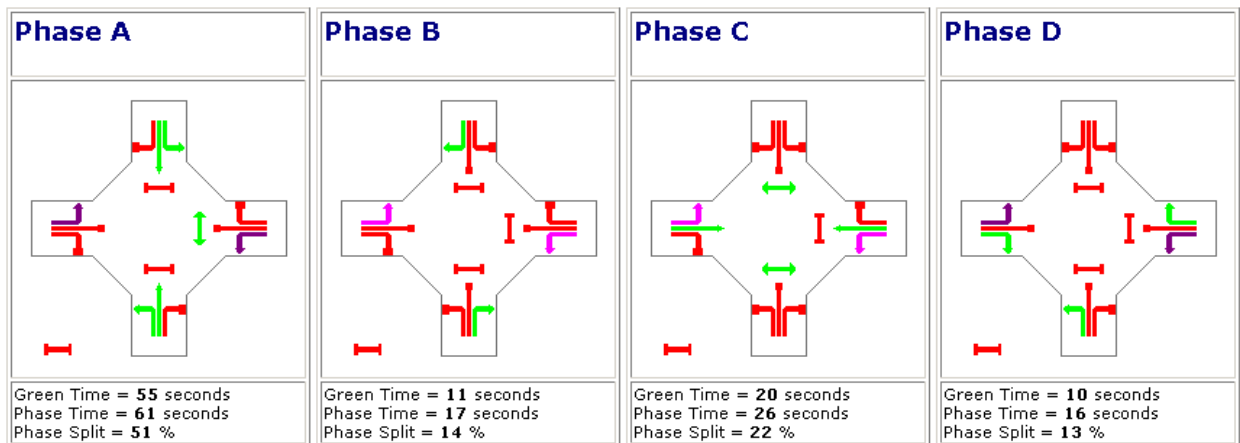




Table 18 Boundary Street / Saunders Street – 2017 Without Development

| AM Peak (2017) | | | | | |
|--------------------------------|----------------------|--------------|--------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Railway Avenue (South) | | | | | |
| Left | 261 | 0.725 | 28.5 | LOS C | 75 |
| Through | 1739 | 1.201 | 421.9 | LOS F | 1271 |
| Right | 166 | 1.102 | 265.2 | LOS F | 170 |
| Approach Total | 2166 | 1.201 | 364.7 | LOS F | 1271 |
| Boundary Street (East) | | | | | |
| Left | 219 | 0.594 | 19.4 | LOS B | 54 |
| Through | 320 | 0.422 | 37.6 | LOS C | 66 |
| Right | 144 | 1.012 | 126.5 | LOS F | 100 |
| Approach Total | 683 | 1.013 | 50.5 | LOS D | 100 |
| Saunders Street (North) | | | | | |
| Left | 307 | 0.781 | 41.8 | LOS C | 171 |
| Through | 766 | 0.781 | 31.3 | LOS C | 188 |
| Right | 76 | 0.555 | 59.4 | LOS E | 40 |
| Approach Total | 1149 | 0.781 | 35.9 | LOS C | 188 |
| Boundary Street (West) | | | | | |
| Left | 591 | 1.000# | 27.7 | LOS B | 93 |
| Through | 377 | 1.288 | 392.3 | LOS F | 870 |
| Right | 228 | 1.000# | 109.2 | LOS F | 95 |
| Approach Total | 1196 | 1.288 | 259.2 | LOS F | 870 |
| All Vehicles | 5194 | 1.288 | 226.4 | LOS F | 1271 |

| PM Peak (2017) | | | | | |
|--------------------------------|----------------------|--------------|--------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Railway Avenue (South) | | | | | |
| Left | 230 | 0.629 | 22.5 | LOS B | 59 |
| Through | 1007 | 0.597 | 25.8 | LOS B | 166 |
| Right | 195 | 1.065 | 215.1 | LOS F | 168 |
| Approach Total | 1432 | 1.065 | 47.0 | LOS D | 168 |
| Boundary Street (East) | | | | | |
| Left | 374 | 1.000# | 35.4 | LOS C | 93 |
| Through | 376 | 0.773 | 55.5 | LOS D | 116 |
| Right | 73 | 0.472 | 67.2 | LOS E | 40 |
| Approach Total | 823 | 1.000 | 49.9 | LOS D | 116 |
| Saunders Street (North) | | | | | |
| Left | 451 | 1.124 | 302.3 | LOS F | 1076 |
| Through | 1432 | 1.124 | 292.6 | LOS F | 1176 |
| Right | 61 | 0.384 | 66.0 | LOS E | 37 |
| Approach Total | 1944 | 1.124 | 287.7 | LOS F | 1176 |
| Boundary Street (West) | | | | | |
| Left | 217 | 0.508 | 14.7 | LOS B | 43 |
| Through | 359 | 1.000# | 53.0 | LOS D | 108 |
| Right | 239 | 1.000# | 95.3 | LOS F | 93 |
| Approach Total | 815 | 1.000 | 50.4 | LOS D | 108 |
| All Vehicles | 5014 | 1.124 | 141.4 | LOS F | 1176 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

With Development Traffic – 2017

Figure 34 and Figure 35 show the phasing summary based on a 120 second cycle time for both peaks. The results of the analysis for the 2017 with development traffic scenario are presented in Table 19 and suggest the intersection will fail. The additional traffic due to the development is also unlikely to have a



significant impact on the results. A potential mitigation solution is discussed in the conclusion of this report. The results indicate the following:

- ▶ An overall minimum LOS F would be achieved under peak traffic conditions;
- ▶ The degree of saturation is well above the practical absorption capacity of 0.9 for signalised intersections for all movements with an overall degree of saturation of 1.248 and 1.125 for the AM and PM peaks respectively;
- ▶ Queue lengths on the northern, southern and western approaches are predicted to be more than a kilometre long. This is unlikely due to driver behaviour however, it will need to be addressed; and
- ▶ Average delays are expected to be well over two minutes in both peaks.

Figure 34 2017 AM Phasing Summary

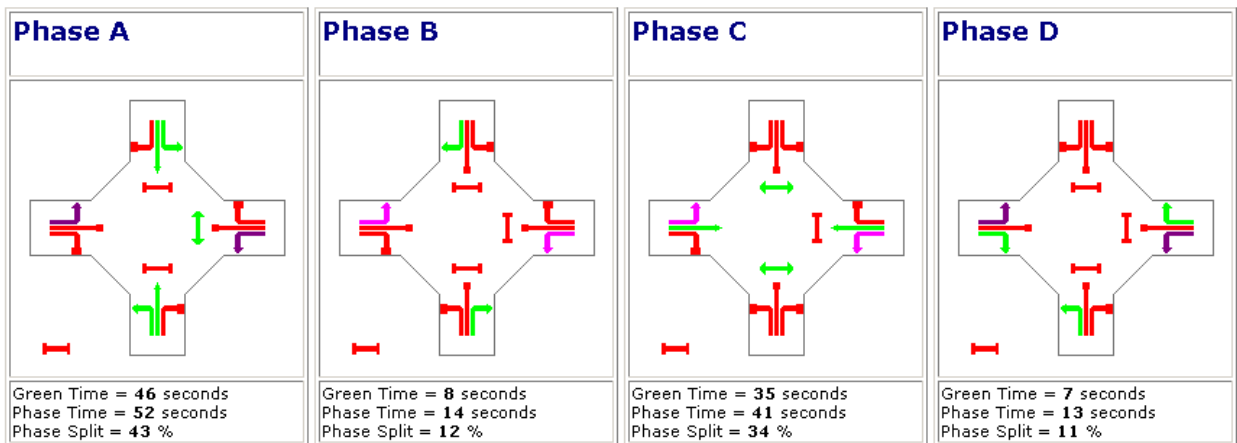


Figure 35 2017 PM Phasing Summary

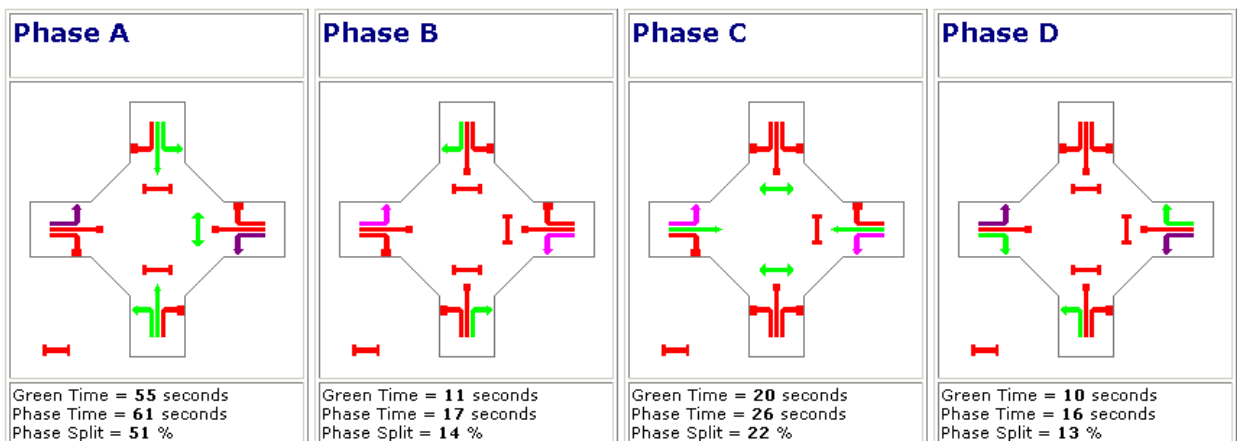




Table 19 Boundary Street / Saunders Street – 2017 With Development

| AM Peak (2017) | | | | | |
|--------------------------------|-----------------------------|------------------|------------------|--------------|--------------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Railway Avenue (South) | | | | | |
| Left | 261 | 0.894 | 42.8 | LOS D | 94 |
| Through | 1739 | 1.248 | 512.9 | LOS F | 1523 |
| Right | 176 | 1.125 | 315.4 | LOS F | 170 |
| Approach Total | 2176 | 1.248 | 446.1 | LOS F | 1523 |
| Boundary Street (East) | | | | | |
| Left | 221 | 0.651 | 19.9 | LOS B | 60 |
| Through | 338 | 0.403 | 36.2 | LOS C | 90 |
| Right | 145 | 1.058 | 201.7 | LOS F | 107 |
| Approach Total | 704 | 1.058 | 56.9 | LOS E | 107 |
| Saunders Street (North) | | | | | |
| Left | 312 | 0.793 | 48.0 | LOS D | 203 |
| Through | 766 | 0.793 | 37.4 | LOS C | 221 |
| Right | 76 | 0.666 | 72.2 | LOS F | 48 |
| Approach Total | 1154 | 0.793 | 42.6 | LOS D | 221 |
| Boundary Street (West) | | | | | |
| Left | 591 | 1.000# | 27.8 | LOS B | 93 |
| Through | 460 | 1.231 | 364.0 | LOS F | 1087 |
| Right | 228 | 1.024 | 154.2 | LOS F | 94 |
| Approach Total | 1279 | 1.231 | 266.8 | LOS F | 1087 |
| All Vehicles | 5313 | 1.248 | 263.7 | LOS F | 1523 |

| PM Peak (2017) | | | | | |
|--------------------------------|-----------------------------|------------------|------------------|--------------|--------------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Railway Avenue (South) | | | | | |
| Left | 230 | 0.629 | 22.5 | LOS B | 59 |
| Through | 1007 | 0.598 | 25.8 | LOS B | 166 |
| Right | 198 | 1.065 | 215.3 | LOS F | 168 |
| Approach Total | 1435 | 1.065 | 47.1 | LOS D | 168 |
| Boundary Street (East) | | | | | |
| Left | 384 | 1.000# | 35.4 | LOS C | 93 |
| Through | 459 | 0.923 | 72.8 | LOS F | 157 |
| Right | 78 | 0.504 | 67.4 | LOS E | 43 |
| Approach Total | 921 | 1.000 | 61.2 | LOS E | 157 |
| Saunders Street (North) | | | | | |
| Left | 453 | 1.125 | 304.5 | LOS F | 1082 |
| Through | 1432 | 1.125 | 294.8 | LOS F | 1182 |
| Right | 61 | 0.384 | 66.0 | LOS E | 37 |
| Approach Total | 1946 | 1.125 | 289.9 | LOS F | 1182 |
| Boundary Street (West) | | | | | |
| Left | 217 | 0.516 | 15.1 | LOS B | 44 |
| Through | 379 | 1.000# | 54.4 | LOS D | 119 |
| Right | 239 | 1.000# | 95.3 | LOS F | 93 |
| Approach Total | 835 | 1.000 | 51.4 | LOS D | 119 |
| All Vehicles | 5137 | 1.125 | 142.3 | LOS F | 1182 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

Without Development Traffic – 2027

Figure 36 and Figure 37 show the phasing summary based on a 120 second cycle time in both peaks. The results of the analysis for the 2027 without construction traffic scenario are presented in Table 20 and suggest the intersection will fail without additional traffic in 2027. A potential mitigation solution is discussed in the conclusion of this report. The results indicate the following:

- ▶ An overall minimum LOS F would be achieved under peak traffic conditions;
- ▶ The degree of saturation is well above the practical absorption capacity of 0.9 for signalised intersections for all movements with an overall degree of saturation of 2.234 and 1.709 for the AM and PM peaks respectively;
- ▶ Queue lengths on all approaches are predicted to be more than a kilometre long. This is unlikely due to driver behaviour however, it will need to be addressed; and
- ▶ Average delays are expected to be well over ten minutes in both peaks. This is again unlikely due to driver behaviour.

Figure 36 2027 AM Phasing Summary

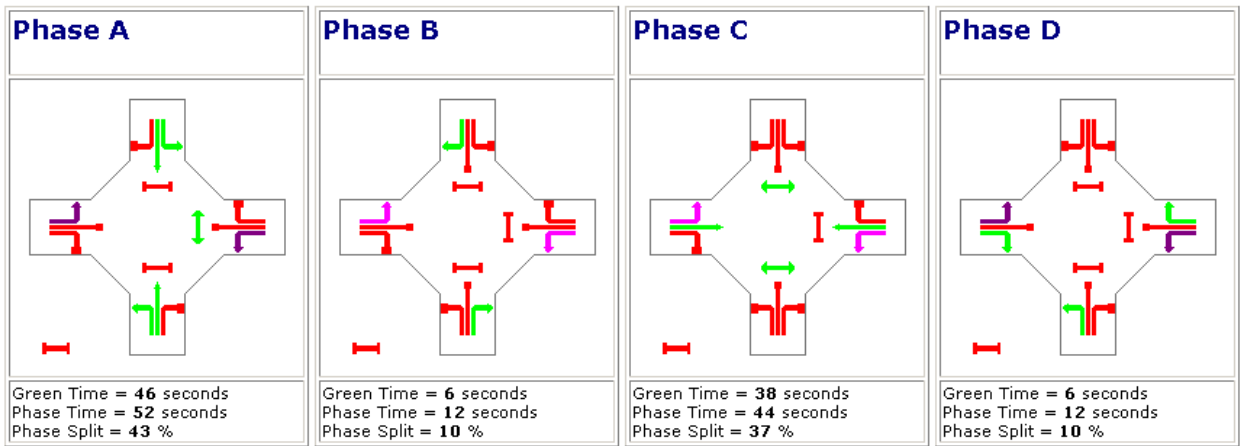


Figure 37 2027 PM Phasing Summary

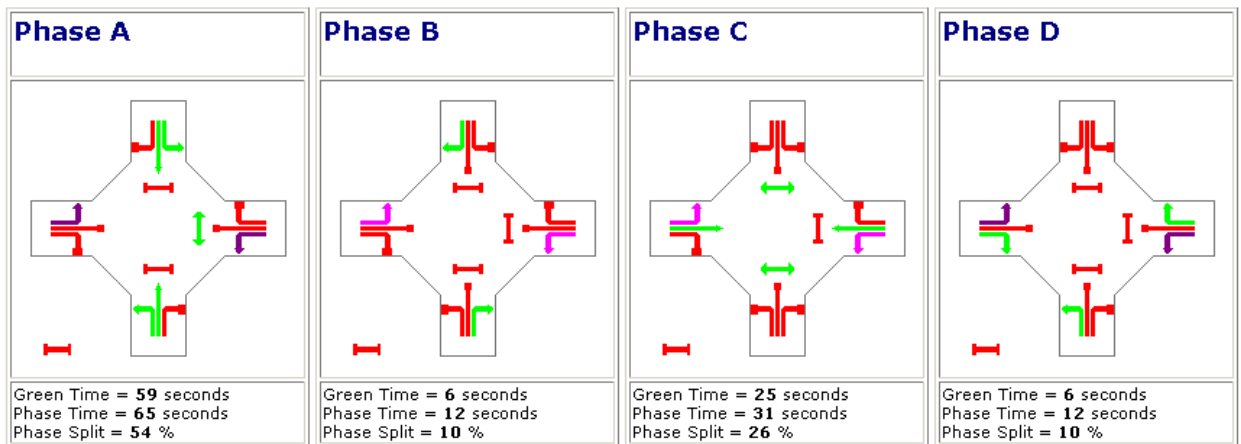




Table 20 Boundary Street / Saunders Street – 2027 Without Development

| AM Peak (2027) | | | | | |
|--------------------------------|----------------------|--------------|---------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Railway Avenue (South) | | | | | |
| Left | 425 | 1.000# | 39.7 | LOS C | 94 |
| Through | 2833 | 2.206 | 2241.1 | LOS F | 5852 |
| Right | 270 | 1.198 | 440.1 | LOS F | 170 |
| Approach Total | 3528 | 2.206 | 2014.5 | LOS F | 5856 |
| Boundary Street (East) | | | | | |
| Left | 356 | 1.000# | 26.6 | LOS B | 94 |
| Through | 474 | 0.684 | 37.5 | LOS C | 159 |
| Right | 235 | 1.087 | 248.0 | LOS F | 108 |
| Approach Total | 1065 | 1.087 | 53.5 | LOS D | 159 |
| Saunders Street (North) | | | | | |
| Left | 500 | 1.311 | 636.4 | LOS F | 1611 |
| Through | 1248 | 1.312 | 626.7 | LOS F | 1805 |
| Right | 124 | 1.037 | 169.5 | LOS F | 86 |
| Approach Total | 1872 | 1.312 | 607.6 | LOS F | 1805 |
| Boundary Street (West) | | | | | |
| Left | 963 | 1.000# | 25.0 | LOS B | 93 |
| Through | 558 | 2.234 | 1923.7 | LOS F | 4877 |
| Right | 371 | 1.050 | 189.6 | LOS F | 94 |
| Approach Total | 1892 | 2.234 | 1521.7 | LOS F | 4877 |
| All Vehicles | 8357 | 2.234 | 1337.9 | LOS F | 5852 |

| PM Peak (2027) | | | | | |
|--------------------------------|----------------------|--------------|---------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Railway Avenue (South) | | | | | |
| Left | 374 | 0.999# | 33.0 | LOS C | 93 |
| Through | 1640 | 1.012 | 118.2 | LOS F | 709 |
| Right | 318 | 1.201 | 448.0 | LOS F | 168 |
| Approach Total | 2332 | 1.201 | 119.2 | LOS F | 709 |
| Boundary Street (East) | | | | | |
| Left | 609 | 1.000# | 35.1 | LOS C | 93 |
| Through | 556 | 1.372 | 446.8 | LOS F | 1083 |
| Right | 119 | 1.090 | 251.5 | LOS F | 107 |
| Approach Total | 1284 | 1.372 | 344.0 | LOS F | 1083 |
| Saunders Street (North) | | | | | |
| Left | 735 | 1.709 | 1346.1 | LOS F | 4253 |
| Through | 2332 | 1.708 | 1337.0 | LOS F | 4627 |
| Right | 99 | 1.038 | 170.8 | LOS F | 86 |
| Approach Total | 3166 | 1.708 | 1306.0 | LOS F | 4627 |
| Boundary Street (West) | | | | | |
| Left | 354 | 1.000# | 35.1 | LOS C | 93 |
| Through | 531 | 1.654 | 918.3 | LOS F | 1806 |
| Right | 354 | 1.055 | 196.4 | LOS F | 93 |
| Approach Total | 1239 | 1.654 | 670.8 | LOS F | 1806 |
| All Vehicles | 8021 | 1.709 | 708.8 | LOS F | 4627 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

With Development Traffic – 2027

Figure 38 and Figure 39 show the phasing summary based on a 120 second cycle time for both peaks. The results of the analysis for the 2027 with development traffic scenario are presented in Table 21 and suggest the intersection will fail. The additional traffic due to the development is also unlikely to have a



significant impact on the results. A potential mitigation solution is discussed in the conclusion of this report. The results indicate the following:

- ▶ An overall minimum LOS F would be achieved under peak traffic conditions;
- ▶ The degree of saturation is well above the practical absorption capacity of 0.9 for signalised intersections for all movements with an overall degree of saturation of 2.310 and 1.710 for the AM and PM peaks respectively;
- ▶ Queue lengths on all approaches are predicted to be more than a kilometre long. This is unlikely due to driver behaviour however, it will need to be addressed; and
- ▶ Average delays are expected to be well over ten minutes in both peaks. This is again unlikely due to driver behaviour.

Figure 38 2027 AM Phasing Summary

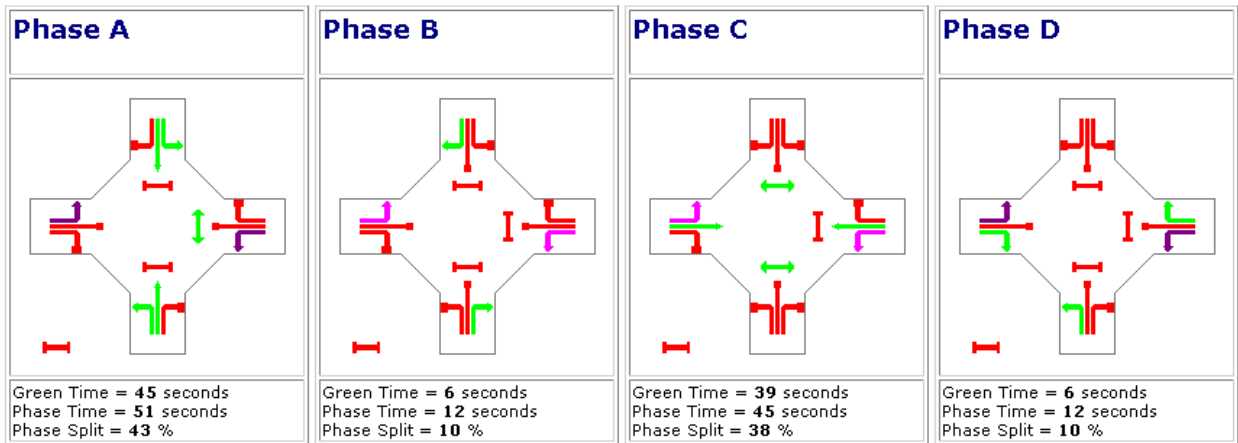


Figure 39 2027 PM Phasing Summary

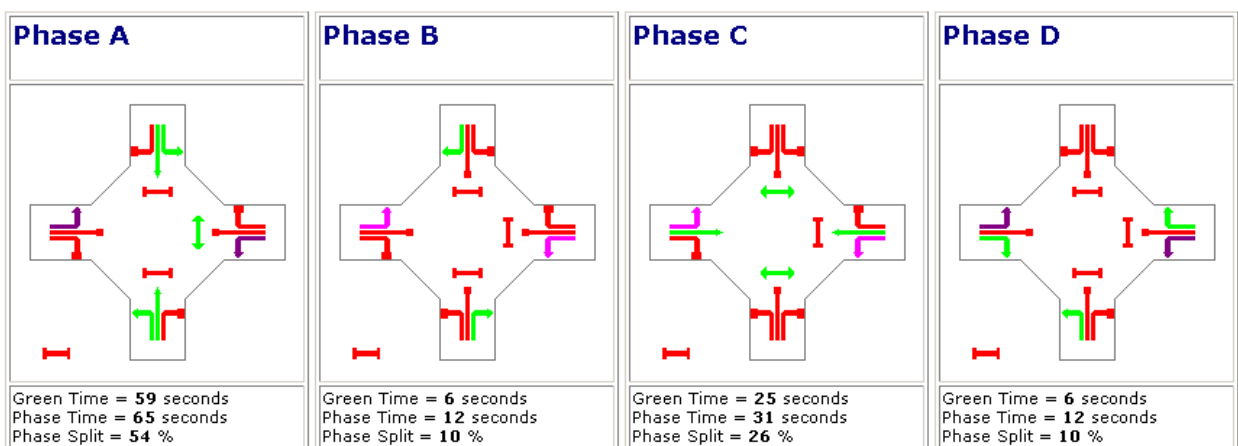




Table 21 Boundary Street / Saunders Street – 2027 With Development

| AM Peak (2027) | | | | | |
|--------------------------------|----------------------|--------------|---------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Railway Avenue (South) | | | | | |
| Left | 425 | 0.999# | 40.2 | LOS C | 94 |
| Through | 2833 | 2.267 | 2351.3 | LOS F | 5993 |
| Right | 280 | 1.198 | 440.0 | LOS F | 170 |
| Approach Total | 3538 | 2.267 | 2116.1 | LOS F | 5996 |
| Boundary Street (East) | | | | | |
| Left | 358 | 1.001# | 26.0 | LOS B | 94 |
| Through | 492 | 0.687 | 36.8 | LOS C | 163 |
| Right | 236 | 1.087 | 248.0 | LOS F | 108 |
| Approach Total | 1086 | 1.087 | 52.6 | LOS D | 163 |
| Saunders Street (North) | | | | | |
| Left | 505 | 1.347 | 698.4 | LOS F | 1706 |
| Through | 1248 | 1.346 | 688.7 | LOS F | 1916 |
| Right | 124 | 1.037 | 169.5 | LOS F | 86 |
| Approach Total | 1877 | 1.346 | 666.8 | LOS F | 1916 |
| Boundary Street (West) | | | | | |
| Left | 963 | 1.001# | 24.5 | LOS B | 93 |
| Through | 642 | 2.310 | 2055.3 | LOS F | 5314 |
| Right | 371 | 1.050 | 189.6 | LOS F | 94 |
| Approach Total | 1976 | 2.311 | 1638.1 | LOS F | 5314 |
| All Vehicles | 8477 | 2.310 | 1419.4 | LOS F | 5993 |

| PM Peak (2027) | | | | | |
|--------------------------------|----------------------|--------------|---------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Railway Avenue (South) | | | | | |
| Left | 374 | 0.999# | 33.0 | LOS C | 93 |
| Through | 1640 | 1.014 | 120.7 | LOS F | 718 |
| Right | 321 | 1.201 | 447.9 | LOS F | 168 |
| Approach Total | 2335 | 1.201 | 121.2 | LOS F | 718 |
| Boundary Street (East) | | | | | |
| Left | 619 | 1.000# | 35.1 | LOS C | 93 |
| Through | 640 | 1.627 | 757.8 | LOS F | 1699 |
| Right | 124 | 1.089 | 251.5 | LOS F | 107 |
| Approach Total | 1383 | 1.627 | 578.3 | LOS F | 1699 |
| Saunders Street (North) | | | | | |
| Left | 737 | 1.710 | 1348.3 | LOS F | 4259 |
| Through | 2332 | 1.709 | 1339.1 | LOS F | 4634 |
| Right | 99 | 1.038 | 170.8 | LOS F | 86 |
| Approach Total | 3168 | 1.709 | 1308.1 | LOS F | 4634 |
| Boundary Street (West) | | | | | |
| Left | 354 | 1.000# | 35.1 | LOS C | 93 |
| Through | 551 | 1.706 | 994.7 | LOS F | 1935 |
| Right | 354 | 1.055 | 196.4 | LOS F | 93 |
| Approach Total | 1259 | 1.706 | 729.1 | LOS F | 1935 |
| All Vehicles | 8145 | 1.710 | 754.4 | LOS F | 4634 |

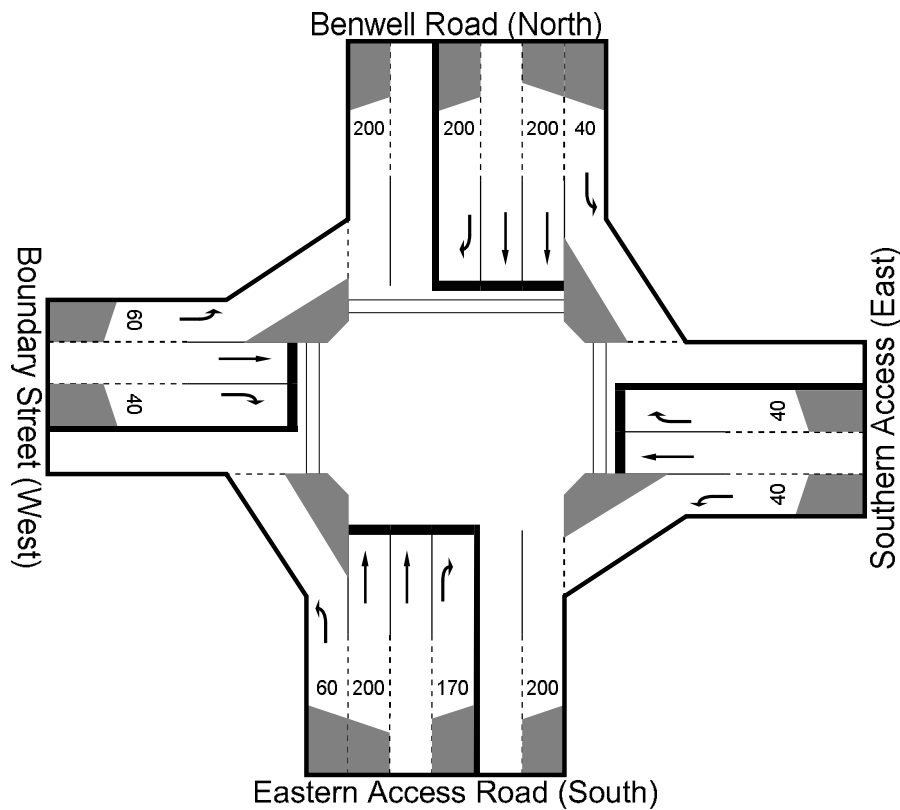
Note: Average Delay is measured in seconds and Queue Length is measured in metres

The impact of the development generated traffic by DMR guidelines is not considered to be significant on the intersection.

1.5.5 Boundary Street / Benwell Road

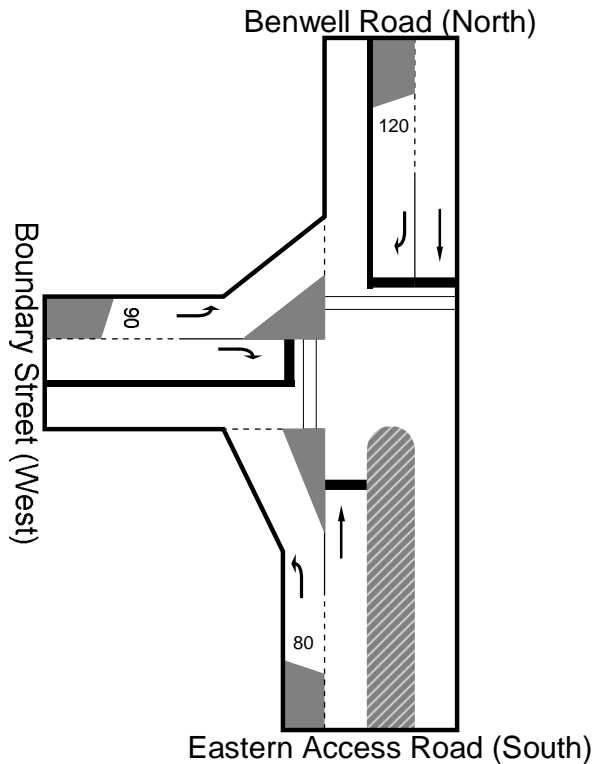
The layout used for the analysis of the new intersection between Boundary Street / Benwell Road for the with development traffic scenario is based on the proposed intersection layout as shown in the Conceptual Design Report produced by Maunsell for the Port of Townsville and is shown in Figure 40.

Figure 40 Boundary Street / Benwell Road Intersection Layout (With Development)



The layout for the without development scenario is based on the Eastern Access Road as a two lane two direction road. Turning lane lengths are as required by the 2027 analysis and is shown in Figure 41.

Figure 41 Boundary Street / Benwell Road Intersection Layout (Without Development)



Without Development Traffic 2017

Figure 42 and Figure 43 show the phasing summary based on a 60 second cycle time in both peaks. The results of the analysis are shown in Table 22 and indicate the following:

- ▶ An overall minimum LOS B would be achieved under peak traffic conditions;
- ▶ The degree of saturation is below the practical absorption capacity of 0.8 for unsignalised intersections for all movements;
- ▶ Queue lengths are within acceptable limits and won't encroach on neighbouring intersections; and
- ▶ Average delays are less than 25 seconds for all approaches in both peaks.



Figure 42 2017 AM Phasing Summary

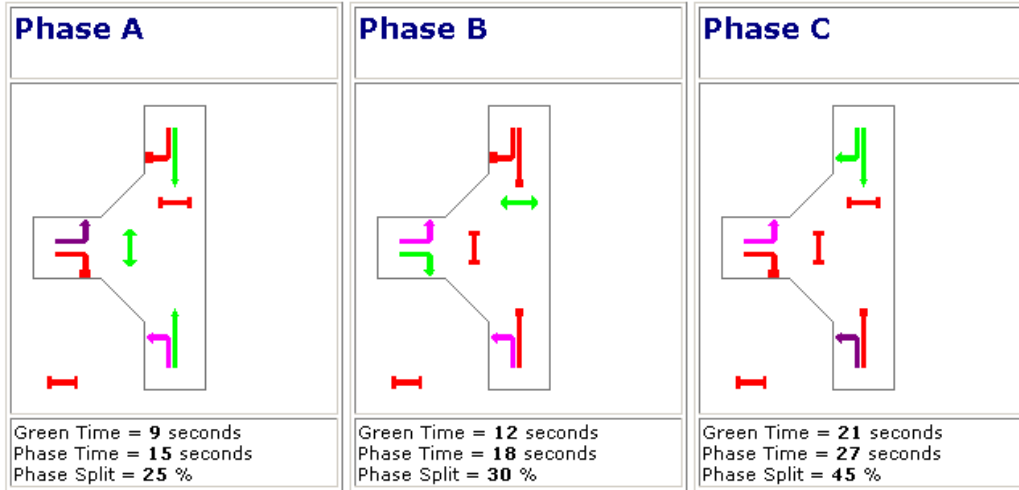
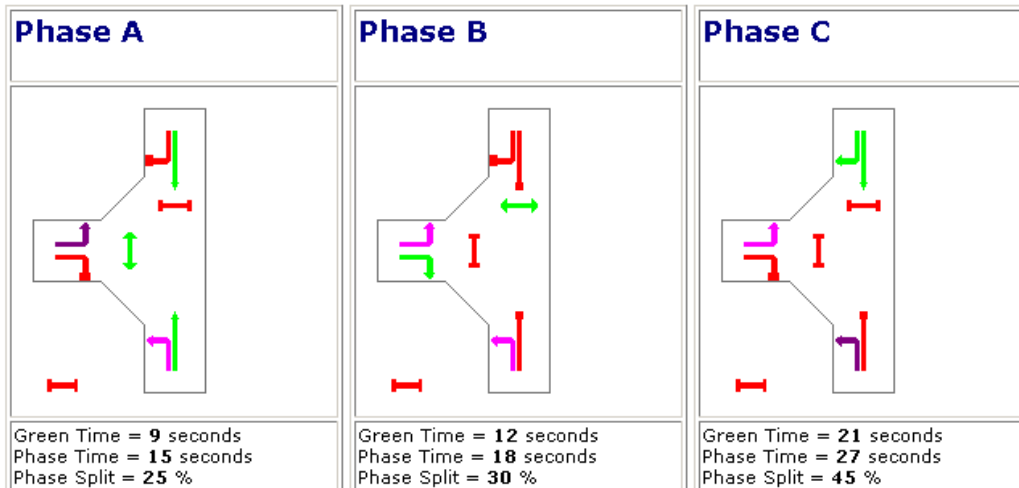


Figure 43 2017 PM Phasing Summary



- | | |
|------------------|-------------------|
| Normal Movement | Permitted/Opposed |
| Slip-Lane | Opposed Slip-Lane |
| Stopped Movement | Continuous |
| Turn On Red | |



Table 22 Boundary Street / Benwell Road – 2017 Without Development

| AM Peak (2017) | | | | | |
|------------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Eastern Access Road (South) | | | | | |
| Left | 9 | 0.008 | 9.2 | LOS A | 1 |
| Through | 78 | 0.342 | 26.3 | LOS B | 31 |
| Approach Total | 87 | 0.342 | 24.6 | LOS B | 31 |
| Benwell Road (North) | | | | | |
| Through | 78 | 0.081 | 5.4 | LOS A | 13 |
| Right | 197 | 0.374 | 25.8 | LOS B | 53 |
| Approach Total | 275 | 0.375 | 20.0 | LOS B | 53 |
| Boundary Street (West) | | | | | |
| Left | 201 | 0.166 | 8.9 | LOS A | 11 |
| Right | 9 | 0.026 | 29.8 | LOS C | 3 |
| Approach Total | 210 | 0.166 | 9.8 | LOS A | 11 |
| All Vehicles | 572 | 0.374 | 16.9 | LOS B | 53 |

| PM Peak (2017) | | | | | |
|------------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Eastern Access Road (South) | | | | | |
| Left | 9 | 0.008 | 9.2 | LOS A | 1 |
| Through | 78 | 0.342 | 26.3 | LOS B | 31 |
| Approach Total | 87 | 0.342 | 24.6 | LOS B | 31 |
| Benwell Road (North) | | | | | |
| Through | 78 | 0.081 | 5.4 | LOS A | 13 |
| Right | 197 | 0.374 | 25.8 | LOS B | 53 |
| Approach Total | 275 | 0.375 | 20.0 | LOS B | 53 |
| Boundary Street (West) | | | | | |
| Left | 201 | 0.166 | 8.9 | LOS A | 11 |
| Right | 9 | 0.026 | 29.8 | LOS C | 3 |
| Approach Total | 210 | 0.166 | 9.8 | LOS A | 11 |
| All Vehicles | 572 | 0.374 | 16.9 | LOS B | 53 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

With Development Traffic 2017

Figure 44 and Figure 45 show the phasing summary based on a 100 second and 80 second cycle time in the AM and PM peaks respectively. The results of the analysis are shown in Table 23 and indicate the following:

- ▶ An overall minimum LOS C in the AM peak and LOS B in PM peak would be achieved;
- ▶ The degree of saturation is below the practical absorption capacity of 0.9 for signalised intersections for all movements;
- ▶ Queue lengths are within acceptable limits and won't encroach on neighbouring intersections; and
- ▶ Average delays are less than 38 seconds for all approaches in both peaks.



Figure 44 2017 AM Phasing Summary

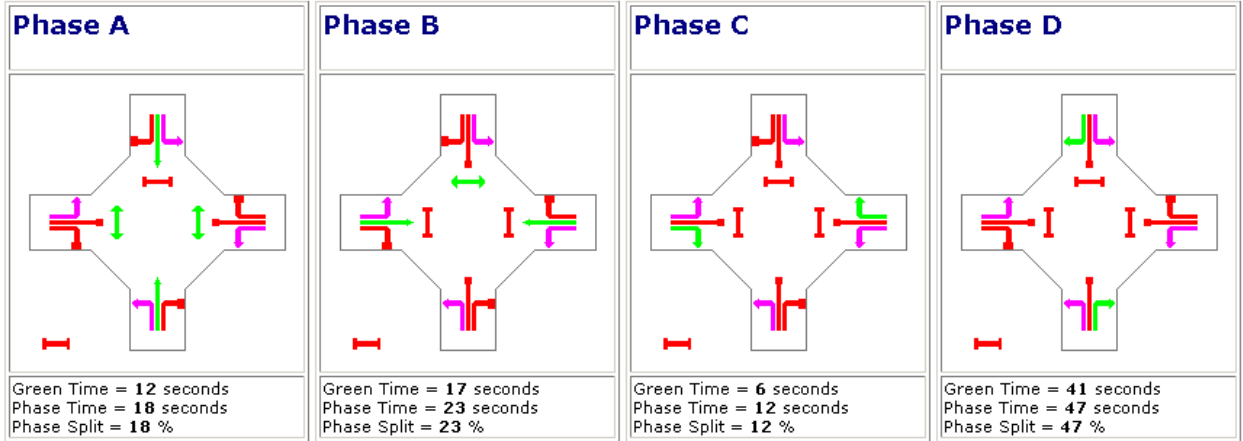


Figure 45 2017 PM Phasing Summary

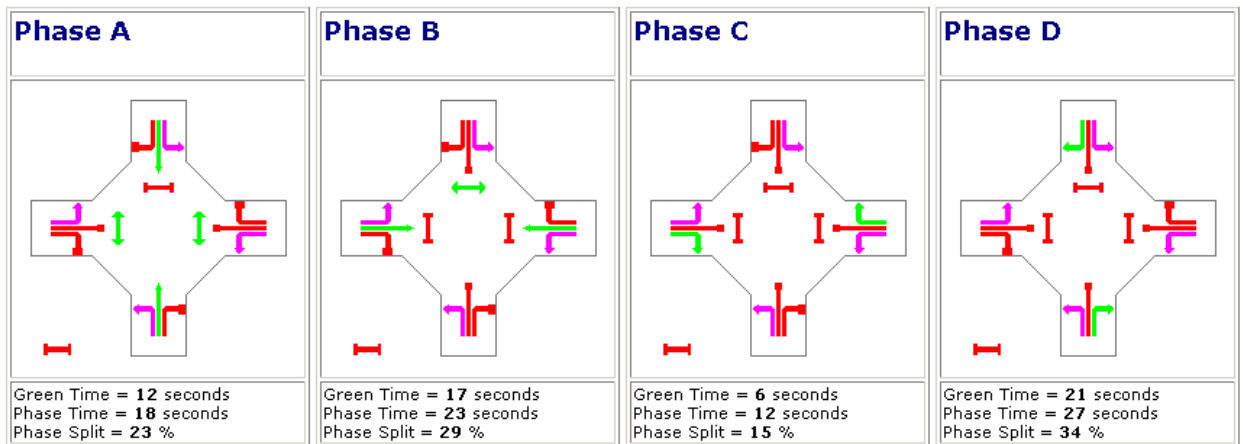




Table 23 Boundary Street / Benwell Road – 2017 With Development

| AM Peak (2017) | | | | | |
|-----------------------------------|-----------------------------|------------------|------------------|--------------|--------------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Easter Access Road (South) | | | | | |
| Left | 9 | 0.007 | 8.2 | LOS A | 0 |
| Through | 122 | 0.336 | 45.6 | LOS D | 39 |
| Right | 427 | 0.693 | 35.6 | LOS C | 164 |
| Approach Total | 558 | 0.693 | 37.4 | LOS C | 164 |
| Southern Access (East) | | | | | |
| Left | 87 | 0.094 | 8.9 | LOS A | 4 |
| Through | 23 | 0.085 | 38.3 | LOS C | 13 |
| Right | 6 | 0.067 | 60.0 | LOS E | 4 |
| Approach Total | 116 | 0.094 | 17.4 | LOS B | 13 |
| Benwell Road (North) | | | | | |
| Left | 27 | 0.029 | 8.9 | LOS A | 1 |
| Through | 87 | 0.226 | 44.6 | LOS D | 26 |
| Right | 198 | 0.321 | 30.9 | LOS C | 74 |
| Approach Total | 312 | 0.321 | 32.8 | LOS C | 74 |
| Boundary Street (West) | | | | | |
| Left | 205 | 0.164 | 8.3 | LOS A | 8 |
| Through | 114 | 0.363 | 40.5 | LOS C | 50 |
| Right | 9 | 0.087 | 58.9 | LOS E | 5 |
| Approach Total | 328 | 0.363 | 20.8 | LOS B | 50 |
| All Vehicles | 1314 | 0.693 | 30.4 | LOS C | 164 |

| PM Peak (2017) | | | | | |
|-----------------------------------|-----------------------------|------------------|------------------|--------------|--------------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Easter Access Road (South) | | | | | |
| Left | 9 | 0.007 | 8.3 | LOS A | 0 |
| Through | 89 | 0.195 | 33.5 | LOS C | 23 |
| Right | 108 | 0.274 | 35.1 | LOS C | 43 |
| Approach Total | 206 | 0.274 | 33.2 | LOS C | 43 |
| Southern Access (East) | | | | | |
| Left | 406 | 0.441 | 9.2 | LOS A | 23 |
| Through | 108 | 0.317 | 29.6 | LOS C | 45 |
| Right | 27 | 0.240 | 49.9 | LOS D | 15 |
| Approach Total | 541 | 0.441 | 15.3 | LOS B | 45 |
| Benwell Road (North) | | | | | |
| Left | 6 | 0.006 | 9.0 | LOS A | 0 |
| Through | 119 | 0.247 | 33.7 | LOS C | 28 |
| Right | 202 | 0.513 | 37.2 | LOS C | 77 |
| Approach Total | 327 | 0.513 | 35.4 | LOS C | 77 |
| Boundary Street (West) | | | | | |
| Left | 202 | 0.162 | 8.4 | LOS A | 8 |
| Through | 29 | 0.073 | 27.4 | LOS B | 10 |
| Right | 9 | 0.070 | 47.5 | LOS D | 4 |
| Approach Total | 240 | 0.162 | 12.1 | LOS A | 10 |
| All Vehicles | 1314 | 0.513 | 22.5 | LOS B | 77 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

Without Development Traffic 2027

Figure 46 and Figure 47 show the phasing summary based on a 60 second cycle time in both peaks. The results of the analysis are shown in Table 24 and indicate the following:

- ▶ An overall minimum LOS B would be achieved under peak traffic conditions;

- ▶ The degree of saturation is below the practical absorption capacity of 0.9 for signalised intersections for all movements;
- ▶ Queue lengths are within acceptable limits and won't encroach on neighbouring intersections; and
- ▶ Average delays are less than 29 seconds for all approaches in both peaks.

Figure 46 2027 AM Phasing Summary

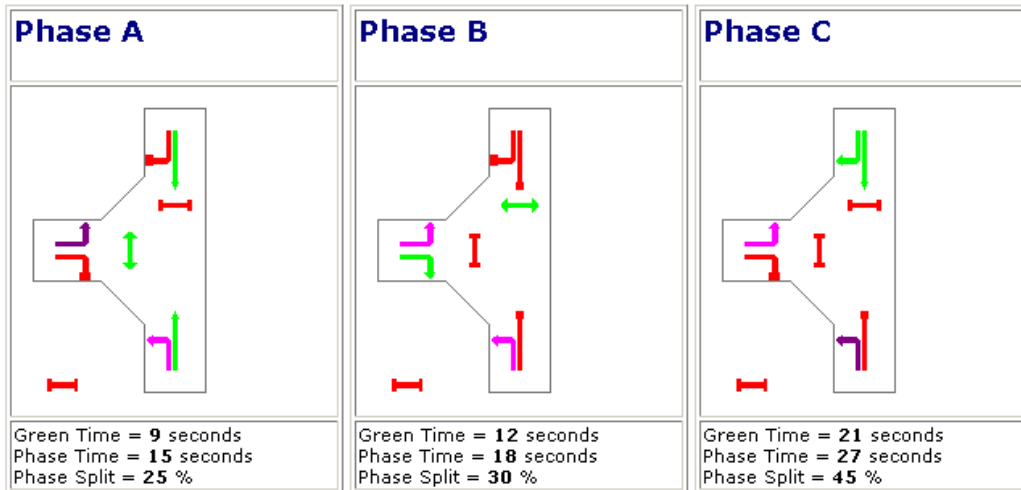


Figure 47 2027 PM Phasing Summary

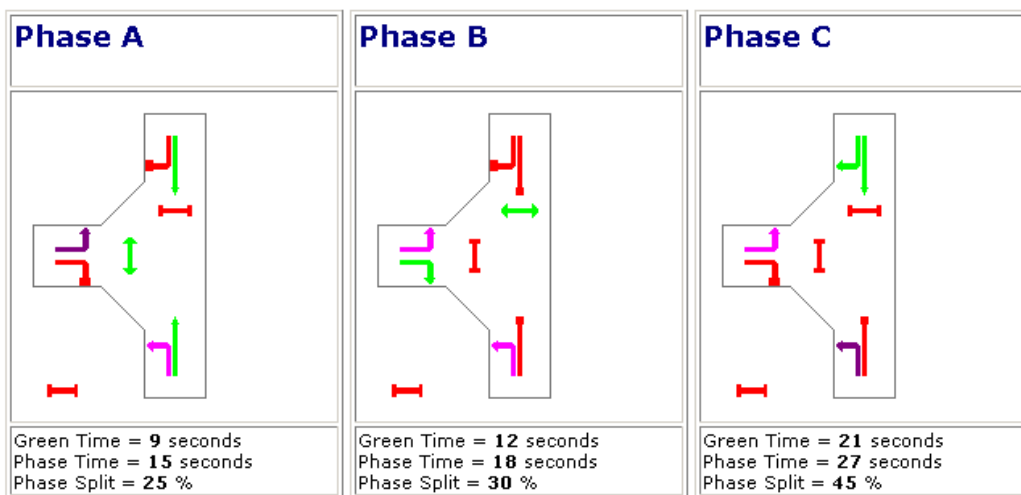




Table 24 Boundary Street / Benwell Road – 2027 Without Development

| AM Peak (2027) | | | | | |
|------------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Eastern Access Road (South) | | | | | |
| Left | 17 | 0.019 | 11.3 | LOS A | 2 |
| Through | 154 | 0.593 | 30.8 | LOS C | 65 |
| Approach Total | 171 | 0.593 | 28.9 | LOS C | 65 |
| Benwell Road (North) | | | | | |
| Through | 154 | 0.146 | 4.9 | LOS A | 26 |
| Right | 388 | 0.645 | 28.3 | LOS B | 112 |
| Approach Total | 542 | 0.645 | 21.6 | LOS B | 112 |
| Boundary Street (West) | | | | | |
| Left | 395 | 0.358 | 9.7 | LOS A | 34 |
| Right | 17 | 0.056 | 35.4 | LOS C | 6 |
| Approach Total | 412 | 0.358 | 10.8 | LOS A | 34 |
| All Vehicles | 1125 | 0.645 | 18.8 | LOS B | 112 |

| PM Peak (2027) | | | | | |
|------------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Eastern Access Road (South) | | | | | |
| Left | 17 | 0.019 | 11.3 | LOS A | 2 |
| Through | 154 | 0.593 | 30.8 | LOS C | 65 |
| Approach Total | 171 | 0.593 | 28.9 | LOS C | 65 |
| Benwell Road (North) | | | | | |
| Through | 154 | 0.146 | 4.9 | LOS A | 26 |
| Right | 388 | 0.645 | 28.3 | LOS B | 112 |
| Approach Total | 542 | 0.645 | 21.6 | LOS B | 112 |
| Boundary Street (West) | | | | | |
| Left | 195 | 0.177 | 9.5 | LOS A | 16 |
| Right | 17 | 0.056 | 35.4 | LOS C | 6 |
| Approach Total | 212 | 0.177 | 11.5 | LOS A | 16 |
| All Vehicles | 925 | 0.645 | 20.7 | LOS B | 112 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

With Development Traffic 2027

Figure 44 and Figure 45 show the phasing summary based on a 100 second and 90 second cycle time in the AM and PM peaks respectively. The results of the analysis are shown in Table 23 and indicate the following:

- ▶ An overall minimum LOS C in the AM peak and LOS B in PM peak would be achieved;
- ▶ The degree of saturation is below the practical absorption capacity of 0.9 for signalised intersections for all movements;
- ▶ Queue lengths are within acceptable limits and will not encroach on neighbouring intersections; and
- ▶ Average delays are less than 41 seconds for all approaches in both peaks.

Figure 48 2027 AM Phasing Summary

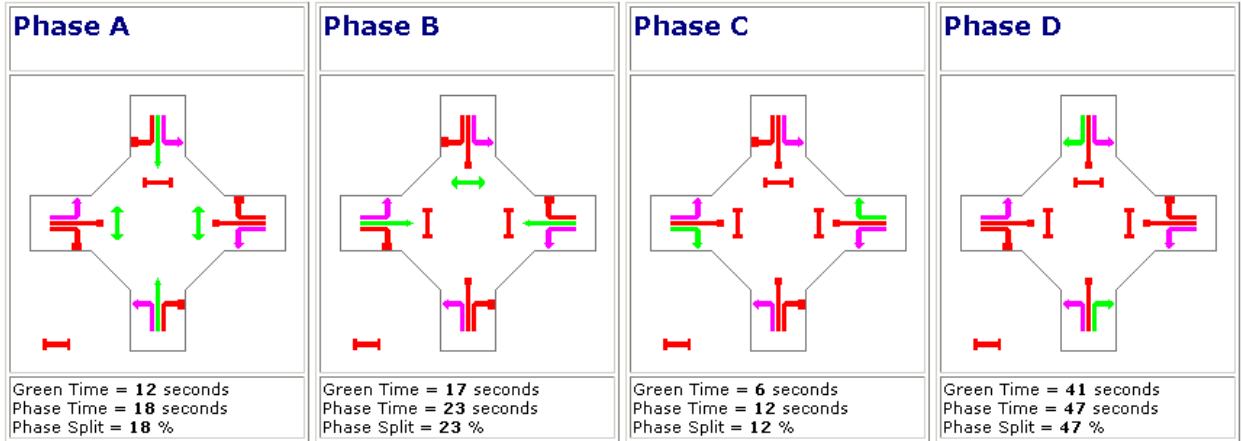


Figure 49 2027 PM Phasing Summary

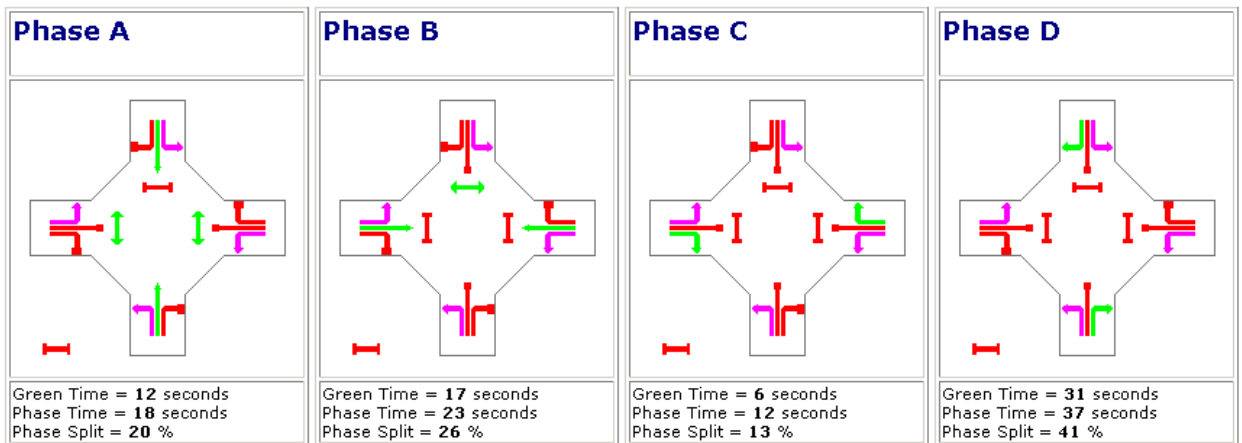




Table 25 Boundary Street / Benwell Road – 2027 With Development

| AM Peak (2027) | | | | | |
|-----------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Easter Access Road (South) | | | | | |
| Left | 17 | 0.014 | 8.2 | LOS A | 1 |
| Through | 197 | 0.542 | 47.0 | LOS D | 61 |
| Right | 427 | 0.693 | 35.6 | LOS C | 164 |
| Approach Total | 641 | 0.693 | 38.4 | LOS C | 164 |
| Southern Access (East) | | | | | |
| Left | 87 | 0.094 | 8.9 | LOS A | 4 |
| Through | 23 | 0.085 | 38.3 | LOS C | 13 |
| Right | 6 | 0.067 | 60.0 | LOS E | 4 |
| Approach Total | 116 | 0.094 | 17.4 | LOS B | 13 |
| Benwell Road (North) | | | | | |
| Left | 27 | 0.029 | 8.9 | LOS A | 1 |
| Through | 163 | 0.423 | 46.0 | LOS D | 47 |
| Right | 389 | 0.631 | 34.7 | LOS C | 147 |
| Approach Total | 579 | 0.631 | 36.7 | LOS C | 147 |
| Boundary Street (West) | | | | | |
| Left | 399 | 0.321 | 8.3 | LOS A | 18 |
| Through | 114 | 0.363 | 40.5 | LOS C | 50 |
| Right | 17 | 0.159 | 59.4 | LOS E | 9 |
| Approach Total | 530 | 0.363 | 16.9 | LOS B | 50 |
| All Vehicles | 1866 | 0.693 | 30.4 | LOS C | 164 |

| PM Peak (2027) | | | | | |
|-----------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Easter Access Road (South) | | | | | |
| Left | 17 | 0.014 | 8.2 | LOS A | 1 |
| Through | 165 | 0.409 | 40.5 | LOS C | 47 |
| Right | 108 | 0.209 | 31.9 | LOS C | 42 |
| Approach Total | 290 | 0.409 | 35.4 | LOS C | 47 |
| Southern Access (East) | | | | | |
| Left | 406 | 0.441 | 9.2 | LOS A | 23 |
| Through | 108 | 0.357 | 35.3 | LOS C | 52 |
| Right | 27 | 0.270 | 55.8 | LOS D | 17 |
| Approach Total | 541 | 0.441 | 16.7 | LOS B | 52 |
| Benwell Road (North) | | | | | |
| Left | 6 | 0.006 | 8.9 | LOS A | 0 |
| Through | 195 | 0.455 | 40.7 | LOS C | 50 |
| Right | 393 | 0.760 | 40.6 | LOS C | 157 |
| Approach Total | 594 | 0.760 | 40.3 | LOS C | 157 |
| Boundary Street (West) | | | | | |
| Left | 396 | 0.319 | 8.4 | LOS A | 17 |
| Through | 29 | 0.082 | 32.7 | LOS C | 12 |
| Right | 17 | 0.143 | 53.7 | LOS D | 8 |
| Approach Total | 442 | 0.319 | 11.7 | LOS A | 17 |
| All Vehicles | 1867 | 0.760 | 25.9 | LOS B | 157 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

1.5.6 Benwell Road / Archer Street

A conceptual layout and control of the existing intersection is shown in Figure 50. The capacity of this intersection has also been assessed as a signal control and roundabout as shown in Figure 51 and Figure 52 respectively.



Figure 50 Benwell Road / Archer Street Intersection Layout – Existing Priority

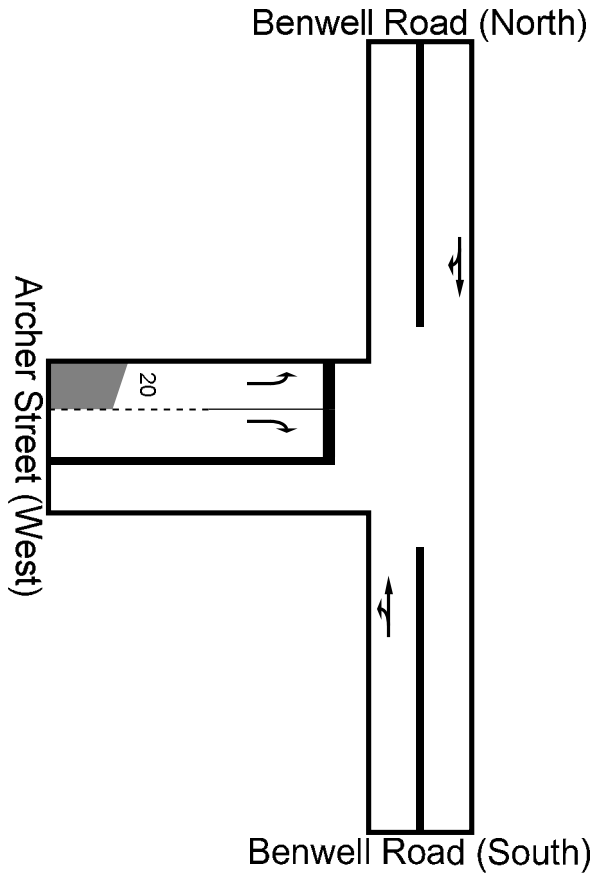


Figure 51 Benwell Road / Archer Street Intersection Layout - Signalised

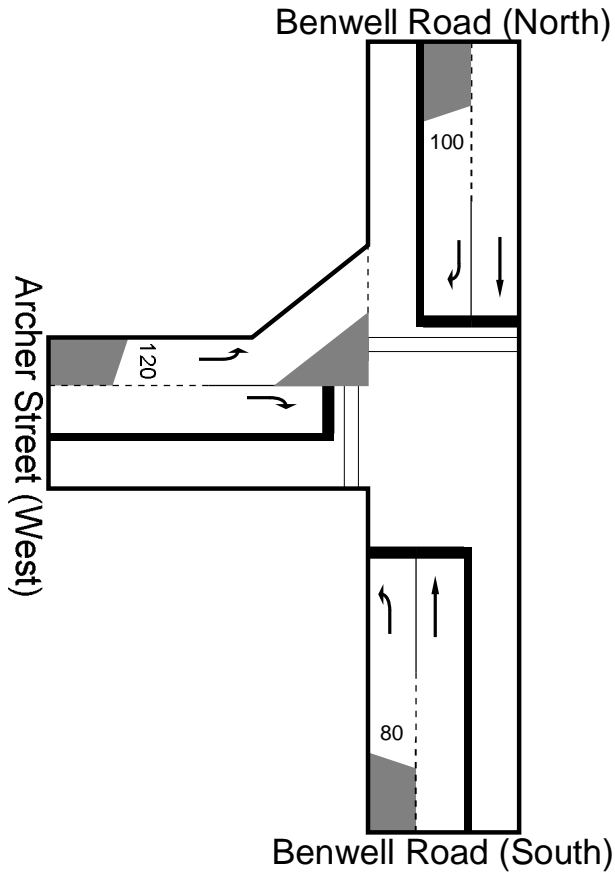
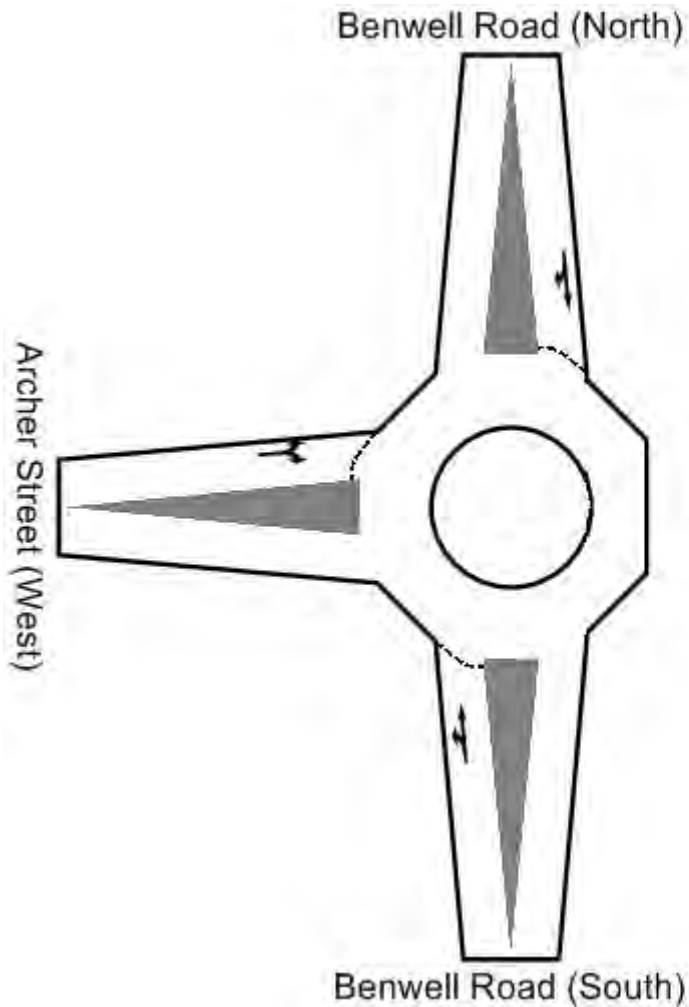


Figure 52 Benwell Road / Archer Street Intersection Layout - Roundabout



Background Traffic 2009

The results of the analysis for the 2009 background traffic scenario with the existing priority control intersection form are presented in Table 26. The results indicate the following:

- ▶ An overall minimum LOS A is achieved under peak traffic conditions;
- ▶ The degree of saturation is below the practical absorption capacity of 0.8 for unsignalised intersections for all movements;
- ▶ Queue lengths are within acceptable limits and do not encroach on neighbouring intersections; and
- ▶ Average delays are less than 13 seconds for all movements in both peaks.



Table 26 Benwell Road / Archer Street – 2009 Background

| AM Peak (2009) | | | | | |
|-----------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Left | 41 | 0.099 | 8.5 | LOS A | 0 |
| Through | 121 | 0.099 | 0.0 | LOS A | 0 |
| Approach Total | 162 | 0.099 | 2.2 | LOS A | |
| Benwell Road (North) | | | | | |
| Through | 106 | 0.073 | 0.7 | LOS A | 4 |
| Right | 10 | 0.073 | 9.3 | LOS A | 4 |
| Approach Total | 116 | 0.073 | 1.4 | LOS A | 4 |
| Archer Street (West) | | | | | |
| Left | 14 | 0.016 | 12.0 | LOS A | 1 |
| Right | 54 | 0.067 | 12.8 | LOS A | 2 |
| Approach Total | 68 | 0.067 | 12.7 | LOS A | 2 |
| All Vehicles | 346 | 0.099 | 4.0 | N/A | 4 |

| PM Peak (2009) | | | | | |
|-----------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Left | 52 | 0.098 | 8.5 | LOS A | 0 |
| Through | 110 | 0.098 | 0.0 | LOS A | 0 |
| Approach Total | 162 | 0.098 | 2.7 | LOS A | |
| Benwell Road (North) | | | | | |
| Through | 104 | 0.074 | 0.7 | LOS A | 4 |
| Right | 13 | 0.073 | 9.3 | LOS A | 4 |
| Approach Total | 117 | 0.074 | 1.6 | LOS A | 4 |
| Archer Street (West) | | | | | |
| Left | 14 | 0.016 | 11.9 | LOS A | 1 |
| Right | 57 | 0.070 | 12.8 | LOS A | 2 |
| Approach Total | 71 | 0.070 | 12.6 | LOS A | 2 |
| All Vehicles | 350 | 0.098 | 4.4 | N/A | 4 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

With Development Traffic 2017 (Priority)

The results of the analysis for the 2017 with development traffic scenario are presented in Table 27. The results indicate the following:

- ▶ An overall minimum LOS A would be achieved under peak traffic conditions;
- ▶ The degree of saturation is below the practical absorption capacity of 0.8 for unsignalised intersections for all movements;
- ▶ Queue lengths are within acceptable limits and don't encroach on neighbouring intersections; and
- ▶ Average delays are less than 20 seconds for all movements in both peaks.



Table 27 Benwell Road / Archer Street – 2017 With Development (Priority)

| AM Peak (2017) | | | | | |
|-----------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Left | 83 | 0.252 | 8.5 | LOS A | 0 |
| Through | 328 | 0.252 | 0.0 | LOS A | 0 |
| Approach Total | 411 | 0.252 | 1.7 | LOS A | |
| Benwell Road (North) | | | | | |
| Through | 263 | 0.182 | 2.1 | LOS A | 14 |
| Right | 20 | 0.182 | 10.7 | LOS A | 14 |
| Approach Total | 283 | 0.182 | 2.7 | LOS A | 14 |
| Archer Street (West) | | | | | |
| Left | 35 | 0.049 | 14.3 | LOS A | 2 |
| Right | 128 | 0.314 | 20.0 | LOS B | 12 |
| Approach Total | 163 | 0.314 | 18.8 | LOS B | 12 |
| All Vehicles | 857 | 0.314 | 5.3 | N/A | 14 |

| PM Peak (2017) | | | | | |
|-----------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Left | 124 | 0.241 | 8.5 | LOS A | 0 |
| Through | 273 | 0.241 | 0.0 | LOS A | 0 |
| Approach Total | 397 | 0.241 | 2.7 | LOS A | |
| Benwell Road (North) | | | | | |
| Through | 294 | 0.211 | 1.7 | LOS A | 15 |
| Right | 34 | 0.211 | 10.3 | LOS A | 15 |
| Approach Total | 328 | 0.211 | 2.6 | LOS A | 15 |
| Archer Street (West) | | | | | |
| Left | 27 | 0.036 | 13.7 | LOS A | 1 |
| Right | 111 | 0.272 | 19.5 | LOS B | 10 |
| Approach Total | 138 | 0.272 | 18.4 | LOS B | 10 |
| All Vehicles | 863 | 0.272 | 5.1 | N/A | 15 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

With Development Traffic 2027 (Priority)

The results of the analysis for the 2027 with development traffic scenario suggest that the intersection will fail in 2027 without additional traffic as a stop priority intersection. The results are presented in Table 28 and indicate the following:

- ▶ An overall LOS F would be achieved under peak traffic conditions, this is caused by the minor approach on Archer Street, the major approaches on Benwell Road achieve a LOS A;
- ▶ The degree of saturation is well above the practical absorption capacity of 0.8 for unsignalised intersections for minor movements in both peaks;
- ▶ Queue lengths are lengths on the western approach are more than a kilometre long and would interfere with accesses on Archer Street. This is unlikely due to drive behaviour as drivers would most likely use another route; and
- ▶ Average overall delays are more than four minutes in both peaks.



Table 28 Benwell Road / Archer Street – 2027 With Development (Priority)

| AM Peak (2027) | | | | | |
|-----------------------------|----------------------|--------------|---------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Left | 157 | 0.463 | 8.5 | LOS A | 0 |
| Through | 599 | 0.463 | 0.0 | LOS A | 0 |
| Approach Total | 756 | 0.463 | 1.8 | LOS A | |
| Benwell Road (North) | | | | | |
| Through | 508 | 0.369 | 7.7 | LOS A | 56 |
| Right | 36 | 0.367 | 16.3 | LOS B | 56 |
| Approach Total | 544 | 0.369 | 8.2 | LOS A | 56 |
| Archer Street (West) | | | | | |
| Left | 58 | 0.141 | 21.3 | LOS B | 6 |
| Right | 225 | 2.250 | 2303.1 | LOS F | 1227 |
| Approach Total | 283 | 2.243 | 1835.5 | LOS F | 1227 |
| All Vehicles | 1583 | 2.250 | 331.8 | N/A | 1227 |

| PM Peak (2027) | | | | | |
|-----------------------------|----------------------|--------------|---------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Left | 216 | 0.451 | 8.5 | LOS A | 0 |
| Through | 526 | 0.451 | 0.0 | LOS A | 0 |
| Approach Total | 742 | 0.451 | 2.5 | LOS A | |
| Benwell Road (North) | | | | | |
| Through | 535 | 0.403 | 6.6 | LOS A | 58 |
| Right | 55 | 0.401 | 15.2 | LOS B | 58 |
| Approach Total | 590 | 0.403 | 7.4 | LOS A | 58 |
| Archer Street (West) | | | | | |
| Left | 51 | 0.105 | 19.4 | LOS B | 4 |
| Right | 212 | 2.078 | 2002.7 | LOS F | 1085 |
| Approach Total | 263 | 2.075 | 1618.1 | LOS F | 1085 |
| All Vehicles | 1595 | 2.078 | 270.7 | N/A | 1085 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

Without Development Traffic 2027 (Priority)

The results of the analysis for the 2027 without development traffic scenario suggest that the intersection will fail in 2027 without additional traffic as a stop priority intersection. The results are presented in Table 29 and indicate the following:

- ▶ An overall LOS F would be achieved under peak traffic conditions, this is caused by the minor approach on Archer Street, the major approaches on Benwell Road achieve an LOS A;
- ▶ The degree of saturation is well above the practical absorption capacity of 0.8 for unsignalised intersections for minor movements in both peaks;
- ▶ Queue lengths are lengths on the western approach are more than 600 metres and would interfere with accesses on Archer Street; and
- ▶ Average overall delays are more than two minutes in both peaks.



Table 29 Benwell Road / Archer Street – 2027 Without Development

| AM Peak (2027) | | | | | |
|-----------------------------|----------------------|--------------|--------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Left | 151 | 0.421 | 8.5 | LOS A | 0 |
| Through | 536 | 0.420 | 0.0 | LOS A | 0 |
| Approach Total | 687 | 0.420 | 1.9 | LOS A | |
| Benwell Road (North) | | | | | |
| Through | 483 | 0.344 | 6.0 | LOS A | 46 |
| Right | 34 | 0.343 | 14.7 | LOS B | 46 |
| Approach Total | 517 | 0.344 | 6.6 | LOS A | 46 |
| Archer Street (West) | | | | | |
| Left | 46 | 0.092 | 19.0 | LOS B | 4 |
| Right | 198 | 1.500 | 971.6 | LOS F | 672 |
| Approach Total | 244 | 1.504 | 792.0 | LOS F | 672 |
| All Vehicles | 1448 | 1.500 | 136.7 | N/A | 672 |

| PM Peak (2027) | | | | | |
|-----------------------------|----------------------|--------------|--------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Left | 189 | 0.418 | 8.5 | LOS A | 0 |
| Through | 498 | 0.418 | 0.0 | LOS A | 0 |
| Approach Total | 687 | 0.418 | 2.3 | LOS A | |
| Benwell Road (North) | | | | | |
| Through | 474 | 0.346 | 5.4 | LOS A | 44 |
| Right | 43 | 0.347 | 14.0 | LOS A | 44 |
| Approach Total | 517 | 0.347 | 6.1 | LOS A | 44 |
| Archer Street (West) | | | | | |
| Left | 48 | 0.089 | 18.3 | LOS B | 4 |
| Right | 207 | 1.468 | 909.3 | LOS F | 673 |
| Approach Total | 255 | 1.471 | 741.6 | LOS F | 673 |
| All Vehicles | 1459 | 1.468 | 132.9 | N/A | 673 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

With Development Traffic 2017 (Signalised)

Figure 53 and Figure 54 show the phasing summary based on a 60 second cycle time for both peaks. The 2017 with development traffic scenario is predicted to allow the intersection to operate in a satisfactory fashion. The results are shown in Table 30 and indicate the following:

- ▶ An overall minimum LOS B would be achieved under peak traffic conditions;
- ▶ The degree of saturation is below the practical absorption capacity of 0.9 for signalised intersections for all movements;
- ▶ Queue lengths are within acceptable limits and don't encroach on neighbouring intersections; and
- ▶ Average delays are less than 28 seconds for all approaches in both peaks.



Figure 53 2017 AM Phasing Summary

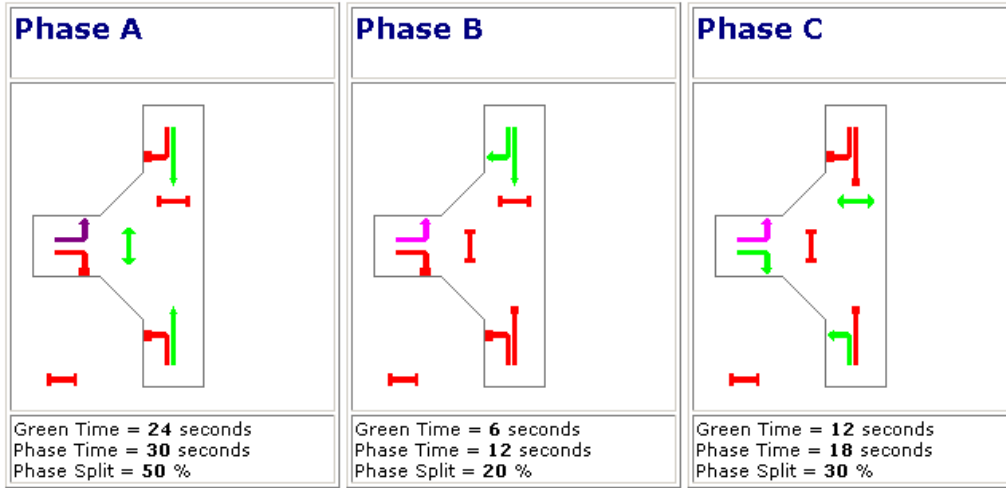


Figure 54 2017 PM Phasing Summary

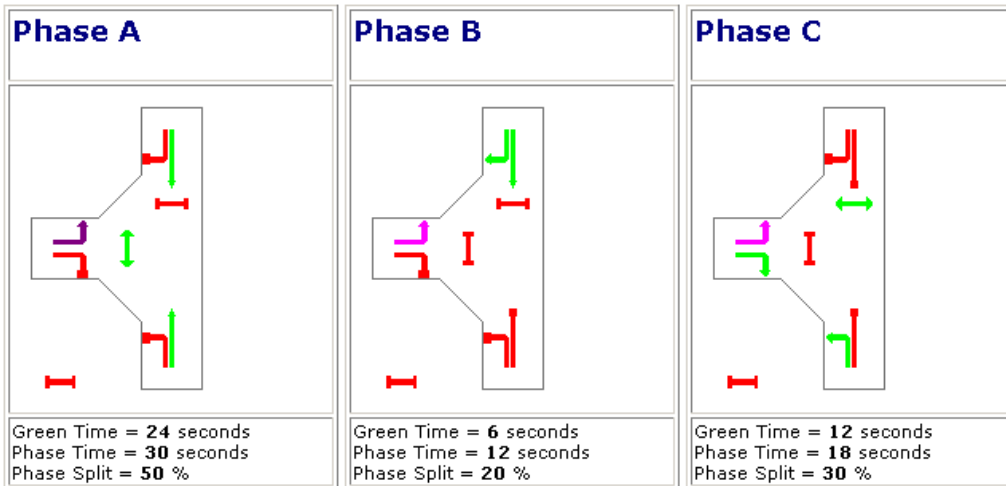




Table 30 Benwell Road / Archer Street – 2017 With Development (Signalised)

| AM Peak (2017) | | | | | |
|-----------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Left | 83 | 0.237 | 31.1 | LOS C | 23 |
| Through | 328 | 0.511 | 15.0 | LOS B | 82 |
| Approach Total | 411 | 0.511 | 18.2 | LOS B | 82 |
| Benwell Road (North) | | | | | |
| Through | 263 | 0.273 | 6.2 | LOS A | 46 |
| Right | 20 | 0.115 | 36.9 | LOS C | 7 |
| Approach Total | 283 | 0.273 | 8.4 | LOS A | 46 |
| Archer Street (West) | | | | | |
| Left | 35 | 0.035 | 10.2 | LOS A | 3 |
| Right | 128 | 0.366 | 32.0 | LOS C | 35 |
| Approach Total | 163 | 0.366 | 27.3 | LOS B | 35 |
| All Vehicles | 857 | 0.511 | 16.7 | LOS B | 82 |

| PM Peak (2017) | | | | | |
|-----------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Left | 124 | 0.355 | 31.8 | LOS C | 34 |
| Through | 273 | 0.425 | 14.3 | LOS A | 68 |
| Approach Total | 397 | 0.425 | 19.8 | LOS B | 68 |
| Benwell Road (North) | | | | | |
| Through | 294 | 0.305 | 6.4 | LOS A | 51 |
| Right | 34 | 0.195 | 37.3 | LOS C | 11 |
| Approach Total | 328 | 0.305 | 9.6 | LOS A | 51 |
| Archer Street (West) | | | | | |
| Left | 27 | 0.026 | 9.7 | LOS A | 2 |
| Right | 111 | 0.316 | 31.7 | LOS C | 31 |
| Approach Total | 138 | 0.316 | 27.4 | LOS B | 31 |
| All Vehicles | 863 | 0.425 | 17.1 | LOS B | 68 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

Without Development Traffic 2017

The results of the analysis for the 2017 without development traffic scenario based on a three-leg stop priority are presented in Table 31. The results indicate the following:

- ▶ An overall minimum LOS A would be achieved under peak traffic conditions;
- ▶ The degree of saturation is below the practical absorption capacity of 0.8 for unsignalised intersections for all movements;
- ▶ Queue lengths are within acceptable limits and don't encroach on neighbouring intersections; and
- ▶ Average delays are less than 18 seconds for all movements in both peaks.



Table 31 Benwell Road / Archer Street – 2017 Without Development

| AM Peak (2017) | | | | | |
|-----------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Left | 77 | 0.214 | 8.5 | LOS A | 0 |
| Through | 272 | 0.214 | 0.0 | LOS A | 0 |
| Approach Total | 349 | 0.214 | 1.9 | LOS A | |
| Benwell Road (North) | | | | | |
| Through | 245 | 0.166 | 1.5 | LOS A | 11 |
| Right | 17 | 0.167 | 10.1 | LOS A | 11 |
| Approach Total | 262 | 0.166 | 2.0 | LOS A | 11 |
| Archer Street (West) | | | | | |
| Left | 23 | 0.031 | 13.5 | LOS A | 1 |
| Right | 101 | 0.214 | 17.3 | LOS B | 7 |
| Approach Total | 124 | 0.213 | 16.6 | LOS B | 7 |
| All Vehicles | 735 | 0.214 | 4.4 | N/A | 11 |

| PM Peak (2017) | | | | | |
|-----------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Left | 97 | 0.213 | 8.5 | LOS A | 0 |
| Through | 253 | 0.213 | 0.0 | LOS A | 0 |
| Approach Total | 350 | 0.213 | 2.4 | LOS A | |
| Benwell Road (North) | | | | | |
| Through | 240 | 0.167 | 1.4 | LOS A | 12 |
| Right | 22 | 0.167 | 10.1 | LOS A | 12 |
| Approach Total | 262 | 0.167 | 2.2 | LOS A | 12 |
| Archer Street (West) | | | | | |
| Left | 24 | 0.032 | 13.4 | LOS A | 1 |
| Right | 105 | 0.215 | 17.1 | LOS B | 8 |
| Approach Total | 129 | 0.215 | 16.4 | LOS B | 8 |
| All Vehicles | 741 | 0.215 | 4.7 | N/A | 12 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

With Development Traffic 2027 (Signalised)

Figure 55 and Figure 56 show the phasing summary based on a 70 second cycle time for both peaks. The 2027 with development traffic scenario is predicted to allow the intersection to operate in a satisfactory fashion. The results are shown in Table 30 and indicate the following:

- ▶ An overall minimum LOS B would be achieved under peak traffic conditions;
- ▶ The degree of saturation is below the practical absorption capacity of 0.9 for signalised intersections for all movements;
- ▶ Queue lengths are within acceptable limits and don't encroach on neighbouring intersections; and
- ▶ Average delays are less than 37 seconds for all approaches in both peaks.



Figure 55 2027 AM Phasing Summary

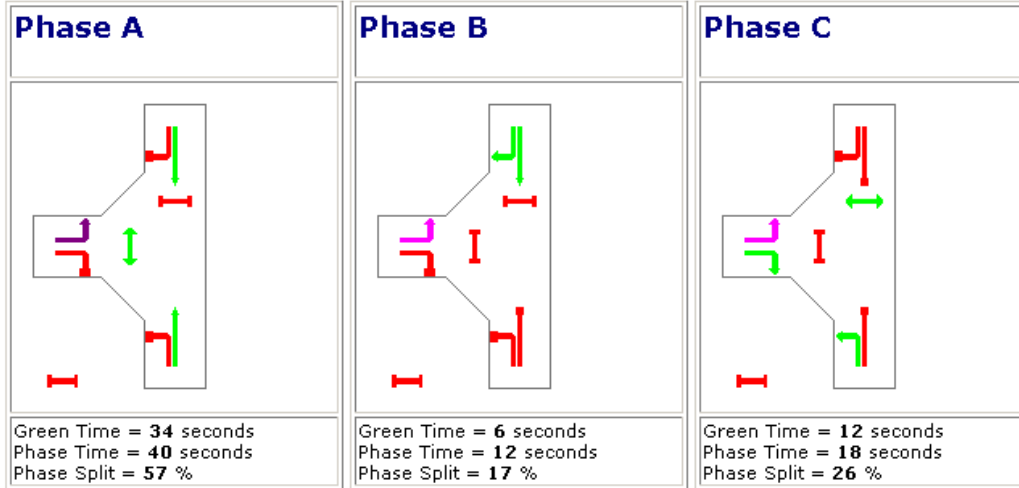


Figure 56 2027 PM Phasing Summary

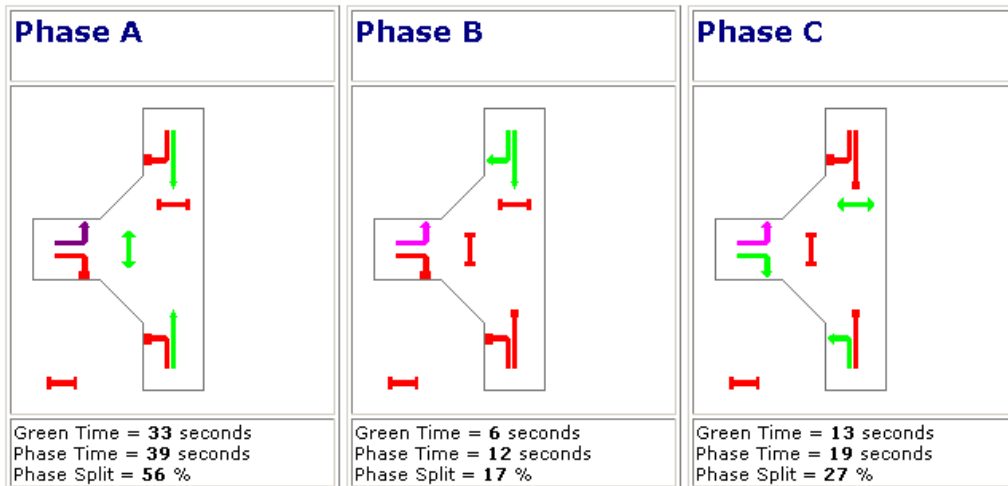




Table 32 Benwell Road / Archer Street – 2027 With Development (Signalised)

| AM Peak (2027) | | | | | |
|-----------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Left | 157 | 0.522 | 38.3 | LOS C | 50 |
| Through | 599 | 0.768 | 18.6 | LOS B | 172 |
| Approach Total | 756 | 0.768 | 22.7 | LOS B | 172 |
| Benwell Road (North) | | | | | |
| Through | 508 | 0.482 | 6.5 | LOS A | 93 |
| Right | 36 | 0.240 | 43.2 | LOS D | 14 |
| Approach Total | 544 | 0.482 | 8.9 | LOS A | 93 |
| Archer Street (West) | | | | | |
| Left | 58 | 0.077 | 14.1 | LOS A | 9 |
| Right | 225 | 0.750 | 42.2 | LOS C | 73 |
| Approach Total | 283 | 0.749 | 36.4 | LOS C | 73 |
| All Vehicles | 1583 | 0.768 | 20.4 | LOS B | 172 |

| PM Peak (2027) | | | | | |
|-----------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Left | 216 | 0.663 | 39.1 | LOS C | 68 |
| Through | 526 | 0.695 | 16.1 | LOS B | 141 |
| Approach Total | 742 | 0.695 | 22.8 | LOS B | 141 |
| Benwell Road (North) | | | | | |
| Through | 535 | 0.519 | 7.2 | LOS A | 103 |
| Right | 55 | 0.368 | 43.9 | LOS D | 21 |
| Approach Total | 590 | 0.519 | 10.6 | LOS A | 103 |
| Archer Street (West) | | | | | |
| Left | 51 | 0.062 | 12.8 | LOS A | 7 |
| Right | 212 | 0.652 | 39.1 | LOS C | 66 |
| Approach Total | 263 | 0.652 | 34.0 | LOS C | 66 |
| All Vehicles | 1595 | 0.695 | 20.2 | LOS B | 141 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

With Development Traffic 2017 (Roundabout)

The results of the analysis for the 2017 with development traffic scenario are presented in Table 33. The results indicate the following:

- ▶ An overall minimum LOS A would be achieved under peak traffic conditions;
- ▶ The degree of saturation is below the practical absorption capacity of 0.85 for roundabouts for all movements;
- ▶ Queue lengths are within acceptable limits and don't encroach on neighbouring intersections; and
- ▶ Average delays are less than 14 seconds for all movements in both peaks.



Table 33 Benwell Road / Archer Street – 2017 With Development (Roundabout)

| AM Peak (2017) | | | | | |
|-----------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Left | 83 | 0.304 | 5.7 | LOS A | 25 |
| Through | 328 | 0.304 | 5.2 | LOS A | 25 |
| Approach Total | 411 | 0.304 | 5.3 | LOS A | 25 |
| Benwell Road (North) | | | | | |
| Through | 263 | 0.273 | 6.3 | LOS A | 21 |
| Right | 20 | 0.274 | 12.6 | LOS A | 21 |
| Approach Total | 283 | 0.273 | 6.7 | LOS A | 21 |
| Archer Street (West) | | | | | |
| Left | 35 | 0.161 | 8.0 | LOS A | 9 |
| Right | 128 | 0.162 | 13.9 | LOS A | 9 |
| Approach Total | 163 | 0.162 | 12.7 | LOS A | 9 |
| All Vehicles | 857 | 0.304 | 7.2 | LOS A | 25 |

| PM Peak (2017) | | | | | |
|-----------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Left | 124 | 0.300 | 5.8 | LOS A | 24 |
| Through | 273 | 0.300 | 5.3 | LOS A | 24 |
| Approach Total | 397 | 0.300 | 5.5 | LOS A | 24 |
| Benwell Road (North) | | | | | |
| Through | 294 | 0.302 | 6.1 | LOS A | 24 |
| Right | 34 | 0.304 | 12.5 | LOS A | 24 |
| Approach Total | 328 | 0.303 | 6.8 | LOS A | 24 |
| Archer Street (West) | | | | | |
| Left | 27 | 0.129 | 7.5 | LOS A | 7 |
| Right | 111 | 0.129 | 13.4 | LOS A | 7 |
| Approach Total | 138 | 0.129 | 12.2 | LOS A | 7 |
| All Vehicles | 863 | 0.304 | 7.1 | LOS A | 24 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

With Development Traffic 2027 (Roundabout)

The results of the analysis for the 2027 with development traffic scenario are presented in Table 34. The results indicate the following:

- ▶ An overall minimum LOS A would be achieved under peak traffic conditions;
- ▶ The degree of saturation is below the practical absorption capacity of 0.85 for a roundabout for all movements;
- ▶ Queue lengths are within acceptable limits and don't encroach on neighbouring intersections; and
- ▶ Average delays are less than 18 seconds for all movements in both peaks.



Table 34 Benwell Road / Archer Street – 2027 With Development (Roundabout)

| AM Peak (2027) | | | | | |
|-----------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Left | 157 | 0.573 | 6.0 | LOS A | 71 |
| Through | 599 | 0.573 | 5.5 | LOS A | 71 |
| Approach Total | 756 | 0.572 | 5.6 | LOS A | 71 |
| Benwell Road (North) | | | | | |
| Through | 508 | 0.596 | 8.3 | LOS A | 63 |
| Right | 36 | 0.600 | 14.7 | LOS B | 63 |
| Approach Total | 544 | 0.595 | 8.7 | LOS A | 63 |
| Archer Street (West) | | | | | |
| Left | 58 | 0.392 | 11.7 | LOS A | 27 |
| Right | 225 | 0.391 | 17.6 | LOS B | 27 |
| Approach Total | 283 | 0.391 | 16.4 | LOS B | 27 |
| All Vehicles | 1583 | 0.600 | 8.6 | LOS A | 71 |

| PM Peak (2027) | | | | | |
|-----------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Left | 216 | 0.578 | 6.2 | LOS A | 69 |
| Through | 526 | 0.577 | 5.8 | LOS A | 69 |
| Approach Total | 742 | 0.577 | 5.9 | LOS A | 69 |
| Benwell Road (North) | | | | | |
| Through | 535 | 0.626 | 8.4 | LOS A | 70 |
| Right | 55 | 0.625 | 14.8 | LOS B | 70 |
| Approach Total | 590 | 0.627 | 9.0 | LOS A | 70 |
| Archer Street (West) | | | | | |
| Left | 51 | 0.338 | 10.5 | LOS A | 23 |
| Right | 212 | 0.338 | 16.4 | LOS B | 23 |
| Approach Total | 263 | 0.338 | 15.3 | LOS B | 23 |
| All Vehicles | 1595 | 0.626 | 8.6 | LOS A | 70 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

Benwell Road / Archer Street Intersection Options

The analysis has shown that a priority intersection is unacceptable due to the high volume of traffic approaching from the west on Archer Street and will fail to achieve desirable operating parameters at the 2027 horizon year. It should be noted that the existing intersection form operates acceptably with development traffic at the 2017 horizon.

The results of the options testing for upgrade of this intersection beyond 2017 shows that a roundabout and signalised intersection treatments will provide adequate capacity to accommodate forecast traffic volumes.

1.5.7 Benwell Road / Secondary Access (Proposed Access)

This intersection will be a new intersection which will provide a secondary access location to the development. The intersection layouts and control types which have been tested in this analysis are shown in Figure 57, Figure 58 and Figure 59 which represent a signal control, roundabout and priority control respectively. These layouts show the minimum intersection layout required for capacity reasons



and do not represent actual design requirements. As this is a new intersection resulting from the development, it has only been assessed for with development scenarios at 2017 and 2027.

Figure 57 Benwell Road / Secondary Access Intersection Layout - Signalised

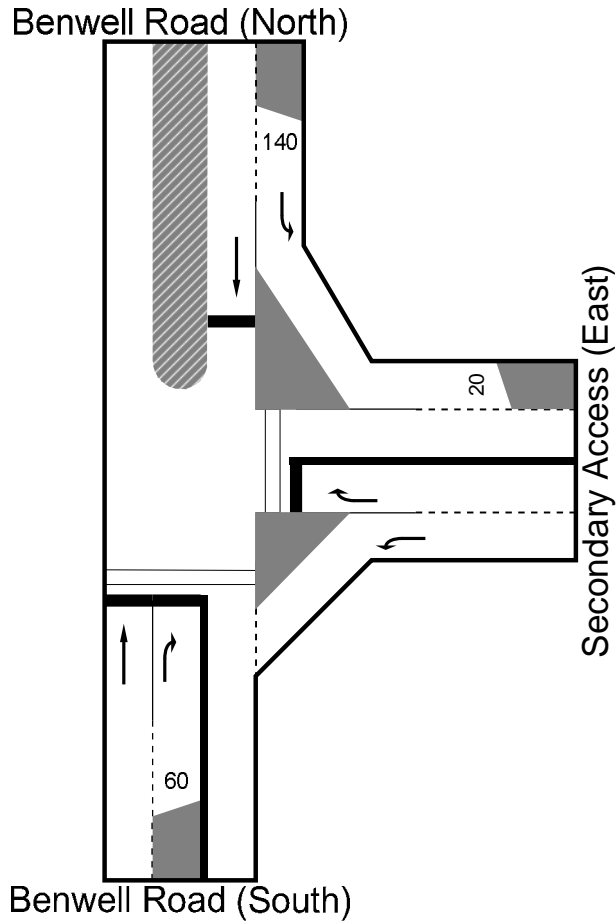


Figure 58 Benwell Road / Secondary Access Intersection Layout - Roundabout

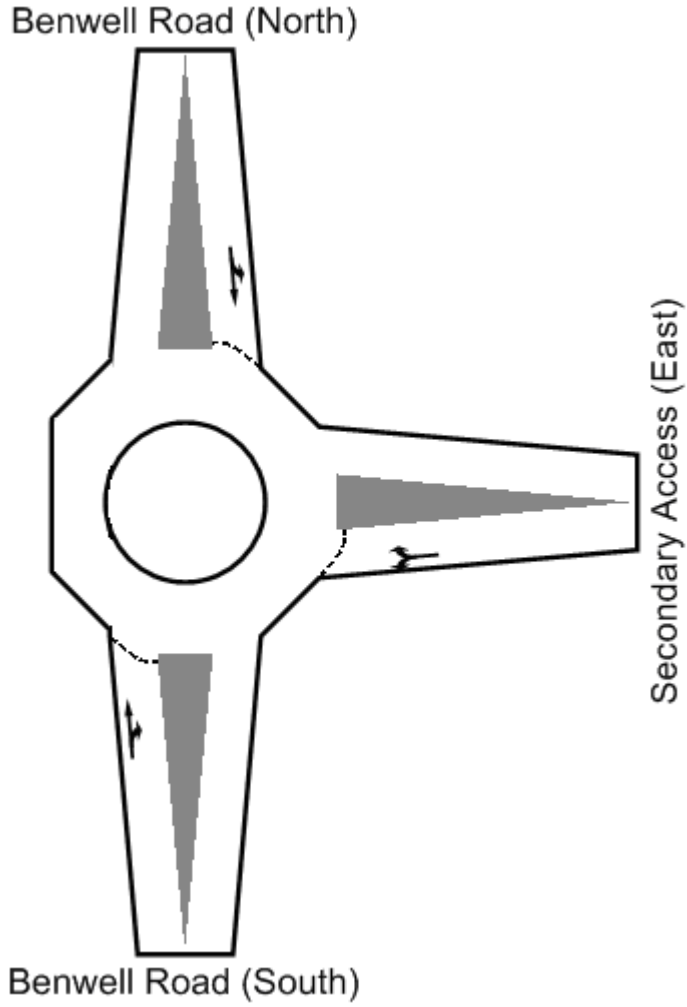
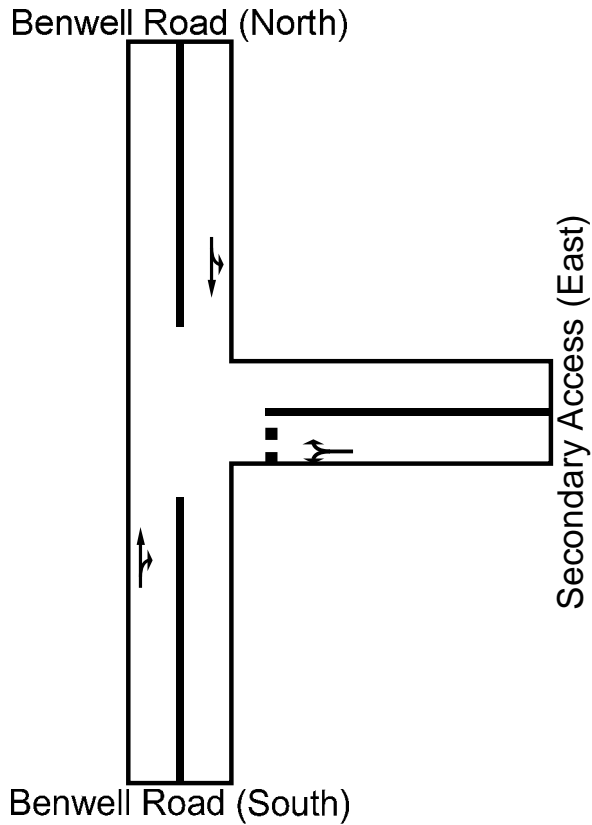


Figure 59 Benwell Road / Secondary Access Intersection Layout - Priority



With Development Traffic 2017 (Signalised)

Figure 60 and Figure 61 show the phasing summary based on a 70 second and 100 second cycle time in the AM and PM peaks respectively. The results of the analysis for the 2017 with development traffic scenario are presented in Table 35 and indicate the following:

- ▶ An overall minimum LOS A would be achieved under peak traffic conditions;
- ▶ The degree of saturation is below the practical absorption capacity of 0.9 for signalised intersections for all movements;
- ▶ Queue lengths are within acceptable limits and do not encroach on neighbouring intersections; and
- ▶ Average delays are less than 22 seconds for all approaches in both peaks.



Figure 60 2017 AM Phasing Summary

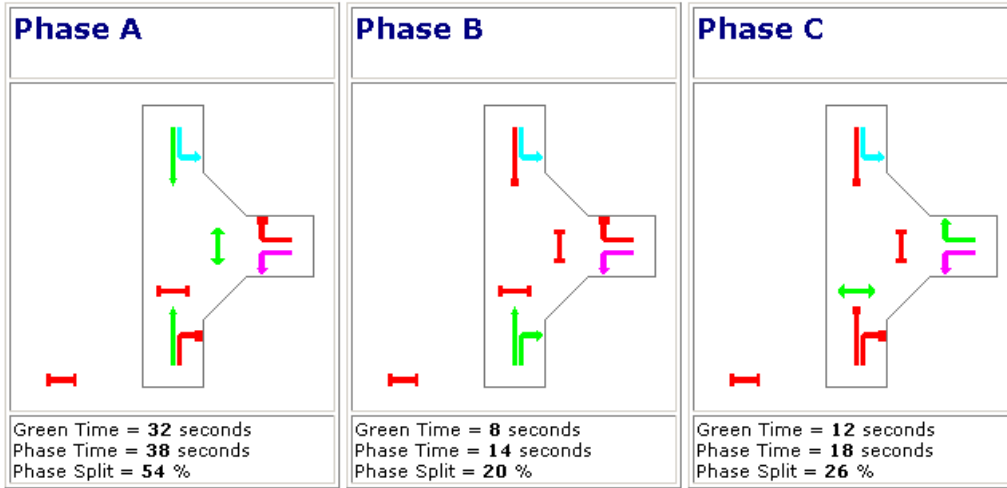


Figure 61 2017 PM Phasing Summary

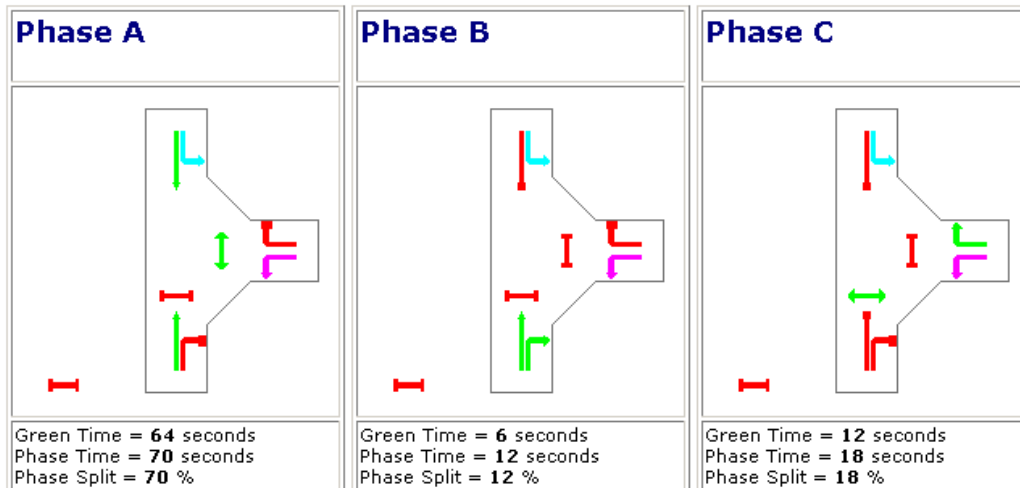




Table 35 Benwell Road / Secondary Access – 2017 With Development (Signalised)

| AM Peak (2017) | | | | | |
|--------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Through | 280 | 0.265 | 5.4 | LOS A | 48 |
| Right | 60 | 0.350 | 42.7 | LOS D | 27 |
| Approach Total | 340 | 0.350 | 11.9 | LOS A | 48 |
| Secondary Access (East) | | | | | |
| Left | 12 | 0.010 | 9.0 | LOS A | 1 |
| Right | 10 | 0.038 | 36.2 | LOS C | 4 |
| Approach Total | 22 | 0.038 | 21.4 | LOS B | 4 |
| Benwell Road (North) | | | | | |
| Left | 10 | 0.007 | 8.5 | LOS A# | 0# |
| Through | 253 | 0.344 | 13.3 | LOS A | 65 |
| Approach Total | 263 | 0.344 | 13.1 | LOS A | 65 |
| All Vehicles | 625 | 0.350 | 12.8 | LOS A | 65 |

| PM Peak (2017) | | | | | |
|--------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Through | 260 | 0.213 | 3.6 | LOS A | 44 |
| Right | 15 | 0.167 | 61.3 | LOS E | 10 |
| Approach Total | 275 | 0.213 | 6.8 | LOS A | 44 |
| Secondary Access (East) | | | | | |
| Left | 57 | 0.043 | 8.9 | LOS A | 3 |
| Right | 10 | 0.055 | 52.6 | LOS D | 6 |
| Approach Total | 67 | 0.054 | 15.4 | LOS B | 6 |
| Benwell Road (North) | | | | | |
| Left | 10 | 0.007 | 8.5 | LOS A# | 0# |
| Through | 248 | 0.241 | 8.1 | LOS A | 60 |
| Approach Total | 258 | 0.241 | 8.2 | LOS A | 60 |
| All Vehicles | 600 | 0.241 | 8.3 | LOS A | 60 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

With Development Traffic 2027 (Signalised)

Figure 62 and Figure 63 show the phasing summary based on a 100 and 120 second cycle time in the AM and PM peaks respectively. The results of the analysis for the 2027 with development traffic scenario are presented in Table 36 and indicate the following:

- ▶ An overall minimum LOS A would be achieved under peak traffic conditions however the right turn movements from the southern and eastern approaches fail;
- ▶ The degree of saturation is below the practical absorption capacity of 0.9 for signalised intersections for all movements;
- ▶ Queue lengths are within acceptable limits and don't encroach on neighbouring intersections; and
- ▶ Average delays are less than 29 seconds for all approaches in both peaks.



Figure 62 2027 AM Phasing Summary

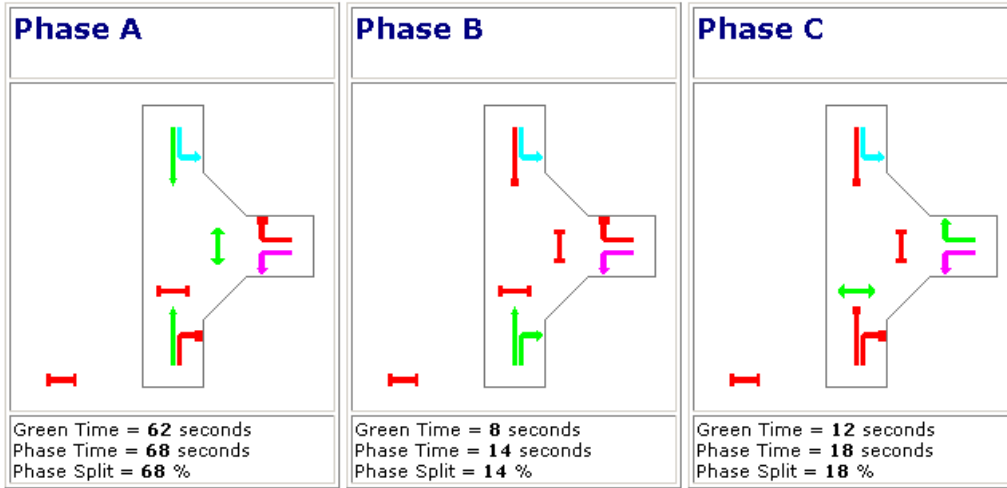


Figure 63 2027 PM Phasing Summary

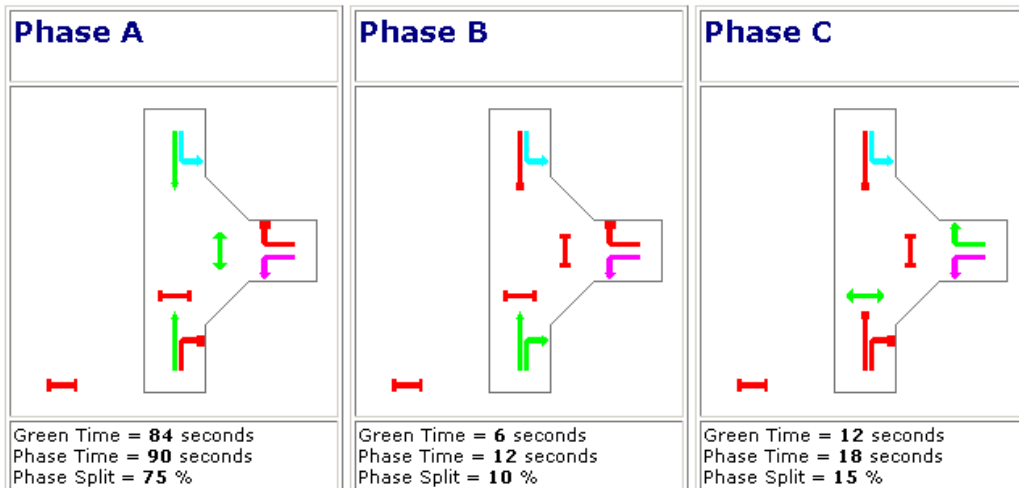




Table 36 Benwell Road / Secondary Access – 2027 With Development (Signalised)

| AM Peak (2027) | | | | | |
|--------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Through | 551 | 0.452 | 4.7 | LOS A | 102 |
| Right | 60 | 0.500 | 60.7 | LOS E | 38 |
| Approach Total | 611 | 0.500 | 10.2 | LOS A | 102 |
| Secondary Access (East) | | | | | |
| Left | 12 | 0.009 | 8.9 | LOS A | 1 |
| Right | 10 | 0.055 | 52.6 | LOS D | 6 |
| Approach Total | 22 | 0.054 | 28.7 | LOS C | 6 |
| Benwell Road (North) | | | | | |
| Left | 10 | 0.007 | 8.5 | LOS A# | 0# |
| Through | 498 | 0.500 | 11.2 | LOS A | 131 |
| Approach Total | 508 | 0.500 | 11.1 | LOS A | 131 |
| All Vehicles | 1141 | 0.500 | 10.9 | LOS A | 131 |

| PM Peak (2027) | | | | | |
|--------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Through | 513 | 0.399 | 3.7 | LOS A | 93 |
| Right | 15 | 0.200 | 73.0 | LOS F | 12 |
| Approach Total | 528 | 0.399 | 5.7 | LOS A | 93 |
| Secondary Access (East) | | | | | |
| Left | 57 | 0.042 | 8.8 | LOS A | 3 |
| Right | 10 | 0.065 | 63.6 | LOS E | 7 |
| Approach Total | 67 | 0.065 | 17.0 | LOS B | 7 |
| Benwell Road (North) | | | | | |
| Left | 10 | 0.007 | 8.5 | LOS A# | 0# |
| Through | 489 | 0.435 | 8.2 | LOS A | 122 |
| Approach Total | 499 | 0.435 | 8.2 | LOS A | 122 |
| All Vehicles | 1094 | 0.435 | 7.5 | LOS A | 122 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

With Development Traffic 2017 (Roundabout)

The results of the analysis of the Benwell Road / Secondary Access intersection with a roundabout in 2017 indicate that it will operate with free flowing traffic. The results of the analysis are shown in Table 37 and indicate the following:

- ▶ An overall minimum LOS A would be achieved under peak traffic conditions;
- ▶ The degree of saturation is below the practical absorption capacity of 0.85 for roundabouts for all movements;
- ▶ Queue lengths are within acceptable limits and don't encroach on neighbouring intersections; and
- ▶ Average delays are less than 15 seconds for all movements in both peaks.



Table 37 Benwell Road / Secondary Access – 2017 With Development (Roundabout)

| AM Peak (2017) | | | | | |
|--------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Through | 280 | 0.256 | 5.2 | LOS A | 21 |
| Right | 60 | 0.256 | 12.2 | LOS A | 21 |
| Approach Total | 340 | 0.256 | 6.4 | LOS A | 21 |
| Secondary Access (East) | | | | | |
| Left | 12 | 0.027 | 8.5 | LOS A | 2 |
| Right | 10 | 0.027 | 14.4 | LOS A | 2 |
| Approach Total | 22 | 0.027 | 11.2 | LOS A | 2 |
| Benwell Road (North) | | | | | |
| Left | 10 | 0.233 | 6.9 | LOS A | 17 |
| Through | 253 | 0.232 | 5.7 | LOS A | 17 |
| Approach Total | 263 | 0.232 | 5.8 | LOS A | 17 |
| All Vehicles | 625 | 0.256 | 6.3 | LOS A | 21 |

| PM Peak (2017) | | | | | |
|--------------------------------|----------------------|--------------|------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Through | 260 | 0.209 | 5.2 | LOS A | 17 |
| Right | 15 | 0.208 | 12.2 | LOS A | 17 |
| Approach Total | 275 | 0.209 | 5.5 | LOS A | 17 |
| Secondary Access (East) | | | | | |
| Left | 57 | 0.081 | 8.7 | LOS A | 5 |
| Right | 10 | 0.081 | 14.6 | LOS B | 5 |
| Approach Total | 67 | 0.081 | 9.6 | LOS A | 5 |
| Benwell Road (North) | | | | | |
| Left | 10 | 0.200 | 6.3 | LOS A | 14 |
| Through | 248 | 0.200 | 5.2 | LOS A | 14 |
| Approach Total | 258 | 0.200 | 5.3 | LOS A | 14 |
| All Vehicles | 600 | 0.209 | 5.9 | LOS A | 17 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

With Development Traffic 2027 (Roundabout)

The results of the analysis for a roundabout in 2027 with development traffic predict that the intersection will operate in an acceptable manner. The results presented in Table 38 indicate the following:

- ▶ An overall minimum LOS A would be achieved under peak traffic conditions;
- ▶ The degree of saturation is below the practical absorption capacity of 0.85 for roundabouts for all movements;
- ▶ Queue lengths are within acceptable limits and don't encroach on neighbouring intersections; and
- ▶ Average delays are less than 18 seconds for all movements in both peaks.



Table 38 Benwell Road / Secondary Access – 2027 With Development (Roundabout)

| AM Peak (2027) | | | | | |
|--------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Through | 551 | 0.453 | 5.2 | LOS A | 50 |
| Right | 60 | 0.455 | 12.2 | LOS A | 50 |
| Approach Total | 611 | 0.453 | 5.9 | LOS A | 50 |
| Secondary Access (East) | | | | | |
| Left | 12 | 0.036 | 11.3 | LOS A | 2 |
| Right | 10 | 0.036 | 17.2 | LOS B | 2 |
| Approach Total | 22 | 0.036 | 14.0 | LOS A | 2 |
| Benwell Road (North) | | | | | |
| Left | 10 | 0.435 | 7.0 | LOS A | 40 |
| Through | 498 | 0.436 | 5.9 | LOS A | 40 |
| Approach Total | 508 | 0.436 | 5.9 | LOS A | 40 |
| All Vehicles | 1141 | 0.455 | 6.1 | LOS A | 50 |

| PM Peak (2027) | | | | | |
|--------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Through | 513 | 0.393 | 5.2 | LOS A | 40 |
| Right | 15 | 0.395 | 12.2 | LOS A | 40 |
| Approach Total | 528 | 0.393 | 5.4 | LOS A | 40 |
| Secondary Access (East) | | | | | |
| Left | 57 | 0.107 | 11.6 | LOS A | 7 |
| Right | 10 | 0.106 | 17.5 | LOS B | 7 |
| Approach Total | 67 | 0.107 | 12.5 | LOS A | 7 |
| Benwell Road (North) | | | | | |
| Left | 10 | 0.385 | 6.4 | LOS A | 33 |
| Through | 489 | 0.378 | 5.2 | LOS A | 33 |
| Approach Total | 499 | 0.378 | 5.3 | LOS A | 33 |
| All Vehicles | 1094 | 0.395 | 5.8 | LOS A | 40 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

With Development Traffic 2017 (Priority)

The results of the analysis for the 2017 with development traffic scenario for a three-leg give way priority intersection are presented in Table 39. The results indicate the following:

- ▶ An overall minimum LOS A would be achieved under peak traffic conditions;
- ▶ The degree of saturation is below the practical absorption capacity of 0.8 for unsignalised intersections for all movements;
- ▶ Queue lengths are within acceptable limits and don't encroach on neighbouring intersections; and
- ▶ Average delays are less than 19 seconds for all movements in both peaks.



Table 39 Benwell Road / Secondary Access – 2017 With Development (Priority)

| AM Peak (2017) | | | | | |
|--------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Through | 280 | 0.258 | 3.6 | LOS A | 26 |
| Right | 60 | 0.259 | 13.4 | LOS A | 26 |
| Approach Total | 340 | 0.258 | 5.3 | LOS A | 26 |
| Secondary Access (East) | | | | | |
| Left | 12 | 0.097 | 23.2 | LOS B | 4 |
| Right | 10 | 0.096 | 23.6 | LOS B | 4 |
| Approach Total | 22 | 0.096 | 23.4 | LOS B | 4 |
| Benwell Road (North) | | | | | |
| Left | 10 | 0.164 | 9.4 | LOS A | 0 |
| Through | 253 | 0.164 | 0.0 | LOS A | 0 |
| Approach Total | 263 | 0.164 | 0.4 | LOS A | |
| All Vehicles | 625 | 0.259 | 3.9 | N/A | 26 |

| PM Peak (2017) | | | | | |
|--------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Through | 260 | 0.183 | 3.1 | LOS A | 19 |
| Right | 15 | 0.183 | 12.9 | LOS A | 19 |
| Approach Total | 275 | 0.183 | 3.7 | LOS A | 19 |
| Secondary Access (East) | | | | | |
| Left | 57 | 0.157 | 18.7 | LOS B | 6 |
| Right | 10 | 0.156 | 18.5 | LOS B | 6 |
| Approach Total | 67 | 0.157 | 18.7 | LOS B | 6 |
| Benwell Road (North) | | | | | |
| Left | 10 | 0.161 | 9.4 | LOS A | 0 |
| Through | 248 | 0.161 | 0.0 | LOS A | 0 |
| Approach Total | 258 | 0.161 | 0.4 | LOS A | |
| All Vehicles | 600 | 0.183 | 3.9 | N/A | 19 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

With Development Traffic 2027 (Priority)

The Benwell Road / Secondary Access intersection with a give-way priority layout allows for acceptable conditions with minimal delays on the minor approach. The results of the analysis for the 2027 with development traffic scenario are presented in Table 40 and indicate the following:

- ▶ An overall minimum LOS A would be achieved under peak traffic conditions;
- ▶ The degree of saturation is below the practical absorption capacity of 0.8 for unsignalised intersections for all movements;
- ▶ Queue lengths are within acceptable limits and don't encroach on neighbouring intersections; and
- ▶ Average delays are less than 13 seconds for the major approaches in both peaks. The eastern approach experiences delays of up to 40 seconds for both movements.



Table 40 Benwell Road / Secondary Access – 2027 With Development (Priority)

| AM Peak (2027) | | | | | |
|--------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Through | 551 | 0.452 | 11.8 | LOS A | 90 |
| Right | 60 | 0.451 | 21.6 | LOS B | 90 |
| Approach Total | 611 | 0.452 | 12.8 | LOS A | 90 |
| Secondary Access (East) | | | | | |
| Left | 12 | 0.185 | 39.7 | LOS C | 6 |
| Right | 10 | 0.182 | 40.1 | LOS C | 6 |
| Approach Total | 22 | 0.183 | 39.9 | LOS C | 6 |
| Benwell Road (North) | | | | | |
| Left | 10 | 0.312 | 9.4 | LOS A | 0 |
| Through | 498 | 0.317 | 0.0 | LOS A | 0 |
| Approach Total | 508 | 0.317 | 0.2 | LOS A | |
| All Vehicles | 1141 | 0.452 | 7.7 | N/A | 90 |

| PM Peak (2027) | | | | | |
|--------------------------------|----------------------|--------------|-------------|--------------|-------------------|
| Movement | Demand Flow (veh/hr) | DoS (V/C) | Ave Delay | LOS | 95% Back of Queue |
| Benwell Road (South) | | | | | |
| Through | 513 | 0.346 | 9.2 | LOS A | 67 |
| Right | 15 | 0.349 | 19.0 | LOS B | 67 |
| Approach Total | 528 | 0.346 | 9.5 | LOS A | 67 |
| Secondary Access (East) | | | | | |
| Left | 57 | 0.247 | 24.9 | LOS B | 12 |
| Right | 10 | 0.250 | 25.3 | LOS B | 12 |
| Approach Total | 67 | 0.247 | 25.0 | LOS B | 12 |
| Benwell Road (North) | | | | | |
| Left | 10 | 0.312 | 9.4 | LOS A | 0 |
| Through | 489 | 0.311 | 0.0 | LOS A | 0 |
| Approach Total | 499 | 0.311 | 0.2 | LOS A | |
| All Vehicles | 1094 | 0.349 | 6.2 | N/A | 67 |

Note: Average Delay is measured in seconds and Queue Length is measured in metres

Benwell Road / Secondary Access Intersection Options

The results for this intersection of the three different analyses of at grade intersection options show that all three control options operate within desirable parameters at the 2027 horizon with development traffic.

1.6 Conclusion

This report has investigated the potential construction and operational traffic related impacts of the proposed development by conducting intersection analyses at the following locations:

- ▶ Bruce Highway / Stuart Drive (Existing);
- ▶ Bruce Highway / Abbott Street (Existing);
- ▶ Boundary Street / Saunders Street (Existing);
- ▶ Boundary Street / Benwell Road (Proposed);
- ▶ Benwell Road / Archer Street (Existing); and
- ▶ Benwell Road / Secondary Access (Proposed).



The analysis has shown that the Boundary Street / Saunders Street intersection is expected to fail in 2011 due to continued growth in background traffic in the area. As a result of the significant growth in traffic realised to 2027, a feasible upgrade alternative was unable to be achieved and so further investigation is recommended to accommodate future demand at this intersection. An enhanced at-grade Boundary Street / Saunders Street intersection to accommodate the forecast traffic volumes is unlikely to be achieved without major rail relocations on the western side and property acquisitions on the eastern side.

From the traffic impact study, the following conclusions are made:

- ▶ The impact of the traffic generated by the development is not considered by DMR guidelines to be significant at the following existing intersections because the development traffic contributes less than 5% of the background traffic:
 - Bruce Highway / Stuart Drive (Existing);
 - Bruce Highway / Abbott Street (Existing);
 - Boundary Street / Saunders Street (Existing);
- ▶ Construction related traffic generated by the proposed development of the site will have a negligible impact on the adjacent road network at the 2011 horizon;
- ▶ An upgrade of the Benwell Road / Archer Street intersection would be required some time between 2017 and 2027 as a result primarily of increased background traffic (right turn from Archer Street to Benwell Road). A signalised and roundabout control have been tested and both show that they could accommodate the forecast traffic volumes to 2027 in their simplest form;
- ▶ The analysis of the Benwell Road / Secondary Access intersection shows that the intersection will provide satisfactory operating conditions for all approaches with either a priority control, a roundabout or signals;
- ▶ An upgrade of the Benwell Road / Boundary Street intersection will be required with the addition of a fourth leg which will be the primary access to the site. An enhanced signalised intersection form will be required at this location;
- ▶ Based on a 90/10 split between the two access locations, an average 37.2 metre queue is expected for traffic entering the site and an average 35.4 metre queue is expected for vehicles exiting resulting from the closure of the proposed level crossing on the northern (secondary) access to the site;

The assessment has satisfactorily demonstrated that there are no foreseeable traffic related impacts that should prohibit the proposed development from proceeding.



Appendix A

Queue Length Calculation

2027 Peak – Both Directions

2027 AM Peak Flow – 63 Vehicles / Hour

2027 PM Peak Flow – 60 Vehicles / Hour

Commercial Vehicle Percentage: 33%

%CV Breakdown based on average queue space:

- ▶ 10% 13 metres
- ▶ 15% 19 metres
- ▶ 8% 37 metres

Average queue space for a light vehicle – 7 metres

Boom gate stoppage time – 3 minutes

$$\begin{aligned}\text{Queue length for AM} &= 63/60 * 3 * ((0.67 * 7) + (0.10 * 13) + (0.15 * 19) + (0.08 * 37)) \\ &= 37.17 \text{ metres}\end{aligned}$$

$$\begin{aligned}\text{Queue length for PM} &= 60/60 * 3 * ((0.67 * 7) + (0.10 * 13) + (0.15 * 19) + (0.08 * 37)) \\ &= 35.4 \text{ metres}\end{aligned}$$

Total queue space required on western side = 38 metres

Total queue space required on eastern side = 36 metres



Appendix B
SIDRA 3.2 Results

Movement Summaries



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