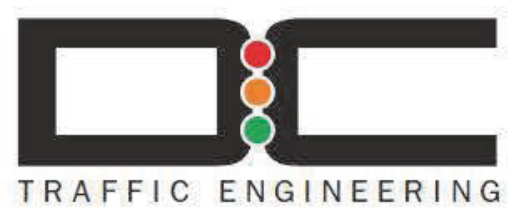




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Traffic and Transport Impact Assessment



Bengalla Mining Company Pty Limited

Continuation of Mining Project

Traffic and Transport Impact Assessment



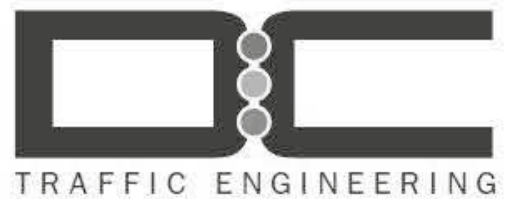
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Bengalla Mining Company Pty Limited

Continuation of Mining Project

Traffic and Transport Impact Assessment

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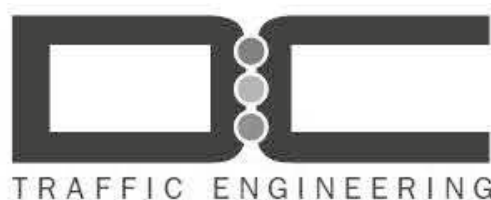
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1 Introduction

Bengalla Mining Company Pty Limited (BMC) operates Bengalla Coal Mine (Bengalla), which is located in the Upper Hunter Valley of NSW, approximately 130 km north-west of Newcastle and 4 km west of Muswellbrook. Bengalla is bounded by Wybong Road to the north, Bengalla Link Road to the west and south, and the Hunter River to the east (Figure 1).

Bengalla is an open cut, strip mining operation where mining advances generally to the west based on dragline strips approximately 60m in width. Pre-stripped overburden is removed by loader and/or excavator and trucks, in advance of the dragline operation and subsequent coaling. Mining is conducted by an equipment fleet consisting of a dragline, loading units, trucks, various other ancillary equipment and approximately 400 full-time employees.

BMC is seeking Development Consent under Division 4.1 of Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to facilitate the continuation of open cut coal mining largely within current mining authorities for a further 24 years as shown on Figure 1.

The Project is generally comprised of:

- Open cut mining at a rate of up to 15 Mtpa ROM coal for 24 years continuing to utilise a dragline and truck / excavator fleet;
- Extending mining to the west of current operations;
- An out of pit Overburden Emplacement Area (OEA) to the west of Dry Creek which may be utilised for excess spoil material until it is intercepted by mining;
- Processing, handling and transportation of coal via the existing CHPP (to be upgraded) and rail loop for export and domestic sale;
- An additional CHPP stockpile and ROM coal stockpile;
- Continued use, extension and upgrades to existing coal infrastructure;
- The construction of a radio tower;
- Relocation of the Explosives Magazine and Reload Facility;
- Relocation of a section of Bengalla Link Road near the existing mine access road to enable coal extraction;
- The diversion of Dry Creek via dams and pipe work with a later permanent re-alignment of Dry Creek through rehabilitation areas once stability is established;
- Relocation of water storage infrastructure as mining progresses through existing dams (including the Staged Discharge Dam);
- The construction of raw water dams and a clean water dam;
- A workforce of approximately 900 full time equivalent personnel at peak production; and
- Supporting power and water reticulation infrastructure.

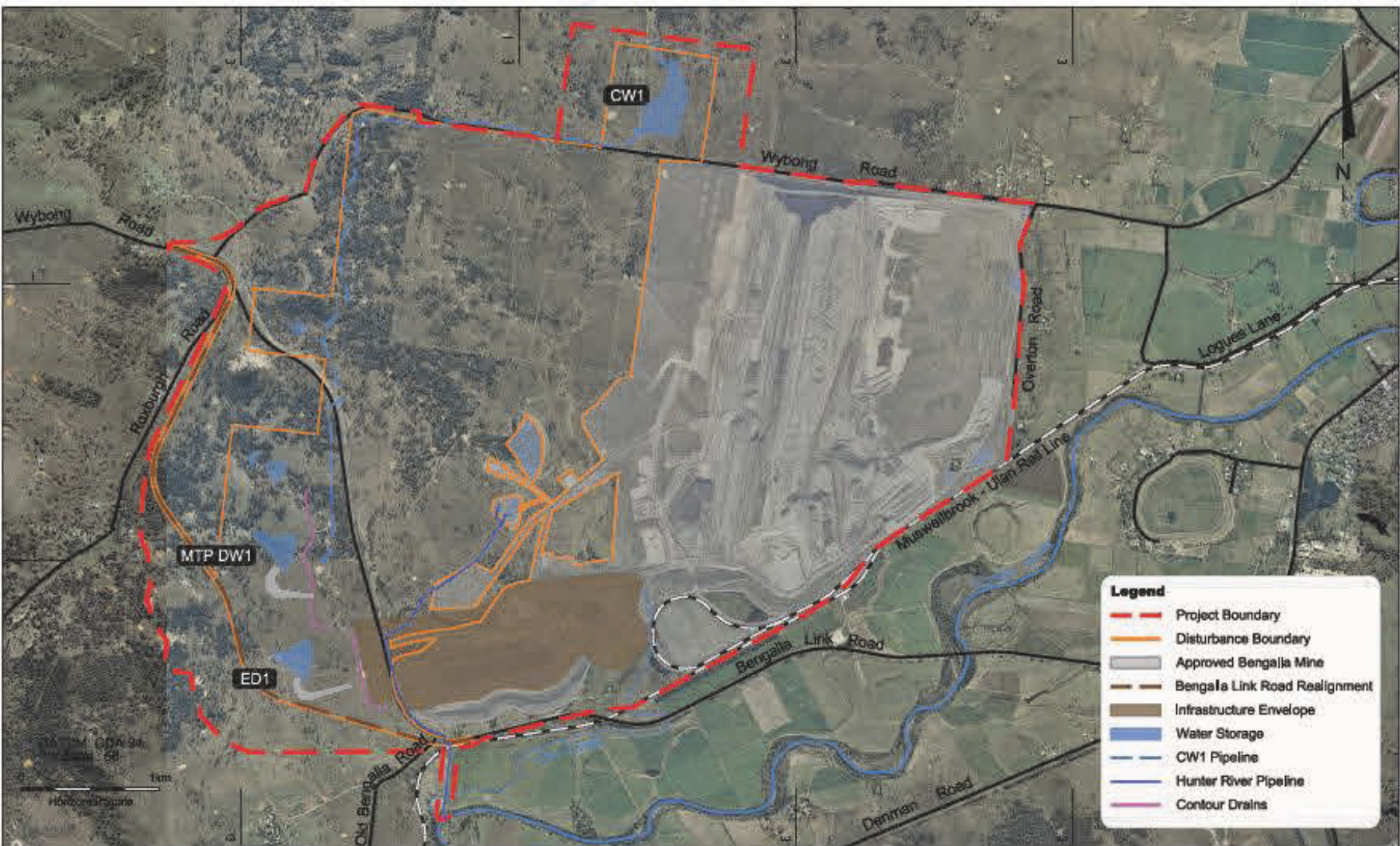


Figure 1 Locality map (source: Hansen Bailey, 2012)

DC Traffic Engineering Pty Ltd was commissioned by Hansen Bailey on behalf of BMC to undertake a Traffic and Transport Impact Assessment for the Project. The purpose of this assessment is to form part of the Environmental Impact Statement (EIS) being prepared by Hansen Bailey.

Through reference to the Director General's Environmental Assessment Requirements (DGRs) as well as a submissions letter from Muswellbrook Shire Council, the following study scope items were identified for the Traffic and Transport Impact Assessment:

- Accurate predictions of the road traffic generated by the Project (Section 3).
- An assessment of the local and regional road network, with particular regard to cumulative traffic impact assessment (Section 3), condition assessment of the existing network (Section 2), and proposed new road infrastructure (Section 4). This is also to cover emergency access, travel time performance, an assessment of equivalent standard axles (ESAs) generated by the Project, and the movement of over dimensioned loads (Section 4). The following roads are to be assessed:
 - Bengalla Link Road;
 - Wybong Road;
 - Edderton Road (incorporating proposed diversions);
 - Thomas Mitchell Drive;
 - Skellatar Stock Route; and
 - The State Road Network including Denman Road and the New England Highway.
- A road safety impact assessment of the above roads (Section 5).
- An assessment of the potential impacts of the development on the capacity, efficiency, travel time, and safety of the rail network having regard to the strategic objectives and cumulative impacts for the passenger and freight rail network including a review of impacts to relevant railway level crossings. This is covered in Section 6.
- Details of interactions with the approved rail corridor for Mount Pleasant Project (Section 6).
- Details of Project-to-Port or Project-to-customer transport movements, train path availability, and any required rail infrastructure works (Section 6).
- Mitigation and management measures that would be required to maintain, and/or improve the capacity, efficiency and safety of the road and rail networks in the surrounding area over the life of the Project. This is covered in each section and also summarised in Section 7.
- Details of the existing interactions with and potential opportunities to join inter-mine arrangements for maintenance and/or upgrade of public roads, particularly Thomas Mitchell Drive. This is covered in various sections and also summarised in Section 7.

2 Existing conditions

2.1 Road network conditions

The key roads in the surrounding network include:

- Bengalla Mine Access Road;
- Bengalla Link Road;
- Roxburgh Road;
- Wybong Road;
- Edderton Road;
- Thomas Mitchell Drive;
- Skellatar Stock Route;
- Denman Road; and
- New England Highway.

These roads are shown in Figure 1 and described in the following sections.

2.1.1 Bengalla Mine Access Road

This road extends eastward from Bengalla Link Road and provides access to Bengalla administration, mine and office area. It passes just north of the current coal handling and processing area. It is owned and managed by BMC.

Bengalla Mine Access Road is a two-lane-two-way (2L2W) configuration (Figure 2) with a 60 km/h speed limit at its western end and a reduction to 40 km/h at its eastern end in approach to the Mine Infrastructure Area. Two speed humps with a 20 km/h designated speed limit (along with extensive signage) are also located on the Bengalla Mine Access Road to maintain safe speeds while entering and exiting Bengalla.



Figure 2 Bengalla Mine Access Road

This road will continue to provide access to Bengalla for the Project. There may be some minor realignment work required to accommodate mine infrastructure. However, this is not regarded as a major impact as there is ample space to the north of the road to accommodate both the relocation of the road, as well as its intersection with Bengalla Link Road.

2.1.2 Roxburgh Road

Roxburgh Road is a rural 2L2W road running from north east to south west under the care and jurisdiction of MSC. At its northern end, it commences at Bengalla Link Road near the Bengalla Link Road/ Wybong Road intersection. It extends south west for approximately 8.5 km and meets Mangoola Road.

Originally this road commenced at Wybong Road at its northern end. However, when the Bengalla Link Road Stage 2 Extension was completed, which effectively linked up the original southern portion of Bengalla Link Road, with Wybong Road, the new terminus point became Bengalla Link Road. The Bengalla Link Road/ Roxburgh Road intersection is a T intersection with Roxburgh Road as the western and terminating leg. The intersection has a channelized right turn (CHR) configuration consisting of an indented right turn lane for southbound traffic on Bengalla Link Road.

Roxburgh Road carries a very low volume of traffic. This is largely in part due to access restrictions put in place by Mangoola Coal Mine which prohibit any of their project traffic from using this road.

2.1.3 Bengalla Link Road

Bengalla Link Road is a 2L2W rural road connecting Denman Road at its southern end to Wybong Road at its northern end. The original 6.2 km length from Denman Road to Bengalla Mine Access Road was constructed as an access to Bengalla (Figure 3). This road is under the care and jurisdiction of MSC.

The remaining 2.9 km section from Bengalla Mine Access Road to Wybong Road, known as the Stage 2 Extension, was completed in 2009 to fulfil BMC's commitment to the Muswellbrook Shire Council's (MSC) *Western Roads Strategy (1997)*.



Figure 3 Bengalla Link Road, looking northbound from north of Wantana Dairy.

The completion of the Stage 2 Extension was critical to provide access to other coal projects. These included the Mangoola Coal Mine located approximately 7 km west of Bengalla Link Road on the southern side of Wybong Road; and the future Mount

Pleasant Project which (once commenced) would be located generally to the north of Wybong Road and to the north-east of Bengalla Link Road. This aligns with the Western Roads Strategy by providing a principle access route to these three coal projects and thereby minimise mine-related traffic on other local roads such as:

- Wybong Road to the west of Mangoola Coal;
- Kayuga Road (including the narrow heritage bridge over the Hunter River); and
- Roxburgh Road, Mangoola Road and Reedy Creek Road (there are prohibitions in place preventing the use of these roads by Mangoola Coal traffic).

Bengalla Link Road is signposted as an 80 km/h route to the north of Bengalla Mine Access Road, and 100 km/h to the south. The route provides a reasonable geometric standard with 3.5 m lanes and good quality clear zones. In particular, the Stage 2 Extension from Bengalla Mine to Wybong Road contains sealed shoulders and indented right-turn lanes at the Bengalla Mine Access Road, Roxburgh Road and Wybong Road.

The section of Bengalla Link Road immediately north of Denman Road carried 830 vehicles/day in 2011 (as indicated by traffic surveys carried out for this project in September 2011). Heavy vehicles make up 12% of all traffic.

The Project will involve a realignment of Bengalla Link Road by approximately Year 20 to allow for mining activities to progress to the west. The impacts of this realignment have been discussed in Section 5.2.

2.1.4 Wybong Road

Wybong Road is a 2L2W rural collector road that runs in an approximate east-west alignment between the Golden Highway at Sandy Hollow, and Kayuga Road, to the west of the Muswellbrook town centre. It falls under the jurisdiction of MSC.

The 16 km section of Wybong Road between the Golden Highway, Sandy Hollow and Mangoola Coal Mine is a low volume road generally consisting of a sealed width between 6.0-8.0m.

The 7 km section between Mangoola Coal Mine and Bengalla Link Road is a higher standard 100 km/h road with an 8.5 m sealed width (2 x 3.25 m lanes, and 2 x 1.0 m sealed shoulders).

Wybong Road is also well furnished with linemarking, curve warning signage, guideposts, and safety barriers where necessary (Figure 4). These upgrades were carried out as part of the Mangoola Coal Mine's Early Works Program. This section carries approximately 1,000 vehicles/day.



Figure 4 Wybong Road, west of Spring Creek (looking west).

The Bengalla Link Road/ Wybong Road intersection is T intersection configuration and is located approximately 7 km east of the Mangoola Coal Mine, and 2.9 km north of Bengalla Mine Access Road. The intersection priority has been adjusted such that Wybong Road West leads directly into Bengalla Link Road forming the priority route approaches to the T intersection. The eastern portion of Wybong Road from Kayuga is the northern and terminating leg to this T intersection. This is commensurate with MSC's Western Roads Strategy which places emphasis on Bengalla Link Road as the principle route for access to the three coal projects – Bengalla, Mangoola Coal and Mount Pleasant Project.

The lower priority assigned to Wybong Road East is also appropriate as this route, including the Kayuga Road narrow heritage bridge over the Hunter River, is not a sustainable long-term access route to Muswellbrook.

The eastern-most 10 km section of Wybong Road between Bengalla Link Road and Kayuga Road passes to the north of the Project Boundary. This is also a low volume road whose future function would be primarily to provide access to Mount. Pleasant Mine, an approved coal project which has not yet commenced mining. There are longer term considerations for closing off this portion of Wybong Road and re-routing Aberdeen-bound traffic to new upgraded connections. Mount Pleasant's development consent allows for the closure of this section of road during mining.

The function of the sections of Wybong Road between Sandy Hollow and Mangoola Coal Mine, and between Bengalla Link Road and Kayuga Road have been significantly reduced since the opening of the Bengalla Link Road Stage 2 Extension from Bengalla Mine to Wybong Road. The primary access route to Mangoola, Mount Pleasant and Bengalla mines is now via Bengalla Link Road, and then Denman Road to either Muswellbrook, Singleton (via Thomas Mitchell Drive), or Merriwa via the Golden Highway. The function of Bengalla Link Road in this manner is consistent with the objectives of the Western Roads Strategy.

2.1.5 Edderton Road

Edderton Road is a 15 km local rural road linking the Golden Highway in the south to Denman Road in the north. It is located approximately 10 km west of Jerrys Plains and approximately 8 km south of Muswellbrook. It is under the care and jurisdiction of MSC.

Edderton Road has a 2L2W configuration with no line marking and no sealed shoulders. The sealed width is generally less than 6m and the pavement has significant patching. Saddlers Creek crosses the route as a floodway approximately 3.5 km north of the Golden Highway. This has resulted in a deep sag vertical curve and associated advanced warning signs (Figure 5). Edderton Road has a 14 tonne load limit with signs placed at both ends. This is an appropriate safeguard to protect the pavement condition, and in response to the substandard road alignment and width.

Edderton Road carries approximately 760 vehicles/day at its northern end and 680 vehicles/day at its southern end with heavy vehicles making up approximately 19% of all traffic. As a result of the load limit, most of the heavy vehicles are single unit rigid trucks.



Figure 5 Edderton Road, looking north towards the Saddlers Creek floodway

Approximately 7 km of the southern-most section of Edderton Road will be realigned by Anglo American as part of the Drayton South Coal Project (Hansen Bailey, 2011). This will result in the new route projecting towards the south-west and intersecting with the Golden Highway approximately 5 km west of its current intersection.

Edderton Road also runs through the western portion of Mining Lease (ML) 1358, which is held by Mt Arthur Coal. Mt Arthur Coal (MAC) holds an approval to realign approximately 6 km of the northern-most section of this road (including its intersection with Denman Road).

It is envisaged that this route would not attract a significant volume of traffic from the Project. This is due to the following:

- Traffic heading towards the Singleton would tend to use Thomas Mitchell Drive due to the directness and higher standard of that route compared with the poor alignment of Edderton Road.

- Traffic heading towards Denman, Merriwa and beyond would tend to use either Denman Road or the Golden Highway via Sandy Hollow.
- The 14 tonne load limit applied to Edderton Road would rule out heavy vehicles generated by the Project.

2.1.6 Thomas Mitchell Drive

Thomas Mitchell Drive is an 11 km local road linking Denman Road to the north west and the New England Highway to the south east which is under the jurisdiction of MSC. Thomas Mitchell Drive attracts a significant volume of traffic travelling between Denman and the New England Highway. This route effectively bypasses the longer and slower moving main road alternatives through the Muswellbrook town centre.

Thomas Mitchell Drive has a 2L2W configuration with an approximate 7m sealed width. There are two railway overbridges along the route – both associated with the section of the Antienne Rail Spur between Drayton loop junction and MAC (Figure 6). The vertical clearance along this route as imposed by these structures is 5.5m.

Thomas Mitchell Drive provides access to the Muswellbrook Industrial Estate at its northern end between Denman Road and Glen Munro Road. It also provides direct access to MAC and Drayton Mines. The sections of this road north and south of Glen Munro Road are signposted as 80 km/h and 100 km/h zones respectively.

Thomas Mitchell Drive carries approximately 5,400 vehicles/day at its western end, and 3,100 vehicles/day at its eastern end (data sourced from September 2011 surveys). The September 2011 surveys also indicated that heavy vehicles make up 16% of traffic at the eastern end of the route and 12% of traffic at the western end.



Figure 6 Thomas Mitchell Drive, looking southbound towards the Antienne Rail Spur (MAC rail overbridge)

Hunter Valley Energy Coal Pty Ltd (HVEC) are obligated to carry out further improvements to Thomas Mitchell Drive as part of their Open Cut Consolidation Project. Item 47 (Schedule 3) of Project Approval 09_0062 requires them to “fund the upgrade of Thomas Mitchell Drive, as outlined in the RTA’s Review of Thomas Mitchell Drive Route Assessment” (Department of Planning, 2010, p17). This will involve the following improvement works:

- Upgrade of the Denman Road/ Thomas Mitchell Drive intersection to a seagull configuration with an indented right-turn lane for access into Thomas Mitchell Drive, a protected acceleration lane for right-turns out of Thomas Mitchell Drive, and retention of the existing left-turn deceleration lane on Denman Road.
- Upgrade of the New England Highway/ Thomas Mitchell Drive intersection to a seagull configuration with right-turn and left-turn deceleration and acceleration lanes on the New England Highway.

These two points above are important considerations in addressing future capacity needs due to regional traffic growth. These have been quantitatively examined in Section 3.

2.1.7 Skellatar Stock Route

Skellatar Stock Route- Ironbark Road- Rutherford Road is a collector road which passes from Denman Road (Sydney Road) to the New England Highway on the south-western and south-eastern side of the Muswellbrook town centre respectively. This route is under the care and jurisdiction of MSC.

At its western end, Skellatar Stock Route has a 2L2W configuration with an approximate sealed width of 6m. There is no linemarking or kerb and guttering provided at this end of the route. It meets Denman Road as the eastern and terminating leg to a basic right turn (BAR) configured T intersection. The route provides access to residential, sporting and racing facilities, as well as retail facilities.

Towards the middle of this route near the intersection with Adams Street, the route has more of a residential character with increased density of residential properties and driveways, and streets lined with kerb and guttering and street lighting (Figure 7).

Rutherford Road provides access to several major retail outlets including supermarkets, bulky goods retail/ electrical goods stores and car yards. Rutherford Road has a divided configuration with a raised median provided throughout its length. Several median breaks are provided for right-turns and u-turns.

The entire route is marked as a 50 km/h area and a 10 tonne load limit applies to the section from west of the retail strip on Rutherford Road to the western end of the route at Denman Road.



Figure 7 Skellatar Stock Route through the residential area

It is envisaged that this route would not attract a significant volume of traffic from the Project. This is due to the following:

- Traffic heading towards the south-west would tend to use Thomas Mitchell Drive due to the directness of that route and the higher speed limits of 80-100 km/h compared with the 50 km/h speed limit applied to Skellatar Stock Route-Ironbark Road-Rutherford Road.
- Traffic heading towards the north would tend to use Denman Road and Sydney Street due to the directness of the route.
- The 10 tonne load limit applied to Skellatar Stock Route would rule out heavy vehicles generated by the Project.

2.1.8 Denman Road

Denman Road is a State Road under the care and jurisdiction of NSW Roads and Maritime Services (RMS) and provides a link between the New England Highway at Muswellbrook, and the Golden Highway north east of Denman. This 21 km road passes to the south of the Project Boundary and follows the approximate north-east to south-westerly direction of the Hunter River (to the north of the road).

Denman Road is a 2L2W undivided road with a 7 to 9m sealed width (Figure 8). There is localised pavement widening at key intersections to accommodate turn lanes. The route is signposted as a 100 km/h route to the west and 80 km/h to the east of Bengalla Link Road respectively.

Denman Road carries approximately 6,700 vehicles/day to the east of Thomas Mitchell Drive (Hansen Bailey, 2009) and 4,900 vehicles/day to the east of Bengalla Link Road (latter figure sourced from September 2011 surveys). The September 2011 surveys indicated that heavy vehicles make up 11% of all Denman Road traffic to the east of Bengalla Link Road.



Figure 8 Denman Road looking northbound towards Thomas Mitchell Drive

As stated in Section 2.1.5, BHP Billiton is committed to upgrading the Denman Road intersection with Thomas Mitchell Drive.

2.1.9 New England Highway

The New England Highway is a major highway providing a link between Newcastle and Brisbane via the regional inland centres of Muswellbrook, Tamworth, Armidale and Glen Innes. As an Auslink route, the primary funding source for route improvements comes from the Australian Government. However, RMS manages the route on behalf of the Australian Government.

As an Auslink route, it is a freight route of strategic national importance, particularly in servicing road freight movement between Sydney and Brisbane. The highway offers a parallel inland alternative to the Pacific Highway, and as such acts as a detour route when there are incidents on the Pacific Highway.

The New England Highway passes to the east of the Project Boundary and runs in a north-west to south-easterly direction. To the south of the Muswellbrook town centre, the route is a two-lane undivided configuration with indented turning lanes/ deceleration lanes at key intersections (Figure 9). Near the Liddell and Bayswater Power Stations, the New England Highway is a four-lane divided road with limited access. Further south towards Singleton the road reverts back to a two-lane undivided road with the occasional overtaking lane provided on steep graded sections. The route is signposted as a 100 km/h route for most of its length except for sections passing through towns.

The New England Highway carries approximately 15,500 vehicles/day.



Figure 9 New England Highway, looking south towards the intersection with Thomas Mitchell Drive on the right

As stated in Section 2.1.5, BHP Billiton is committed to upgrading the New England Highway intersection with Thomas Mitchell Drive.

2.2 Key intersections

2.2.1 Bengalla Link Road/ Bengalla Mine Access Road

The Bengalla Link Road/ Bengalla Mine Access Road intersection is a give way controlled T intersection with the Bengalla Mine Access Road as the eastern and terminating leg (Figure 10). The intersection has a channelised right-turn (CHR) configuration with a 160m right-turn lane on Bengalla Link Road southern approach to the intersection.



Figure 10 Bengalla Link Road, looking northbound towards the intersection with Bengalla Mine Access Road (right-hand side)

Bengalla Link Road has one through lane in either direction as well as the right-turn lane in the southern approach as described above. Bengalla Mine Access Road also provides one lane in each direction.

The Bengalla Link Road approaches are signposted as 100 km/h speed zones whilst Bengalla Mine Access Road is signposted as a 60 km/h zone in the immediate approach to the intersection. Bengalla Mine Access Road approaches the intersection on a downhill grade.

2.2.2 Denman Road/ Bengalla Link Road

The Denman Road/ Bengalla Link Road intersection is a give way controlled T intersection with Bengalla Link Road as the northern and terminating approach. The intersection has a CHR and channelised left-turn (CHL) configuration including a 150m right-turn lane and 85m left-turn lane on Denman Road eastern and western approaches respectively (Figure 11). There is also a 230m acceleration lane provided on Denman Road to the east of the intersection to allow left-turning traffic from Bengalla Link Road to accelerate to a safe merge speed.



Figure 11 Denman Road looking westbound towards the intersection with Bengalla Link Road (right-hand side).

As seen in Figure 11, there is one through lane approaching the intersection from all legs. The indented right and left turn lanes provide improved safety and traffic conditions by laterally separating faster moving through traffic from slower moving turning/ queuing traffic (hence reducing rear-end crash risk), and providing a safe area to queue without impeding the through traffic flows.

There are acceptable entering sight distances from Bengalla Link Road to both approaches of Denman Road. Similarly, there is reasonable safe intersection sight distance from both Denman Road approaches to vehicles at the hold line of the Bengalla Link Road approach.

Street lighting was provided at the intersection as part of Mangoola Coal's commitments prior to an Early Works Program in 2008.

Bengalla Link Road is signposted as a 100 km/h speed zone whilst the Denman Road approaches are signposted as 80 km/h zones. However, approximately 180 m west of the intersection, the speed limit on Denman Road increases to 100 km/h.

2.2.3 Denman Road/ Thomas Mitchell Drive

The Denman Road/ Thomas Mitchell Drive intersection is a give-way controlled T intersection with Thomas Mitchell Drive as the southern and terminating approach. The intersection has an auxiliary lane (AUR configuration) which allows through traffic in the northbound direction of Denman Road to pass around queued traffic waiting to turn right (Figure 12). The intersection also provides an indented left-turn deceleration lane and a short left-turn acceleration lane.



Figure 12 Denman Road, looking north towards Thomas Mitchell Drive (right-hand side).

The gap acceptance sight distances from the Thomas Mitchell Drive approach towards oncoming traffic on Denman Road from the north and south are acceptable.

Denman Road is signposted as an 80 km/h speed zone, whilst Thomas Mitchell Drive is 80 km/h in the approach to the intersection.

Street lighting is provided at this intersection and the poles are slip-based structures.

The Denman Road/ Thomas Mitchell Drive intersection was upgraded in 2004 as a commitment of the Mount Pleasant Mine Project. Mitchell McCotter (2010b) stated that these upgrades included improvements to the intersection channelisation to increase storage length for right-turners.

Furthermore, HVEC is obligated to carry out further improvements to this intersection by 2019 as part of their Open Cut Consolidation Project at MAC. This will involve an upgrade to a seagull T-intersection configuration with indented right-turn and left-turn deceleration lanes for access onto Thomas Mitchell Drive, as well as a protected right-turn acceleration lane for entry onto Denman Road. These improvements are to be carried out by the end of 2019 (Department of Planning, 2010).

2.2.4 New England Highway/ Thomas Mitchell Drive

The New England Highway/ Thomas Mitchell Drive intersection is a give-way controlled T intersection with Thomas Mitchell Drive as the western and terminating approach. The intersection has a CHR/CHL configuration including a 150m indented right-turn lane, and a 150m left-turn lane in the New England Highway northern and southern approaches respectively. Thomas Mitchell Drive provides two lanes in approach to the intersection for exclusive left-turns and right-turns.

A gap acceptance sight distance equivalent to 12 to 15 seconds of travel at 100 km/h is available from the hold line of the Thomas Mitchell Drive approach to oncoming traffic from the south (Figure 13). This is considered acceptable for judging gaps for left and right turn movements. The corresponding gap acceptance sight distance towards oncoming traffic from the north was measured at 15 seconds which is also acceptable.



Figure 13 Looking south from the Thomas Mitchell Drive hold line towards the New England Highway.

The Thomas Mitchell Drive approach is on a right-hand horizontal curve on a downhill grade. New England Highway and Thomas Mitchell Drive are signposted as 100 km/h speed zones in the vicinity of this intersection. As such warning signs including REDUCE SPEED and T-INTERSECTION AHEAD have been installed on the Thomas Mitchell Drive approach. Street lighting is also provided at this intersection.

HVEC has commenced the upgrade to this intersection as part of their Open Cut Consolidation Project at MAC (Department of Planning, 2010). This includes the upgrade to a seagull configuration allowing for a two-stage crossing for right-turning traffic. This upgrade is scheduled for completion in late 2012.

2.3 Existing traffic conditions

2.3.1 RTA traffic surveys

RTA (2004a) provides traffic volume data for the New England Highway in the form of annual average daily traffic (AADT) volumes. AADT is the bi-directional traffic volume expressed in vehicles/day.

The following traffic counting stations are located in close proximity to the Project:

- Station 05.244: New England Highway, at the southern boundary of the Muswellbrook built up area.
- Station 05.037: New England Highway at Foy Brook Bridge to the north of Singleton.

RTA (2004a) provides traffic volume counts for these locations for the following years: 1980, 1984, 1988, 1992, 1995, 1998, 2001 and 2004.

Figure 14 shows the traffic volumes surveyed for the two New England Highway counting stations. The graph shows that the traffic volumes were similar for both sites. In 1980, the New England Highway carried approximately 7,500 vehicles/day, which later increased to approximately 12,000 vehicles/day by 2004.

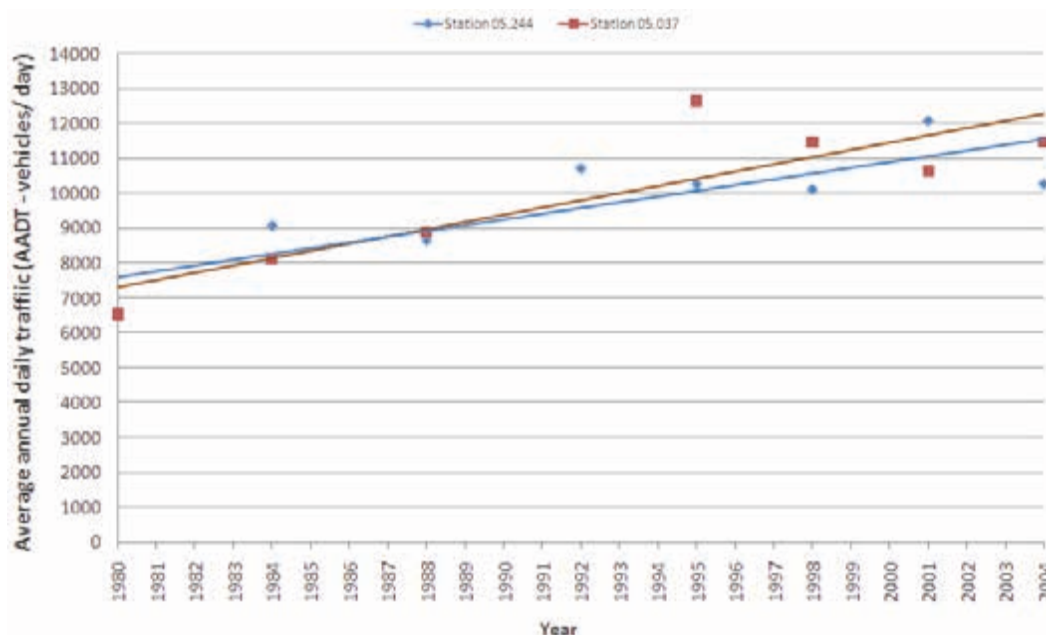


Figure 14 Traffic volumes (AADT) surveyed along the New England Highway (RTA, 2004a).

This data showed that traffic volumes increased by approximately 2.5% per annum over the 24 year period between 1980 and 2004. As such, the traffic modelling work described in Section 4 has also adopted an annual growth rate of 2.5% per annum to account for changes in the background (non-Project related) traffic for future test case scenarios.

RMS also supplied more recent data for the period from 2005 to 2009 for counting station 05.244. Table 1 shows the traffic volumes for each of these years in axle pairs. It should be noted that the conversion from axle pairs to vehicle numbers is dependent on the volume of heavy vehicles as a proportion of all vehicles, and the average number of axle pairs per heavy vehicle. However, assuming that the relative breakdown in light and heavy vehicles has remained consistent over these years, the change in axle pair-based traffic volumes can be used to determine traffic growth trends. This more recent data confirms that an average traffic growth rate of 2.7% per year has been experienced between 2005 and 2009.

Table 1 More recent traffic data for counting station 05.244 (axle pairs/day)

Year	2005	2006	2007	2008	2009
Traffic volume (axle pairs/ day)	10,335	10,481	10,809	11,152	11,489

This more recent data in Table 1 supports the earlier findings (from Figure 14) regarding the adopted 2.5% per year growth rate in background traffic. It should be noted that the data in Figure 14 is in vehicles/day (and not axle pairs/day) and is therefore the more appropriate basis for estimating traffic growth.

2.3.2 2011 traffic survey results

In September 2011, the following midblock traffic data surveys were carried out:

- Bengalla Link Road, approximately 200m north of Denman Road.
- Bengalla Link Road, approximately 300m north of Bengalla Mine Access Road.
- Denman Road, 300m east of Bengalla Link Road.
- Thomas Mitchell Drive, 200m south of Denman Road.
- Thomas Mitchell Drive, 200m west of New England Highway.

Each of the midblock surveys consisted of a breakdown by direction and a breakdown by vehicle type according to the standard Austroads 12-bin classification system. The surveys were conducted between 8-14 September 2011 and captured the full 24 hours each day.

A turning movement survey was also conducted at the intersection of Denman Road and Bengalla Link Road on 8 September 2011. This was carried out between 0600-1000h and 1500-1900h.

All survey locations have been shown in Figure 15.

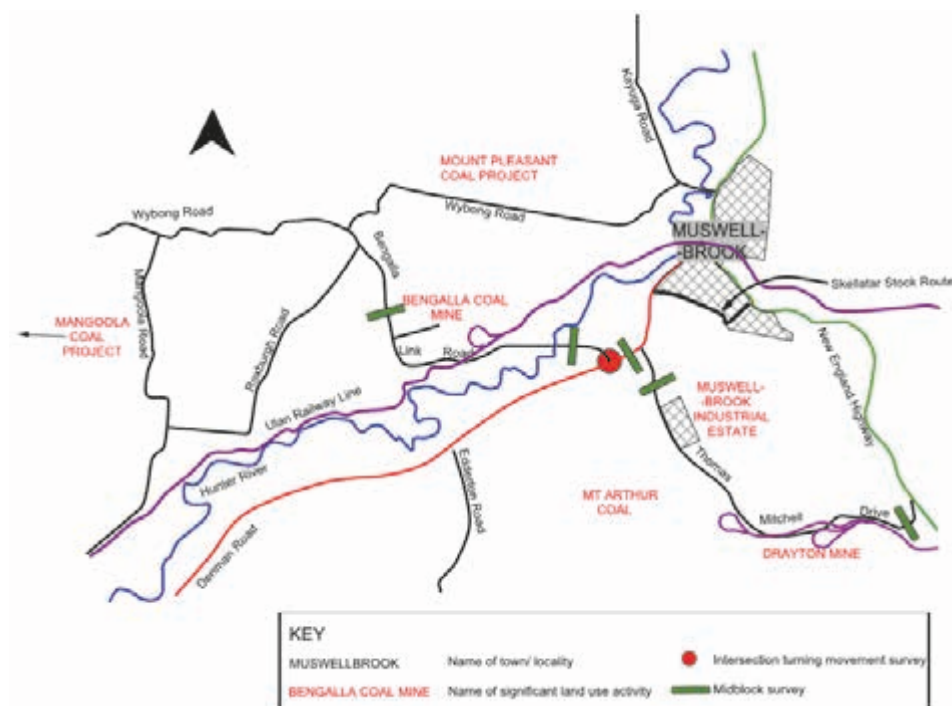


Figure 15 Traffic survey locations

From these surveys, the following peak periods were identified:

- AM peak: 0600-0700h
- PM peak: 1600-1700h

The intersection turning movement volumes and midblock volumes for these two peak periods are shown on Figure 16 and Figure 17.

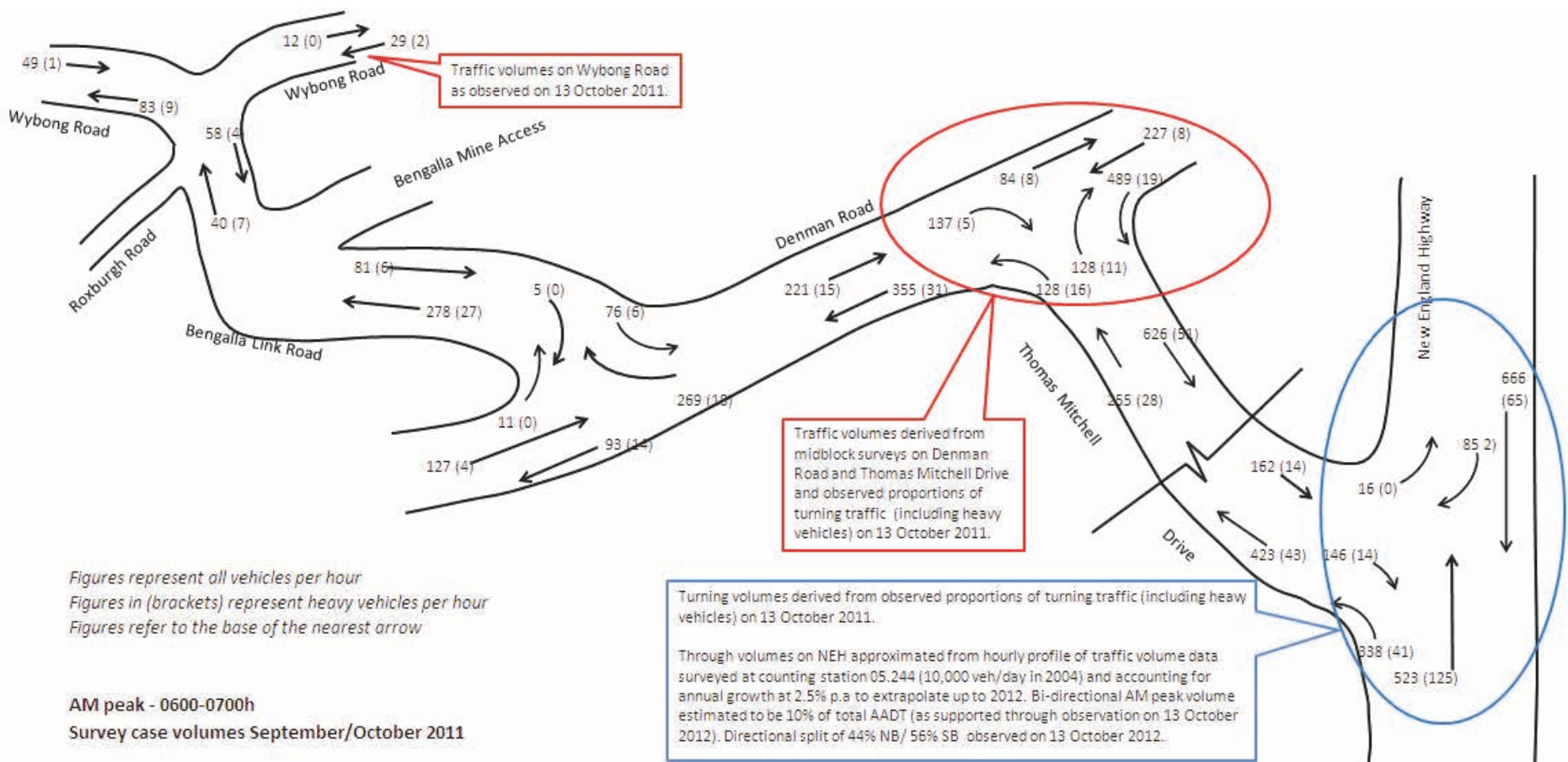


Figure 16 Existing AM peak hour volumes as surveyed (May, 2011).

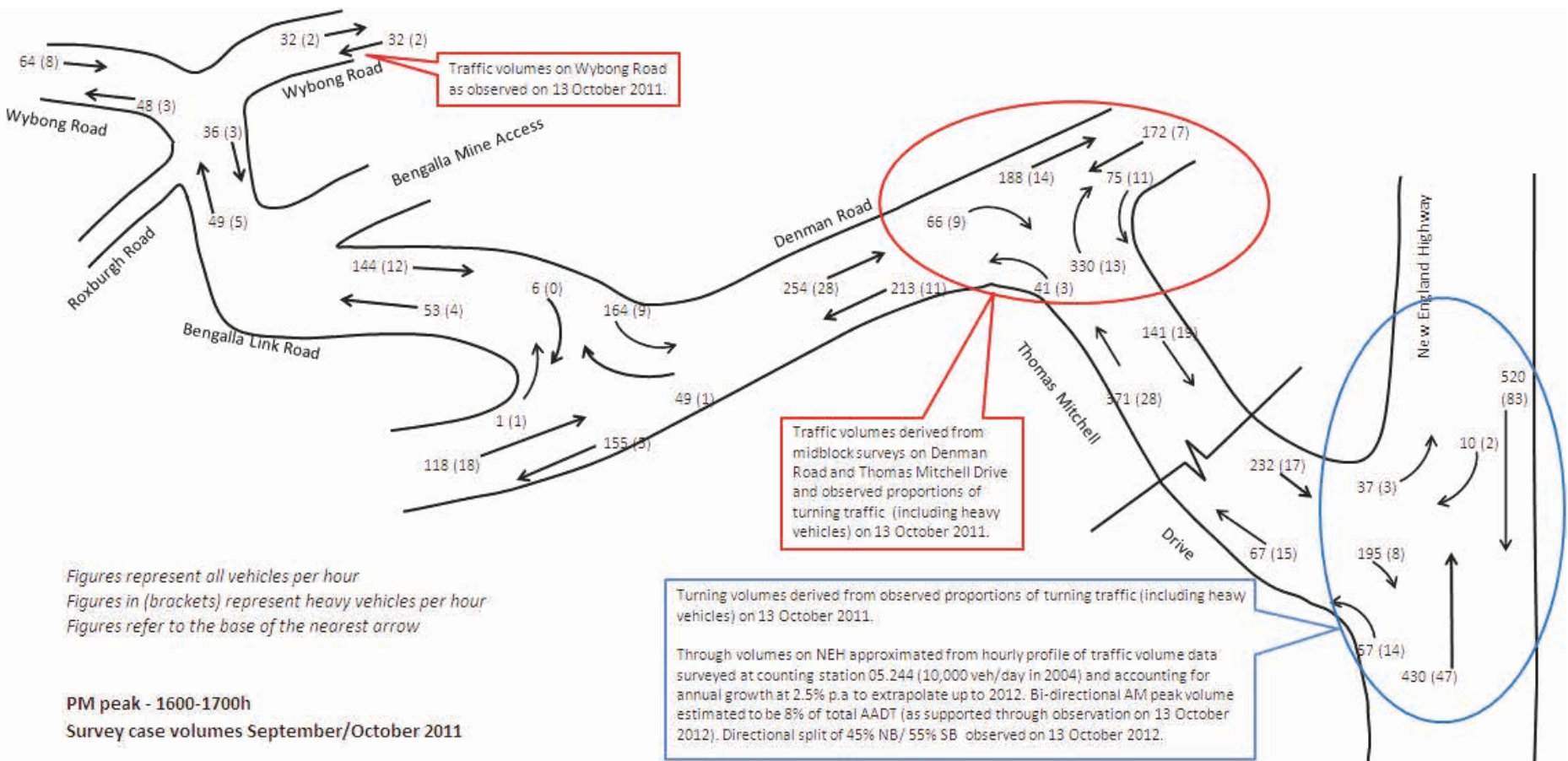


Figure 17 Existing PM peak hour volumes as surveyed (May, 2011).

The following points need to be acknowledged with regard to the traffic volumes shown in Figure 16 and Figure 17 for the year 2011:

- The 2011 traffic volumes are representative of an 8Mtpa production rate. This is 2.7Mtpa less than the currently approved 10.7Mtpa maximum production rate. As such, the traffic volumes for the base case (approved) conditions would need to be adjusted from the surveyed volumes to account for the additional resources and effort needed if the production rate were at its maximum of 10.7Mtpa.
- In 2011, there were 358 permanent employees working at Bengalla. This is 82 less than the maximum of 440 employees as currently approved. As such, the traffic volumes for the base case (approved) conditions would need to be adjusted from the surveyed volumes to account for the 82 additional employees.
- At the time of the surveys, the coal handling preparation plant (CHPP) was being upgraded at Bengalla. As such, a portion of the traffic volumes generated by the mine would have been associated with this “one-off” construction activity. These vehicle trips were therefore removed from the surveyed volumes in order to reflect the true base case operational conditions.

2.3.3 Intersection traffic performance – existing conditions

Justification for selection of study intersections

From the Project Boundary, traffic heading to the north of Muswellbrook could travel via Wybong Road, Kayuga Road and Aberdeen Street to access the New England Highway north of the town centre. Alternatively, this same traffic could head south along Bengalla Link Road, then use Denman Road and the New England Highway. For the purposes of this study, the southern route via Denman Road was regarded as the principle access route. This is due to the following:

- Bengalla Link Road is a high standard 100 km/h road which is regarded as the principle access route to Bengalla, Mangoola Coal Mine, and Mount Pleasant Coal Project. This route is designated as a major access route to the Wybong and Castlerock areas under MSC's Western Roads Strategy (1997).
- The section of Wybong Road between Bengalla Link Road and Kayuga Road is a lower standard road with poorer pavement width and seal conditions. There are a number of floodways along this route. Furthermore, there is a narrow one-lane bridge on Kayuga Road at the eastern end of this route.
- The Denman Road/ Bengalla Link Road intersection was recently upgraded (as part of the Mangoola's Early Works) to provide high-standard safety and traffic management facilities including indented right and left turn lanes, and a dedicated, exclusive left-turn acceleration lane.

From the Project Boundary, traffic heading towards Sandy Hollow, Merriwa and beyond could travel along Wybong Road to Sandy Hollow. Alternatively, they could travel south on Bengalla Link Road, and then west along Denman Road via the township of Denman. The route via Denman Road was regarded as the principle access route for the purposes of this study. This is due to the following:

- Adherence to the function of Bengalla Link Road as a principle access route under the Western Roads Strategy.

- The section of Wybong Road between Mangoola Coal and Sandy Hollow is a lower standard road with numerous curves, culverts and squeeze points, and floodways.

From the Project Boundary, traffic heading to the south of Muswellbrook would most likely use Bengalla Link Road, Denman Road and Thomas Mitchell Drive. This is the most direct route and all three roads are appropriate as through routes. The route via Skellatar Stock Route, Ironbark Road and Rutherford Road is unlikely to be a competitive route due to the relatively longer travel distance and time, and the lower mobility function of this route compared with Thomas Mitchell Drive. The alternative route via the Golden Highway is also not attractive as it requires a circuitous route via either Wybong Road or Denman Road.

As such, the following are regarded as the key intersections with regard to providing road transport access to the Project:

- Denman Road/ Bengalla Link Road intersection– which provides access to Sandy Hollow, Merriwa and beyond, as well as to north of Muswellbrook, and to Denman Road and Thomas Mitchell Drive. The nomination of this intersection also negates the need to assess the Bengalla Link Road/ Bengalla Mine Access Road intersection. This is because if the Denman Road/ Bengalla Link Road intersection can cater for projected traffic demands, then the intersection with Bengalla Mine Access Road would will also cater for the increased volumes, as this intersection would not receive as much traffic as the former.
- Denman Road/ Thomas Mitchell Drive intersection – which would be used by northbound traffic heading to Muswellbrook and beyond, as well as southbound traffic heading towards Singleton.
- New England Highway/ Thomas Mitchell Drive intersection – which would be used by southbound traffic heading towards Singleton.

Although Project-generated traffic could use other intersections and routes, these three intersections are regarded as having more critical access functions for the Project from a regional transport context. As such, they serve as appropriate test sites for Project-related traffic impacts.

The traffic volumes as shown on Figure 16 and Figure 17 were used to model the existing traffic conditions at these three key intersections. This was carried out using the SIDRA intersection performance simulation software. SIDRA considers the volumes and arrival rates of traffic in the approaches to the intersection, as well as the gap acceptance requirements for each of the low priority movements. It measures traffic performance via traffic level of service (LoS), degree of saturation (DoS), average intersection delay (in seconds/vehicle), and 95th percentile/maximum queue length. These performance indicators are described in more detail in Appendix A.

Table 2 provides a summary of the modelled SIDRA outputs for each of the key intersections for the AM and PM peak periods respectively. Appendix A describes the traffic performance indicators and the full SIDRA outputs are provided in Appendix B.

Table 2 Modelled SIDRA outputs for each of the key intersections – Existing traffic volumes (based on Figure 16 and Figure 17)

Intersection	Period	Degree of saturation (DoS)	Average intersection delay (sec/ vehicle)	Level of Service (LoS)	Maximum queue length (m)
Denman Road/ Bengalla Link Road	0600-0700h	0.285	8.0	A	11.4
	1600-1700h	0.175	5.9	B	6.4
Denman Road/ Thomas Mitchell Drive	0600-0700h	0.307	11.1	B	11.5
	1600-1700h	0.496	9.6	B	28.0
New England Highway/ Thomas Mitchell Drive	0600-0700h	1.397	40.3	F	264.5
	1600-1700h	0.682	6.7	C	33.0

Notes:

- (1) LoS is for the worst movement.
- (2) The existing traffic conditions are representative of a production rate of 8Mtpa and a workforce of 358 workers. The currently approved conditions allow for a maximum production rate of 10.7Mtpa and a workforce of 440 workers.
- (3) The existing traffic conditions were based on surveys carried out in late 2011. This coincided with the construction of the Bengalla CHPP. This is considered a “one-off” activity and not part of normal operational conditions.

Table 2 indicates that all of the study intersections except for the New England Highway/ Thomas Mitchell Drive intersection are performing satisfactorily under existing traffic conditions. This is exhibited by the DoS being less than 0.5, indicating that up to 50% of the available intersection capacity is being used with a residual capacity of 50% or greater. This is also indicated by average delays being less than 15 seconds/ vehicle and LoS for the worst movement being B or better. The maximum queue lengths were less than 30m.

The New England Highway/ Thomas Mitchell Drive intersection is exhibiting poor performance particularly in the AM period where the DoS is greater than 1. This indicates that the demand traffic volumes are greater than the available capacity. There are modelled delays of 40 seconds per vehicle and an intersection LoS of F indicated that traffic flows would be “forced”. The modelled maximum queue lengths are in the order of 265m.

On closer examination (see SIDRA outputs in Appendix B), the poor LoS is being experienced in the Thomas Mitchell Drive approach where the demand right-turn volume of 146 vehicles/hour (shown in the SIDRA output as 154 vehicles/hour based on a 95% peak hour factor) are attempting to cross the 523 vehicles/hour in the northbound direction of New England Highway. These right-turning vehicles also need to give way to the 85 right-turning vehicles from the New England Highway to Thomas Mitchell Drive, as well as merge into the southbound traffic stream which has an AM peak volume of 666

vehicles/hour. Furthermore, the right-turning traffic needs gaps in the northbound and southbound traffic streams to coincide in order to execute the right-turn movement as a “one stage entry”.

This intersection is further examined in Section 3 with regard to likely future performance.

2.4 Existing rail network conditions

2.4.1 Area of influence

In this traffic and transport impact assessment, the Project is regarded as having a significant impact over the extent of the rail network where it makes up 10% or more of the overall rail traffic volumes.

The Hunter Valley Rail Corridor carries rail traffic generated by coal mines, agricultural produce (crops and livestock), as well as passenger trains. In general, there is a lack of rail traffic volume data which collectively accounts for rail movements generated by all three of these major sources. As such, this traffic and transport impact assessment has relied on ARTC forecasts for coal volumes (in tonnes) for 2016 and beyond. This assumes a proportional relationship between the volume of coal transported and the number of trains generated.

ARTC (2012) forecasted a total of 125Mtpa of product coal that will pass through the section of the Hunter Valley Rail Network at Muswellbrook Junction in 2016. As such, the forecasted 12.3Mtpa of product coal (from 15Mtpa of ROM coal) generated by the Project will make up 9.8% of the total rail output for coal transportation at this point in the network. As this is less than the 10% threshold, the area of influence of the Project is considered to extend from Bengalla Mine to the Muswellbrook Junction. This is considered to be conservative since it only considers coal trains. If passenger trains and agriculture trains volumes could be accounted for, then this would further reduce the relative proportion of rail movements generated by the Project.

2.4.2 Rail network capacity and constraints

The railway network servicing the Hunter Valley, Western and Gunnedah Basin Coal Fields consist of a dedicated double track rail line between Port Waratah and Maitland, a shared double track line with some sections of third track from Maitland to Muswellbrook, and a shared single track with passing loops from that point north (towards Gunnedah) and west (towards Ulan). The section of the network between Port Waratah and Muswellbrook is capable of handling rolling stock with 30 tonne axle loadings (i.e. 120 gross tonne wagons) (ARTC, 2011).

Trains made up of 120 tonne wagons are generally restricted to 60 km/h loaded and 80 km/h empty, while 100 tonne wagon coal trains are allowed to travel at 80 km/h. Because most of the coal trains use 120 tonne wagons, the coal network tends to move at 60 km/h in the loaded direction and 80 km/h in the empty direction. The average coal payload per loaded train from the Bengalla Rail Loop (see Figure 1) is approximately 7,700 tonnes. (ARTC, 2011). In 2011, Bengalla dispatched 647 loaded trains with payloads varying between 7,200 and 8,500 tonnes (Bengalla Mining Company, 2011).

In 2011, the coal haulage demands from these three regions were serviced by 43 trains including:

- 22 trains of 91 x 120 tonne wagons (8500 nominal net tonnes)
- 8 trains of 74 x 120 tonne wagons (7200 nominal net tonnes)
- 4 trains of 72 x 100 tonne wagons (5400 nominal net tonnes)
- 3 trains of 60 x 120 tonne wagons (5500 nominal net tonnes)
- 4 trains of 42 x 100 tonne wagons (3000 nominal net tonnes)
- 2 trains of 2000 nominal net tonnes, composed of non-standard wagons

(ARTC, 2011).

ARTC (2011) noted that the surrounding rail network is likely to have the carrying capacity as follows:

- Bengalla Rail Loop (including Mount Pleasant): 15 trains/day (41 Mtpa) in 2011 rising to 21 trains/day (60Mtpa) in 2015.
- Between Bengalla Rail Loop and Muswellbrook: 21 trains/day (59Mtpa) in 2011 rising to 36 trains/day (104Mtpa) in 2015.
- Between Muswellbrook and Antiene: 47 trains/day (132Mtpa) from 2011 to 2015.

2.4.3 Safety

The main rail safety issues as identified by ARTC (2011) include the following:

- The impact of the steep graded Nundah and Allandale Banks on headways and network efficiency (Figure 18).
- The conflicts and gap requirements at key junctions such as the Muswellbrook, Drayton and Maitland Junctions.

Steep grades

ARTC is progressively working to address network deficiencies. Their 2011 Strategy (ARTC, 2011) provides details regarding how they are consulting the wider industry with a view to identifying and prioritising the need and timing of network upgrades. As an example, the previous version of the Strategy (ARTC, 2009) listed the Minimbah Bank along with the Nundah and Allandale Banks as key network constraints. However, with a recent commitment to deliver the Minimbah to Maitland Third Road project, this will effectively address the capacity constraint at Minimbah. This section currently carries the highest volume of trains along the Hunter Valley Coal Network.

The Nundah Bank, to the north-west of Singleton, will become constrained in 2013. ARTC (2011) proposed that this section be upgraded to include a third track as well.

Junction conflicts

The Drayton Junction is the junction of the Main Northern Railway Line and the Drayton Loop which services Drayton and MAC. The main issue with this junction is the low-speed, high-maintenance turnout which has experienced frequent downtime due to regular maintenance works. The 25 km/h operational speed of the turnout means that more time, and larger gaps are required for trains entering the Main Northern Railway Line. This increases exposure to safety incidents as well as reducing the number of train paths available. ARTC (2011) has recommended that the turnout be upgraded to increase the operational speed to 40 km/h.

The Muswellbrook Junction is a major conflict point between trains from the Ulan Line and trains from the Gunnedah Basin. ARTC (2011) indicated that trains arriving at this junction had a high probability of stopping to allow for other train movements. Potential delays were noted in the order of 6-10 minutes per train service. The ARTC is recommending that a three-track configuration be provided at this junction by 2014.

ARTC does not have any specific long-term plans to address the capacity and safety issues with the Maitland Junction. However, it acknowledges that there is a need to replace the low-speed, high-maintenance turnouts.

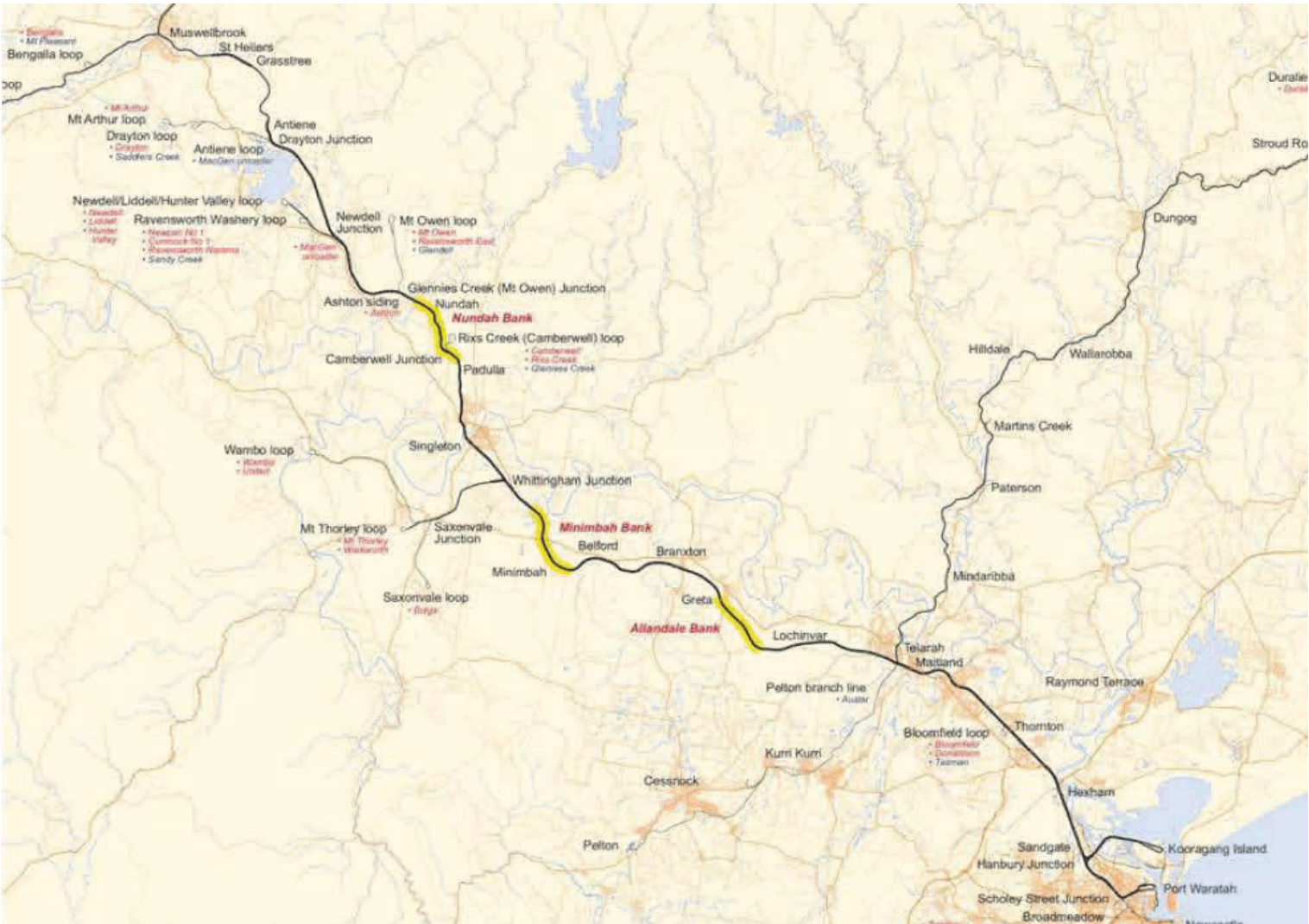


Figure 18 Hunter Valley coal rail network –Muswellbrook to Newcastle (Source: ARTC, 2009).

2.4.4 Railway crossings

The Bengalla Rail Loop meets the Ulan Rail Line to the north of Bengalla Link Road. From that point, the Ulan Rail Line extends north east towards the Muswellbrook town centre where it crosses the New England Highway as a rail-over-road bridge.

As noted in Section 2.4.1, the area of influence of the Project on the Hunter Valley Rail Network is considered to extend from the Project to Muswellbrook Junction. There are no railway level crossings of public roads in this section of the rail network. As such, this traffic and transport impact assessment does not include any formal assessments of railway level crossings. However, notwithstanding this, a preliminary review of the railway level crossings between Muswellbrook and Singleton has been conducted and described below, despite these being outside the area of influence.

Between Muswellbrook and Singleton, railway level crossings exist at the following locations:

- Hebden Road (southern occurrence), Ravensworth.
- Glennies Creek Road, Camberwell.
- Dights Crossing Road, Oak Park.

All three railway level crossings are similar in terms of the type of traffic control used, the storage length available in the road approaches, and the function and volume of the roads. With regard to traffic control, all three crossings are actively controlled with flashing lights and boom barriers. Sufficient sight distance is provided towards the railway level crossing flashing signals and associated warning devices.

The extensive storage length provided in each of the road approaches is sufficient to prevent short stacking risks. Furthermore, the traffic volumes using these roads are very low and it is not expected that there could be significant queue build up due to a passing train.

As an indication of traffic impacts due to a passing train, the Hebden Road railway level crossing (Figure 19) was reviewed with respects to traffic impacts due to passing trains.



Figure 19 Railway level crossing on Hebden Road, to the east of New England Highway, Ravensworth

The Hebden Road approaches provide considerable storage length in the event of a passing train. One potential constraint identified is the narrow one-lane bridge over Bowmans Creek, which is 300m east of the railway level crossing. As a one-lane bridge, any queues that form in the southbound direction due to a passing train may potentially spill back and block the passage of northbound vehicles over the bridge. There are several self-mitigating attributes in this regard, including:

- A GIVE WAY sign has been provided for southbound traffic approaching the bridge. As such, these drivers are required to observe whether there is a clear unobstructed path across the bridge and whether there is sufficient storage length beyond the bridge. By contrast, the northbound approach is not required to give way.
- Passing trains at this crossing were observed to require a total road closure period of 90 seconds. Even if traffic volumes along Hebden Road were at the 1,200 vehicle/ hour saturation levels (which is highly unlikely), this would only result in a maximum of 30 vehicles that would arrive at the crossing. With an average queue length of 7m for light vehicles, this would equate to a 210m queue length. As this is significantly less than the 300m distance between the railway level crossing and the narrow bridge, the queue is unlikely to block the bridge.

2.4.5 Planned upgrades

The 2009-18 ARTC Strategy had previously proposed a passing loop on the short section between Bengalla Junction and the previously proposed Mount Pleasant Project junction. The requirement for this loop was primarily driven by the development of Mount Pleasant Project. However, the current proposal for loading for the Mount Pleasant Project is to utilise the Bengalla Rail Loop. As such, junction conflicts due to both mines will be consolidated at the same junction.

With this change, rail movements on the Bengalla–Mangoola section will fall short of the original forecasts. To address the shortfall the most likely solution is to extend the existing Bengalla passing loop approximately 1 km westward, taking it beyond Bengalla Junction. Retaining the connection into the mine off both tracks would offer greater operational flexibility in that the loop could be used for inbound trains to Bengalla (whilst waiting for eastbound trains to pass), or alternatively it could be used by eastbound trains to pass around any slow moving trains entering or exiting the Bengalla Rail Loop.

This passing loop is currently in the development stage and is not subject to this Project.

3 Traffic and transport generation implications of the Project

3.1 Base case conditions

3.1.1 Traffic volumes – base case

As noted in Section 2.3.2, the 2011 surveyed volumes were not representative of the current approved conditions associated with Bengalla. Table 3 describes the corrections that have been applied in order to present a true base case condition reflective of the approved Bengalla.

Table 3 Corrections required to account for the base case (approved Bengalla) conditions.

Component	Conditions at time of survey	Approved Bengalla	Corrections required for base case condition
Coal production	7 Mtpa ROM coal	10.7 Mtpa ROM Coal	It has been assumed that this discrepancy would not result in additional road traffic during the modelled peak periods. There may be additional service vehicles generated but these are likely to be outside the peak period. Also, the increased product coal yield would have a more significant impact on rail traffic generation.
Workforce	358 FTE workers	440 FTE workers	Need to account for additional 82 workers. Assuming that 70% (30 workers) would be required for the day shift and 30% (12 workers) would be required for the night shift. This would generate 30 inbound and 12 outbound light vehicle trips during the AM peak, and 30 outbound and 12 inbound light vehicle trips in the PM peak.
CHPP upgrade	CHPP was being upgraded	The CHPP upgrade was a one-off activity and is not considered part of the sustained traffic conditions during the operational phase of the mine	Need to remove an assumed 20 vehicle trips ¹ from the inbound direction in the AM peak, and 20 outbound vehicles trips from the PM peak. See commentary following this table.

¹ The Statement of Environmental Effects for BMC's *Modification to Mining Operations* (Hansen Bailey, 2006) did not include details of the construction workforce required for the CHPP upgrade.

To ensure a conservative assessment, it was assumed that the inbound and outbound traffic associated with the PM shift change would occur in the assessment period of 1600-1700h.

Considering these corrections, there would be:

- A net increase of 10 inbound light vehicle trips during the AM peak.
- 12 additional outbound light vehicle trips during the AM peak.
- A net increase of 10 outbound light vehicle trips during the PM peak.
- 12 additional inbound light vehicle trips during the PM peak.

The following trip distribution was assumed based on an assessment of existing employee places or residence (as at 2011):

- 40% of trips distributed to Muswellbrook via Denman Road.
- 28% of trips distributed to Scone and Aberdeen via Wybong Road.
- 27% of trips distributed to Singleton and Lower Hunter via Thomas Mitchell Drive.
- 5% of trips distributed to Denman via Denman Road.

The base case volumes are shown in Figure 20 and Figure 21 which account for these corrections.

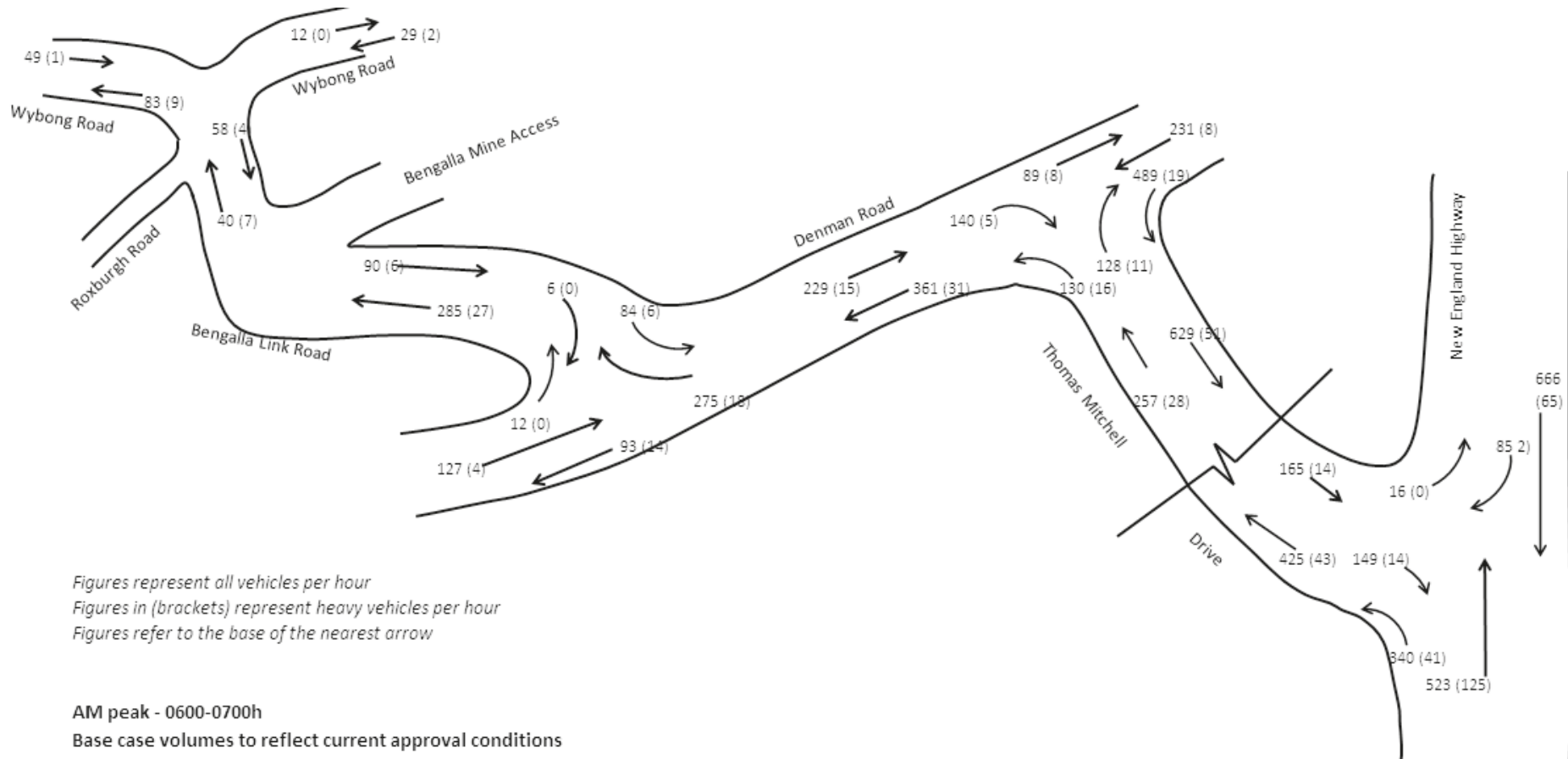


Figure 20 Base case AM peak hour volumes accounting for corrections.

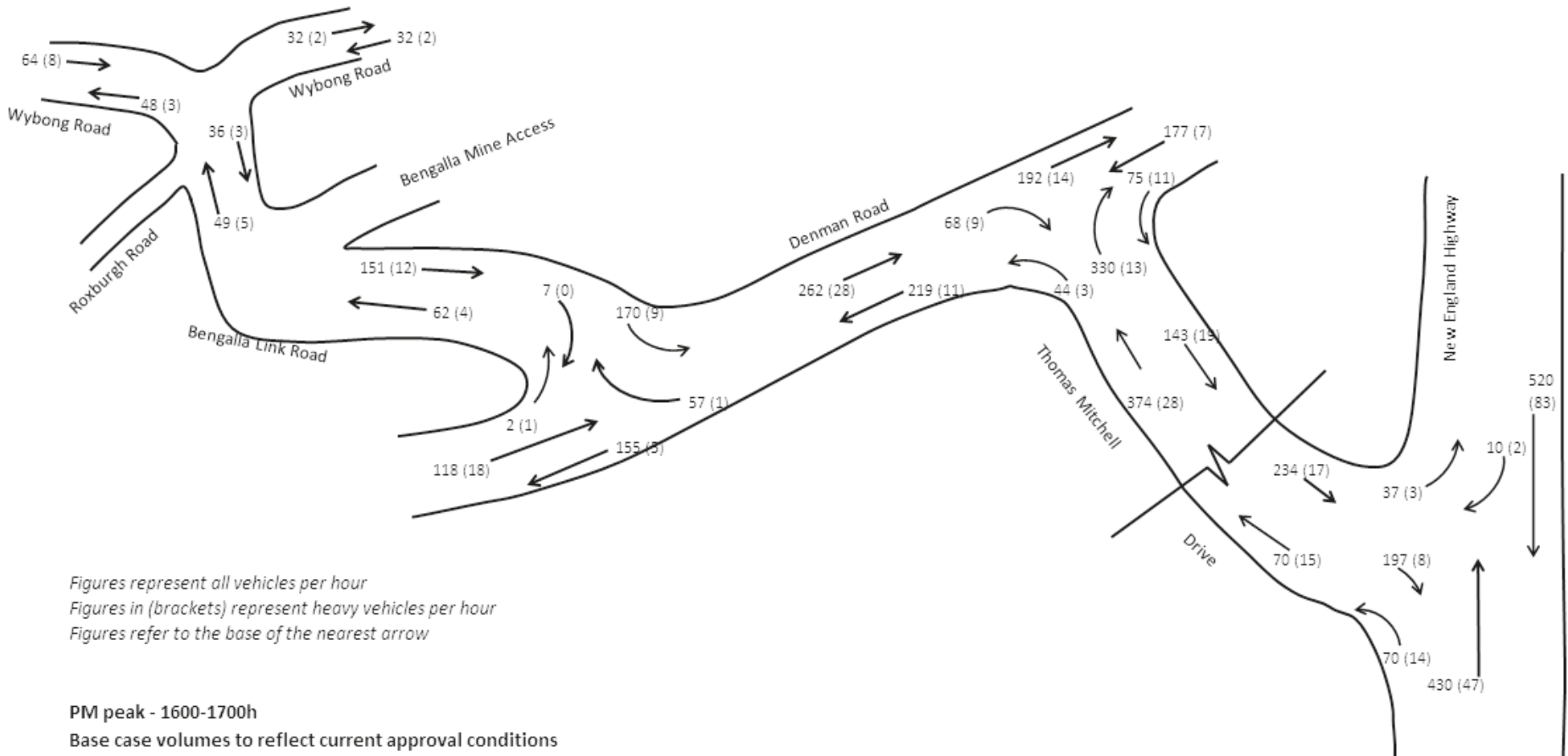


Figure 21 Base case PM peak hour volumes accounting for corrections.

3.1.2 Modelled traffic performance – base case

The traffic volumes as shown in Figure 20 and Figure 21 were used to model the base case traffic conditions at the three key intersections. This was carried out using the SIDRA intersection performance simulation software.

Table 4 provides a summary of the modelled SIDRA outputs for each of the key intersections for the base case AM and PM peak periods respectively. The full SIDRA outputs are provided in Appendix B.

Table 4 Modelled SIDRA outputs for each of the key intersections – Base case traffic volumes (based on Figure 20 and Figure 21).

Intersection	Period	Degree of saturation (DoS)	Average intersection delay (sec/ vehicle)	Level of Service (LoS)	Maximum queue length (m)
Denman Road/ Bengalla Link Road	0600-0700h	0.293	8.1	A	11.7
	1600-1700h	0.181	6.1	B	6.7
Denman Road/ Thomas Mitchell Drive	0600-0700h	0.316	11.1	B	11.9
	1600-1700h	0.503	9.6	B	28.5
New England Highway/ Thomas Mitchell Drive	0600-0700h	1.426	42.5	F	276.5
	1600-1700h	0.691	6.8	C	33.7

Notes:

(1) LoS is for the worst movement.

The corrections made to the traffic volumes as described in Section 3.1.1 have resulted in very little change to the modelled performance of the base case. It should be emphasised that the base case does not actually exist. Rather, it is the traffic scenario that *would* exist if Bengalla were generating traffic in accordance with the maximum allowable workforce and production rates under the existing approvals. Similar to the models of the existing case shown in Table 2, the worst performing of the study intersections would continue to be New England Highway/ Thomas Mitchell Drive. This would have a DoS of 1.426, i.e. there is 42% more traffic volume demand than the available capacity. The average intersection delays would be 42.5 seconds/ vehicle, and the worst movement LoS would be F. Modelled maximum queue lengths would be approximately 280m. Similar to the existing case, these traffic performance results are associated with the right-turn movement from Thomas Mitchell Drive to New England Highway. The Denman Road/ Bengalla Link Road and the Denman Road/ Thomas Mitchell Drive intersections are operating satisfactorily.

It should be noted that HVEC are committed to upgrading the New England Highway/ Thomas Mitchell Drive and Denman Road/ Thomas Mitchell Drive intersections. The New England Highway/ Thomas Mitchell Drive intersection will be a seagull configuration with the following facilities:

- A 180m right-turn deceleration lane on the New England Highway;
- A 160m left-turn deceleration lane on the New England Highway leading into a high angled slip lane.
- A left-turn acceleration lane from Thomas Mitchell Drive to New England Highway. This lane will provide more than 200m of acceleration and merge length which greatly reduces the gap acceptance requirements of this movement.
- A 200m, protected right-turn acceleration lane from Thomas Mitchell Drive to New England Highway. As a seagull arrangement, the right-turning traffic from Thomas Mitchell Drive to New England Highway would become a “two-stage entry” with the first stage being the crossing of the northbound through lane, and the second stage being the high speed merge with the southbound through lane. This greatly reduces the gap acceptance requirements and would increase the capacity of the right-turning movement, which was the worst performing movement according to the SIDRA models.

The Denman Road/ Thomas Mitchell Drive intersection would also be upgrade to a seagull configuration, albeit with reduced lengths for the turning lanes.

These future intersection configurations have been examined in more detail in Section 3.2.

3.2 Traffic generation due to construction

3.2.1 Traffic volumes – construction phase

The indicative construction schedule is shown in Table 5

Table 5 Indicative construction schedule with projected worker numbers required.

Infrastructure construction component	Year 1				Year 2				Year 3			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Stage 1 - Upgrade to Mine Infrastructure (13 Mtpa)												
Temporary construction administration area												
Existing car park extension												
Covered stores building												
Modification to existing bathhouse												
Construction of new light vehicle workshop												

Infrastructure construction component	Year 1				Year 2				Year 3			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Earthworks, drainage and water management												
Office (Block F)												
Stage 1 & 2 Upgrade to CHPP (13 Mtpa & 15 Mtpa)												
Relocation of reject bin and associated conveyors												
Conveyor and transfer station civil works												
Installation of stockpile stacker and reclaimers												
Construction of CHPP module 3												
Construction of additional filter house												
Upgrade of existing and construction of new conveyor and transfer stations												
CHPP commissioning and verification												
Earthworks, drainage and water management												
Relocation of the upgraded ROM bin, primary crusher station and associated earthworks												
Installation of new ROM conveyors and transfer stations												
Installation of new sizing and screening station												
Stage 2 - Upgrade to Mine Infrastructure (15 Mtpa)												
Hydrocarbon storage area upgrade												
Eastern public and light vehicle carparks												
New tyre change facility												
Modification to existing and construction of new bathhouse												
Office block (Block G)												
Construction of generator compound												
Workshop extension												

Infrastructure construction component	Year 1				Year 2				Year 3			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Earthworks, drainage and water management												
Other Works												
Refuelling upgrade to 550,000 L												
New tyre storage facility												
Dragline maintenance pad												
Refuelling upgrade to 880,000 L												
Dry Creek Diversion (including CW1 construction, pipeline establishment, pump commissioning, power reticulation and associated earthworks)												
Relocation of the explosives and reload facility												
Indicative construction manning required (per day)	-	-	85	195	315	245	160	150	45	85	125	150

As indicated in Table 5, the peak of the construction phase is likely to occur in quarter 1 of year 2 when up to 315 workers will need to report to the site each day. As a conservative measure, it has been assumed that 80% of this workforce would need to access the site during the AM peak, and egress from the site during the PM peak. A 100% car usage factor has been applied (ie. no other forms of transport) with a vehicle occupancy rate of 1.0 persons/ vehicle.

The following trip distribution was assumed based on an assessment of places of residence for existing employees:

- 40% of trips distributed to Muswellbrook via Denman Road;
- 27% of trips distributed to Singleton and Lower Hunter via Thomas Mitchell Drive; 28% of trips distributed to Scone and Aberdeen via Wybong Road; and
- 5% of trips distributed to Denman via Denman Road.

The traffic volumes due to the peak construction phase were added to the base case volumes in order to establish a "peak construction" traffic scenario for traffic impact modelling purposes. As the peak construction phase would be in year 2, it was assumed that two year's worth of background traffic growth would also be experienced. The traffic volumes for the peak construction case have been depicted in Figure 22 and Figure 23 for the AM and PM peaks respectively.

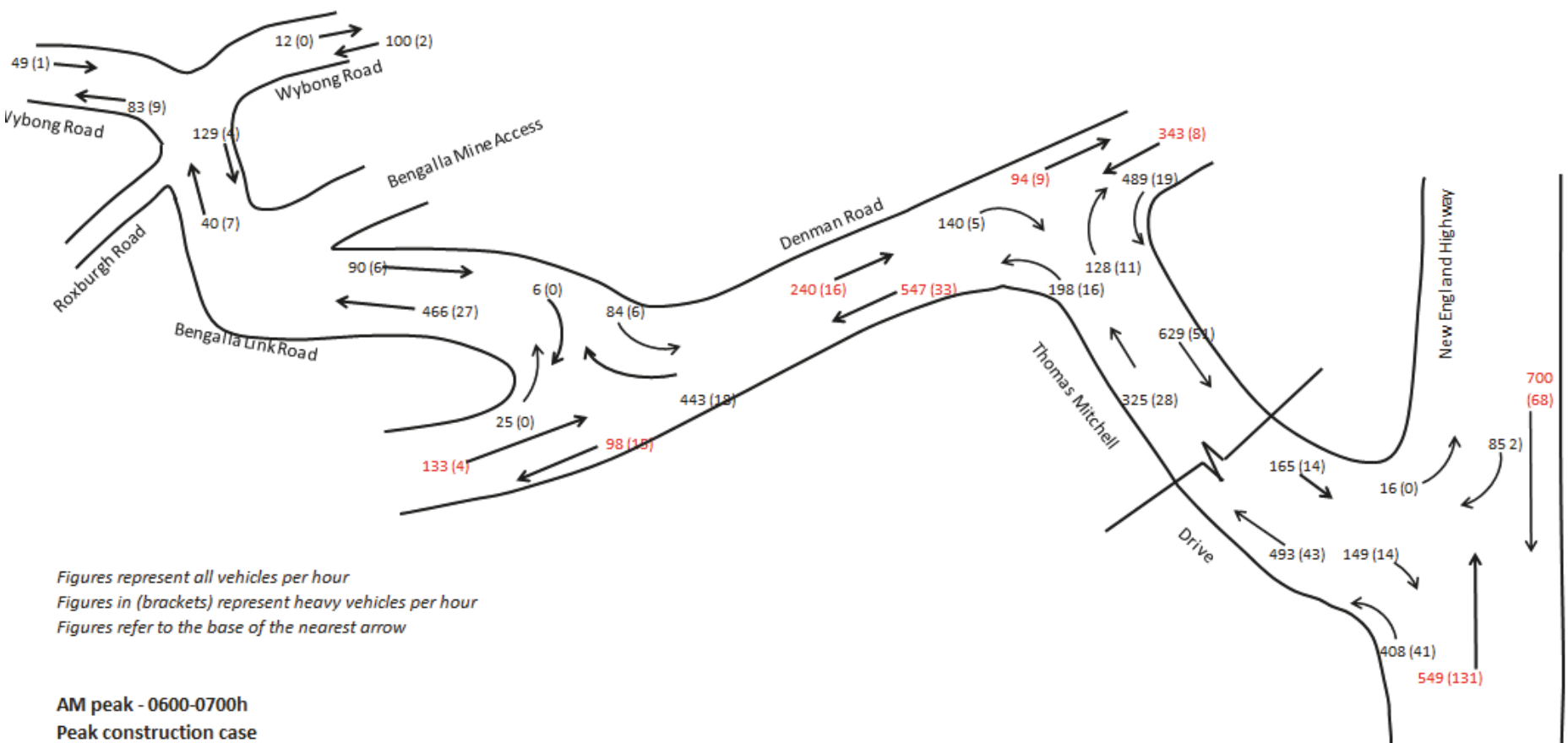


Figure 22 Traffic volumes for the AM period of the peak construction phase in Year 2.

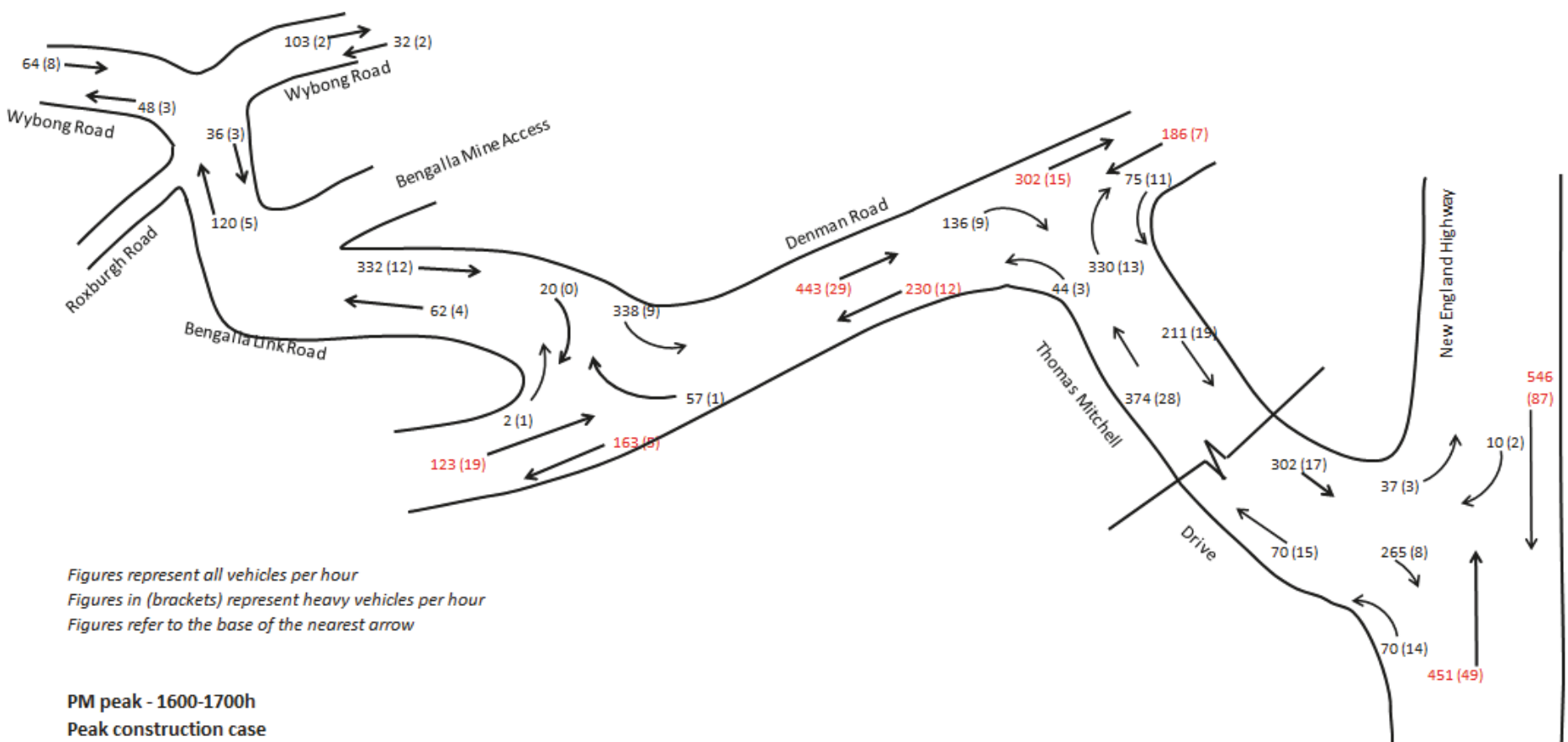


Figure 23 Traffic volumes for the PM period of the peak construction phase in Year 2.

3.2.2 Modelled traffic performance – peak construction phase

The traffic volumes as shown in Figure 22 and Figure 23 were used to model the traffic impacts in Year 2, the peak construction phase. The three key intersections as described in Section 2.3.3 were modelled using the SIDRA software in these respects. Table 7 provides a summary of the model results. The full SIDRA outputs are provided in Appendix B.

Table 6 Modelled SIDRA outputs for each of the key intersections – Peak construction case traffic volumes (based on Figure 22 and Figure 23).

Intersection	Period	Degree of saturation (DoS)	Average intersection delay (sec/ vehicle)	Level of Service (LoS)	Maximum queue length (m)
Denman Road/ Bengalla Link Road	0600-0700h	0.482	9.6	A	24.0
	1600-1700h	0.369	8.0	B	12.9
Denman Road/ Thomas Mitchell Drive	0600-0700h	0.389	11.3	B	13.4
	1600-1700h	0.633	10.3	B	31.9
New England Highway/ Thomas Mitchell Drive	0600-0700h NB carriageway	0.342	8.0	B	8.5
	0600-0700h SB carriageway	0.402	0.4	A	3.9
	0600-0700 combined	0.402	5.2	B	8.5
	1600-1700h NB carriageway	0.261	6.4	B	8.9
	1600-1700h SB carriageway	0.325	0.6	A	5.8
	1600-1700 combined	0.325	4.2	B	8.9

Notes:

(1) LoS is for the worst movement.

The modelled performance of the Denman Road intersections with Bengalla Link Road and Thomas Mitchell Drive was regarded as acceptable which indicates that the intersections, in their current configurations, have sufficient capacity to accommodate the traffic demands due to the peak construction conditions of the Project.

The traffic modelling in Table 6 accounts for the upgrades to the New England Highway/ Thomas Mitchell Drive intersection which will be completed in late 2012. This involves the conversion of the intersection to a seagull configuration as shown in Figure 24. These are works being carried out by HVEC as part of the Mt Arthur Coal Mine.

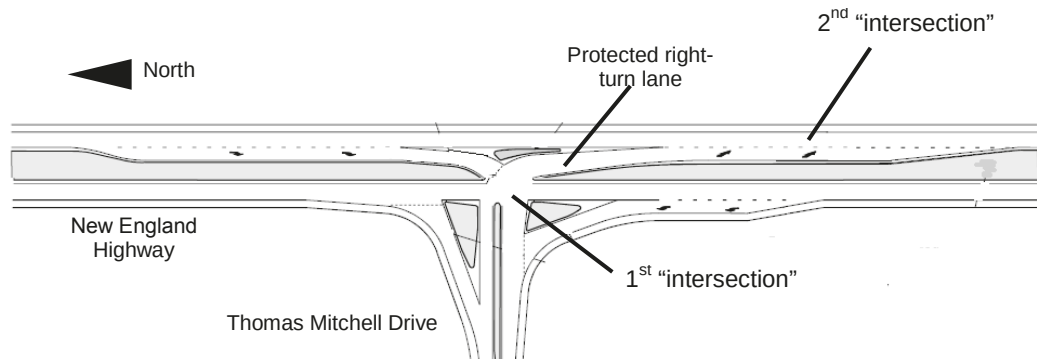


Illustration is an example only – not to scale

Figure 24 Typical seagull T-intersection configuration

One major advantage of a seagull configuration is that it allows for the right-turning movement from Thomas Mitchell Drive to enter the New England Highway as a “two-stage crossing”. That is, the entering driver from Thomas Mitchell Drive only needs to judge gaps in the northbound traffic stream of the New England Highway, as well as the southbound right-turn lane. Once there are sufficient gaps in these traffic streams, the driver would cross the northbound carriageway and then enter a protected acceleration lane. This acceleration lane allows them to enter the southbound traffic as a high-speed merge as the “second stage”. The advantage of this configuration is that it greatly simplifies the decision making requirements of the entering driver. Whilst they still require a minimum five second gap in the northbound carriageway, they no longer require *coinciding* gaps in both travel directions of the New England Highway. This creates more entering opportunities as the relative probability of receiving coinciding northbound and southbound gaps is substantially less than receiving these gaps separately in two crossing stages. This attribute would significantly reduce the potential delay for right-turning traffic from Thomas Mitchell Drive. It is for this reason that the assessment for this intersection is comprised of two separate SIDRA models which are combined to provide an overall result (see Table 6).

The traffic modelling for the seagull configuration of New England Highway/ Thomas Mitchell Drive also indicated that this intersection would perform satisfactorily with the proposed construction traffic added. This was indicated by the good modelled levels of service of B.

3.3 Traffic generation during the operational phase

3.3.1 Traffic volumes – operational phase

The Project will involve continuation of mining at Bengalla for a further 24 years. The mine plan indicates that the maximum production yield of up to 15 Mtpa of ROM coal will be achieved in Year 4 of the mine plan and then up to 15 Mtpa for the remaining 20 year period. However, Year 15 has been nominated as the peak production year as this is likely to coincide with high production periods from neighbouring mines. As such, Year 15 would best account for the cumulative traffic impacts of the Project alongside peak production from neighbouring mining projects.

The traffic and transport generation implications of Year 15, as the nominated peak operational period, are as follows:

- 12.3 Mt product coal yield: This has more implications on rail traffic but would also generate additional road transport movements for ancillary services and supplies. It has been assumed that an additional 12 truck movements would be generated by the Project each week day. This would include six inbound trucks and six outbound trucks. It has been assumed that all trucks would have trip origins from the south-east (Singleton, Maitland and Newcastle). These would be evenly spread throughout the day with approximately one inbound and one outbound trip in each of the AM/ PM assessment periods.
- Additional workforce: There would be an additional 460 full time equivalent workers employed by the Project. It has been assumed that these would be split over four consecutive day/night shifts such that 35% of workers would be required in the day shift of day 1, 15% would be required in the night shift of day 1, 35% would be required in the day shift of day 2, and 15% would be required in the night shift of day 2.
- Vehicle occupancy rate: A vehicle occupancy rate of 1 person/vehicle has been conservatively assumed for the additional workers. Although in reality some workers may car pool and hence reduce the number of car trips needed, there are also others that may be dropped off/picked up to/from work which would generate twice as many car movements due to the vehicle not remaining on site during the work shift. To a certain extent, these two aspects will result in no significant variation to predicted traffic volumes.
- Times of trip generation: All inbound trips associated with the start of the day shift, and outbound trips associated with the end of night shift are assumed to be generated in the 0600-0700h assessment period. It was assumed that the inbound and outbound traffic associated with the PM shift change would occur in the 1600-1700h assessment period. In reality the afternoon peak may be more spread out due to greater variability in end-of-work time. However, by adopting the surveyed PM peak of 1600-1700h, a more conservative assessment is assured since there would be less spare network capacity during this period.
- Trip distribution: The following trip distribution was assumed based on an assessment of places of residence for existing employees:
 - 40% of trips distributed to Muswellbrook via Denman Road;
 - 28% of trips distributed to Scone and Aberdeen via Wybong Road;

- 27% of trips distributed to Singleton and Lower Hunter via Thomas Mitchell Drive; and
- 5% of trips distributed to Denman via Denman Road.
- Growth in background traffic: Background traffic on Denman Road and the New England Highway were assumed to grow at 2.5% p.a as determined in Section 2.3.1. The 2.5% p.a growth rate was only applied to the through movements along these two routes. Year 15 of the Project would equate to 18 years of growth from the survey year of 2011.
- The growth in individual turning movements such as New England Highway-Thomas Mitchell Drive, Thomas Mitchell Drive-Denman Road, Denman Road-Bengalla Link Road and vice versa were determined through a “first principles” approach considering foreseeable growth in traffic generated by Drayton, MAC, Mangoola Coal Mine and Mount Pleasant Project. These have been discussed in Section 3.4 as part of the cumulative traffic impact assessment.

Figure 25 and Figure 26 show the total traffic volumes that would be generated in the AM and PM assessment periods for Year 15. This accounts for the traffic growth and traffic generation as discussed above.

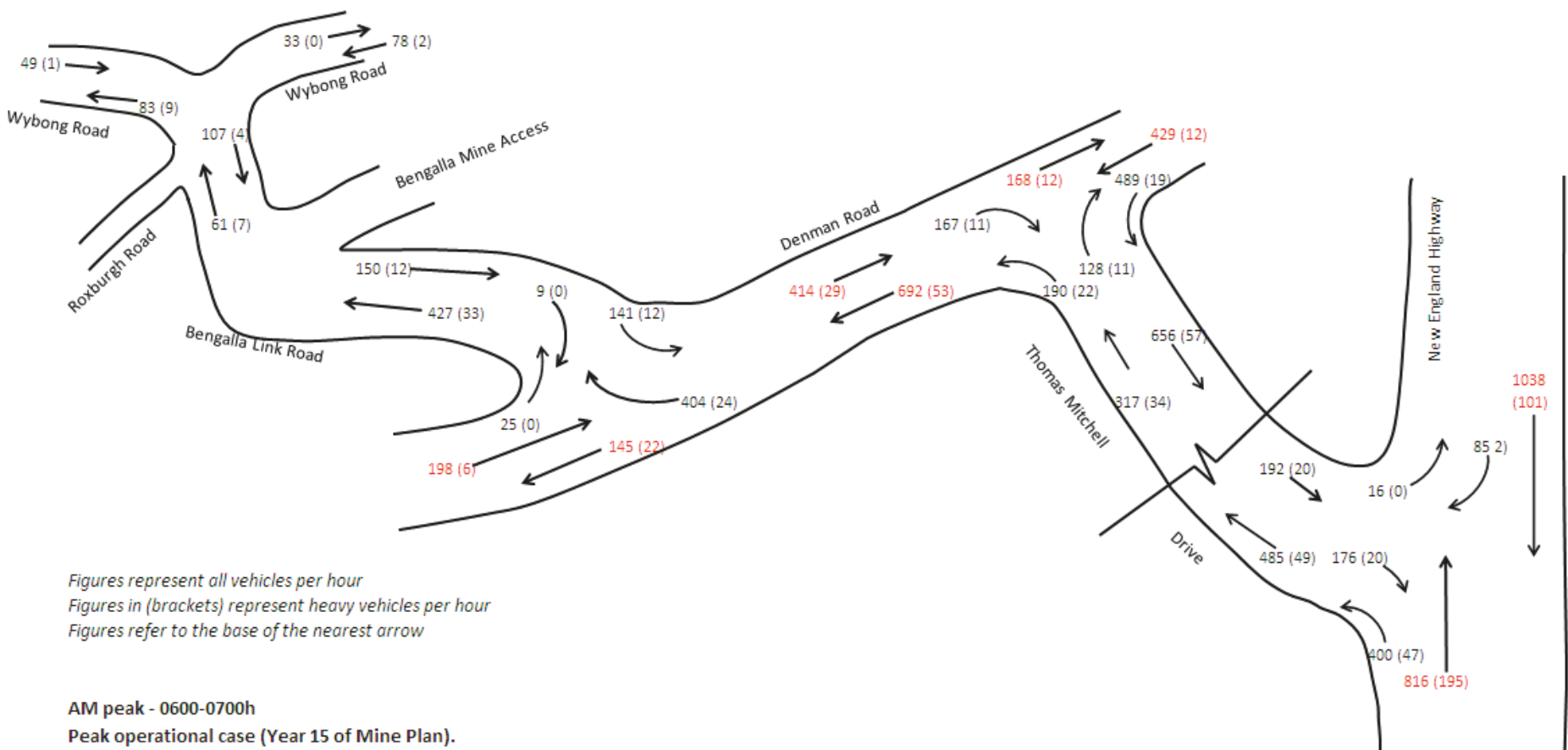


Figure 25 Traffic volumes for the AM period of the peak operational phase in Year 15.

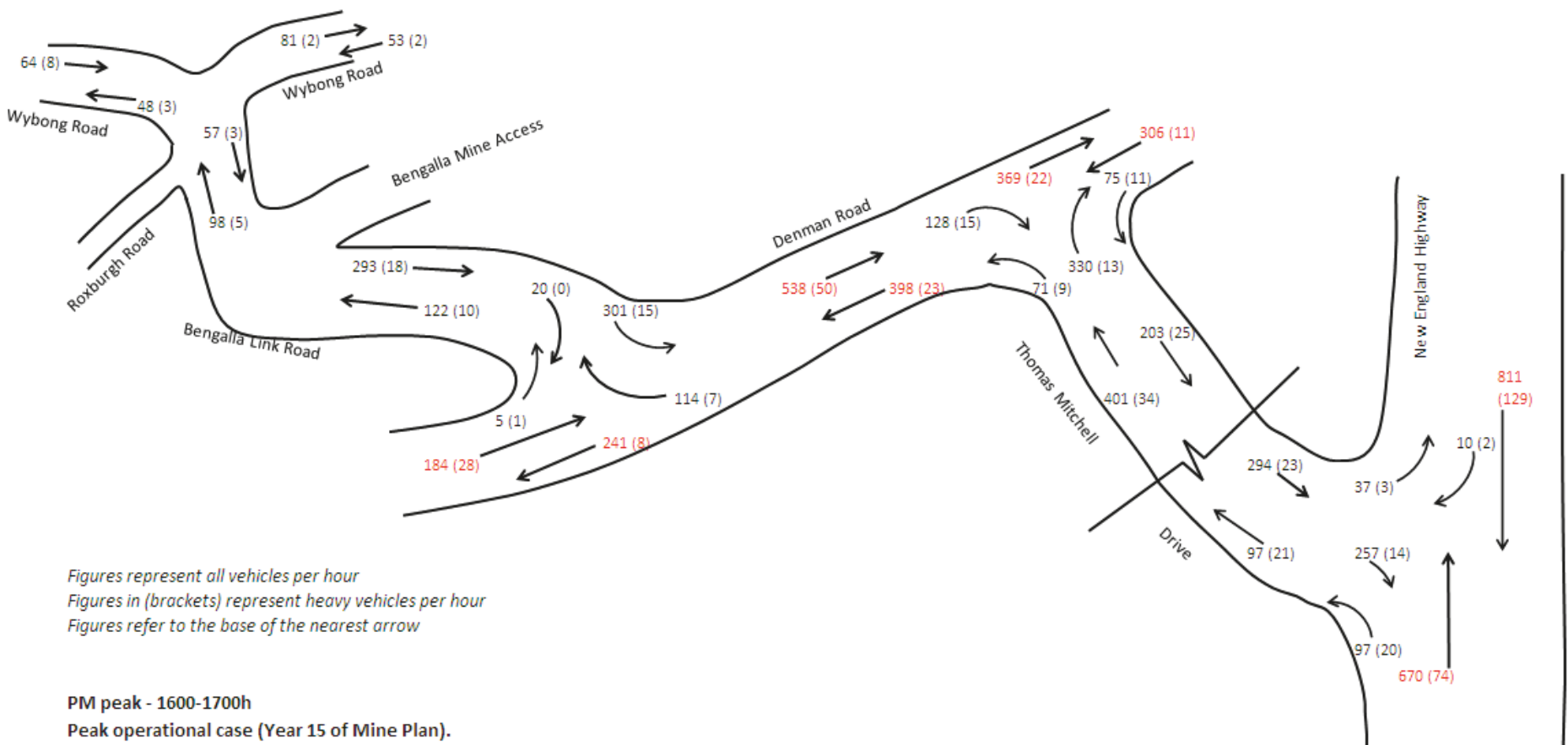


Figure 26 Traffic volumes for the PM period of the peak operational phase in Year 15.

3.3.2 Modelled traffic performance – peak operational phase

The traffic volumes as shown in Figure 25 and Figure 26 were used to model the traffic impacts in Year 15, the peak operational phase. The three key intersections as described in Section 2.3.3 were modelled using the SIDRA software in these respects. Table 7 provides a summary of the model results. The full SIDRA outputs are provided in Appendix B.

Table 7 Modelled SIDRA outputs for each of the key intersections – Peak operational case traffic volumes (based on Figure 25 and Figure 26).

Intersection	Period	Degree of saturation (DoS)	Average intersection delay (sec/ vehicle)	Level of Service (LoS) (2)	Maximum queue length (m)
Denman Road/ Bengalla Link Road	0600-0700h	0.495	9.3	B	31.5
	1600-1700h	0.365	7.2	A	15.9
Denman Road/ Thomas Mitchell Drive	0600-0700h	0.546	11.7	C	23.8
	1600-1700h	0.819	12.5	C	62.1
New England Highway/ Thomas Mitchell Drive (1)	0600-0700h NB carriageway	0.509	7.9	B	22.6
	0600-0700h SB carriageway	0.596	1.0	A	11.5
	0600-0700 combined	0.596	5.1	B	22.6
	1600-1700h NB carriageway	0.362	5.7	B	14.6
	1600-1700h SB carriageway	0.483	0.9	A	11.1
	1600-1700 combined	0.483	3.75	B	14.6

Notes:

- (1) This assessment is of the proposed upgrade to the New England Highway/ Thomas Mitchell Drive intersection as described in Figure 24. These are scheduled for completion in late 2012.
- (2) LoS is for the worst movement.

The modelled performance of the Denman Road intersections with Bengalla Link Road and Thomas Mitchell Drive was regarded as acceptable which indicates that the intersections, in their current configurations, have sufficient capacity to accommodate the traffic demands due to the peak operational conditions of the Project.

The proposed seagull configuration for the New England Highway/ Thomas Mitchell Drive intersection (scheduled for completion in late 2012) was also assessed using SIDRA. The SIDRA assessments shown in Table 7 indicate that the proposed upgrade of the New England Highway/ Thomas Mitchell Drive intersection will perform satisfactorily with the additional traffic loading from the Project.

3.4 Cumulative traffic generation

3.4.1 Mangoola Coal Mine

PB (2010) carried out an assessment of the traffic impacts associated with “Modification 4” to the Mangoola Coal Mine Approval 06_0014. This Modification was approved on 22 June 2012 and will involve the relocation of a 500kV electricity transmission line to allow mining activity to progress. Whilst this is a “once-off” construction activity with little ongoing traffic impact over the longer term, the Modification also seeks to increase the number of employees from the currently approved 240 to a maximum of 300 employees. The latter has more significance to assessing the long-term cumulative traffic impacts.

PB (2010) stated that the increase from 240 to 300 employees would result in an additional 31 light vehicle trips in the AM peak and an additional 29 vehicle trips in the PM peak. This is based on an assumption that all of the additional 60 employees would work during the day shift. This study has adopted the same assumptions to be consistent with the PB study.

The following trip distribution information was applied to the Modification-generated traffic:

- All 31 light vehicles generated in the AM peak would be inbound, and all 29 light vehicles generated in the PM peak would be outbound.
- The trips would be distributed in a similar manner as applied previously, i.e.
 - 40% of trips distributed to Muswellbrook via Denman Road.
 - 28% of trips distributed to Scone and Aberdeen via Wybong Road.
 - 27% of trips distributed to Singleton and Lower Hunter via Thomas Mitchell Drive.
 - 5% of trips distributed to Denman via Denman Road.

3.4.2 Mount Pleasant Project

Mount Pleasant Project is located to the north of Bengalla though mining has not yet commenced. This study has conservatively assumed that the Mount Pleasant Project will be fully operational at Year 15 of the Bengalla Project.

ERM Mitchell McCotter (1998) prepared an Environmental Impact Statement for the Mount Pleasant Project which included an assessment of the likely traffic impacts. That assessment indicated that this coal mine would require 380 employees during the peak operational period. An 85% car usage factor was applied which is equivalent to a car occupancy of 1.2 persons/ vehicle.

ERM Mitchell McCotter (1998) indicated that the operational workforce would be distributed between two shifts. The exact start and end times of the shifts were not specified although it was clear that a day time and a night time shift would be required. This study has assumed that 60% of the workforce would be required for the day shift and 40% would be required for the night shift. Furthermore, it has been assumed that the inbound traffic associated with the start of the day shift and the outbound traffic associated with the end of the night shift would coincide with the AM assessment period. Correspondingly, the end of day shift outbound traffic and the start of night shift inbound traffic would coincide with the PM assessment period. This is a conservative assumption since the typical 12-hour shift would put the afternoon shift change closer to 1800-1900h rather than the 1600-1700h period adopted for the PM assessment period.

ERM Mitchell McCotter (1998) also estimated 20 additional light vehicles a day for servicing requirements, and 10 truck deliveries a day. However, it was assumed that all of these trips would be outside the AM and PM assessment periods.

This study has assumed that this traffic would have similar traffic distribution as discussed previously, ie.

- 40% of trips distributed to Muswellbrook via Denman Road.
- 28% of trips distributed to Scone and Aberdeen via Wybong Road.
- 27% of trips distributed to Singleton and Lower Hunter via Thomas Mitchell Drive.
- 5% of trips distributed to Denman via Denman Road.

3.4.3 Mt. Arthur Coal

Mt Arthur Coal is an existing mine located off Thomas Mitchell Drive to the immediate west of Drayton Mine. The 2009 traffic impact assessment for the Mt Arthur Coal Consolidation Project (Hansen Bailey, 2009) identified the following:

- The Mt Arthur Coal Consolidation Project would result in an increased coal production to 36 Mtpa ROM coal.
- An increase to the operation workforce of 720 full time equivalent positions (total of 1420) would be expected in Year 15 of the Bengalla Project. Similarly, 70% of the workforce would travel to the site on any weekday at a vehicle occupancy rate of 1.17 persons/vehicle. As such, 430 inbound light vehicle trips and 430 outbound light vehicle trips would be generated per weekday by the site during the peak operation phase in 2014 (assumed to be evenly distributed over two 12-hour shifts). An additional 20 light vehicle visits would occur each day with both inbound and outbound trips. A 60/40 split has been assumed for the day time versus night time shifts.
- Traffic generated from Mt Arthur Coal would be distributed 65%/35% to the west/east respectively. At the Denman Road end, the generated traffic would be distributed 90%/10% to the east (Muswellbrook)/west (Denman) respectively. At the New England Highway end, 100% of the generated traffic would be distributed to the south.

3.4.4 Drayton Mine

Drayton Coal Mine is located along Thomas Mitchell Drive to the south-west of the Project. This mine is scheduled to exhaust all available extraction limits in the next five years. As such, Anglo American is seeking a new Project Approval to facilitate the extraction of coal for a further period of 27 years south of the current mine known as the Drayton South Coal Project.

As a replacement project with little change to the maximum production yield and workforce, no further additional traffic is expected under this application. As the September 2011 surveys were representative of operational conditions associated with the existing Drayton Coal Mine, they are considered to be an adequate account of the future traffic generation from the Drayton South Project.

3.4.5 Summary of traffic generation from other coal projects

Figure 27 and Figure 28 show the total traffic volumes for the AM and PM assessment periods which account for the cumulative traffic generation from known coal projects in the vicinity of the Project. These account for the additional traffic generation as described in Sections 3.4.1 to 3.4.4.

No publicly available information exists on the Muswellbrook West project, and as such it has not been included in this assessment. Dartbrook Underground is currently under care and maintenance with no additional information available publicly, and as such is not included in this assessment.

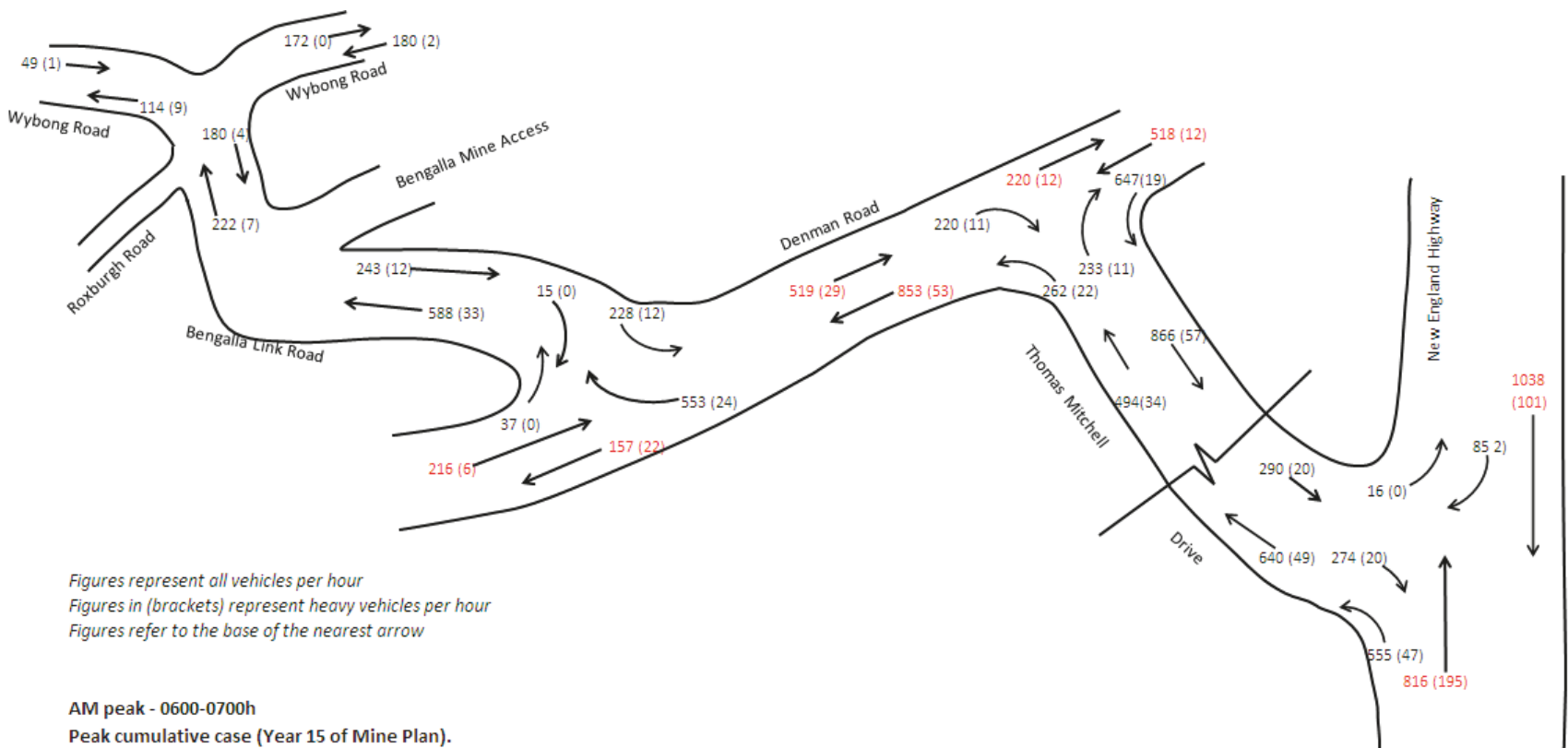


Figure 27 Traffic volumes for the AM period of the cumulative impact case - Year 15.

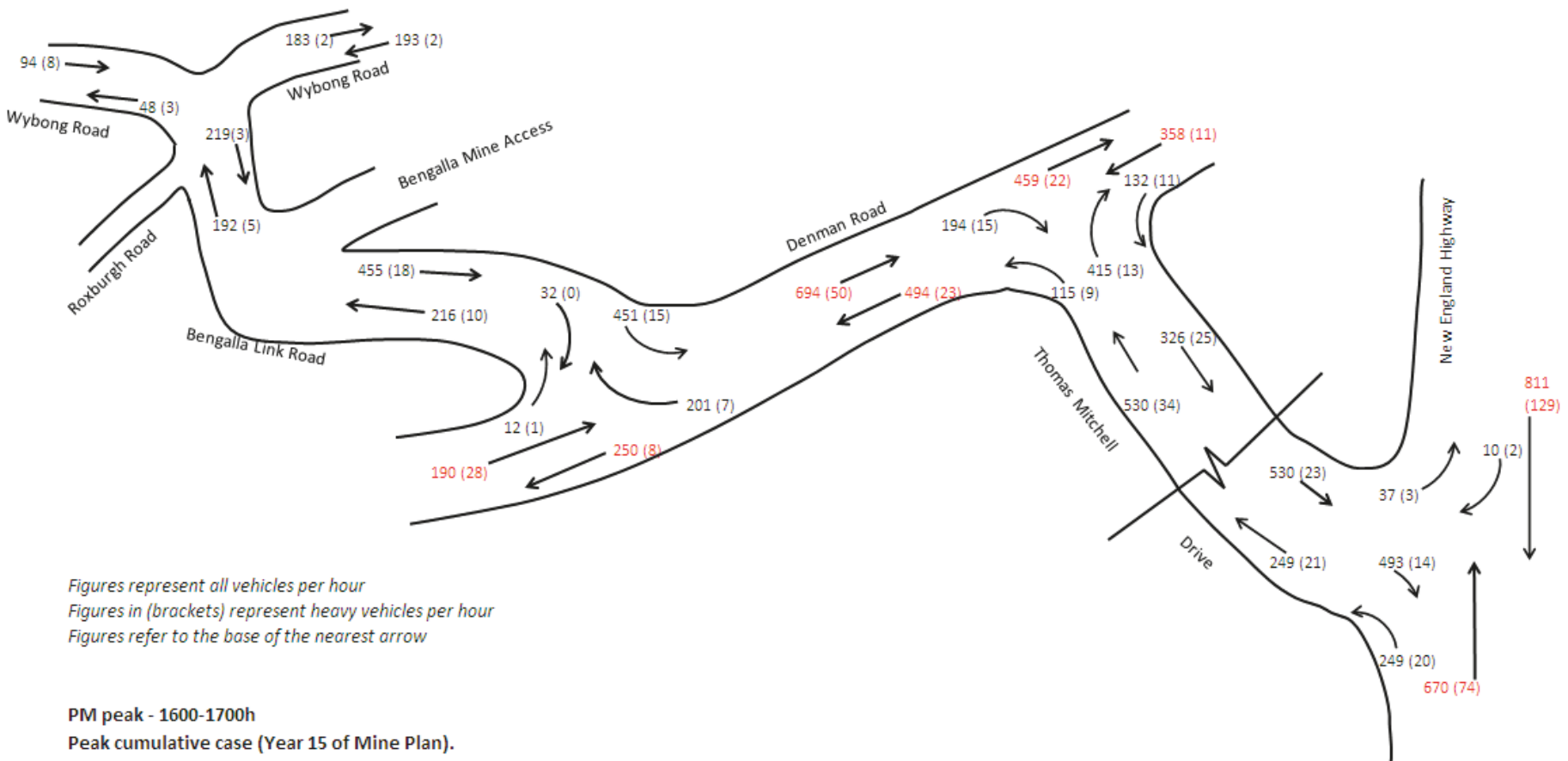


Figure 28 Traffic volumes for the PM period of the cumulative impact case - Year 15.

3.4.6 Modelled traffic performance – cumulative operational phase

The cumulative operational phase includes the combined impacts of project-related traffic growth, foreseeable traffic growth from neighbouring coal mining projects, and the background traffic growth. Year 15 of the Bengalla Project was assumed to be the assessment year.

The cumulative impacts of the Project and known coal mining activities from neighbouring coal mines were also modelled using SIDRA. The SIDRA outputs for the three key intersections are provided in Table 8.

Table 8 Modelled SIDRA outputs for each of the key intersections – cumulative case traffic volumes (based on Figure 27 and Figure 28).

Intersection	Period	Degree of saturation (DoS)	Average intersection delay (sec/ vehicle)	Level of Service (LoS) (2)	Maximum queue length (m)
Denman Road/ Bengalla Link Road	0600-0700h	0.729	12.1	B	72.8
	1600-1700h	0.561	9.6	B	41.6
Denman Road/ Thomas Mitchell Drive	0600-0700h	1.13	44.3	F	201.5
	1600-1700h	1.446	113.9	F	665.2
New England Highway/ Thomas Mitchell Drive (1)	0600-0700h NB carriageway	0.799	11.5	C	53.6
	0600-0700h SB carriageway	0.596	1.5	A	17.9
	0600-0700 combined	0.799	8.0	C	53.6
	1600-1700h NB carriageway	0.647	9.5	B	6.8
	1600-1700h SB carriageway	0.64	2.1	A	29.5
	1600-1700 combined	0.65	7.3	B	29.5

Notes:

- (1) This assessment is of the proposed upgrade to the New England Highway/ Thomas Mitchell Drive intersection as described in Figure 24. These are scheduled for completion in late 2012.
- (2) LoS is for the worst movement.

The cumulative operational phase indicated that under these combined sources of traffic growth, the Denman Road/ Thomas Mitchell Drive intersection would also begin to fail with a modelled LoS of F.

As stated previously, HVEC are committed to upgrading the Denman Road/ Thomas Mitchell Drive intersection to a seagull configuration. As this is due for completion in 2019, it would be opened to traffic well before Year 15 of the Project.

Table 9 shows the SIDRA outputs for the proposed upgrade to the Denman Road/ Thomas Mitchell Drive intersection to a seagull configuration. As indicated in this table, the proposed new intersection layout would perform satisfactorily under the cumulative impact scenario for Year 15. This is indicated by the DoS being less than 0.5 indicating that less than 50% of the available intersection capacity would be required. This is also indicated by LoS of B, and average intersection delays of 10 seconds/vehicle or less.

Table 9 Modelled SIDRA outputs for future seagull intersection at Denman Road/ Thomas Mitchell Drive - Cumulative case based on Figure 27 and Figure 28.

Period	Intersection point	No. of vehicles/ hour	Degree of saturation (DoS)	Average intersection delay (sec/ vehicle)	Level of Service (LoS)	Maximum queue length (m)
0600-0700h	Westbound carriageway Denman Road	1979	0.418	10.6	B	20.1
	Eastbound carriageway Denman Road	477	0.157	0.2	A	4.8
	Combined	2211	0.418	9.5	B	20.1
1600-1700	Westbound carriageway Denman Road	1278	0.444	10.5	B	27.0
	Eastbound carriageway Denman Road	920	0.336	0.7	A	12.0
	Combined	1761	0.444	8.0	B	27.0

4 Assessment of road traffic impacts

Section 3 of this Traffic and Transport Impact Assessment included a comprehensive overview of potential road traffic impacts in terms of the likely impact to the operation of key intersections. This considered the residual capacity of each of the key intersections and to what degree the intersection would be affected by the Project-related traffic.

This section expands on Section 3 by considering the potential road impacts due to Project related traffic. Road impacts have been assessed by considering:

(i) the capacity and efficiency of the midblocks in carrying the forecast traffic volumes due to the Project, as well as (ii) forecasts of Equivalent Standard Axles (ESA) that would be generated by the background and Project related traffic. ESAs are a standard measure of the impact loads imparted on a road's pavement due to increases in heavy vehicle traffic. These analyses have been carried out on Bengalla Link Road, Wybong Road and Thomas Mitchell Drive as preliminary indicators of overall network performance.

4.1 Midblock traffic performance

The midblock traffic performance of the principal access routes was assessed using the Highway Capacity Manual method for two-lane highways. This method considers the bi-directional traffic volume along a midblock section of road during the highest volume hours of the day. It considers the impact of traffic volumes on travel speed and the percentage of time that drivers spend following another vehicle. The faster the travel speed, or the closer it is to a driver's desired speed under free flow conditions, the better the level of service (LoS). By contrast, the less time a driver spends following another vehicle, the better the LoS.

Table 10 shows the results of the midblock traffic assessment for the existing and cumulative case scenarios. The existing case is based on the traffic volumes from Figure 16 and Figure 17. The cumulative case is based on the traffic volumes from Figure 27 and Figure 28. The full workings and calculations are provided in Appendix C. Appendix A provides an interpretation of traffic LoS for intersections. This can also be used as a guide to LoS descriptors (A to F) for midblock traffic performance as well.

Table 10 Midblock level of service (LoS) for existing and cumulative case scenarios

Midblock	Assessment period	Existing case* LoS	Cumulative Project case** LoS
Bengalla Link Road, south of Bengalla Mine Access Road	AM	C	D
	PM	B	C
Wybong Road, west of Bengalla Link Road	AM	B	B
	PM	B	B
Thomas Mitchell Drive, west of New England Highway	AM	C	D
	PM	C	C

* This is actually based on traffic volumes as surveyed in 2011.

** This is based on Year 15 of the Project with consideration of neighbouring mines.

As shown in Table 10, the midblock of Wybong Road to the west of Bengalla Link Road will retain its existing LoS of B in the cumulative case scenario. This midblock is relatively resilient to adverse traffic performance/ conditions as its current volumes are considerably low and have substantial spare capacity to absorb the forecast traffic demands from the cumulative case scenario.

The Bengalla Link Road midblock to the south of the Mine Access Road, and Thomas Mitchell Drive to the west of the New England Highway are likely to drop one level of service in the cumulative case scenario. However, in all cases, the LoS will remain at D or better which means the roads will be operating within the available capacity limits. It should be emphasised that (i) these are for the highest volume periods of the day, and (ii) that the traffic demands leading to the LoS level drop are due to the cumulative effect of foreseeable expansion in other mining projects as well as the Project.

As these three routes will continue to operate within their respective midblock capacity limits, there are no further mitigation measures recommended.

4.2 Axle loading

The standard measure for vehicle axle impacts to road pavement is the equivalent standard axle (ESA). This considers both the number of axles on a heavy vehicle as well as the distribution of the load. As such, a vehicle with a higher number of axles will not necessarily impart a larger impact to road pavement than vehicles with fewer axles. This is because the vehicle with more axles may be better able to distribute its load across more axles.

Main Roads Western Australia (no date) have provided an indication of the multiplier to be used to convert vehicles to ESAs. These are as shown in Table 11 for the 10 classes of heavy vehicles (classes 3-12) as specified by Austroads. The Austroads vehicle classification system is provided in Appendix D.

Table 11 also shows the number of vehicles counted from each class of heavy vehicle for five survey sites in September 2011. Using the ESA multipliers, the total number of ESAs for each survey site was determined, as well as the average number of ESAs per heavy vehicle. This shows that heavy vehicles on Bengalla Link Road and Denman Road have an average of 1.62 ESAs/ vehicle. By contrast, heavy vehicles on the eastern and western sections of Thomas Mitchell Drive had averages of 1.98 and 1.45 ESAs/ vehicle respectively. Provided that the same patterns of heavy vehicle usage are sustained, with respect to the relative proportion use of each vehicle type, it is reasonable to conclude that heavy vehicles on these three routes would have an average of 1.62 ESAs.

Table 11 Multipliers used to convert vehicle numbers to ESAs.

	Austrroads Vehicle class										
Vehicle class	3	4	5	6	7	8	9	10	11	12	Total
ESA multiplier	0.6	1.5	3.6	1.3	1.7	2.6	3.1	5.3	5.7	10.8	
BLR 1 # veh	164	28	17	3	4	3	41	20	1	0	280
BLR 1 # ESAs	99	42	60	4	8	7	126	104	6	0	454
ESA/ veh	1.62										
BLR 2 # veh	51	11	6	1	2	1	18	4	0	0	95
BLR 2 # ESAs	31	17	21	2	4	2	55	23	0	0	155
ESA/ veh	1.63										
Denman # veh	327	53	22	6	13	9	70	45	4	0	549
Denman # ESAs	196	79	78	7	21	23	218	241	24	0	889
ESA/ veh	1.62										
TMD 1 # veh	194	108	28	3	2	9	83	49	4	0	479
TMD 1 # ESAs	116	161	102	3	4	25	257	258	20	2	948
ESA/ veh	1.98										
TMD 2 # veh	392	98	40	8	5	5	63	33	2	0	646
TMD 2 # ESAs	235	147	145	10	8	14	196	173	11	2	941
ESA/ veh	1.46										

BLR 1 – Bengalla Link Road, 200m north of Denman Road

BLR 2 – Bengalla Link Road, 300m north of Bengalla Mine Access Road

Denman – Denman Road, 300m east of Bengalla Link Road.

TMD 1 – Thomas Mitchell Drive, 200m west of New England Highway.

TMD 2 - Thomas Mitchell Drive, 200m south of Denman Road.

A more detailed analysis is required in order to determine the likely increases in ESAs generated by the Project as well as from other neighbouring coal projects and from the general growth in background traffic. The traffic forecasts discussed in Section 3 for both the Project as well as the neighbouring coal projects were limited by the information available. As the traffic volume forecasts from other reviewed literature tended to focus on traffic impacts in the peak period as opposed to traffic volumes generated over the whole day, it is not possible to accurately forecast the growth in ESAs along these principal access routes.

Notwithstanding the above, there is confidence from the above analysis that each heavy vehicle is likely to generate 1.62 ESA of loading on the road pavement. It is important to acknowledge that some measures to reduce the ESAs generated by individual truck trips, such as using smaller vehicles, may generate higher volumes of those vehicles. As such, whilst the number of ESAs per heavy vehicle may drop, the total number of heavy vehicles may increase. This may have a neutral or negative cumulative impact. It may also result in poorer traffic performance.

4.3 Ongoing management of roads in the surrounding network

The surrounding road network has undergone a large number of improvements due to the individual coal mine operators. These include road network improvements and maintenance contributions developed as part of existing operations and projects development consent requirements (see **Table 12**). In particular, BMC has worked collaboratively with MSC and RMS in the management of roads in this network including:

- The construction of the Bengalla Link Road Stage 2 Extension from Bengalla Mine Access Road to Wybong Road, which is consistent with the *Western Road Strategy* objectives.
- The proposed construction of the Bengalla Link Road realignment as part of this Project.
- Maintenance contributions to Bengalla Link Road.

These are substantial improvements to the safety and operation of the main road network. Furthermore, the extension of Bengalla Link Road has allowed heavy vehicles to be re-distributed to this route rather than Wybong Road.

Similarly, other road upgrades have been carried out with input from neighbouring mining companies. These include the upgrade of Wybong Road between Mangoola Coal Mine and Bengalla Link Road Stage 2 Extension; upgrades to the Wybong Road intersections with Bengalla Link Road and Golden Highway; upgrades to the Bengalla Link Road/Denman Road intersection; completed and proposed upgrades to the Thomas Mitchell Drive intersections at New England Highway and Denman Road respectively; maintenance contributions to Wybong Road and Thomas Mitchell Drive; and proposed realignments (and hence upgrades) to Edderton Road.

BMC remain committed to liaising with MSC and RMS and other coal mine operators regarding the ongoing management of the surrounding road network.

Table 12 Existing Mining Operations and Projects Road Management Commitments

Mine/Project	Source	Commitment
Bengalla Mine	DA 211/93	- Be responsible for the costs of maintenance of the Bengalla Link Road from Denman Road to the Western Limit of the 1 in 100 year flood level for the life of the mine or as otherwise agreed with MSC; - Maintain signs giving at least 24 hours notice of road closure on Wybong Road and Bengalla Link Road; - Provision of \$125,000 (indexed annually) to be used for the maintenance of roads in the Muswellbrook Shire.
Mt Arthur Coal Mine	09_0062	- Mt Arthur Coal will provide a capital contribution of \$3M towards the cost of the upgrade of Thomas Mitchell Drive and a further \$4.06 M capital. - Mt Arthur will provide MSC with \$120,000 (indexed annually) per annum for the purpose of a sinking fund connected with the ongoing maintenance of Thomas Mitchell Drive and restricted for that purpose.
Drayton South Coal Project	Drayton South Coal Project Response to Submissions (Hansen Bailey, May 2013)	- A payment of \$1 M as a direct contribution towards the cost of the Thomas Mitchell Drive upgrade. - An annual contribution of \$100,000 to MSC to assist in funding road maintenance in the Muswellbrook LGA.
Mangoola Mine	PA 06_0014	\$11.5 M in total road and intersection upgrades; and \$220,000 275,000 per year during operations for maintenance of MSC's local roads network.
Mount Pleasant Project	DA 92/97	Costs associated with the maintenance of roads, as reasonably apportioned to the use of the road by Mount Pleasant, up to a maximum annual payment of \$220,000 (indexed annually). This contribution will be made for recurrent road maintenance to be used at MSC's discretion for the purpose.

5 Road safety impacts

5.1 Crash data analysis

Transport for NSW maintain a database of road crash records for NSW which is known as CRASHLINK. Reported road crashes² are only captured in CRASHLINK if they:

- Result in a person being killed as a result of the crash; or
- Result in a person being injured as a result of the crash; or.
- Result in one or more vehicles being towed away.

A crash is coded as a fatal event if one or more persons involved died within 30 days of the event and the cause of death was related to the crash event. Deaths due to unrelated medical conditions or episodes are not coded as fatal crashes irrespective of whether the medical condition/episode was experienced at the time of the crash. A crash is coded as an injury event if one or more persons were hospitalised as a result of the crash, or if one or more persons was treated for injuries on site.

A query of the CRASHLINK database was carried out for the following roads:

- Bengalla Link Road between Wybong Road and Denman Road.
- Wybong Road between Golden Highway and Kayuga Road.
- Edderton Road between Denman Road and Golden Highway.
- Thomas Mitchell Drive between Denman Road and New England Highway.
- Skellatar Stock Route-Rutherford Road between Denman Road and New England Highway.
- Denman Road between Golden Highway and New England Highway.
- New England Highway between Aberdeen Street, Muswellbrook and the Golden Highway, Whittingham.
- The Golden Highway between the New England Highway, Whittingham and Wybong Road, Sandy Hollow.

The period of the crash dataset that was queried was the five-year period between 1 July 2006 and 30 June 2011. At the time of writing, this was the latest five year period for which there was fully validated, non-provisional crash data.

An analysis of the crash data was carried out in order to identify the road safety risks and hence the likely impacts on and due to Project-related traffic. Bengalla Link Road, Wybong Road, Edderton Road, Thomas Mitchell Drive, Skellatar Stock Route, and

² Road crashes that occur on public roads must be reported to the NSW Police if a person is killed or injured as a result of the crash, or if there is property damage in excess of \$500. Road crash events must also be reported to the Police if one of the drivers/ persons involved in the crash failed to exchange particulars, or if one or more persons involved in the crash was under the influence of drugs or alcohol. Crashes that do not meet this reporting criteria may still be voluntarily reported to the Police. CRASHLINK only captures records of crash events which result in persons being killed or injured, or where vehicles are towed away. Self-reported crashes are not captured in CRASHLINK.

Denman Road were regarded as the routes which could potentially be directly affected by Project-related traffic (or alternatively whose safety risks could directly affect Project-related traffic).

As such, a more detailed crash data analysis was carried out for these routes to identify crash trends as well as high risk locations. Whilst the New England Highway and the Golden Highway would also be used by Project-generated traffic, these would have a less direct, and by contrast to the previous routes, a more “global” influence on Project traffic. As such, a broad level analysis was carried out for these two roads.

Sections 5.1.1 to 5.1.8 provide a summary of the crash data analysis results.

5.1.1 Bengalla Link Road

In the five-year period between 1 July 2006 and 30 June 2011, there were no crashes reported for Bengalla Link Road between Wybong Road and Denman Road. However, it should be noted that the Bengalla Link Road “Stage 2 Extension” from Bengalla Mine to Wybong Road was completed in 2008 to fulfil obligations under the Muswellbrook Western Roads Strategy (1997) in providing a principal access route to Bengalla Mine, Mangoola Coal Mine and the future Mount Pleasant Project. As such, the road only operated as a through link from Wybong Road to Denman Road for the last three years of this five-year dataset period. This needs to be acknowledged, as the future road safety performance of the route with regard to crash frequency is likely to change simply because the function of the road has changed dramatically (from a *no through road* to a major high-speed through route) and as traffic volumes continue to increase.

As noted in Section 2.1.2, Bengalla Link Road provides a reasonable geometric standard. The Project will require a diversion of 6 km of this route in order to accommodate the Project as the mining activity progresses to the west. This proposed diversion will be designed to a similar (if not better) geometric standard. The horizontal and vertical alignment will be commensurate with a 100 km/h design speed, and the travel lanes will be 3.5 m wide with 1.0 m sealed shoulders. The proposed diversion will be required prior to Year 24 of the Project.

The intersection of the diversion with the alignment of Bengalla Link Road at the southern end will become the intersection providing access to the Project Boundary. This intersection will be of a similar capacity, configuration and safety standard as the existing intersection of Bengalla Link Road and Bengalla Mine Access Road. That is, it will have a channelized right-turn (CHR) configuration with a westbound right-turn lane of 160m or greater.

The diverted route will cross the existing alignment of Roxburgh Road and as such would require a new intersection with Roxburgh Road. This intersection will have a similar capacity, configuration and safety standard as the existing Bengalla Link Road/Roxburgh Road intersection. This will be a CHR intersection with a southbound 160m right-turn lane on the diverted route. This will allow decelerating and stationary right-turn vehicles to stand clear of the faster moving through traffic.

The diverted route will be designed and constructed in accordance with the Austroads Road Design Guide. The road would be subjected to road safety audits at the design and pre-opening stages to ensure that safety concerns are identified and closed out.

5.1.2 Wybong Road

In the five-year period between 1 July 2007 and 30 June 2011, there were a total of 20 crashes reported for the section of Wybong Road between Golden Highway, Sandy Hollow and Kayuga Road, Muswellbrook. This equates to an average crash rate of 32 crashes per 100 million-vehicle-kilometres-travelled (MVKT)³. This is less than the State-wide average of 32.8 crashes/100MVKT for rural two-lane-two-way (2L2W) roads (RTA, 2004b).

A crash trends analysis was carried out for the 20 crashes reported during this dataset period. This included a collision diagram as shown in Figure 29 which was used to identify common crash causation factors, and common crash clusters (if any). The trends analysis revealed the following:

- 1 (5%) of the crashes resulted in a fatality, 10 (50%) of the crashes resulted in injuries and 9 (45%) of the crashes resulted in a towaway.
- 17 (85%) of crashes were coded as single vehicle crashes. Furthermore, 15 (75%) of these were single vehicle loss-of-control events. 14 (70%) of these resulted in the vehicle leaving the roadway. 12 (60%) of these resulted in the vehicle striking a roadside object.
- 6 (30%) of the 20 crashes occurred on the section of Wybong Road to the east of Bengalla Link Road. Five of these crashes occurred in 2007 or 2008 which was before the opening of the Bengalla Link Road Stage 2 Extension. The opening of this Extension resulted in a significant re-distribution of Wybong Road East's traffic to Bengalla Link Road. As Bengalla Link Road offers a significantly better alignment and safety standard compared with this section of Wybong Road, the re-distribution of traffic as described above, would be expected to result in a significant net reduction in safety risk – as a greater proportion of traffic (in a regional context) would be re-distributed from a lower standard route (Wybong Road East) to the higher standard route (Bengalla Link Road). As such, the recent improvements to the road network and principal access routes would address the crash history associated with the eastern section of Wybong Road. This section is not likely to be used by Project-related traffic, as it would be quicker to access Muswellbrook via Bengalla Link Road and Denman Road. The signage along this route was upgraded as part of the Mangoola Coal Mine Early Works.
- 10 (50%) of the 20 crashes occurred on the section of Wybong Road to the west of Northern Access Road (Mangoola Coal Mine). This section of Wybong Road is not likely to be used by Bengalla Mine, as it would be quicker to access Sandy Hollow via Bengalla Link Road and Denman Road, which have a better alignment and safety standard compared with this section of Wybong Road. The signage along this route was also upgraded as part of Mangoola Coal Mine Early Works.

³ This crash rate is based on an adopted AADT of 1,000 vehicles/day for Wybong Road, and a 34km route length between the Golden Highway, Sandy Hollow and Kayuga Road, Muswellbrook.

- 3 (15%) crashes occurred in the section of Wybong Road from Northern Access Road to Bengalla Link Road. This section was upgraded as part of the Mangoola Coal Mine. The upgrade resulted in the provision of an 8.5m sealed roadway consisting of two 3.25m lanes, two 1.0m shoulders, improved clear zone quality, upgrades to the approach barriers at Sandy and Spring Creeks, and signage and linemarking improvements.
- Further to the above, the relative priority of the Wybong Road/ Bengalla Link Road was adjusted so that the Wybong Road West and the Bengalla Link Road approaches form the through (major) route. Wybong Road East is the northern and terminating approach to the intersection. This was in order to meet the objectives of the Muswellbrook Council Mine Western Roads Strategy with regard to Bengalla Link Road being designated as the principal access route to Bengalla Mine, Mangoola Coal Mine and the future Mount Pleasant Project.
- The Bengalla Link Road/ Wybong Road intersection has a channelized right-turn configuration where the decelerating or stationary right-turning traffic are fully protected within the indented right-turn lane. This intersection provides a sufficient standard of safety and access for traffic related to the future Mount Pleasant Project.

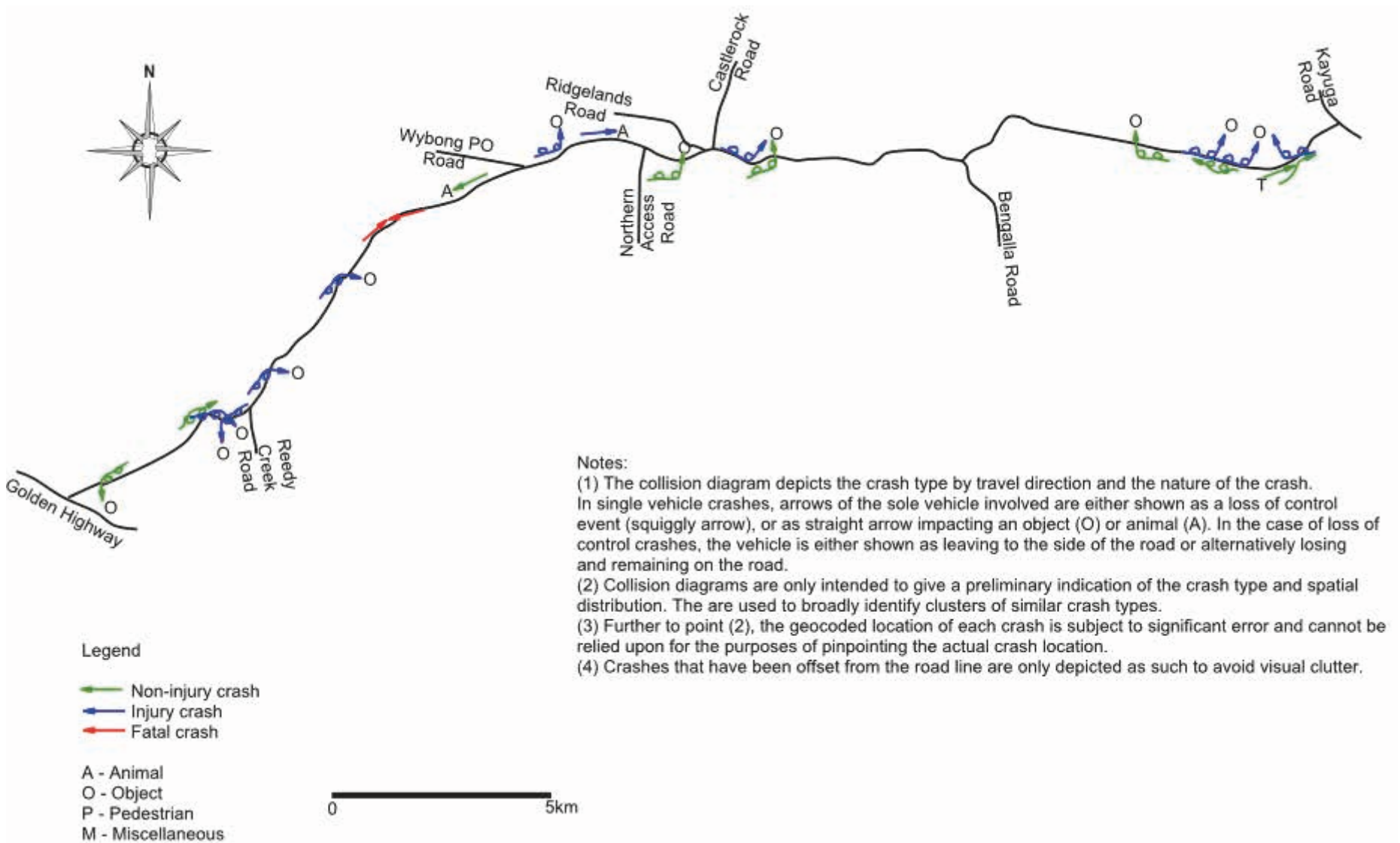


Figure 29 Collision diagram for Wybong Road for five-year period between 1 July 2006 and 30 June 2011.

5.1.3 Edderton Road

In the five-year period between 1 July 2006 and 30 June 2011, there were a total of 12 crashes along the length of Edderton Road between Denman Road and Golden Highway. This equates to an approximate crash rate of 62.6 crashes per 100MVKT⁴. This is higher than the State-wide average of 32.8 crashes/100MVKT for rural two-lane-two-way (2L2W) roads (RTA, 2004b).

A crash trends analysis was carried out for the 12 crashes reported during this dataset period. This included a collision diagram as shown in Figure 30 which was used to identify common crash types, and common crash clusters (if any). The trends analysis revealed the following:

- 9 (75%) of the 12 crashes resulted in an injury, and 3 (25%) resulted in vehicles being towed away. None of the 12 crashes resulted in a fatality.
- 9 (75%) of the 12 crashes were coded as single vehicle crashes. 7 (58%) of these were loss-of-control crashes. 6 (50%) of these resulted in the vehicle leaving the road and striking a road side object.
- 8 (67%) of the crashes involved a light truck. It should be noted that there are signs provided at each end of the road to prohibit the use of the road by trucks greater than 14 tonnes gross vehicle mass (GVM).
- 4 (33%) of the crashes occurred on the section of Edderton Road between 0-7 km north of Golden Highway. This section will be realigned as part of the Drayton South Coal Project. The new road will meet Golden Highway approximately 5 km west of the current Golden Highway/ Edderton Road intersection. The realigned section will have 3 m wide lanes, 1.3 m wide shoulders, and 1 m and 2 m wide verges in fill embankment and cut sections respectively. Multiple culvert-under-causeway-type structures will be provided at low points along the road, as required, to satisfy surface hydrology requirements and to provide an improved vertical alignment of the road. As such, to a large extent this proposed realignment will address the 33% of crashes recorded for this section.
- Similarly, a section of Edderton Road further north is proposed to be realigned as part of the Mt Arthur Coal Mine. This realignment will also offer improved alignment and safety performance. Effectively, the two realignments will result in more than 80% of the existing route being replaced by a new road.

⁴ This crash rate is based on an adopted AADT of 700 vehicles/day for Edderton Road, and a 15 km route length between Denman Road and the Golden Highway.

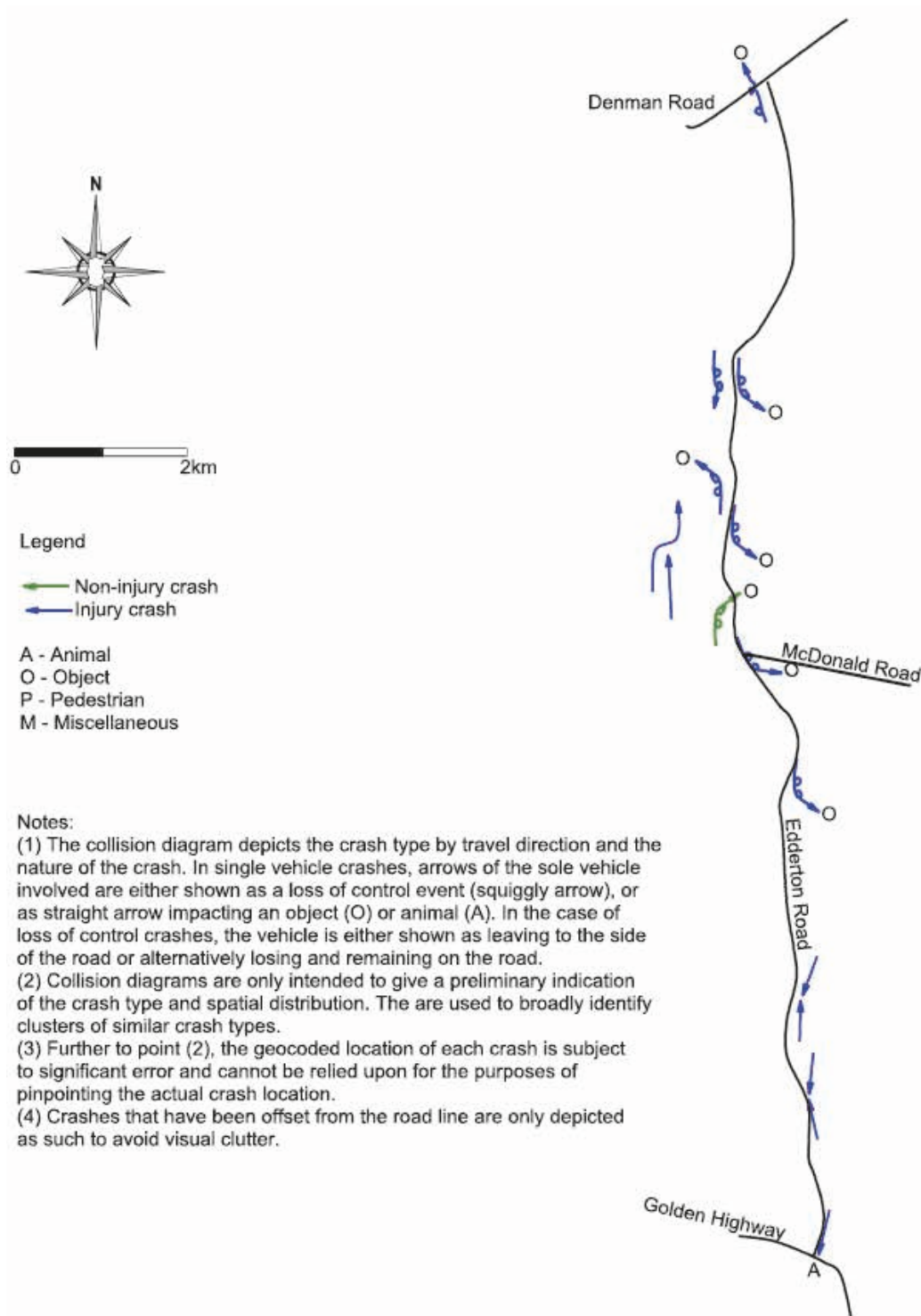


Figure 30 Collision diagram for Edderton Road for five-year period between 1 July 2006 and 30 June 2011.

5.1.4 Thomas Mitchell Drive

In the five-year period between 1 July 2006 and 30 June 2011, there were a total of 32 crashes along the length of Thomas Mitchell Drive between Denman Road and the New England Highway. This equates to an approximate crash rate of 40.0 crashes per 100MVKT⁵. This is higher than the State-wide average of 32.8 crashes/100MVKT for rural two-lane-two-way (2L2W) roads (RTA, 2004b).

A crash trends analysis was carried out for the 32 crashes reported during this dataset period. This included a collision diagram as shown in Figure 31 which was used to identify common crash types, and common crash clusters (if any). The trends analysis revealed the following:

- 16 (50%) of the crashes resulted in injuries, and 16 (50%) resulted in vehicles being towed away. None of the 32 crashes resulted in a fatality.
- 16 (50%) of the 32 crashes occurred when the road surface was wet.
- 17 (53%) of the 32 crashes were single vehicle crashes. 16 (50%) of these were loss-of-control crashes resulting in the vehicle leaving the road. 10 (31%) of these resulted in the vehicle striking a road side object.
- 16 (50%) of the crashes resulted in injuries.
- 5 crashes (16%) occurred at the New England Highway/ Thomas Mitchell Drive intersection. 4 (12.5%) of these involved a right-turning vehicle from Thomas Mitchell Drive being impacted by a northbound through vehicle on New England Highway. HVEC is committed to upgrading this intersection to a seagull configuration as part of the Mt. Arthur Coal Mine. These intersection upgrades will include (i) an indented and fully protected right-turn lane from New England Highway to Thomas Mitchell Drive, (ii) a protected acceleration lane for the right-turn from Thomas Mitchell Drive to New England Highway, and (iii) a left-turn lane from New England Highway to Thomas Mitchell Drive. These proposed upgrades would significantly reduce the risk of these crash types.
- 1 (3%) of the crashes occurred at the Denman Road/ Thomas Mitchell Drive intersection and involved a right-turning vehicle from Denman Road West being impacted by a westbound through vehicle on Denman Road East. This intersection will also be upgraded by BHP Billiton as part of the Mt. Arthur Coal Mine. The proposed seagull configuration will have an indented exclusive right-turn lane for eastbound vehicles on Denman Road and a protected acceleration lane for right-turning traffic from Thomas Mitchell Drive. The proposed upgrade will significantly reduce the risk of this crash type.
- 11 (34%) of the crashes involved a single vehicle losing control on the curvilinear section of Thomas Mitchell Drive from 0-500m west of New England Highway. This section already contains a number of safeguards against loss-of-control crashes including REDUCE SPEED and T INTERSECTION AHEAD warning signs.

⁵ This crash rate is based on an adopted AADT of 4,000 vehicles/day for Thomas Mitchell Drive, and a 11 km route length between Denman Road and the New England Highway.

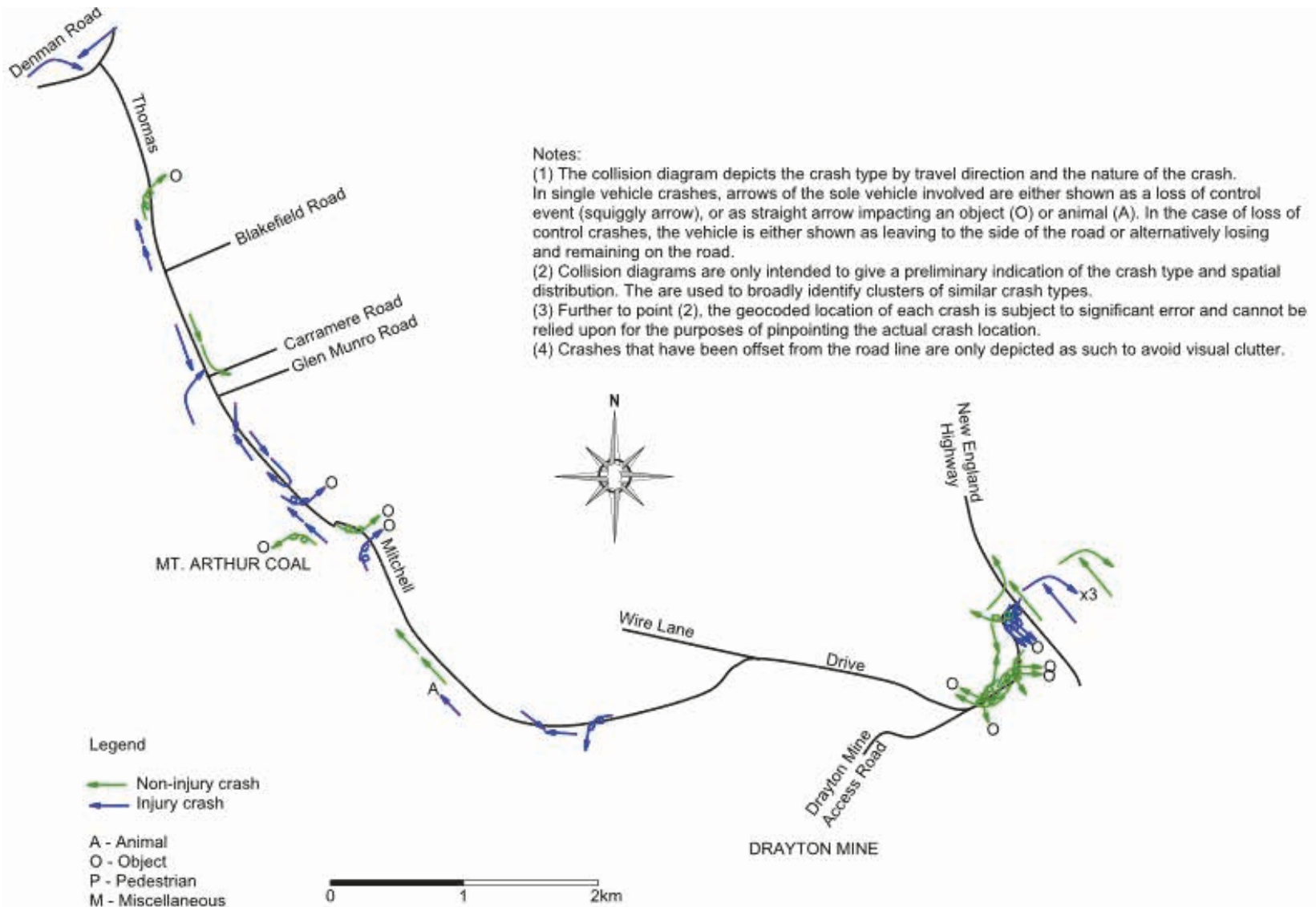


Figure 31 Collision diagram for Thomas Mitchell Drive for five-year period between 1 July 2006 and 30 June 2011.

5.1.5 Skellatar Stock Route

In the five-year period between 1 July 2006 and 30 June 2011, there were a total of 16 crashes along the length of Skellatar Stock Route-Ironbark Road-Rutherford Road between Denman Road and the New England Highway.

A crash trends analysis was carried out for the 16 crashes reported during this dataset period. This included a collision diagram as shown in Figure 32 which was used to identify common crash types, and common crash clusters (if any). The trends analysis revealed the following:

- 10 (62%) of the crashes resulted in injuries and 6 (38%) resulted in vehicles being towed away. None of the 16 crashes resulted in fatalities.
- 13 (81%) of the 16 crashes occurred at or within 10m approach of an intersection.
- 12 (75%) of the crashes were multiple vehicle crashes involving two or more vehicles. Rear-end crashes were the most common types making up 6 (38%) of all crashes.
- 4 (25%) of the crashes occurred in the hour between 1700-1800h. 3 (19%) of these occurred on a weekday.

It is not expected that this route would be frequently used by Project-related traffic unless there was a local destination along this route. Any traffic intending to head south on the New England Highway would most likely use Thomas Mitchell Drive as this has significantly reduced travel time.

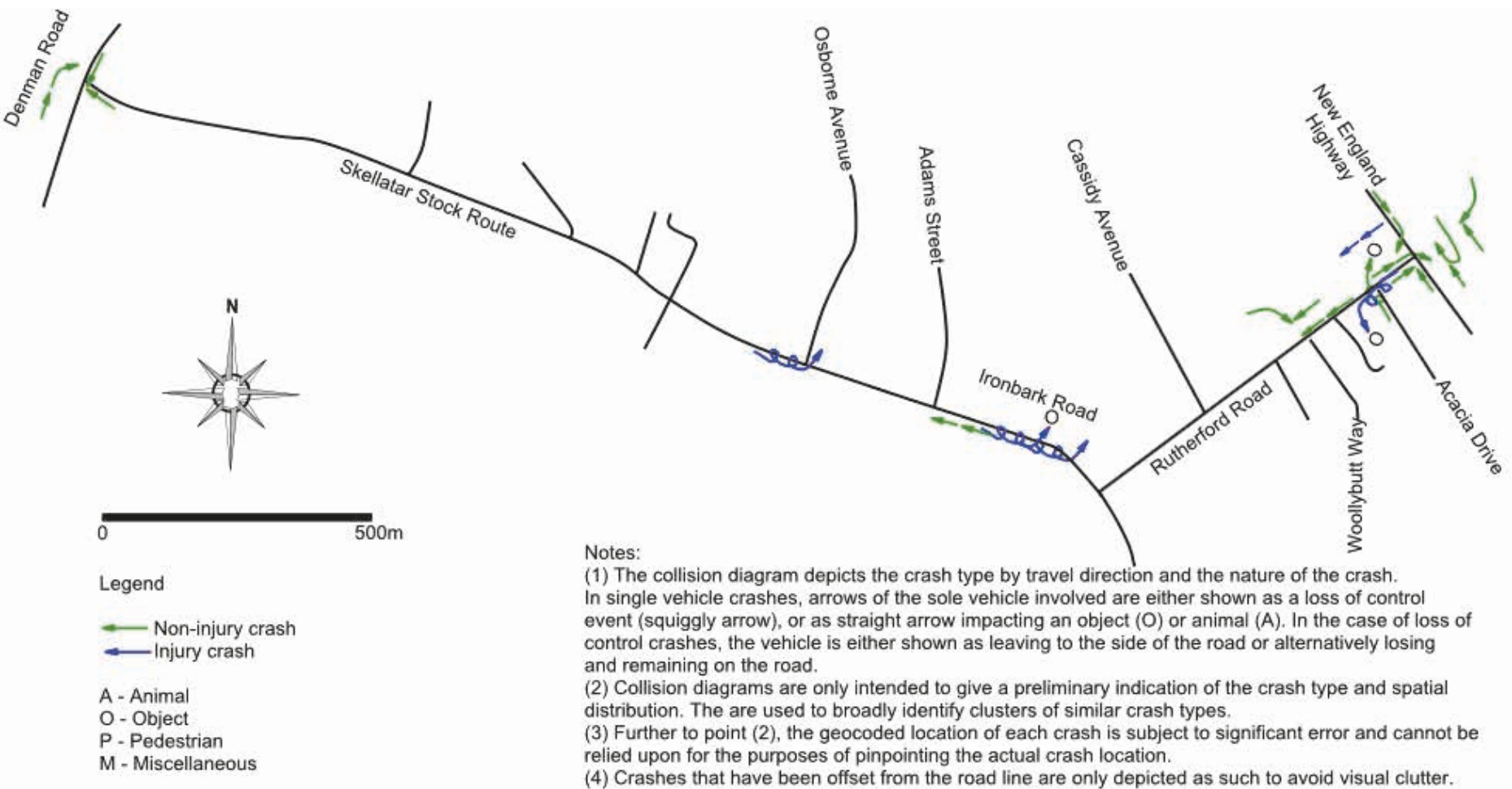


Figure 32 Collision diagram for Skellatar Stock Route-Ironbark Road-Rutherford Road for five-year period between 1 July 2006 and 30 June 2011.

5.1.6 Denman Road

In the five-year period between 1 July 2006 and 30 June 2011, there were a total of 49 crashes along the length of Denman Road between the New England Highway and the Golden Highway. This equates to an approximate crash rate of 21.9 crashes per 100MVKT⁶. This is lower than the State-wide average of 32.8 crashes/100MVKT for rural two-lane-two-way (2L2W) roads (RTA, 2004b).

A crash trends analysis was carried out for the 49 crashes reported during this dataset period. This included a collision diagram as shown in Figure 33 which was used to identify common crash types, and common crash clusters (if any). The trends analysis revealed the following:

- 27 (55%) of the crashes resulted in injuries, and 22 (45%) resulted in vehicles being towed away. None of the 49 crashes resulted in a road fatality.
- 22 (45%) of the 49 crashes were single vehicle crashes. The collision diagram in Figure 33 indicates that 14 (29%) of these occurred in the section of Denman Road to the west of Bengalla Link Road. This section is signposted as a 100km/h speed zone and also has relatively lower traffic volumes. Furthermore, this section also has a lower frequency of driveways and side roads, and hence less vehicle-to-vehicle crash conflicts.
- 27 (55%) of the 49 crashes were multiple vehicle crashes involving two or more vehicles. The collision diagram indicates that 17 (35%) of these occurred to the east of Bengalla Link Road. This section is signposted with 60km/h and 80km/h speed zone and experiences more interrupted traffic flow conditions due to the higher traffic volumes, and higher frequency of driveways and side roads. 16 (33%) of these crashes were coded as *intersection crashes*.

⁶ This crash rate is based on an adopted AADT of 5,800 vehicles/day for Denman Road, and a 21 km route length between the New England Highway and the Golden Highway.

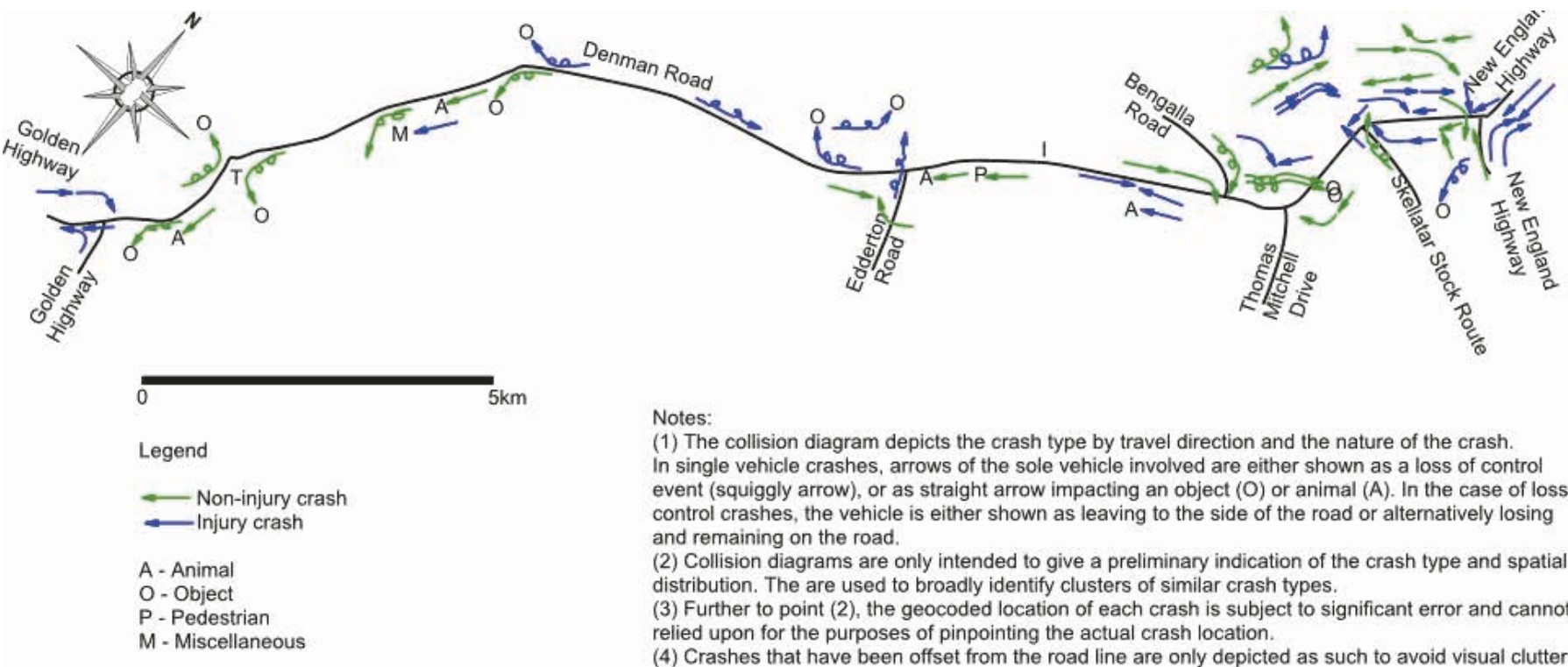


Figure 33 Collision diagram for Denman Road for five-year period between 1 July 2006 and 30 June 2011.

5.1.7 New England Highway

In the five-year period between 1 July 2006 and 30 June 2011, there were a total of 317 crashes along the length of the New England Highway between Aberdeen Street Muswellbrook and the Golden Highway, Whittingham. This equates to an approximate crash rate of 19.1 crashes per 100MVKT⁷. This is lower than the State-wide average of 32.8 crashes/100MVKT for rural two-lane-two-way (2L2W) roads (RTA, 2004b).

A crash trends analysis was carried out for the 317 crashes reported during this dataset period. This revealed the following:

- Of the 317 crashes, 9 (2.8%) were fatal crashes, 138 (44%) were injury crashes, and 170 (54%) were towaway crashes.
- 235 (74%) of the crashes were multiple vehicle crashes involving two or more vehicles. This was significantly higher than that experienced on Wybong Road, Edderton Road, Thomas Mitchell Drive and Denman Road. This indicates that the larger traffic volumes, and hence larger volumes of *conflicting* traffic streams is a major factor in the types of crashes experienced along this route.
- The most common crash type were rear-end crashes with a total of 96 (30%) of the 317 crashes.

5.1.8 Golden Highway

In the five-year period between 1 July 2006 and 30 June 2011, there were a total of 142 crashes along the length of the Golden Highway between the New England Highway, Whittingham and Wybong Road, Sandy Hollow. This equates to an approximate crash rate of 37 crashes per 100MVKT⁸. This is higher than the State-wide average of 32.8 crashes/100MVKT for rural two-lane-two-way (2L2W) roads (RTA, 2004b).

A crash trends analysis was carried out for the 142 crashes reported during this dataset period. This revealed the following:

- 5 (3.5%) of the crashes resulted in a fatality, 68 (48%) of them resulted in injuries, and 69 (49%) of them resulted in vehicles being towed away.
- 73 (51%) of the crashes were single vehicle crashes. 59 (42%) of these involved vehicles leaving the roadway. 49 (35%) of these involved the vehicle striking a roadside object.

⁷ This crash rate is based on an adopted AADT of 2,600 vehicles/day for the New England Highway, and a 81 km route length between Aberdeen Street, Muswellbrook and the Golden Highway, Whittingham.

⁸ This crash rate is based on an adopted AADT of 2,600 vehicles/day for the Golden Highway, and a 11 km route length between Denman Road and the New England Highway.

5.2 Proposed diversion of Bengalla Link Road

5.2.1 Travel time impacts of the diversion

As discussed in Sections 2.1.2 and 5.1.1, the Project will involve a diversion of Bengalla Link Road to allow for mining activities to progress to the west. The proposed diversion will be required towards Year 24 of the Project.

At its southern end, the Bengalla Link Road diversion will commence approximately 1 km south of the Bengalla Mine Access Road. At this location, the existing Bengalla Link Road curves from an east-west alignment to a north-south alignment via an approximate 350 m radius curve. Instead of curving to the north, the diversion will continue westward for 1.5 km before curving to the north-west towards Roxburgh Road. The diversion will pass across a saddle between two peaks and then run parallel with Roxburgh Road for 1.5 km. The diversion will enter the road corridor of the existing Bengalla Link Road approximately 200 m south of the Wybong Road intersection. The northern tie-in with Wybong Road will be located approximately 520 m west of the Bengalla Link Road/ Wybong Road intersection.

The total road length of the proposed diversion will be 5.6 km compared with the 4.7 km section of the existing Bengalla Link Road which it will bypass. This equates to an additional road length of 900 m for through traffic travelling between Wybong and the Denman Road/ Bengalla Link Road intersection.

For an adopted average travel speed of 90 km/h, this will equate to 36 seconds of additional travel time per vehicle. This is not considered to be significant from a regional travel time and access perspective.

5.2.2 Road safety impacts of the diversion

As stated in Section 5.1.1, the intersection of the diversion with the alignment of Bengalla Link Road at the southern end will become the intersection providing access to the Project. This intersection will be of a similar capacity, configuration and safety standard as the existing Bengalla Link Road/ Bengalla Mine Access Road intersection. This includes a channelized right-turn configuration with a westbound right-turn lane of 160m or greater.

Roxburgh Road will run parallel with the diverted section of Bengalla Link Road. A short section of Roxburgh Road at its northern end will also need to be realigned to ensure a perpendicular angle of intersection with the new alignment of Bengalla Link Road. The new Bengalla Link Road/ Roxburgh Road intersection will also provide similar safety features to the existing intersection as shown in Figure 34. This includes a channelized right-turn facility with an indented right-turn lane of similar length to the existing intersection. The "like for like" replacement in this regard is justifiable since the Project would not be generating any additional traffic volumes to or from Roxburgh Road



Figure 34 Bengalla Link Road at its existing intersection with Roxburgh Road facing south

5.3 Emergency access

The most critical emergency services that would need to access the Project and surrounding areas are the NSW Fire Brigade and ambulance services. Also of importance to the Project is the need to manage traffic movements during unplanned incidents such as fires and floods. These issues are discussed in more detail in Sections 5.3.1 and 5.3.2. It should be emphasised that the discussion in these sections is only with regard to the impact of the Project on emergency access.

5.3.1 Fire Brigade and Ambulance access

As discussed in Section 2.1.2, Bengalla Link Road is a high-standard route which acts as the principal access route between Wybong and Muswellbrook. It generally consists of a high-speed alignment with a sealed width of 9m or more and good, traversable clear zones for access to all areas of the road reserve.

As discussed in Section 5.2.1, the proposed diversion of Bengalla Link Road will only result in an additional 900m of road length which equates to 36 seconds of additional travel time for through traffic. This is not considered significant from a regional travel time and access perspective and should not adversely affect accessibility requirements for emergency services.

Fire Brigade access to the Project would be provided via the main entry from Bengalla Link Road (including its proposed diversion) and Bengalla Mine Access Road.

In these respects, the Project should not have any significant adverse impacts on accessibility for fire management or ambulatory services.

5.3.2 Flood and fire evacuation

The Project will not impact the ability of the road network to cater for flood and fire evacuation requirements. Wybong Road, Denman Road and Thomas Mitchell Drive will remain unaltered by the Project.

The proposed Bengalla Link Road diversion will provide a similar standard of safety and efficiency as the existing alignment. This includes a design speed of 100 km/h for most of its length and 80 km/h for the northern tie-in. A total sealed carriageway width of 11 m would be provided including 2m sealed shoulders. The new route should not have any significant adverse impacts on flood and fire evacuation requirements of the Project and the surrounding area.

5.4 Over-dimensioned loads

All over-dimensioned loads will need to be approved by RMS if the trucks are required to use any State Roads. Similar approvals are needed from the respective local government where local roads will be used. Typically, a traffic management plan (TMP) is required to support the application and would provide more specific detail of each case. The TMP would describe the nature and dimension of the load, as well as its origin and destination. It will need to detail the proposed traffic management arrangements which will need to be in accordance with RMS's *Traffic Control at Worksites Manual*.

The TMP would also identify any vulnerable features of the proposed haul route such as width restrictions and narrow points, load limited bridges and structures, bridges and overhead structures with insufficient headroom clearance, and intersections with tight geometry for large turning vehicles.

A preliminary analysis of the surrounding road network has identified a number of potential constraints including:

- The two rail-over-road bridges on Thomas Mitchell Drive, which have vertical clearances of 5.5m.
- The rail-over-road bridge on the New England Highway (Bridge Street) at Muswellbrook.
- The bridges over the Hunter River and Sandy Creek Bridges on the Golden Highway at Denman.
- The narrow one-lane bridge on Kayuga Road over the Hunter River. However, this is not a principal access route to the Project.

Despite these constraints, there are a sufficient number of alternative routes available with all over-dimensioned loads to access Bengalla Link Road and the Project.

5.5 Ongoing management of roads in the surrounding network

As stated in Section 4.3, BMC remain committed to liaising with MSC and RMS and other coal mine operators regarding the ongoing management of the surrounding road network.

6 Rail network impacts

6.1 Rail traffic generation by the Project

In 2011, Bengalla produced 7Mt of ROM coal (existing case), although it has approval to extract up to 10.7Mtpa. The ROM production in 2011 yielded approximately 5.4Mt of product coal. Under the Project-scenario at full-production, the Project will extract 15Mtpa of ROM coal. This is predicted to yield approximately 12.3Mtpa of product coal.

As stated in Section 2.4.2, the average coal payload per loaded train from the Bengalla loop is approximately 7,700 tonnes. (ARTC, 2011). Based on this payload, the existing, and Project conditions would generate 1090 and 1540 loaded train movements per year respectively. Table 12 provides more detail in this regard.

Table 13 Forecast train movements due to the Project

	Existing case	Base case	Project case
Product coal yield	5.4 Mtpa (from 7.0Mtpa ROM)	8.4Mtpa (from 10.7Mtpa ROM)	12.3Mtpa (from 15.0 Mtpa ROM)
Average train payload	7700 t/ train	7700 t/ train	7700 t/ train
Number of loaded trains per year	700	1,090	1,597
Number of loaded trains per day*	2.3	3.5	5.1
Number of train movements per day (including empty inbound)	4.6	7.0	10.2
Number of train movements per hour**	0.19	0.29	0.42

* Assuming 310 haulage days per year.

** Assuming 24h rail load out operations.

Based on Table 12, the Project is likely to generate an additional 3 train movements per day compared with the base case.

6.2 Rail traffic generation from other mine projects

6.2.1 Drayton South

Drayton South is a continuation project from the existing Drayton Coal Project. As such, it is not expected to generate any more train movements compared with the existing situation.

6.2.2 Mount Arthur Coal

Hansen Bailey (2009) reported that the MAC consolidation project would result in an increase in rail haulage from 19Mtpa to 27Mtpa. Although the existing approval to generate up to 24 train movements (i.e. two-way movements) per day would not change, the number of days per year that would generate 24 train movements/day would

increase. Consequently, this assessment has assumed there will be no increase to the maximum daily number of trains generated from MAC.

6.2.3 Mount Pleasant Project

EMGA Mitchell McLennan (2010a) reported that the Mount Pleasant Project would produce 10.5 Mtpa of ROM coal. Product coal would be transported by rail to the Port of Newcastle using 9000 tonne trains. The product coal would be loaded to rail wagons either via a new railway loop from the Muswellbrook to Newcastle Railway Line (to the west of the Bengalla Mine loop), or alternatively, it would be conveyed to the existing railway loop at Bengalla Mine. A total of three loaded train movements would be generated per day, or six movements when accounting for the empty inbound movements.

BMC will continue to liaise and collaborate with Mount Pleasant Coal Project with regard to the rail infrastructure needs and traffic generation for both projects.

6.2.4 Mangoola Coal Mine

Xstrata Mangoola currently has approval under PA 06_0014 and other approved Modifications (up to Modification 4) to produce up to 10.5Mtpa of ROM coal. There are no known plans to expand the coal production operations at this mine. As such, this cumulative rail impact assessment has not accounted for any additional rail movements above the existing volumes.

6.3 Summary of forecast rail movements

The cumulative impact of the Project with other known mine developments including Mount Arthur Coal, Mount Pleasant, and Mangoola Coal Mine would result in an additional 9 train movements per day along the Main Northern Railway Line. These are summarised in Table 13. As this is less than one train movement per hour, the rail network should be able to absorb these additional movements without adverse impact to overall network operations.

Table 14 Summary of cumulative train traffic generation – Year 15 (above existing conditions)

Project	Additional one-way train movements/ day	Additional train movements/ day
Mangoola Coal Mine	0 (same as existing)	0 (same as existing)
Drayton South	0 (same as existing)	0 (same as existing)
Mount Arthur Coal	0	0
Bengalla Mine (Project)	1.5	3
Mount Pleasant Coal Project	3	6
Total additional trains	4.5	9

6.4 ARTC committed rail network improvements

The ARTC's (2012) *2012-2021 Hunter Valley Corridor Capacity Strategy Consultation Document* and the previous 2011 version (ARTC, 2011) provides a broad snapshot of the existing conditions on the Hunter Valley coal rail network. This document is regularly updated with coal production (and hence transportation) forecasts from the Hunter Valley, Gunnedah Basin and Ulan corridor which are determined through consultation with the coal mining industry.

ARTC (2012) also describe a number of rail network deficiencies as well as proposed network upgrades. The proposed upgrades were made as a strategic response to the forecast increase in coal production in the Hunter Valley. To a large extent, these forecasts accounted for foreseeable increases in coal production, including those at the four coal projects described in Section 6.3.

ARTC (2011) has identified the following rail network deficiencies which are relevant to coal transportation from the Project to the port. The improvements as recommended by ARTC have also been described below.

- The Muswellbrook-Bengalla section is only 5.5 km long and would most logically be enhanced by double tracking rather than by splitting the section with a loop. ARTC (2011) also note that this section is located in the floodplain of the Hunter River.
- The Allandale Bank (near Greta), the Minimbah and Numbah Banks (north of Singleton) which have minimum headways of up to 14-16 minutes between loaded coal trains. ARTC (2009) recommended that a third railroad be constructed on the Numbah Bank. It also recommended a third railroad for the section of the network between Minimbah and Maitland, which would effectively address both the Minimbah and Allandale Banks.
- The Maitland Junction (junction of passenger line to Brisbane): The ARTC (2009) Strategy does not make any recommendations for improving this junction other than saying that this junction should be subject to further analysis.
- Key junctions with coal loading loops including the Whittingham (Mount Thorley and Bulga), Newdell (Ravensworth, Newdell and Liddell), and Drayton (Drayton and MAC). ARTC (2009) proposes that both the Newdell and Drayton junctions be upgraded with high-speed (60 km/h) swing-nose turn-outs. ARTC further report that the Whittingham Junction will be effectively treated as part of the Minimbah Bank third road project.

The network upgrade recommendations made by ARTC are not considered mitigation measures for this study. Rather, they are described in this report to highlight the need for ongoing liaison between Bengalla and ARTC regarding the scheduled roll out of rail network infrastructure improvements. This is essential to enable ARTC to continue to refine their coal production forecasts and network improvement strategy.

It should also be noted that all capacity upgrades to the main railway lines (ie. not privately-owned rail loops) are carried out by ARTC. These are largely financed through the revenue generated from contracted train paths. ARTC controls and closely monitors the performance of the network with respects to the demand for train paths, the allocation of train path availability, and the sale of train paths through contracts with rail traffic generators.

This further highlights the importance of ongoing liaison between BMC and ARTC. Through such consultation, the forecasted increase in coal tonnages from the Project would be accounted for via “prospective volumes”. These are then considered (by ARTC) in the timing and roll out of rail infrastructure improvements with the program for upgrades being consolidated as these prospective coal tonnage/ volumes become “contracted volumes”. In this manner, potential impacts to the rail line from a capacity and train path availability perspective are somewhat self-mitigated through the forecasting of prospective volumes, and the sale of train paths.

6.5 Railway crossings

As stated in Section 2.4.4, there are no railway level crossings in the area of influence of the Project (between the Project and Muswellbrook Junction). However, a preliminary review was carried out of three railway level crossings between Muswellbrook and Singleton even though these were outside the area of influence.

Section 2.4.4 describes the existing safeguards provided at the Hebden Road (southern occurrence), Glennies Creek Road and Dights Crossing Road railway crossings. These are regarded as sufficient with respect to additional rail movements generated by the Project.

7 Conclusions

This Traffic and Transport Impact Assessment has examined the potential impacts of the Project with respect to:

- Impacts on the likely traffic performance of the critical access intersections at Denman Road/ Bengalla Link Road, Denman Road/ Thomas Mitchell Drive, and New England Highway/ Thomas Mitchell Drive due to Project-related traffic.
- Cumulative impacts on the critical access intersections at Denman Road/ Bengalla Link Road, Denman Road/ Thomas Mitchell Drive, and New England Highway/ Thomas Mitchell Drive due to the other concurrent mine expansion projects.
- Midblock traffic performance along the access routes of Bengalla Link Road, Wybong Road and Thomas Mitchell Drive.
- Road safety issues on surrounding routes such as Bengalla Link Road, Wybong Road, Edderton Road, Thomas Mitchell Drive, Skellatar Stock Route, Denman Road, New England Highway and Golden Highway.
- The potential travel time impacts of the proposed Bengalla Link Road Diversion.
- Road safety issues associated with the proposed Bengalla Link Road Diversion.
- The potential impact of increased rail movements on the Ulan Railway Line and the Main Northern Railway.
- The potential traffic impacts due to increased closures of railway level crossings.

7.1 Traffic performance at critical intersections

SIDRA traffic models were developed for the following key intersections in order to assess the base case conditions:

- Denman Road/ Bengalla Link Road.
- Denman Road/ Thomas Mitchell Drive.
- New England Highway/ Thomas Mitchell Drive.

The base case conditions would consist of the existing traffic volumes plus additional traffic generated by the Project if it were producing the maximum allowed ROM coal yield of 10.7Mtpa. This analysis shows that the Denman Road intersections with Bengalla Link Road and Thomas Mitchell Drive would perform satisfactorily with LoS of B or better. The New England Highway/ Thomas Mitchell Drive intersection would continue to perform poorly with a LoS of F. This would be due to the difficulty for right-turning traffic from Thomas Mitchell Drive to find gaps in northbound and southbound traffic streams of the New England Highway. It should also be acknowledged that the SIDRA model of the existing conditions (where the prevailing production rate of the Project is 8Mtpa) also indicates that this intersection fails to perform satisfactorily.

The three study intersections were also used to assess the likely traffic impacts due to the peak construction and operational phases of the Project. This analysis showed that the Denman Road intersections with Bengalla Link Road and Thomas Mitchell Drive would perform satisfactorily with intersection LoS of C or better. The proposed seagull configuration of New England Highway/ Thomas Mitchell Drive intersection (due for completion in late 2012) would also perform satisfactorily with a LoS of B.

The three study intersections were also used to assess the cumulative traffic impacts due to the peak operational phase of the Project along with the foreseeable growth in mining activity in the surrounding region. This analysis showed that the intersection at Denman Road/ Thomas Mitchell Drive would fail to perform satisfactorily. However, a re-assessment using the proposed seagull upgrade (due for completion in 2019) demonstrated that this intersection would perform satisfactorily with a LoS of B or better. As the committed upgrade to the Denman Road/ Thomas Mitchell Drive intersection would successfully cater for the total peak period traffic loading under the cumulative impacts case, no further mitigation measures are proposed.

7.2 Midblock traffic performance

A midblock capacity assessment was carried out for the following roads as a preliminary indicator of overall road network impact:

- Bengalla Link Road, south of Bengalla Mine Access Road.
- Wybong Road, west of Bengalla Link Road.
- Thomas Mitchell Drive, west of New England Highway.

The analysis of the existing case scenario showed that each road has a midblock LoS of C or better which is considered to be reasonable performance. Under the cumulative case scenario, (i.e. under the conservative assumption that surrounding mines achieve and sustain peak production in Year 15 of the Project) these sections of road would perform with a midblock LoS of D or better during the weekday peak periods. As this is within the capacity limits of each road, this was also considered acceptable. As such, no mitigation measures were proposed.

7.3 Road safety issues

A road safety assessment was carried out for the following roads:

- Bengalla Link Road, between Wybong Road and Denman Road.
- Wybong Road, between Golden Highway and Kayuga Road.
- Edderton Road, between Denman Road and Golden Highway.
- Thomas Mitchell Drive, between Denman Road and New England Highway
- Skellatar Stock Route (including Ironbark Road and Rutherford Road), between Denman Road and New England Highway.
- Denman Road between New England Highway and Golden Highway.
- New England Highway, between Muswellbrook and Whittingham.
- Golden Highway, between New England Highway and Wybong Road.

This assessment revealed that Bengalla Link Road, Wybong Road, Denman Road and the New England Highway have experienced lower (better) crash rates compared with the statewide average for two-lane-two way rural roads. There was no equivalent statewide average for which Skellatar Stock Route could be compared with. Nevertheless, it was not expected that this road would be extensively used by Project-related traffic since Thomas Mitchell Drive offers a more direct southbound route.

Although Edderton Road and Thomas Mitchell Drive exhibited crash rates that were higher (poorer) than the statewide average, it was recognised that there are committed upgrades to both roads which will result in substantial improvements to road safety. Almost the entire length of Edderton Road will be effectively diverted as a combined result of mining activities at Drayton South and Mount Arthur Coal. This would present opportunities to significantly improve the alignment and conditions of the road. As previously stated, the Thomas Mitchell Drive intersections with Denman Road and New England Highway will be upgraded by HVEC which will also present a major opportunity to address safety issues along this route.

In these respects, there are no mitigation measures proposed with regard to potential road safety impacts.

7.4 Bengalla Link Road Diversion

The Bengalla Link Road Diversion will result in a net increase of 900m of additional road length. For through traffic travelling along this road, this would result in a worst-case additional 36 seconds of travel time under normal operating conditions of the road. This was not considered significant and as such, no further mitigation measures are recommended.

The Diversion will result in the new alignment of Bengalla Link Road running parallel with a substantial length of Roxburgh Road. To address safety concerns with regard to the angle of intersection between these two roads, it is likely that a portion of Roxburgh Road will need to be realigned as well.

The Diversion will result in a “like for like” replacement of the intersections with Bengalla Mine Access Road (the old alignment of Bengalla Link Road would effectively form part of this access route), and Roxburgh Road. These intersections are currently a channelized right-turn (CHR) configuration.

The Bengalla Link Road Diversion will be developed in consultation with MSC.

7.5 Forecast train movements

The Project will result in 10.1 train movements per day which is three additional train movements compared with the existing scenario. When added to the forecast movements from the future Mount Pleasant Project, there will be a total of nine additional train movements along the Bengalla Rail Loop, as well as the section of the Ulan Line up to the Muswellbrook Junction. This would equate to approximately 0.42 train movements per hour when spread over 24 hours of a day.

ARTC has forecast the growth in rail movements across the Hunter Valley Coal Corridor in order to identify strategic network upgrades. To a large extent, these forecasts have accounted for foreseeable growth in coal movement from the Muswellbrook Region. As such, it is recommended that Bengalla continue to liaise with ARTC regarding proposed rail movements so that these can be accounted for in the strategic plan.

There are no railway level crossings within the area of influence of the Project which is considered to be between the Project and Muswellbrook Junction. Notwithstanding this, the impact of road closures at the three railway level crossings at Hebden Road (southern occurrence), Glennies Creek Road and Dights Crossing Road were examined with respects to safety and traffic performance. The assessment demonstrated that each crossing has sufficient upstream road length to accommodate likely traffic queues. As such, there are no further mitigation measures proposed in this regard.

8 References

ARTC (2012) *2012-2021 Hunter Valley Corridor Capacity Strategy Consultation Document*.

ARTC (2011) *2011-2020 Hunter Valley Corridor Capacity Strategy Consultation Document*.

ARTC (2009) *2009-2018 Hunter Valley Corridor Capacity Strategy Consultation Document*.

Bengalla Mining Company (2011) *Annual Environmental Management Report and Annual Review*.

ERM Mitchell McCotter (1998) *Mount Pleasant Mine – Environmental Impact Statement Volume 1*.

Hansen Bailey (2012) *Locality map* (specifically supplied for this report)

Hansen Bailey (2011) *Preliminary Environmental Assessment – Drayton South Coal Project*.

Hansen Bailey (2006) *Statement of Environmental Effects – Bengalla Coal Mine Modification to Mining Operations*.

Main Roads Western Australia (no date) *Mid West Regional Road Group – Local Road Project Funding Distribution Model*.

PB (2010) *Mangoola Coal Mine 500kV Electricity Transmission Line Relocation – Traffic Assessment*.

RTA (2004a) *Traffic Volume Data for Northern and Hunter Regions*.

RTA (2004b) *Road environment safety update 22 - Rural road crash rates by road stereotype*.

Appendix A

Explanation of key traffic performance indicators

Level of service (LoS)

The SIDRA intersection simulation software is used to determine the likely traffic performance indicators including level of service (LoS), degree of saturation (DoS), average delay and maximum queue length (represented by 95th percentile queue length). At signalised and roundabout intersections, the LoS criteria are related to average intersection delay (seconds per vehicle). At sign controlled intersections (give way and stop), the LoS is based on the average delay (seconds per vehicle) for the worst movement. The following table summarises the intersection LoS criteria.

Level of Service	Average Delay (seconds per vehicle)	Traffic Signals, Roundabout	Give Way and Stop Signs
A	Less than 14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity. At signals, incidents will cause excessive delays. Roundabouts require other control mode	At capacity; requires other control mode
F	Greater than 71	Unsatisfactory with excessive queuing	Unsatisfactory with excessive queuing; requires other control mode

Source: RTA Guide to Traffic Generating Developments, 2002.

Degree of saturation (DoS)

DoS is defined as the ratio of demand flow to capacity, and therefore has no unit. As it approaches 1.0, extensive queues and delays could be expected. For DoS greater than 1.0, a small increment in traffic volumes would result in an exponential increase in delays and queue length. For a satisfactory situation, the DoS should be less than the nominated practical degree of saturation, usually 0.90. The intersection DoS is based on the movement with the highest ratio.

Average delay

Delay is the difference between interrupted and uninterrupted travel times through the intersection and is measured in seconds per vehicle. The delays include queued vehicles decelerating and accelerating to and/or from stop, as well as delays experienced by all vehicles negotiating the intersection.

At signalised and roundabout intersections, the average intersection delay is usually reported and is taken as the weighted average delay by summing the product of the individual movement traffic volumes and their corresponding calculated delays and dividing these by the total number of vehicles entering the intersection. At sign controlled intersections, the average delay for the worst movement is usually reported.

Maximum queue length

Queue length is the number of vehicles waiting at the hold line and is usually quoted as the 95th percentile back of queue, which is the value below which 95 percent of all observed queue lengths fall. For signalised intersections, it is measured as the number of vehicles per traffic lane at the start of the green period, when the traffic starts moving again after a red signal. The intersection queue length is usually taken from the movement with the longest queue length.

Explanation of SIDRA model outputs

An example of a SIDRA model output is provided below. An explanation of the model outputs follows the table.

Kamilaroi Highway/ Mine Access Road intersection 2028 AM peak operational
Giveaway / Yield (Two-Way)

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Kamilaroi Hwy S											
4	L	65	3.2	0.036	14.2	NA ^s	NA ^s	NA ^s	0.00	0.74	73.1
5	T	268	14.1	0.150	0.0	LOS A	0.0	0.0	0.00	0.00	110.0
Approach		334	12.0	0.150	2.8	LOS A	0.0	0.0	0.00	0.14	100.2
North: Kamilaroi Hwy N											
11	T	268	14.1	0.150	0.0	LOS A	0.0	0.0	0.00	0.00	110.0
12	R	97	2.2	0.112	15.8	LOS B	0.5	3.7	0.39	0.78	62.7
Approach		365	11.0	0.150	4.2	LOS B	0.5	3.7	0.10	0.21	95.4
West: Mine Access Road											
1	L	97	2.2	0.234	12.1	LOS A	1.1	8.1	0.50	0.75	54.6
3	R	65	3.2	0.235	12.2	LOS A	1.1	8.1	0.50	0.84	54.6
Approach		162	2.6	0.235	12.2	LOS A	1.1	8.1	0.50	0.79	54.6
All Vehicles		861	9.8	0.235	5.1	NA	1.1	8.1	0.14	0.29	84.8

“South: Kamilaroi Hwy S”: This indicates that the approach in question is the southern approach to the intersection, which is the Kamilaroi Highway South approach.

L, T, R: Refer to the *left-turn*, *through*, and *right-turn* movements in that approach respectively.

Demand flow: is the traffic volume for the corresponding turning movement.

HV%: means the percentage of heavy vehicles in the corresponding traffic stream.

Deg Satn: Refers to the degree of saturation (DoS) for that turning movement. See the explanation for DoS provided in this Appendix.

Average delay (seconds/vehicle): Traffic delay consists of dynamic delay and static delay. Dynamic delay consists of the time taken for a vehicle to slow down, negotiate through the intersection, and then speed up to the target speed of the intersection departure. This is particularly prominent for turning movements as there is significant deceleration and acceleration involved. Static delay is the delay incurred when the vehicle is in a queue and is not moving.

LoS: Refers to Level of Service as explained in this Appendix.

95% back of queue: This is the queue length in vehicles and in metres which is only exceeded for 5% of the time. This is regarded as the maximum queue length for design purposes.

Prop queued: This refers to the proportion of traffic in the corresponding traffic stream that is queued.

Effective stop rate per vehicle: This is the average number of stops per vehicle. This considers vehicles in a queue and whether they progress to the front of the queue via series of start-stops (move ups) in which case there would be a high stop rate, or whether the vehicle tends to progress toward the queue head in one go. For priority-controlled intersections (not traffic signals) where queue progression is largely related to the randomness of gap availability and gap acceptance, there tends to be a relatively higher effective stop rate for vehicles in the low priority movements.

Average speed: The average speed of vehicles in the corresponding traffic stream.

Appendix B

SIDRA model outputs for intersection traffic performance assessments



Location/ period	Existing base case	Adjusted base case	Peak construction case	Peak operational case																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
AM peak 0600-0700 Denman/ Bengalla Link Road	<table><tr><th colspan="12">Movement Performance - Vehicles</th></tr><tr><th>Mov ID</th><th>Turn</th><th>Control</th><th>Flow veh/h</th><th>PHV %</th><th>Seg Type</th><th>Average Delay sec</th><th>Level of Service</th><th>95% Back of Queue Vehicle Length m</th><th>Prop. Queue</th><th>Effective Stop Time per veh</th><th>Average Speed km/h</th></tr><tr><td colspan="12">East Denman Road (E)</td></tr><tr><td>5</td><td>T</td><td>R</td><td>365</td><td>15.1</td><td>0.085</td><td>0.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>80.0</td></tr><tr><td>6</td><td>R</td><td>R</td><td>260</td><td>5.7</td><td>0.285</td><td>12.7</td><td>L0S A</td><td>1.6</td><td>11.4</td><td>0.36</td><td>67.0</td></tr><tr><td>Approach</td><td>365</td><td>6.0</td><td>0.285</td><td>8.4</td><td>L0S A</td><td>1.6</td><td>11.4</td><td>0.36</td><td>0.34</td><td>67.0</td></tr><tr><td colspan="12">North Bengalla Link Road</td></tr><tr><td>7</td><td>L</td><td>R</td><td>80</td><td>7.9</td><td>0.087</td><td>13.6</td><td>L0S A</td><td>0.4</td><td>3.0</td><td>0.26</td><td>67.0</td></tr><tr><td>8</td><td>R</td><td>L</td><td>0</td><td>0.0</td><td>0.080</td><td>13.0</td><td>L0S A</td><td>0.4</td><td>3.0</td><td>0.26</td><td>60.0</td></tr><tr><td>Approach</td><td>80</td><td>7.9</td><td>0.087</td><td>13.6</td><td>L0S A</td><td>0.4</td><td>3.0</td><td>0.26</td><td>0.70</td><td>60.0</td></tr><tr><td colspan="12">West Denman Road (W)</td></tr><tr><td>9</td><td>L</td><td>L</td><td>134</td><td>5.1</td><td>0.070</td><td>8.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>80.0</td></tr><tr><td>10</td><td>T</td><td>T</td><td>134</td><td>5.1</td><td>0.070</td><td>8.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>80.0</td></tr><tr><td>Approach</td><td>145</td><td>2.9</td><td>0.070</td><td>8.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.00</td><td>76.0</td></tr><tr><td>All Vehicles</td><td>612</td><td>6.9</td><td>0.285</td><td>8.0</td><td>NA</td><td>1.6</td><td>11.4</td><td>0.36</td><td>0.46</td><td>67.0</td></tr></table>	Movement Performance - Vehicles												Mov ID	Turn	Control	Flow veh/h	PHV %	Seg Type	Average Delay sec	Level of Service	95% Back of Queue Vehicle Length m	Prop. Queue	Effective Stop Time per veh	Average Speed km/h	East Denman Road (E)												5	T	R	365	15.1	0.085	0.0	L0S A	0.0	0.0	0.00	80.0	6	R	R	260	5.7	0.285	12.7	L0S A	1.6	11.4	0.36	67.0	Approach	365	6.0	0.285	8.4	L0S A	1.6	11.4	0.36	0.34	67.0	North Bengalla Link Road												7	L	R	80	7.9	0.087	13.6	L0S A	0.4	3.0	0.26	67.0	8	R	L	0	0.0	0.080	13.0	L0S A	0.4	3.0	0.26	60.0	Approach	80	7.9	0.087	13.6	L0S A	0.4	3.0	0.26	0.70	60.0	West Denman Road (W)												9	L	L	134	5.1	0.070	8.0	L0S A	0.0	0.0	0.00	80.0	10	T	T	134	5.1	0.070	8.0	L0S A	0.0	0.0	0.00	80.0	Approach	145	2.9	0.070	8.0	L0S A	0.0	0.0	0.00	0.00	76.0	All Vehicles	612	6.9	0.285	8.0	NA	1.6	11.4	0.36	0.46	67.0	<table><tr><th colspan="12">Movement Performance - Vehicles</th></tr><tr><th>Mov ID</th><th>Turn</th><th>Control</th><th>Flow veh/h</th><th>PHV %</th><th>Seg Type</th><th>Average Delay sec</th><th>Level of Service</th><th>95% Back of Queue Vehicle Length m</th><th>Prop. Queue</th><th>Effective Stop Time per veh</th><th>Average Speed km/h</th></tr><tr><td colspan="12">East Denman Road (E)</td></tr><tr><td>5</td><td>T</td><td>R</td><td>365</td><td>15.1</td><td>0.085</td><td>0.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>80.0</td></tr><tr><td>6</td><td>R</td><td>R</td><td>260</td><td>5.6</td><td>0.280</td><td>12.7</td><td>L0S A</td><td>1.6</td><td>11.7</td><td>0.37</td><td>67.0</td></tr><tr><td>Approach</td><td>365</td><td>6.0</td><td>0.280</td><td>8.4</td><td>L0S A</td><td>1.6</td><td>11.7</td><td>0.37</td><td>0.34</td><td>67.0</td></tr><tr><td colspan="12">North Bengalla Link Road</td></tr><tr><td>7</td><td>L</td><td>R</td><td>80</td><td>7.1</td><td>0.086</td><td>13.6</td><td>L0S A</td><td>0.5</td><td>3.4</td><td>0.26</td><td>67.0</td></tr><tr><td>8</td><td>R</td><td>L</td><td>0</td><td>0.0</td><td>0.084</td><td>13.0</td><td>L0S A</td><td>0.5</td><td>3.4</td><td>0.26</td><td>60.0</td></tr><tr><td>Approach</td><td>80</td><td>6.7</td><td>0.084</td><td>13.6</td><td>L0S A</td><td>0.5</td><td>3.4</td><td>0.26</td><td>0.71</td><td>60.0</td></tr><tr><td colspan="12">West Denman Road (W)</td></tr><tr><td>9</td><td>L</td><td>L</td><td>134</td><td>5.0</td><td>0.067</td><td>11.9</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>80.0</td></tr><tr><td>10</td><td>T</td><td>T</td><td>134</td><td>5.1</td><td>0.070</td><td>8.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>80.0</td></tr><tr><td>Approach</td><td>145</td><td>2.9</td><td>0.070</td><td>1.9</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.00</td><td>76.0</td></tr><tr><td>All Vehicles</td><td>626</td><td>6.7</td><td>0.280</td><td>8.1</td><td>NA</td><td>1.6</td><td>11.7</td><td>0.36</td><td>0.46</td><td>67.2</td></tr></table>	Movement Performance - Vehicles												Mov ID	Turn	Control	Flow veh/h	PHV %	Seg Type	Average Delay sec	Level of Service	95% Back of Queue Vehicle Length m	Prop. Queue	Effective Stop Time per veh	Average Speed km/h	East Denman Road (E)												5	T	R	365	15.1	0.085	0.0	L0S A	0.0	0.0	0.00	80.0	6	R	R	260	5.6	0.280	12.7	L0S A	1.6	11.7	0.37	67.0	Approach	365	6.0	0.280	8.4	L0S A	1.6	11.7	0.37	0.34	67.0	North Bengalla Link Road												7	L	R	80	7.1	0.086	13.6	L0S A	0.5	3.4	0.26	67.0	8	R	L	0	0.0	0.084	13.0	L0S A	0.5	3.4	0.26	60.0	Approach	80	6.7	0.084	13.6	L0S A	0.5	3.4	0.26	0.71	60.0	West Denman Road (W)												9	L	L	134	5.0	0.067	11.9	L0S A	0.0	0.0	0.00	80.0	10	T	T	134	5.1	0.070	8.0	L0S A	0.0	0.0	0.00	80.0	Approach	145	2.9	0.070	1.9	L0S A	0.0	0.0	0.00	0.00	76.0	All Vehicles	626	6.7	0.280	8.1	NA	1.6	11.7	0.36	0.46	67.2	<table><tr><th colspan="12">Movement Performance - Vehicles</th></tr><tr><th>Mov ID</th><th>Turn</th><th>Control</th><th>Flow veh/h</th><th>PHV %</th><th>Seg Type</th><th>Average Delay sec</th><th>Level of Service</th><th>95% Back of Queue Vehicle Length m</th><th>Prop. Queue</th><th>Effective Stop Time per veh</th><th>Average Speed km/h</th></tr><tr><td colspan="12">East Denman Road (E)</td></tr><tr><td>5</td><td>T</td><td>R</td><td>103</td><td>15.3</td><td>0.058</td><td>0.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>80.0</td></tr><tr><td>6</td><td>R</td><td>R</td><td>466</td><td>4.1</td><td>0.402</td><td>13.7</td><td>L0S A</td><td>3.3</td><td>24.0</td><td>0.45</td><td>67.0</td></tr><tr><td>Approach</td><td>569</td><td>6.1</td><td>0.402</td><td>11.2</td><td>NA</td><td>3.3</td><td>24.0</td><td>0.37</td><td>0.63</td><td>63.0</td></tr><tr><td colspan="12">North Bengalla Link Road</td></tr><tr><td>7</td><td>L</td><td>R</td><td>58</td><td>7.1</td><td>0.100</td><td>13.6</td><td>L0S A</td><td>0.4</td><td>2.8</td><td>0.28</td><td>67.0</td></tr><tr><td>8</td><td>R</td><td>L</td><td>0</td><td>0.0</td><td>0.100</td><td>13.0</td><td>L0S A</td><td>0.4</td><td>2.8</td><td>0.28</td><td>60.0</td></tr><tr><td>Approach</td><td>58</td><td>6.7</td><td>0.100</td><td>13.7</td><td>L0S A</td><td>0.4</td><td>2.8</td><td>0.28</td><td>0.71</td><td>62.0</td></tr><tr><td colspan="12">West Denman Road (W)</td></tr><tr><td>9</td><td>L</td><td>L</td><td>26</td><td>0.0</td><td>0.014</td><td>11.3</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>80.0</td></tr><tr><td>10</td><td>T</td><td>T</td><td>140</td><td>3.9</td><td>0.073</td><td>0.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>80.0</td></tr><tr><td>Approach</td><td>166</td><td>2.5</td><td>0.073</td><td>1.0</td><td>NA</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.12</td><td>76.5</td></tr><tr><td>All Vehicles</td><td>631</td><td>5.4</td><td>0.402</td><td>9.6</td><td>NA</td><td>3.3</td><td>24.0</td><td>0.29</td><td>0.54</td><td>65.2</td></tr></table>	Movement Performance - Vehicles												Mov ID	Turn	Control	Flow veh/h	PHV %	Seg Type	Average Delay sec	Level of Service	95% Back of Queue Vehicle Length m	Prop. Queue	Effective Stop Time per veh	Average Speed km/h	East Denman Road (E)												5	T	R	103	15.3	0.058	0.0	L0S A	0.0	0.0	0.00	80.0	6	R	R	466	4.1	0.402	13.7	L0S A	3.3	24.0	0.45	67.0	Approach	569	6.1	0.402	11.2	NA	3.3	24.0	0.37	0.63	63.0	North Bengalla Link Road												7	L	R	58	7.1	0.100	13.6	L0S A	0.4	2.8	0.28	67.0	8	R	L	0	0.0	0.100	13.0	L0S A	0.4	2.8	0.28	60.0	Approach	58	6.7	0.100	13.7	L0S A	0.4	2.8	0.28	0.71	62.0	West Denman Road (W)												9	L	L	26	0.0	0.014	11.3	L0S A	0.0	0.0	0.00	80.0	10	T	T	140	3.9	0.073	0.0	L0S A	0.0	0.0	0.00	80.0	Approach	166	2.5	0.073	1.0	NA	0.0	0.0	0.00	0.12	76.5	All Vehicles	631	5.4	0.402	9.6	NA	3.3	24.0	0.29	0.54	65.2	<table><tr><th colspan="12">Movement Performance - Vehicles</th></tr><tr><th>Mov ID</th><th>Turn</th><th>Control</th><th>Flow veh/h</th><th>PHV %</th><th>Seg Type</th><th>Average Delay sec</th><th>Level of Service</th><th>95% Back of Queue Vehicle Length m</th><th>Prop. Queue</th><th>Effective Stop Time per veh</th><th>Average Speed km/h</th></tr><tr><td colspan="12">East Denman Road (E)</td></tr><tr><td>5</td><td>T</td><td>R</td><td>403</td><td>16.2</td><td>0.088</td><td>0.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>80.0</td></tr><tr><td>6</td><td>R</td><td>R</td><td>403</td><td>5.9</td><td>0.405</td><td>13.1</td><td>L0S B</td><td>4.0</td><td>31.5</td><td>0.54</td><td>66.0</td></tr><tr><td>Approach</td><td>403</td><td>6.0</td><td>0.405</td><td>11.1</td><td>L0S B</td><td>4.0</td><td>31.5</td><td>0.46</td><td>0.66</td><td>62.0</td></tr><tr><td colspan="12">North Bengalla Link Road</td></tr><tr><td>7</td><td>L</td><td>R</td><td>140</td><td>6.5</td><td>0.162</td><td>14.5</td><td>L0S A</td><td>0.9</td><td>6.7</td><td>0.37</td><td>67.0</td></tr><tr><td>8</td><td>R</td><td>L</td><td>0</td><td>0.0</td><td>0.162</td><td>13.0</td><td>L0S A</td><td>0.9</td><td>6.7</td><td>0.37</td><td>60.0</td></tr><tr><td>Approach</td><td>140</td><td>6.0</td><td>0.162</td><td>14.4</td><td>L0S A</td><td>0.9</td><td>6.7</td><td>0.37</td><td>0.74</td><td>62.0</td></tr><tr><td colspan="12">West Denman Road (W)</td></tr><tr><td>9</td><td>L</td><td>L</td><td>26</td><td>0.0</td><td>0.014</td><td>11.3</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>80.0</td></tr><tr><td>10</td><td>T</td><td>T</td><td>200</td><td>3.0</td><td>0.108</td><td>0.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>80.0</td></tr><tr><td>Approach</td><td>226</td><td>2.7</td><td>0.108</td><td>1.9</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.00</td><td>77.4</td></tr><tr><td>All Vehicles</td><td>671</td><td>6.9</td><td>0.405</td><td>9.3</td><td>NA</td><td>4.0</td><td>31.5</td><td>0.38</td><td>0.52</td><td>66.6</td></tr></table>	Movement Performance - Vehicles												Mov ID	Turn	Control	Flow veh/h	PHV %	Seg Type	Average Delay sec	Level of Service	95% Back of Queue Vehicle Length m	Prop. Queue	Effective Stop Time per veh	Average Speed km/h	East Denman Road (E)												5	T	R	403	16.2	0.088	0.0	L0S A	0.0	0.0	0.00	80.0	6	R	R	403	5.9	0.405	13.1	L0S B	4.0	31.5	0.54	66.0	Approach	403	6.0	0.405	11.1	L0S B	4.0	31.5	0.46	0.66	62.0	North Bengalla Link Road												7	L	R	140	6.5	0.162	14.5	L0S A	0.9	6.7	0.37	67.0	8	R	L	0	0.0	0.162	13.0	L0S A	0.9	6.7	0.37	60.0	Approach	140	6.0	0.162	14.4	L0S A	0.9	6.7	0.37	0.74	62.0	West Denman Road (W)												9	L	L	26	0.0	0.014	11.3	L0S A	0.0	0.0	0.00	80.0	10	T	T	200	3.0	0.108	0.0	L0S A	0.0	0.0	0.00	80.0	Approach	226	2.7	0.108	1.9	L0S A	0.0	0.0	0.00	0.00	77.4	All Vehicles	671	6.9	0.405	9.3	NA	4.0	31.5	0.38	0.52	66.6
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5	T	R	365	15.1	0.085	0.0	L0S A	0.0	0.0	0.00	80.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
6	R	R	260	5.6	0.280	12.7	L0S A	1.6	11.7	0.37	67.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
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9	L	L	134	5.0	0.067	11.9	L0S A	0.0	0.0	0.00	80.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
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5	T	R	103	15.3	0.058	0.0	L0S A	0.0	0.0	0.00	80.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
6	R	R	466	4.1	0.402	13.7	L0S A	3.3	24.0	0.45	67.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
Approach	569	6.1	0.402	11.2	NA	3.3	24.0	0.37	0.63	63.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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7	L	R	58	7.1	0.100	13.6	L0S A	0.4	2.8	0.28	67.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
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9	L	L	26	0.0	0.014	11.3	L0S A	0.0	0.0	0.00	80.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
10	T	T	140	3.9	0.073	0.0	L0S A	0.0	0.0	0.00	80.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
Approach	166	2.5	0.073	1.0	NA	0.0	0.0	0.00	0.12	76.5																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
All Vehicles	631	5.4	0.402	9.6	NA	3.3	24.0	0.29	0.54	65.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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5	T	R	403	16.2	0.088	0.0	L0S A	0.0	0.0	0.00	80.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
6	R	R	403	5.9	0.405	13.1	L0S B	4.0	31.5	0.54	66.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
Approach	403	6.0	0.405	11.1	L0S B	4.0	31.5	0.46	0.66	62.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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7	L	R	140	6.5	0.162	14.5	L0S A	0.9	6.7	0.37	67.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
8	R	L	0	0.0	0.162	13.0	L0S A	0.9	6.7	0.37	60.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
Approach	140	6.0	0.162	14.4	L0S A	0.9	6.7	0.37	0.74	62.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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9	L	L	26	0.0	0.014	11.3	L0S A	0.0	0.0	0.00	80.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
10	T	T	200	3.0	0.108	0.0	L0S A	0.0	0.0	0.00	80.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
Approach	226	2.7	0.108	1.9	L0S A	0.0	0.0	0.00	0.00	77.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
All Vehicles	671	6.9	0.405	9.3	NA	4.0	31.5	0.38	0.52	66.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
PM peak 1600-1700 Denman/ Bengalla Link Road	<table><tr><th colspan="12">Movement Performance - Vehicles</th></tr><tr><th>Mov ID</th><th>Turn</th><th>Control</th><th>Flow veh/h</th><th>PHV %</th><th>Seg Type</th><th>Average Delay sec</th><th>Level of Service</th><th>95% Back of Queue Vehicle Length m</th><th>Prop. Queue</th><th>Effective Stop Time per veh</th><th>Average Speed km/h</th></tr><tr><td colspan="12">East Denman Road (E)</td></tr><tr><td>5</td><td>T</td><td>R</td><td>403</td><td>1.9</td><td>0.088</td><td>0.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>80.0</td></tr><tr><td>6</td><td>R</td><td>R</td><td>52</td><td>2.0</td><td>0.084</td><td>12.9</td><td>L0S A</td><td>0.2</td><td>1.8</td><td>0.12</td><td>67.0</td></tr><tr><td>Approach</td><td>276</td><td>2.0</td><td>0.084</td><td>9.0</td><td>L0S A</td><td>0.2</td><td>1.8</td><td>0.12</td><td>0.17</td><td>74.2</td></tr><tr><td colspan="12">North Bengalla Link Road</td></tr><tr><td>7</td><td>L</td><td>R</td><td>179</td><td>5.0</td><td>0.179</td><td>13.4</td><td>L0S A</td><td>0.8</td><td>6.4</td><td>0.27</td><td>62.0</td></tr><tr><td>8</td><td>R</td><td>L</td><td>0</td><td>0.0</td><td>0.179</td><td>12.9</td><td>L0S A</td><td>0.8</td><td>6.4</td><td>0.27</td><td>60.0</td></tr><tr><td>Approach</td><td>179</td><td>5.1</td><td>0.179</td><td>13.4</td><td>L0S A</td><td>0.8</td><td>6.4</td><td>0.27</td><td>0.70</td><td>62.0</td></tr><tr><td colspan="12">West Denman Road (W)</td></tr><tr><td>9</td><td>L</td><td>L</td><td>100.0</td><td>0.001</td><td>16.0</td><td>L0S B</td><td>0.0</td><td>0.0</td><td>0.00</td><td>67.0</td></tr><tr><td>10</td><td>T</td><td>T</td><td>124</td><td>15.3</td><td>0.070</td><td>8.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>80.0</td></tr><tr><td>Approach</td><td>129</td><td>16.0</td><td>0.070</td><td>9.2</td><td>L0S B</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.00</td><td>76.0</td></tr><tr><td>All Vehicles</td><td>619</td><td>6.1</td><td>0.179</td><td>5.9</td><td>NA</td><td>0.8</td><td>6.4</td><td>0.13</td><td>0.31</td><td>71.0</td></tr></table>	Movement Performance - Vehicles												Mov ID	Turn	Control	Flow veh/h	PHV %	Seg Type	Average Delay sec	Level of Service	95% Back of Queue Vehicle Length m	Prop. Queue	Effective Stop Time per veh	Average Speed km/h	East Denman Road (E)												5	T	R	403	1.9	0.088	0.0	L0S A	0.0	0.0	0.00	80.0	6	R	R	52	2.0	0.084	12.9	L0S A	0.2	1.8	0.12	67.0	Approach	276	2.0	0.084	9.0	L0S A	0.2	1.8	0.12	0.17	74.2	North Bengalla Link Road												7	L	R	179	5.0	0.179	13.4	L0S A	0.8	6.4	0.27	62.0	8	R	L	0	0.0	0.179	12.9	L0S A	0.8	6.4	0.27	60.0	Approach	179	5.1	0.179	13.4	L0S A	0.8	6.4	0.27	0.70	62.0	West Denman Road (W)												9	L	L	100.0	0.001	16.0	L0S B	0.0	0.0	0.00	67.0	10	T	T	124	15.3	0.070	8.0	L0S A	0.0	0.0	0.00	80.0	Approach	129	16.0	0.070	9.2	L0S B	0.0	0.0	0.00	0.00	76.0	All Vehicles	619	6.1	0.179	5.9	NA	0.8	6.4	0.13	0.31	71.0	<table><tr><th colspan="12">Movement Performance - Vehicles</th></tr><tr><th>Mov ID</th><th>Turn</th><th>Control</th><th>Flow veh/h</th><th>PHV %</th><th>Seg Type</th><th>Average Delay sec</th><th>Level of Service</th><th>95% Back of Queue Vehicle Length m</th><th>Prop. Queue</th><th>Effective Stop Time per veh</th><th>Average Speed km/h</th></tr><tr><td colspan="12">East Denman Road (E)</td></tr><tr><td>5</td><td>T</td><td>R</td><td>169</td><td>1.9</td><td>0.085</td><td>0.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>80.0</td></tr><tr><td>6</td><td>R</td><td>R</td><td>40</td><td>1.8</td><td>0.083</td><td>12.9</td><td>L0S A</td><td>0.3</td><td>2.1</td><td>0.10</td><td>67.0</td></tr><tr><td>Approach</td><td>223</td><td>1.9</td><td>0.083</td><td>3.4</td><td>L0S A</td><td>0.3</td><td>2.1</td><td>0.09</td><td>0.19</td><td>73.6</td></tr><tr><td colspan="12">North Bengalla Link Road</td></tr><tr><td>7</td><td>L</td><td>R</td><td>179</td><td>5.0</td><td>0.181</td><td>13.4</td><td>L0S A</td><td>0.9</td><td>6.7</td><td>0.28</td><td>62.0</td></tr><tr><td>8</td><td>R</td><td>L</td><td>0</td><td>0.0</td><td>0.180</td><td>12.9</td><td>L0S A</td><td>0.9</td><td>6.7</td><td>0.28</td><td>60.0</td></tr><tr><td>Approach</td><td>180</td><td>5.1</td><td>0.181</td><td>13.4</td><td>L0S A</td><td>0.9</td><td>6.7</td><td>0.28</td><td>0.70</td><td>62.0</td></tr><tr><td colspan="12">West Denman Road (W)</td></tr><tr><td>9</td><td>L</td><td>L</td><td>2</td><td>0.0</td><td>0.002</td><td>16.1</td><td>L0S B</td><td>0.0</td><td>0.0</td><td>0.00</td><td>67.0</td></tr><tr><td>10</td><td>T</td><td>T</td><td>124</td><td>15.3</td><td>0.070</td><td>8.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>80.0</td></tr><tr><td>Approach</td><td>128</td><td>16.0</td><td>0.070</td><td>8.3</td><td>L0S B</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.01</td><td>76.6</td></tr><tr><td>All Vehicles</td><td>536</td><td>6.0</td><td>0.181</td><td>6.1</td><td>NA</td><td>0.9</td><td>6.7</td><td>0.13</td><td>0.30</td><td>70.6</td></tr></table>	Movement Performance - Vehicles												Mov ID	Turn	Control	Flow veh/h	PHV %	Seg Type	Average Delay sec	Level of Service	95% Back of Queue Vehicle Length m	Prop. Queue	Effective Stop Time per veh	Average Speed km/h	East Denman Road (E)												5	T	R	169	1.9	0.085	0.0	L0S A	0.0	0.0	0.00	80.0	6	R	R	40	1.8	0.083	12.9	L0S A	0.3	2.1	0.10	67.0	Approach	223	1.9	0.083	3.4	L0S A	0.3	2.1	0.09	0.19	73.6	North Bengalla Link Road												7	L	R	179	5.0	0.181	13.4	L0S A	0.9	6.7	0.28	62.0	8	R	L	0	0.0	0.180	12.9	L0S A	0.9	6.7	0.28	60.0	Approach	180	5.1	0.181	13.4	L0S A	0.9	6.7	0.28	0.70	62.0	West Denman Road (W)												9	L	L	2	0.0	0.002	16.1	L0S B	0.0	0.0	0.00	67.0	10	T	T	124	15.3	0.070	8.0	L0S A	0.0	0.0	0.00	80.0	Approach	128	16.0	0.070	8.3	L0S B	0.0	0.0	0.00	0.01	76.6	All Vehicles	536	6.0	0.181	6.1	NA	0.9	6.7	0.13	0.30	70.6	<table><tr><th colspan="12">Movement Performance - Vehicles</th></tr><tr><th>Mov ID</th><th>Turn</th><th>Control</th><th>Flow veh/h</th><th>PHV %</th><th>Seg Type</th><th>Average Delay sec</th><th>Level of Service</th><th>95% Back of Queue Vehicle Length m</th><th>Prop. Queue</th><th>Effective Stop Time per veh</th><th>Average Speed km/h</th></tr><tr><td colspan="12">East Denman Road (E)</td></tr><tr><td>5</td><td>T</td><td>R</td><td>172</td><td>0.1</td><td>0.086</td><td>0.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>80.0</td></tr><tr><td>6</td><td>R</td><td>R</td><td>60</td><td>1.8</td><td>0.078</td><td>13.0</td><td>L0S A</td><td>0.3</td><td>1.8</td><td>0.09</td><td>67.0</td></tr><tr><td>Approach</td><td>230</td><td>0.7</td><td>0.086</td><td>0.4</td><td>NA</td><td>0.3</td><td>1.8</td><td>0.09</td><td>0.09</td><td>73.6</td></tr><tr><td colspan="12">North Bengalla Link Road</td></tr><tr><td>7</td><td>L</td><td>R</td><td>169</td><td>2.7</td><td>0.188</td><td>13.5</td><td>L0S A</td><td>1.0</td><td>10.9</td><td>0.34</td><td>67.0</td></tr><tr><td>8</td><td>R</td><td>L</td><td>0</td><td>0.0</td><td>0.188</td><td>13.0</td><td>L0S A</td><td>1.0</td><td>10.9</td><td>0.34</td><td>60.0</td></tr><tr><td>Approach</td><td>169</td><td>2.5</td><td>0.188</td><td>13.0</td><td>L0S A</td><td>1.0</td><td>10.9</td><td>0.34</td><td>0.70</td><td>62.0</td></tr><tr><td colspan="12">West Denman Road (W)</td></tr><tr><td>9</td><td>L</td><td>L</td><td>2</td><td>0.0</td><td>0.002</td><td>16.1</td><td>L0S B</td><td>0.0</td><td>0.0</td><td>0.00</td><td>67.0</td></tr><tr><td>10</td><td>T</td><td>T</td><td>129</td><td>15.4</td><td>0.070</td><td>8.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>80.0</td></tr><tr><td>Approach</td><td>127</td><td>16.0</td><td>0.070</td><td>8.2</td><td>NA</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.01</td><td>76.6</td></tr><tr><td>All Vehicles</td><td>740</td><td>6.0</td><td>0.188</td><td>9.0</td><td>NA</td><td>1.0</td><td>10.9</td><td>0.30</td><td>0.40</td><td>62.0</td></tr></table>	Movement Performance - Vehicles												Mov ID	Turn	Control	Flow veh/h	PHV %	Seg Type	Average Delay sec	Level of Service	95% Back of Queue Vehicle Length m	Prop. Queue	Effective Stop Time per veh	Average Speed km/h	East Denman Road (E)												5	T	R	172	0.1	0.086	0.0	L0S A	0.0	0.0	0.00	80.0	6	R	R	60	1.8	0.078	13.0	L0S A	0.3	1.8	0.09	67.0	Approach	230	0.7	0.086	0.4	NA	0.3	1.8	0.09	0.09	73.6	North Bengalla Link Road												7	L	R	169	2.7	0.188	13.5	L0S A	1.0	10.9	0.34	67.0	8	R	L	0	0.0	0.188	13.0	L0S A	1.0	10.9	0.34	60.0	Approach	169	2.5	0.188	13.0	L0S A	1.0	10.9	0.34	0.70	62.0	West Denman Road (W)												9	L	L	2	0.0	0.002	16.1	L0S B	0.0	0.0	0.00	67.0	10	T	T	129	15.4	0.070	8.0	L0S A	0.0	0.0	0.00	80.0	Approach	127	16.0	0.070	8.2	NA	0.0	0.0	0.00	0.01	76.6	All Vehicles	740	6.0	0.188	9.0	NA	1.0	10.9	0.30	0.40	62.0	<table><tr><th colspan="12">Movement Performance - Vehicles</th></tr><tr><th>Mov ID</th><th>Turn</th><th>Control</th><th>Flow veh/h</th><th>PHV %</th><th>Seg Type</th><th>Average Delay sec</th><th>Level of Service</th><th>95% Back of Queue Vehicle Length m</th><th>Prop. Queue</th><th>Effective Stop Time per veh</th><th>Average Speed km/h</th></tr><tr><td colspan="12">East Denman Road (E)</td></tr><tr><td>5</td><td>T</td><td>R</td><td>204</td><td>3.3</td><td>0.103</td><td>0.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>80.0</td></tr><tr><td>6</td><td>R</td><td>R</td><td>126</td><td>6.1</td><td>0.181</td><td>14.0</td><td>L0S A</td><td>0.7</td><td>6.0</td><td>0.46</td><td>67.0</td></tr><tr><td>Approach</td><td>276</td><td>4.2</td><td>0.181</td><td>8.0</td><td>L0S A</td><td>0.7</td><td>6.0</td><td>0.46</td><td>0.28</td><td>67.0</td></tr><tr><td colspan="12">North Bengalla Link Road</td></tr><tr><td>7</td><td>L</td><td>R</td><td>317</td><td>5.0</td><td>0.200</td><td>14.0</td><td>L0S A</td><td>2.2</td><td>16.9</td><td>0.40</td><td>67.0</td></tr><tr><td>8</td><td>R</td><td>L</td><td>0</td><td>0.0</td><td>0.200</td><td>13.0</td><td>L0S A</td><td>2.2</td><td>16.9</td><td>0.40</td><td>60.0</td></tr><tr><td>Approach</td><td>317</td><td>4.7</td><td>0.200</td><td>14.0</td><td>L0S A</td><td>2.2</td><td>16.9</td><td>0.40</td><td>0.70</td><td>67.0</td></tr><tr><td colspan="12">West Denman Road (W)</td></tr><tr><td>9</td><td>L</td><td>L</td><td>5</td><td>0.0</td><td>0.003</td><td>16.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>67.0</td></tr><tr><td>10</td><td>T</td><td>T</td><td>124</td><td>15.2</td><td>0.108</td><td>8.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>80.0</td></tr><tr><td>Approach</td><td>108</td><td>15.3</td><td>0.108</td><td>8.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.00</td><td>76.0</td></tr><tr><td>All Vehicles</td><td>611</td><td>6.0</td><td>0.200</td><td>7.2</td><td>NA</td><td>2.2</td><td>16.9</td><td>0.21</td><td>0.38</td><td>66.0</td></tr></table>	Movement Performance - Vehicles												Mov ID	Turn	Control	Flow veh/h	PHV %	Seg Type	Average Delay sec	Level of Service	95% Back of Queue Vehicle Length m	Prop. Queue	Effective Stop Time per veh	Average Speed km/h	East Denman Road (E)												5	T	R	204	3.3	0.103	0.0	L0S A	0.0	0.0	0.00	80.0	6	R	R	126	6.1	0.181	14.0	L0S A	0.7	6.0	0.46	67.0	Approach	276	4.2	0.181	8.0	L0S A	0.7	6.0	0.46	0.28	67.0	North Bengalla Link Road												7	L	R	317	5.0	0.200	14.0	L0S A	2.2	16.9	0.40	67.0	8	R	L	0	0.0	0.200	13.0	L0S A	2.2	16.9	0.40	60.0	Approach	317	4.7	0.200	14.0	L0S A	2.2	16.9	0.40	0.70	67.0	West Denman Road (W)												9	L	L	5	0.0	0.003	16.0	L0S A	0.0	0.0	0.00	67.0	10	T	T	124	15.2	0.108	8.0	L0S A	0.0	0.0	0.00	80.0	Approach	108	15.3	0.108	8.0	L0S A	0.0	0.0	0.00	0.00	76.0	All Vehicles	611	6.0	0.200	7.2	NA	2.2	16.9	0.21	0.38	66.0	
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5	T	R	169	1.9	0.085	0.0	L0S A	0.0	0.0	0.00	80.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
6	R	R	40	1.8	0.083	12.9	L0S A	0.3	2.1	0.10	67.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
Approach	223	1.9	0.083	3.4	L0S A	0.3	2.1	0.09	0.19	73.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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10	T	T	124	15.3	0.070	8.0	L0S A	0.0	0.0	0.00	80.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
Approach	128	16.0	0.070	8.3	L0S B	0.0	0.0	0.00	0.01	76.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
All Vehicles	536	6.0	0.181	6.1	NA	0.9	6.7	0.13	0.30	70.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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5	T	R	172	0.1	0.086	0.0	L0S A	0.0	0.0	0.00	80.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
6	R	R	60	1.8	0.078	13.0	L0S A	0.3	1.8	0.09	67.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
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7	L	R	169	2.7	0.188	13.5	L0S A	1.0	10.9	0.34	67.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
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9	L	L	2	0.0	0.002	16.1	L0S B	0.0	0.0	0.00	67.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
10	T	T	129	15.4	0.070	8.0	L0S A	0.0	0.0	0.00	80.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
Approach	127	16.0	0.070	8.2	NA	0.0	0.0	0.00	0.01	76.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
All Vehicles	740	6.0	0.188	9.0	NA	1.0	10.9	0.30	0.40	62.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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5	T	R	204	3.3	0.103	0.0	L0S A	0.0	0.0	0.00	80.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
6	R	R	126	6.1	0.181	14.0	L0S A	0.7	6.0	0.46	67.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
Approach	276	4.2	0.181	8.0	L0S A	0.7	6.0	0.46	0.28	67.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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7	L	R	317	5.0	0.200	14.0	L0S A	2.2	16.9	0.40	67.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
8	R	L	0	0.0	0.200	13.0	L0S A	2.2	16.9	0.40	60.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
Approach	317	4.7	0.200	14.0	L0S A	2.2	16.9	0.40	0.70	67.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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9	L	L	5	0.0	0.003	16.0	L0S A	0.0	0.0	0.00	67.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
10	T	T	124	15.2	0.108	8.0	L0S A	0.0	0.0	0.00	80.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
Approach	108	15.3	0.108	8.0	L0S A	0.0	0.0	0.00	0.00	76.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
All Vehicles	611	6.0	0.200	7.2	NA	2.2	16.9	0.21	0.38	66.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
AM peak 0600-0700 Denman/ Thomas Mitchell Drive	<table><tr><th colspan="12">Movement Performance - Vehicles</th></tr><tr><th>Mov ID</th><th>Turn</th><th>Control</th><th>Flow veh/h</th><th>PHV %</th><th>Seg Type</th><th>Average Delay sec</th><th>Level of Service</th><th>95% Back of Queue Vehicle Length m</th><th>Prop. Queue</th><th>Effective Stop Time per veh</th><th>Average Speed km/h</th></tr><tr><td colspan="12">East Denman Road (E)</td></tr><tr><td>21</td><td>L</td><td>L</td><td>138</td><td>12.0</td><td>0.216</td><td>16.0</td><td>L0S B</td><td>1.0</td><td>9.1</td><td>0.59</td><td>67.0</td></tr><tr><td>22</td><td>R</td><td>R</td><td>138</td><td>6.8</td><td>0.272</td><td>18.0</td><td>L0S B</td><td>1.4</td><td>10.1</td><td>0.89</td><td>66.0</td></tr><tr><td>Approach</td><td>286</td><td>10.0</td><td>0.272</td><td>17.3</td><td>L0S B</td><td>1.4</td><td>10.0</td><td>0.80</td><td>0.80</td><td>62.0</td></tr><tr><td colspan="12">North East Denman Road (NE)</td></tr><tr><td>23</td><td>T</td><td>T</td><td>238</td><td>5.0</td><td>0.125</td><td>12.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>80.0</td></tr><tr><td>24</td><td>L</td><td>L</td><td>238</td><td>5.0</td><td>0.125</td><td>12.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>80.0</td></tr><tr><td>Approach</td><td>754</td><td>5.0</td><td>0.125</td><td>9.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.01</td><td>87.0</td></tr><tr><td colspan="12">South East Denman Road (SE)</td></tr><tr><td>25</td><td>T</td><td>T</td><td>238</td><td>5.0</td><td>0.125</td><td>12.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>80.0</td></tr><tr><td>26</td><td>L</td><td>L</td><td>238</td><td>5.0</td><td>0.125</td><td>12.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>80.0</td></tr><tr><td>Approach</td><td>754</td><td>5.0</td><td>0.125</td><td>9.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.01</td><td>87.0</td></tr><tr><td colspan="12">South West Denman Road (SW)</td></tr><tr><td>27</td><td>L</td><td>L</td><td>144</td><td>3.8</td><td>0.040</td><td>16.0</td><td>L0S A</td><td>1.0</td><td>11.0</td><td>0.00</td><td>67.0</td></tr><tr><td>28</td><td>R</td><td>R</td><td>144</td><td>3.8</td><td>0.040</td><td>16.0</td><td>L0S A</td><td>1.0</td><td>11.0</td><td>0.00</td><td>67.0</td></tr><tr><td>Approach</td><td>288</td><td>3.8</td><td>0.040</td><td>11.1</td><td>NA</td><td>1.0</td><td>11.0</td><td>0.21</td><td>0.01</td><td>62.0</td></tr><tr><td>All Vehicles</td><td>1296</td><td>5.0</td><td>0.040</td><td>11.1</td><td>NA</td><td>1.0</td><td>11.0</td><td>0.21</td><td>0.01</td><td>62.0</td></tr></table>	Movement Performance - Vehicles												Mov ID	Turn	Control	Flow veh/h	PHV %	Seg Type	Average Delay sec	Level of Service	95% Back of Queue Vehicle Length m	Prop. Queue	Effective Stop Time per veh	Average Speed km/h	East Denman Road (E)												21	L	L	138	12.0	0.216	16.0	L0S B	1.0	9.1	0.59	67.0	22	R	R	138	6.8	0.272	18.0	L0S B	1.4	10.1	0.89	66.0	Approach	286	10.0	0.272	17.3	L0S B	1.4	10.0	0.80	0.80	62.0	North East Denman Road (NE)												23	T	T	238	5.0	0.125	12.0	L0S A	0.0	0.0	0.00	80.0	24	L	L	238	5.0	0.125	12.0	L0S A	0.0	0.0	0.00	80.0	Approach	754	5.0	0.125	9.0	L0S A	0.0	0.0	0.00	0.01	87.0	South East Denman Road (SE)												25	T	T	238	5.0	0.125	12.0	L0S A	0.0	0.0	0.00	80.0	26	L	L	238	5.0	0.125	12.0	L0S A	0.0	0.0	0.00	80.0	Approach	754	5.0	0.125	9.0	L0S A	0.0	0.0	0.00	0.01	87.0	South West Denman Road (SW)												27	L	L	144	3.8	0.040	16.0	L0S A	1.0	11.0	0.00	67.0	28	R	R	144	3.8	0.040	16.0	L0S A	1.0	11.0	0.00	67.0	Approach	288	3.8	0.040	11.1	NA	1.0	11.0	0.21	0.01	62.0	All Vehicles	1296	5.0	0.040	11.1	NA	1.0	11.0	0.21	0.01	62.0	<table><tr><th colspan="12">Movement Performance - Vehicles</th></tr><tr><th>Mov ID</th><th>Turn</th><th>Control</th><th>Flow veh/h</th><th>PHV %</th><th>Seg Type</th><th>Average Delay sec</th><th>Level of Service</th><th>95% Back of Queue Vehicle Length m</th><th>Prop. Queue</th><th>Effective Stop Time per veh</th><th>Average Speed km/h</th></tr><tr><td colspan="12">East Denman Road (E)</td></tr><tr><td>21</td><td>L</td><td>L</td><td>137</td><td>12.0</td><td>0.224</td><td>16.0</td><td>L0S B</td><td>1.1</td><td>8.2</td><td>0.60</td><td>68.0</td></tr><tr><td>22</td><td>R</td><td>R</td><td>138</td><td>6.6</td><td>0.277</td><td>18.0</td><td>L0S B</td><td>1.4</td><td>10.1</td><td>0.86</td><td>67.0</td></tr><tr><td>Approach</td><td>272</td><td>10.0</td><td>0.277</td><td>17.4</td><td>L0S B</td><td>1.4</td><td>10.0</td><td>0.80</td><td>0.80</td><td>62.0</td></tr><tr><td colspan="12">North East Denman Road (NE)</td></tr><tr><td>23</td><td>L</td><td>L</td><td>916</td><td>3.9</td><td>0.099</td><td>12.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>70.0</td></tr><tr><td>24</td><td>T</td><td>T</td><td>360</td><td>2.0</td><td>0.046</td><td>9.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>100.0</td></tr><tr><td>Approach</td><td>756</td><td>3.0</td><td>0.099</td><td>6.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.01</td><td>67.0</td></tr><tr><td colspan="12">South East Denman Road (SE)</td></tr><tr><td>25</td><td>L</td><td>L</td><td>916</td><td>3.9</td><td>0.099</td><td>12.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>70.0</td></tr><tr><td>26</td><td>T</td><td>T</td><td>360</td><td>2.0</td><td>0.046</td><td>9.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>100.0</td></tr><tr><td>Approach</td><td>756</td><td>3.0</td><td>0.099</td><td>6.0</td><td>L0S A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.01</td><td>67.0</td></tr><tr><td colspan="12">South West Denman Road (SW)</td></tr><tr><td>27</td><td>L</td><td>L</td><td>144</td><td>3.8</td><td>0.040</td><td>16.0</td><td>L0S A</td><td>1.0</td><td>11.0</td><td>0.00</td><td>67.0</td></tr><tr><td>28</td></tr></table>	Movement Performance - Vehicles												Mov ID	Turn	Control	Flow veh/h	PHV %	Seg Type	Average Delay sec	Level of Service	95% Back of Queue Vehicle Length m	Prop. Queue	Effective Stop Time per veh	Average Speed km/h	East Denman Road (E)												21	L	L	137	12.0	0.224	16.0	L0S B	1.1	8.2	0.60	68.0	22	R	R	138	6.6	0.277	18.0	L0S B	1.4	10.1	0.86	67.0	Approach	272	10.0	0.277	17.4	L0S B	1.4	10.0	0.80	0.80	62.0	North East Denman Road (NE)												23	L	L	916	3.9	0.099	12.0	L0S A	0.0	0.0	0.00	70.0	24	T	T	360	2.0	0.046	9.0	L0S A	0.0	0.0	0.00	100.0	Approach	756	3.0	0.099	6.0	L0S A	0.0	0.0	0.00	0.01	67.0	South East Denman Road (SE)												25	L	L	916	3.9	0.099	12.0	L0S A	0.0	0.0	0.00	70.0	26	T	T	360	2.0	0.046	9.0	L0S A	0.0	0.0	0.00	100.0	Approach	756	3.0	0.099	6.0	L0S A	0.0	0.0	0.00	0.01	67.0	South West Denman Road (SW)												27	L	L	144	3.8	0.040	16.0	L0S A	1.0	11.0	0.00	67.0	28																																																																																																																																																																																																																																																																																																					
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Approach	286	10.0	0.272	17.3	L0S B	1.4	10.0	0.80	0.80	62.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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23	T	T	238	5.0	0.125	12.0	L0S A	0.0	0.0	0.00	80.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
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Approach	754	5.0	0.125	9.0	L0S A	0.0	0.0	0.00	0.01	87.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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22	R	R	138	6.6	0.277	18.0	L0S B	1.4	10.1	0.86	67.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
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24	T	T	360	2.0	0.046	9.0	L0S A	0.0	0.0	0.00	100.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
Approach	756	3.0	0.099	6.0	L0S A	0.0	0.0	0.00	0.01	67.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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PM peak 1600- 1700 New England Highway/ Thomas Mitchell Drive	<table><tr><th colspan="12">Movement Performance - Vehicles</th></tr><tr><th>Mov ID</th><th>Turn</th><th>Demand Flow veh/h</th><th>HV %</th><th>Deg. Satn v/c</th><th>Average Delay sec</th><th>Level of Service</th><th>95% Back of Queue Vehicles veh</th><th>Distance m</th><th>Prop. Queued</th><th>Effective Stop Rate per veh</th><th>Average Speed km/h</th></tr><tr><td colspan="12">South: New England Highway (S)</td></tr><tr><td>4</td><td>L</td><td>75</td><td>20.0</td><td>0.246</td><td>14.5</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.77</td><td>59.2</td></tr><tr><td>5</td><td>T</td><td>403</td><td>10.9</td><td>0.249</td><td>9.0</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.00</td><td>100.0</td></tr><tr><td>Approach</td><td></td><td>525</td><td>12.2</td><td>0.249</td><td>11.9</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.10</td><td>94.2</td></tr><tr><td colspan="12">North: New England Highway (N)</td></tr><tr><td>11</td><td>T</td><td>547</td><td>16.0</td><td>0.310</td><td>0.0</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.00</td><td>100.0</td></tr><tr><td>12</td><td>R</td><td>11</td><td>20.0</td><td>0.021</td><td>16.0</td><td>LOS B</td><td>0.1</td><td>0.7</td><td>0.04</td><td>1.00</td><td>51.4</td></tr><tr><td>Approach</td><td></td><td>558</td><td>16.0</td><td>0.310</td><td>0.4</td><td>LOS B</td><td>0.1</td><td>0.7</td><td>0.01</td><td>0.02</td><td>98.9</td></tr><tr><td colspan="12">West: Thomas Mitchell Drive</td></tr><tr><td>1</td><td>L</td><td>39</td><td>8.1</td><td>0.081</td><td>16.7</td><td>LOS B</td><td>0.0</td><td>0.0</td><td>0.01</td><td>0.01</td><td>53.4</td></tr><tr><td>3</td><td>R</td><td>207</td><td>4.1</td><td>0.091</td><td>34.1</td><td>LOS C</td><td>4.5</td><td>33.0</td><td>0.00</td><td>1.12</td><td>45.4</td></tr><tr><td>Approach</td><td></td><td>246</td><td>4.7</td><td>0.091</td><td>31.3</td><td>LOS C</td><td>4.5</td><td>33.0</td><td>0.04</td><td>1.07</td><td>46.2</td></tr><tr><td>All Vehicles</td><td></td><td>1325</td><td>12.5</td><td>0.402</td><td>6.7</td><td>N/A</td><td>4.8</td><td>33.0</td><td>0.16</td><td>0.24</td><td>81.0</td></tr></table>	Movement Performance - Vehicles												Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h	South: New England Highway (S)												4	L	75	20.0	0.246	14.5	LOS A	0.0	0.0	0.00	0.77	59.2	5	T	403	10.9	0.249	9.0	LOS A	0.0	0.0	0.00	0.00	100.0	Approach		525	12.2	0.249	11.9	LOS A	0.0	0.0	0.00	0.10	94.2	North: New England Highway (N)												11	T	547	16.0	0.310	0.0	LOS A	0.0	0.0	0.00	0.00	100.0	12	R	11	20.0	0.021	16.0	LOS B	0.1	0.7	0.04	1.00	51.4	Approach		558	16.0	0.310	0.4	LOS B	0.1	0.7	0.01	0.02	98.9	West: Thomas Mitchell Drive												1	L	39	8.1	0.081	16.7	LOS B	0.0	0.0	0.01	0.01	53.4	3	R	207	4.1	0.091	34.1	LOS C	4.5	33.0	0.00	1.12	45.4	Approach		246	4.7	0.091	31.3	LOS C	4.5	33.0	0.04	1.07	46.2	All Vehicles		1325	12.5	0.402	6.7	N/A	4.8	33.0	0.16	0.24	81.0	<table><tr><th colspan="12">Movement Performance - Vehicles</th></tr><tr><th>Mov ID</th><th>Turn</th><th>Demand Flow veh/h</th><th>HV %</th><th>Deg. 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Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h	South: New England Highway (S)												4	L	74	20.0	0.245	14.4	LOS A	0.0	0.0	0.00	0.77	59.2	5	T	403	10.9	0.249	9.0	LOS A	0.0	0.0	0.00	0.00	100.0	Approach		526	12.2	0.249	11.9	LOS A	0.0	0.0	0.00	0.11	95.0	North: New England Highway (N)												11	T	547	16.0	0.310	0.0	LOS A	0.0	0.0	0.00	0.00	100.0	12	R	11	20.0	0.021	16.1	LOS B	0.1	0.7	0.04	1.00	51.4	Approach		559	16.0	0.310	0.4	LOS B	0.1	0.7	0.01	0.02	98.9	West: Thomas Mitchell Drive												1	L	39	8.1	0.081	16.7	LOS B	0.0	0.0	0.01	0.01	53.3	3	R	207	4.1	0.091	34.5	LOS C	4.7	33.7	0.01	1.13	45.2	Approach		246	4.7	0.091	31.7	LOS C	4.7	33.7	0.04	1.09	45.9	All Vehicles		1331	12.4	0.401	6.8	N/A	4.7	33.7	0.16	0.25	80.7	See subsequent table.	See subsequent table.
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All Vehicles		1331	12.4	0.401	6.8	N/A	4.7	33.7	0.16	0.25	80.7																																																																																																																																																																																																																																																																																																																																																																	

Location/ period	Peak construction case with seagull configuration (first stage crossing)	Peak construction case with seagull configuration (second stage entry)																																																																																																																																																																																																																																																																																				
AM peak 0600-0700 New England Highway/ Thomas Mitchell Drive With seagull configuration	<table><tr><th colspan="12">Movement Performance - Vehicles</th></tr><tr><th>Mov ID</th><th>Turn</th><th>Demand Flow veh/h</th><th>HV %</th><th>Deg. Satn v/c</th><th>Average Delay sec</th><th>Level of Service</th><th>95% Back of Queue Vehicles veh</th><th>Queue Distance m</th><th>Prop. Queued</th><th>Effective Stop Rate per veh</th><th>Average Speed km/h</th></tr><tr><td colspan="12">South: New England Highway (S)</td></tr><tr><td>24</td><td>L</td><td>429</td><td>10.0</td><td>0.248</td><td>13.2</td><td>X</td><td>X</td><td>X</td><td>X</td><td>0.69</td><td>59.1</td></tr><tr><td>25</td><td>T</td><td>578</td><td>23.9</td><td>0.342</td><td>0.0</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.00</td><td>100.0</td></tr><tr><td>Approach</td><td></td><td>1007</td><td>18.0</td><td>0.342</td><td>5.6</td><td>NA</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.30</td><td>82.0</td></tr><tr><td colspan="12">North: New England Highway (N)</td></tr><tr><td>32</td><td>R</td><td>89</td><td>2.4</td><td>0.099</td><td>15.4</td><td>LOS B</td><td>0.4</td><td>3.0</td><td>0.58</td><td>0.82</td><td>59.9</td></tr><tr><td>Approach</td><td></td><td>89</td><td>2.4</td><td>0.099</td><td>15.4</td><td>NA</td><td>0.4</td><td>3.0</td><td>0.58</td><td>0.82</td><td>59.9</td></tr><tr><td colspan="12">West: Thomas Mitchell Drive</td></tr><tr><td>21</td><td>L</td><td>17</td><td>0.0</td><td>0.009</td><td>13.1</td><td>X</td><td>X</td><td>X</td><td>X</td><td>0.76</td><td>43.3</td></tr><tr><td>23</td><td>R</td><td>157</td><td>9.4</td><td>0.253</td><td>18.2</td><td>LOS B</td><td>1.1</td><td>8.5</td><td>0.70</td><td>0.94</td><td>55.6</td></tr><tr><td>Approach</td><td></td><td>174</td><td>8.5</td><td>0.253</td><td>17.7</td><td>LOS B</td><td>1.1</td><td>8.5</td><td>0.64</td><td>0.92</td><td>54.9</td></tr><tr><td>All Vehicles</td><td></td><td>1271</td><td>15.6</td><td>0.342</td><td>8.0</td><td>NA</td><td>1.1</td><td>8.5</td><td>0.13</td><td>0.42</td><td>74.6</td></tr></table>	Movement Performance - Vehicles												Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h	South: New England Highway (S)												24	L	429	10.0	0.248	13.2	X	X	X	X	0.69	59.1	25	T	578	23.9	0.342	0.0	LOS A	0.0	0.0	0.00	0.00	100.0	Approach		1007	18.0	0.342	5.6	NA	0.0	0.0	0.00	0.30	82.0	North: New England Highway (N)												32	R	89	2.4	0.099	15.4	LOS B	0.4	3.0	0.58	0.82	59.9	Approach		89	2.4	0.099	15.4	NA	0.4	3.0	0.58	0.82	59.9	West: Thomas Mitchell Drive												21	L	17	0.0	0.009	13.1	X	X	X	X	0.76	43.3	23	R	157	9.4	0.253	18.2	LOS B	1.1	8.5	0.70	0.94	55.6	Approach		174	8.5	0.253	17.7	LOS B	1.1	8.5	0.64	0.92	54.9	All Vehicles		1271	15.6	0.342	8.0	NA	1.1	8.5	0.13	0.42	74.6	<table><tr><th colspan="12">Movement Performance - Vehicles</th></tr><tr><th>Mov ID</th><th>Turn</th><th>Demand Flow veh/h</th><th>HV %</th><th>Deg. Satn v/c</th><th>Average Delay sec</th><th>Level of Service</th><th>95% Back of Queue Vehicles veh</th><th>Queue Distance m</th><th>Prop. Queued</th><th>Effective Stop Rate per veh</th><th>Average Speed km/h</th></tr><tr><td colspan="12">North: New England Highway (N)</td></tr><tr><td>1</td><td>T</td><td>737</td><td>9.7</td><td>0.402</td><td>0.0</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.00</td><td>100.0</td></tr><tr><td>Approach</td><td></td><td>737</td><td>9.7</td><td>0.402</td><td>0.0</td><td>NA</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.00</td><td>100.0</td></tr><tr><td colspan="12">North West: RT acceleration lane TMD</td></tr><tr><td>2</td><td>T</td><td>157</td><td>9.4</td><td>0.169</td><td>2.3</td><td>LOS A</td><td>0.5</td><td>3.9</td><td>0.51</td><td>0.21</td><td>82.5</td></tr><tr><td>Approach</td><td></td><td>157</td><td>9.4</td><td>0.169</td><td>2.3</td><td>LOS A</td><td>0.5</td><td>3.9</td><td>0.51</td><td>0.21</td><td>82.5</td></tr><tr><td>All Vehicles</td><td></td><td>894</td><td>9.7</td><td>0.402</td><td>0.4</td><td>NA</td><td>0.5</td><td>3.9</td><td>0.09</td><td>0.04</td><td>96.7</td></tr></table>	Movement Performance - Vehicles												Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h	North: New England Highway (N)												1	T	737	9.7	0.402	0.0	LOS A	0.0	0.0	0.00	0.00	100.0	Approach		737	9.7	0.402	0.0	NA	0.0	0.0	0.00	0.00	100.0	North West: RT acceleration lane TMD												2	T	157	9.4	0.169	2.3	LOS A	0.5	3.9	0.51	0.21	82.5	Approach		157	9.4	0.169	2.3	LOS A	0.5	3.9	0.51	0.21	82.5	All Vehicles		894	9.7	0.402	0.4	NA	0.5	3.9	0.09	0.04	96.7
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Location/ period	Peak operational case with seagull configuration (first stage crossing)	Peak operational case with seagull configuration (second stage entry)																																																																																																																																																																																																																																																																																																																																																																								
AM peak 0600-0700 New England Highway/ Thomas Mitchell Drive With seagull configuration	<table><tr><th colspan="12">Movement Performance - Vehicles</th></tr><tr><th>Mov ID</th><th>Turn</th><th>Demand Flow veh/h</th><th>HV %</th><th>Dep. Satn v/s</th><th>Average Delay sec</th><th>Level of Service</th><th>95% Back of Queue Vehicles veh</th><th>95% Back of Queue Distance m</th><th>Prog. 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32	R	11	20.0	0.015	17.7	LOS B	0.1	0.6	0.60	0.77	55.4																																																																																																																																																																																																																																																																																																																																																															
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21	L	36	5.1	0.022	13.5	NA ¹	NA ¹	NA ¹	0.00	0.76	43.3																																																																																																																																																																																																																																																																																																																																																															
23	R	271	6.4	0.313	16.0	LOS B	2.0	14.9	0.65	0.84	57.8																																																																																																																																																																																																																																																																																																																																																															
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		309	5.6	0.313	15.7	LOS B	2.0	14.9	0.57	0.82	56.7																																																																																																																																																																																																																																																																																																																																																															
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		1127	3.6	0.362	5.7	NA	2.0	14.9	0.16	0.32	80.0																																																																																																																																																																																																																																																																																																																																																															
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Mov ID	Turn	Demand Flow veh/h	HV %	Dep. Satn v/s	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prog. Queue	Effective Stop Rate per veh	Average Speed km/h																																																																																																																																																																																																																																																																																																																																																															
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1	T	854	15.9	0.483	9.0	LOS A	0.0	0.0	0.00	0.00	100.0																																																																																																																																																																																																																																																																																																																																																															
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North West: RT acceleration lane TMD																																																																																																																																																																																																																																																																																																																																																																										
2	T	271	5.4	0.336	3.8	LOS A	1.5	11.1	0.65	0.36	78.7																																																																																																																																																																																																																																																																																																																																																															
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		1124	13.4	0.483	0.9	NA	1.5	11.1	0.16	0.09	94.2																																																																																																																																																																																																																																																																																																																																																															

Location/ period	Year 15 cumulative case																																																																																																																																																																																																																																				
AM peak 0600-0700 Denman/ Bengalla Link Road	<table><tr><th colspan="12">Movement Performance - Vehicles</th></tr><tr><th>Mov ID</th><th>Turn</th><th>Demand Flow veh/h</th><th>HV %</th><th>Dep. Satn v/s</th><th>Average Delay sec</th><th>Level of Service</th><th>95% Back of Queue Vehicles veh</th><th>95% Back of Queue Distance m</th><th>Prog. Queue</th><th>Effective Stop Rate per veh</th><th>Average Speed km/h</th></tr><tr><td colspan="12">East: Denman Road (E)</td></tr><tr><td>5</td><td>T</td><td>165</td><td>14.0</td><td>0.092</td><td>9.0</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.00</td><td>80.0</td></tr><tr><td>6</td><td>R</td><td>582</td><td>4.3</td><td>0.729</td><td>19.1</td><td>LOS B</td><td>10.0</td><td>72.8</td><td>0.74</td><td>1.12</td><td>54.2</td></tr><tr><td colspan="12">Approach</td></tr><tr><td></td><td></td><td>747</td><td>6.5</td><td>0.729</td><td>14.9</td><td>LOS B</td><td>10.0</td><td>72.8</td><td>0.58</td><td>0.87</td><td>58.0</td></tr><tr><td colspan="12">North: Bengalla Link Road</td></tr><tr><td>7</td><td>L</td><td>240</td><td>5.3</td><td>0.303</td><td>14.7</td><td>LOS B</td><td>1.6</td><td>11.7</td><td>0.42</td><td>0.76</td><td>61.2</td></tr><tr><td>9</td><td>R</td><td>16</td><td>0.0</td><td>0.304</td><td>14.3</td><td>LOS A</td><td>1.6</td><td>11.7</td><td>0.42</td><td>0.87</td><td>61.5</td></tr><tr><td colspan="12">Approach</td></tr><tr><td></td><td></td><td>256</td><td>4.9</td><td>0.303</td><td>14.7</td><td>LOS B</td><td>1.6</td><td>11.7</td><td>0.42</td><td>0.76</td><td>61.2</td></tr><tr><td colspan="12">West: Denman Road (W)</td></tr><tr><td>10</td><td>L</td><td>39</td><td>0.0</td><td>0.021</td><td>11.3</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.73</td><td>63.3</td></tr><tr><td>11</td><td>T</td><td>227</td><td>2.6</td><td>0.119</td><td>9.0</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.00</td><td>80.0</td></tr><tr><td colspan="12">Approach</td></tr><tr><td></td><td></td><td>266</td><td>2.4</td><td>0.119</td><td>1.7</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.11</td><td>76.7</td></tr><tr><td colspan="12">All Vehicles</td></tr><tr><td></td><td></td><td>1269</td><td>5.3</td><td>0.729</td><td>12.1</td><td>NA</td><td>10.0</td><td>72.8</td><td>0.42</td><td>0.69</td><td>61.6</td></tr></table>	Movement Performance - Vehicles												Mov ID	Turn	Demand Flow veh/h	HV %	Dep. Satn v/s	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prog. Queue	Effective Stop Rate per veh	Average Speed km/h	East: Denman Road (E)												5	T	165	14.0	0.092	9.0	LOS A	0.0	0.0	0.00	0.00	80.0	6	R	582	4.3	0.729	19.1	LOS B	10.0	72.8	0.74	1.12	54.2	Approach														747	6.5	0.729	14.9	LOS B	10.0	72.8	0.58	0.87	58.0	North: Bengalla Link Road												7	L	240	5.3	0.303	14.7	LOS B	1.6	11.7	0.42	0.76	61.2	9	R	16	0.0	0.304	14.3	LOS A	1.6	11.7	0.42	0.87	61.5	Approach														256	4.9	0.303	14.7	LOS B	1.6	11.7	0.42	0.76	61.2	West: Denman Road (W)												10	L	39	0.0	0.021	11.3	LOS A	0.0	0.0	0.00	0.73	63.3	11	T	227	2.6	0.119	9.0	LOS A	0.0	0.0	0.00	0.00	80.0	Approach														266	2.4	0.119	1.7	LOS A	0.0	0.0	0.00	0.11	76.7	All Vehicles														1269	5.3	0.729	12.1	NA	10.0	72.8	0.42	0.69	61.6
Movement Performance - Vehicles																																																																																																																																																																																																																																					
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PM peak 1600-1700 Denman/ Bengalla Link Road	<table><tr><th colspan="12">Movement Performance - Vehicles</th></tr><tr><th>Mov ID</th><th>Turn</th><th>Demand Flow veh/h</th><th>HV %</th><th>Dep. Satn v/s</th><th>Average Delay sec</th><th>Level of Service</th><th>95% Back of Queue Vehicles veh</th><th>95% Back of Queue Distance m</th><th>Prog. Queue</th><th>Effective Stop Rate per veh</th><th>Average Speed km/h</th></tr><tr><td colspan="12">East: Denman Road (E)</td></tr><tr><td>5</td><td>T</td><td>263</td><td>3.2</td><td>0.136</td><td>9.0</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.00</td><td>80.0</td></tr><tr><td>6</td><td>R</td><td>212</td><td>3.5</td><td>0.290</td><td>14.8</td><td>LOS B</td><td>1.6</td><td>11.3</td><td>0.54</td><td>0.87</td><td>59.0</td></tr><tr><td colspan="12">Approach</td></tr><tr><td></td><td></td><td>475</td><td>3.3</td><td>0.290</td><td>6.6</td><td>LOS B</td><td>1.6</td><td>11.3</td><td>0.24</td><td>0.39</td><td>66.4</td></tr><tr><td colspan="12">North: Bengalla Link Road</td></tr><tr><td>7</td><td>L</td><td>475</td><td>3.3</td><td>0.560</td><td>16.0</td><td>LOS B</td><td>5.8</td><td>41.6</td><td>0.52</td><td>0.82</td><td>59.1</td></tr><tr><td>9</td><td>R</td><td>34</td><td>0.0</td><td>0.561</td><td>15.7</td><td>LOS B</td><td>5.8</td><td>41.6</td><td>0.52</td><td>0.93</td><td>59.4</td></tr><tr><td colspan="12">Approach</td></tr><tr><td></td><td></td><td>508</td><td>3.1</td><td>0.561</td><td>16.0</td><td>LOS B</td><td>5.8</td><td>41.6</td><td>0.52</td><td>0.83</td><td>59.1</td></tr><tr><td colspan="12">West: Denman Road (W)</td></tr><tr><td>10</td><td>L</td><td>13</td><td>6.3</td><td>0.007</td><td>12.0</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.74</td><td>63.3</td></tr><tr><td>11</td><td>T</td><td>200</td><td>14.7</td><td>0.112</td><td>9.0</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.00</td><td>80.0</td></tr><tr><td colspan="12">Approach</td></tr><tr><td></td><td></td><td>213</td><td>14.4</td><td>0.112</td><td>0.7</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.04</td><td>76.6</td></tr><tr><td colspan="12">All Vehicles</td></tr><tr><td></td><td></td><td>1196</td><td>5.2</td><td>0.561</td><td>9.6</td><td>NA</td><td>5.8</td><td>41.6</td><td>0.31</td><td>0.51</td><td>65.7</td></tr></table>	Movement Performance - Vehicles												Mov ID	Turn	Demand Flow veh/h	HV %	Dep. Satn v/s	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prog. Queue	Effective Stop Rate per veh	Average Speed km/h	East: Denman Road (E)												5	T	263	3.2	0.136	9.0	LOS A	0.0	0.0	0.00	0.00	80.0	6	R	212	3.5	0.290	14.8	LOS B	1.6	11.3	0.54	0.87	59.0	Approach														475	3.3	0.290	6.6	LOS B	1.6	11.3	0.24	0.39	66.4	North: Bengalla Link Road												7	L	475	3.3	0.560	16.0	LOS B	5.8	41.6	0.52	0.82	59.1	9	R	34	0.0	0.561	15.7	LOS B	5.8	41.6	0.52	0.93	59.4	Approach														508	3.1	0.561	16.0	LOS B	5.8	41.6	0.52	0.83	59.1	West: Denman Road (W)												10	L	13	6.3	0.007	12.0	LOS A	0.0	0.0	0.00	0.74	63.3	11	T	200	14.7	0.112	9.0	LOS A	0.0	0.0	0.00	0.00	80.0	Approach														213	14.4	0.112	0.7	LOS A	0.0	0.0	0.00	0.04	76.6	All Vehicles														1196	5.2	0.561	9.6	NA	5.8	41.6	0.31	0.51	65.7
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		1196	5.2	0.561	9.6	NA	5.8	41.6	0.31	0.51	65.7																																																																																																																																																																																																																										

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AM peak 0600-0700 New England Highway/ Thomas Mitchell Drive (existing configuration)	<table><tr><th colspan="11">Movement Performance - Vehicles</th></tr><tr><th>Mov ID</th><th>Turn</th><th>Demand Flow veh/s</th><th>HV %</th><th>Dep. Satn. s/s</th><th>Average Delay sec</th><th>Level of Service</th><th>95% Back of Queue Vehicles veh</th><th>95% Back of Queue Distance m</th><th>Prog. Queue</th><th>Effective Stop Rate per veh</th><th>Average Speed km/h</th></tr><tr><td colspan="11">South New England Highway (S)</td></tr><tr><td>4</td><td>L</td><td>689</td><td>7.2</td><td>0.390</td><td>13.2</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.76</td><td>59.2</td></tr><tr><td>5</td><td>T</td><td>659</td><td>23.9</td><td>0.509</td><td>0.0</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.00</td><td>100.0</td></tr><tr><td>Approach</td><td></td><td>1348</td><td>16.5</td><td>0.509</td><td>5.9</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.34</td><td>61.1</td></tr><tr><td colspan="11">North New England Highway (N)</td></tr><tr><td>11</td><td>T</td><td>1093</td><td>9.7</td><td>0.596</td><td>0.0</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.00</td><td>100.0</td></tr><tr><td>12</td><td>R</td><td>89</td><td>2.4</td><td>1.260</td><td>363.2</td><td>LOS F</td><td>18.3</td><td>130.5</td><td>1.00</td><td>1.69</td><td>4.8</td></tr><tr><td>Approach</td><td></td><td>1182</td><td>9.2</td><td>1.260</td><td>27.5</td><td>LOS F</td><td>18.3</td><td>130.5</td><td>0.06</td><td>0.13</td><td>50.5</td></tr><tr><td colspan="11">West Thomas Mitchell Drive</td></tr><tr><td>1</td><td>L</td><td>17</td><td>0.0</td><td>0.103</td><td>33.4</td><td>LOS C</td><td>0.4</td><td>2.7</td><td>0.86</td><td>0.97</td><td>35.3</td></tr><tr><td>3</td><td>R</td><td>288</td><td>7.3</td><td>4.807</td><td>3706.8</td><td>LOS F</td><td>155.2</td><td>1154.0</td><td>1.00</td><td>3.14</td><td>0.8</td></tr><tr><td>Approach</td><td></td><td>305</td><td>6.9</td><td>4.807</td><td>3606.1</td><td>LOS F</td><td>155.2</td><td>1154.0</td><td>0.99</td><td>3.02</td><td>0.8</td></tr><tr><td>All Vehicles</td><td></td><td>3036</td><td>12.7</td><td>4.807</td><td>366.3</td><td>NA</td><td>155.2</td><td>1154.0</td><td>0.13</td><td>0.53</td><td>6.6</td></tr></table>	Movement Performance - Vehicles											Mov ID	Turn	Demand Flow veh/s	HV %	Dep. Satn. s/s	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prog. Queue	Effective Stop Rate per veh	Average Speed km/h	South New England Highway (S)											4	L	689	7.2	0.390	13.2	LOS A	0.0	0.0	0.00	0.76	59.2	5	T	659	23.9	0.509	0.0	LOS A	0.0	0.0	0.00	0.00	100.0	Approach		1348	16.5	0.509	5.9	LOS A	0.0	0.0	0.00	0.34	61.1	North New England Highway (N)											11	T	1093	9.7	0.596	0.0	LOS A	0.0	0.0	0.00	0.00	100.0	12	R	89	2.4	1.260	363.2	LOS F	18.3	130.5	1.00	1.69	4.8	Approach		1182	9.2	1.260	27.5	LOS F	18.3	130.5	0.06	0.13	50.5	West Thomas Mitchell Drive											1	L	17	0.0	0.103	33.4	LOS C	0.4	2.7	0.86	0.97	35.3	3	R	288	7.3	4.807	3706.8	LOS F	155.2	1154.0	1.00	3.14	0.8	Approach		305	6.9	4.807	3606.1	LOS F	155.2	1154.0	0.99	3.02	0.8	All Vehicles		3036	12.7	4.807	366.3	NA	155.2	1154.0	0.13	0.53	6.6
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Approach		305	6.9	4.807	3606.1	LOS F	155.2	1154.0	0.99	3.02	0.8																																																																																																																																																																						
All Vehicles		3036	12.7	4.807	366.3	NA	155.2	1154.0	0.13	0.53	6.6																																																																																																																																																																						
PM peak 1600-1700 New England Highway/ Thomas Mitchell Drive (existing configuration)	<table><tr><th colspan="11">Movement Performance - Vehicles</th></tr><tr><th>Mov ID</th><th>Turn</th><th>Demand Flow veh/s</th><th>HV %</th><th>Dep. Satn. s/s</th><th>Average Delay sec</th><th>Level of Service</th><th>95% Back of Queue Vehicles veh</th><th>95% Back of Queue Distance m</th><th>Prog. Queue</th><th>Effective Stop Rate per veh</th><th>Average Speed km/h</th></tr><tr><td colspan="11">South New England Highway (S)</td></tr><tr><td>4</td><td>L</td><td>262</td><td>6.0</td><td>0.149</td><td>13.3</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.76</td><td>59.2</td></tr><tr><td>5</td><td>T</td><td>735</td><td>11.0</td><td>0.388</td><td>0.0</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.00</td><td>100.0</td></tr><tr><td>Approach</td><td></td><td>997</td><td>13.2</td><td>0.388</td><td>3.6</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.21</td><td>68.4</td></tr><tr><td colspan="11">North New England Highway (N)</td></tr><tr><td>11</td><td>T</td><td>654</td><td>15.9</td><td>0.493</td><td>0.0</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.00</td><td>100.0</td></tr><tr><td>12</td><td>R</td><td>11</td><td>20.0</td><td>0.047</td><td>28.7</td><td>LOS C</td><td>0.2</td><td>1.5</td><td>0.79</td><td>0.95</td><td>40.4</td></tr><tr><td>Approach</td><td></td><td>664</td><td>16.0</td><td>0.493</td><td>0.3</td><td>LOS C</td><td>0.2</td><td>1.5</td><td>0.01</td><td>0.01</td><td>96.9</td></tr><tr><td colspan="11">West Thomas Mitchell Drive</td></tr><tr><td>1</td><td>L</td><td>39</td><td>8.1</td><td>0.105</td><td>21.5</td><td>LOS B</td><td>0.4</td><td>3.3</td><td>0.70</td><td>0.93</td><td>46.8</td></tr><tr><td>3</td><td>R</td><td>519</td><td>2.6</td><td>5.580</td><td>4170.6</td><td>LOS F</td><td>281.9</td><td>2021.3</td><td>1.00</td><td>3.95</td><td>0.7</td></tr><tr><td>Approach</td><td></td><td>558</td><td>3.2</td><td>5.564</td><td>3660.9</td><td>LOS F</td><td>281.9</td><td>2021.3</td><td>0.96</td><td>3.74</td><td>0.7</td></tr><tr><td>All Vehicles</td><td></td><td>2389</td><td>10.7</td><td>5.580</td><td>907.7</td><td>NA</td><td>281.9</td><td>2021.3</td><td>0.23</td><td>0.96</td><td>2.9</td></tr></table>	Movement Performance - Vehicles											Mov ID	Turn	Demand Flow veh/s	HV %	Dep. Satn. s/s	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prog. Queue	Effective Stop Rate per veh	Average Speed km/h	South New England Highway (S)											4	L	262	6.0	0.149	13.3	LOS A	0.0	0.0	0.00	0.76	59.2	5	T	735	11.0	0.388	0.0	LOS A	0.0	0.0	0.00	0.00	100.0	Approach		997	13.2	0.388	3.6	LOS A	0.0	0.0	0.00	0.21	68.4	North New England Highway (N)											11	T	654	15.9	0.493	0.0	LOS A	0.0	0.0	0.00	0.00	100.0	12	R	11	20.0	0.047	28.7	LOS C	0.2	1.5	0.79	0.95	40.4	Approach		664	16.0	0.493	0.3	LOS C	0.2	1.5	0.01	0.01	96.9	West Thomas Mitchell Drive											1	L	39	8.1	0.105	21.5	LOS B	0.4	3.3	0.70	0.93	46.8	3	R	519	2.6	5.580	4170.6	LOS F	281.9	2021.3	1.00	3.95	0.7	Approach		558	3.2	5.564	3660.9	LOS F	281.9	2021.3	0.96	3.74	0.7	All Vehicles		2389	10.7	5.580	907.7	NA	281.9	2021.3	0.23	0.96	2.9
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Location/ period	Year 15 cumulative case with seagull configuration (first stage crossing)	Year 15 cumulative case with seagull configuration (second stage entry)																																																																																																																																																																																																																																																																																				
AM peak 0600-0700 Denman Road/ Thomas Mitchell Drive With seagull configuration	<table><tr><th colspan="12">Movement Performance - Vehicles</th></tr><tr><th>Mov ID</th><th>Turn</th><th>Demand Flow veh/s</th><th>HV %</th><th>Deq Sat. v/s</th><th>Average Delay sec</th><th>Level of Service</th><th>95% Back of Queue Vehicles veh</th><th>95% Back of Queue Distance m</th><th>Prop. Queue</th><th>Effective Stop Rate per veh</th><th>Average Speed km/h</th></tr><tr><td colspan="12">South East: Thomas Mitchell Drive</td></tr><tr><td>21</td><td>L</td><td>276</td><td>5.4</td><td>0.157</td><td>13.5</td><td>NA¹</td><td>NA¹</td><td>NA¹</td><td>0.00</td><td>0.76</td><td>43.2</td></tr><tr><td>23</td><td>R</td><td>245</td><td>4.7</td><td>0.415</td><td>20.1</td><td>LOS B</td><td>2.6</td><td>20.1</td><td>0.76</td><td>1.02</td><td>53.2</td></tr><tr><td>Approach</td><td></td><td>521</td><td>6.7</td><td>0.415</td><td>16.6</td><td>LOS B</td><td>2.6</td><td>20.1</td><td>0.37</td><td>0.88</td><td>49.4</td></tr><tr><td colspan="12">North East: Denman Road (N)</td></tr><tr><td>24</td><td>L</td><td>681</td><td>2.9</td><td>0.374</td><td>12.7</td><td>NA¹</td><td>NA¹</td><td>NA¹</td><td>0.00</td><td>0.69</td><td>59.0</td></tr><tr><td>25</td><td>T</td><td>545</td><td>2.3</td><td>0.284</td><td>9.0</td><td>LOS A</td><td>0.0</td><td>9.0</td><td>0.00</td><td>0.00</td><td>100.0</td></tr><tr><td>Approach</td><td></td><td>1226</td><td>2.7</td><td>0.374</td><td>7.0</td><td>LOS A</td><td>0.0</td><td>9.0</td><td>0.00</td><td>0.36</td><td>76.7</td></tr><tr><td colspan="12">South West: Denman Road (S)</td></tr><tr><td>32</td><td>R</td><td>232</td><td>5.0</td><td>0.253</td><td>16.0</td><td>LOS B</td><td>1.5</td><td>16.6</td><td>0.62</td><td>0.88</td><td>59.4</td></tr><tr><td>Approach</td><td></td><td>232</td><td>5.0</td><td>0.253</td><td>16.0</td><td>LOS B</td><td>1.5</td><td>16.6</td><td>0.62</td><td>0.88</td><td>59.4</td></tr><tr><td>All Vehicles</td><td></td><td>1979</td><td>4.0</td><td>0.415</td><td>10.6</td><td>NA</td><td>2.6</td><td>20.1</td><td>0.17</td><td>0.57</td><td>65.7</td></tr></table>	Movement Performance - Vehicles												Mov ID	Turn	Demand Flow veh/s	HV %	Deq Sat. v/s	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queue	Effective Stop Rate per veh	Average Speed km/h	South East: Thomas Mitchell Drive												21	L	276	5.4	0.157	13.5	NA ¹	NA ¹	NA ¹	0.00	0.76	43.2	23	R	245	4.7	0.415	20.1	LOS B	2.6	20.1	0.76	1.02	53.2	Approach		521	6.7	0.415	16.6	LOS B	2.6	20.1	0.37	0.88	49.4	North East: Denman Road (N)												24	L	681	2.9	0.374	12.7	NA ¹	NA ¹	NA ¹	0.00	0.69	59.0	25	T	545	2.3	0.284	9.0	LOS A	0.0	9.0	0.00	0.00	100.0	Approach		1226	2.7	0.374	7.0	LOS A	0.0	9.0	0.00	0.36	76.7	South West: Denman Road (S)												32	R	232	5.0	0.253	16.0	LOS B	1.5	16.6	0.62	0.88	59.4	Approach		232	5.0	0.253	16.0	LOS B	1.5	16.6	0.62	0.88	59.4	All Vehicles		1979	4.0	0.415	10.6	NA	2.6	20.1	0.17	0.57	65.7	<table><tr><th colspan="12">Movement Performance - Vehicles</th></tr><tr><th>Mov ID</th><th>Turn</th><th>Demand Flow veh/s</th><th>HV %</th><th>Deq Sat. v/s</th><th>Average Delay sec</th><th>Level of Service</th><th>95% Back of Queue Vehicles veh</th><th>95% Back of Queue Distance m</th><th>Prop. Queue</th><th>Effective Stop Rate per veh</th><th>Average Speed km/h</th></tr><tr><td colspan="12">South RT acceleration lane TMD</td></tr><tr><td>2</td><td>T</td><td>245</td><td>4.7</td><td>0.157</td><td>0.5</td><td>LOS A</td><td>0.7</td><td>4.8</td><td>0.26</td><td>0.04</td><td>90.6</td></tr><tr><td>Approach</td><td></td><td>245</td><td>4.7</td><td>0.157</td><td>0.5</td><td>LOS A</td><td>0.7</td><td>4.8</td><td>0.26</td><td>0.04</td><td>90.6</td></tr><tr><td colspan="12">South West: Denman Road (SW)</td></tr><tr><td>1</td><td>T</td><td>232</td><td>5.5</td><td>0.123</td><td>0.0</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.00</td><td>100.0</td></tr><tr><td>Approach</td><td></td><td>232</td><td>5.5</td><td>0.123</td><td>0.0</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.00</td><td>100.0</td></tr><tr><td>All Vehicles</td><td></td><td>477</td><td>5.1</td><td>0.157</td><td>0.2</td><td>NA</td><td>0.7</td><td>4.8</td><td>0.13</td><td>0.02</td><td>95.1</td></tr></table>	Movement Performance - Vehicles												Mov ID	Turn	Demand Flow veh/s	HV %	Deq Sat. v/s	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queue	Effective Stop Rate per veh	Average Speed km/h	South RT acceleration lane TMD												2	T	245	4.7	0.157	0.5	LOS A	0.7	4.8	0.26	0.04	90.6	Approach		245	4.7	0.157	0.5	LOS A	0.7	4.8	0.26	0.04	90.6	South West: Denman Road (SW)												1	T	232	5.5	0.123	0.0	LOS A	0.0	0.0	0.00	0.00	100.0	Approach		232	5.5	0.123	0.0	LOS A	0.0	0.0	0.00	0.00	100.0	All Vehicles		477	5.1	0.157	0.2	NA	0.7	4.8	0.13	0.02	95.1
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Approach		232	5.5	0.123	0.0	LOS A	0.0	0.0	0.00	0.00	100.0																																																																																																																																																																																																																																																																											
All Vehicles		477	5.1	0.157	0.2	NA	0.7	4.8	0.13	0.02	95.1																																																																																																																																																																																																																																																																											
AM peak 0600-0700 Denman Road/ Thomas Mitchell Drive With seagull configuration	<table><tr><th colspan="12">Movement Performance - Vehicles</th></tr><tr><th>Mov ID</th><th>Turn</th><th>Demand Flow veh/s</th><th>HV %</th><th>Deq Sat. v/s</th><th>Average Delay sec</th><th>Level of Service</th><th>95% Back of Queue Vehicles veh</th><th>95% Back of Queue Distance m</th><th>Prop. Queue</th><th>Effective Stop Rate per veh</th><th>Average Speed km/h</th></tr><tr><td colspan="12">South East: Thomas Mitchell Drive</td></tr><tr><td>21</td><td>L</td><td>121</td><td>7.8</td><td>0.069</td><td>13.5</td><td>NA¹</td><td>NA¹</td><td>NA¹</td><td>0.00</td><td>0.76</td><td>43.2</td></tr><tr><td>23</td><td>R</td><td>437</td><td>3.1</td><td>0.444</td><td>15.9</td><td>LOS B</td><td>3.8</td><td>27.0</td><td>0.66</td><td>0.97</td><td>57.6</td></tr><tr><td>Approach</td><td></td><td>558</td><td>4.2</td><td>0.444</td><td>15.4</td><td>LOS B</td><td>3.8</td><td>27.0</td><td>0.52</td><td>0.92</td><td>55.6</td></tr><tr><td colspan="12">North East: Denman Road (N)</td></tr><tr><td>24</td><td>L</td><td>139</td><td>6.3</td><td>0.279</td><td>13.0</td><td>NA¹</td><td>NA¹</td><td>NA¹</td><td>0.00</td><td>0.69</td><td>59.2</td></tr><tr><td>25</td><td>T</td><td>377</td><td>3.1</td><td>0.197</td><td>8.8</td><td>LOS A</td><td>0.0</td><td>8.8</td><td>0.00</td><td>0.00</td><td>100.0</td></tr><tr><td>Approach</td><td></td><td>516</td><td>4.5</td><td>0.197</td><td>3.5</td><td>LOS A</td><td>0.0</td><td>8.8</td><td>0.00</td><td>0.19</td><td>88.6</td></tr><tr><td colspan="12">South West: Denman Road (S)</td></tr><tr><td>32</td><td>R</td><td>204</td><td>7.7</td><td>0.177</td><td>14.7</td><td>LOS B</td><td>1.0</td><td>7.7</td><td>0.50</td><td>0.77</td><td>61.3</td></tr><tr><td>Approach</td><td></td><td>204</td><td>7.7</td><td>0.177</td><td>14.7</td><td>LOS B</td><td>1.0</td><td>7.7</td><td>0.50</td><td>0.77</td><td>61.3</td></tr><tr><td>All Vehicles</td><td></td><td>1270</td><td>4.9</td><td>0.444</td><td>10.5</td><td>NA</td><td>3.8</td><td>27.0</td><td>0.31</td><td>0.60</td><td>66.9</td></tr></table>	Movement Performance - Vehicles												Mov ID	Turn	Demand Flow veh/s	HV %	Deq Sat. v/s	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queue	Effective Stop Rate per veh	Average Speed km/h	South East: Thomas Mitchell Drive												21	L	121	7.8	0.069	13.5	NA ¹	NA ¹	NA ¹	0.00	0.76	43.2	23	R	437	3.1	0.444	15.9	LOS B	3.8	27.0	0.66	0.97	57.6	Approach		558	4.2	0.444	15.4	LOS B	3.8	27.0	0.52	0.92	55.6	North East: Denman Road (N)												24	L	139	6.3	0.279	13.0	NA ¹	NA ¹	NA ¹	0.00	0.69	59.2	25	T	377	3.1	0.197	8.8	LOS A	0.0	8.8	0.00	0.00	100.0	Approach		516	4.5	0.197	3.5	LOS A	0.0	8.8	0.00	0.19	88.6	South West: Denman Road (S)												32	R	204	7.7	0.177	14.7	LOS B	1.0	7.7	0.50	0.77	61.3	Approach		204	7.7	0.177	14.7	LOS B	1.0	7.7	0.50	0.77	61.3	All Vehicles		1270	4.9	0.444	10.5	NA	3.8	27.0	0.31	0.60	66.9	<table><tr><th colspan="12">Movement Performance - Vehicles</th></tr><tr><th>Mov ID</th><th>Turn</th><th>Demand Flow veh/s</th><th>HV %</th><th>Deq Sat. v/s</th><th>Average Delay sec</th><th>Level of Service</th><th>95% Back of Queue Vehicles veh</th><th>95% Back of Queue Distance m</th><th>Prop. Queue</th><th>Effective Stop Rate per veh</th><th>Average Speed km/h</th></tr><tr><td colspan="12">South RT acceleration lane TMD</td></tr><tr><td>2</td><td>T</td><td>437</td><td>3.1</td><td>0.336</td><td>1.4</td><td>LOS A</td><td>1.7</td><td>12.0</td><td>0.43</td><td>0.14</td><td>84.9</td></tr><tr><td>Approach</td><td></td><td>437</td><td>3.1</td><td>0.335</td><td>1.4</td><td>LOS A</td><td>1.7</td><td>12.0</td><td>0.43</td><td>0.14</td><td>84.9</td></tr><tr><td colspan="12">South West: Denman Road (SW)</td></tr><tr><td>1</td><td>T</td><td>483</td><td>4.6</td><td>0.256</td><td>0.0</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.00</td><td>100.0</td></tr><tr><td>Approach</td><td></td><td>483</td><td>4.6</td><td>0.255</td><td>0.0</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.00</td><td>100.0</td></tr><tr><td>All Vehicles</td><td></td><td>920</td><td>4.8</td><td>0.336</td><td>0.7</td><td>NA</td><td>1.7</td><td>12.0</td><td>0.20</td><td>0.07</td><td>92.5</td></tr></table>	Movement Performance - Vehicles												Mov ID	Turn	Demand Flow veh/s	HV %	Deq Sat. v/s	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queue	Effective Stop Rate per veh	Average Speed km/h	South RT acceleration lane TMD												2	T	437	3.1	0.336	1.4	LOS A	1.7	12.0	0.43	0.14	84.9	Approach		437	3.1	0.335	1.4	LOS A	1.7	12.0	0.43	0.14	84.9	South West: Denman Road (SW)												1	T	483	4.6	0.256	0.0	LOS A	0.0	0.0	0.00	0.00	100.0	Approach		483	4.6	0.255	0.0	LOS A	0.0	0.0	0.00	0.00	100.0	All Vehicles		920	4.8	0.336	0.7	NA	1.7	12.0	0.20	0.07	92.5
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PM peak 1600-1700 New England Highway/ Thomas Mitchell Drive With seagull configuration	<table><tr><th colspan="12">Movement Performance - Vehicles</th></tr><tr><th>Mov ID</th><th>Turn</th><th>Demand Flow veh/s</th><th>HV %</th><th>Deq Sat. v/s</th><th>Average Delay sec</th><th>Level of Service</th><th>95% Back of Queue Vehicles veh</th><th>95% Back of Queue Distance m</th><th>Prop. Queue</th><th>Effective Stop Rate per veh</th><th>Average Speed km/h</th></tr><tr><td colspan="12">South: New England Highway (S)</td></tr><tr><td>24</td><td>L</td><td>262</td><td>6.0</td><td>0.149</td><td>13.0</td><td>NA¹</td><td>NA¹</td><td>NA¹</td><td>0.00</td><td>0.69</td><td>59.1</td></tr><tr><td>25</td><td>T</td><td>705</td><td>0.3</td><td>0.362</td><td>8.0</td><td>LOS A</td><td>0.0</td><td>8.0</td><td>0.00</td><td>0.00</td><td>100.0</td></tr><tr><td>Approach</td><td></td><td>967</td><td>2.4</td><td>0.362</td><td>3.5</td><td>LOS A</td><td>0.0</td><td>8.0</td><td>0.00</td><td>0.19</td><td>88.5</td></tr><tr><td colspan="12">North: New England Highway (N)</td></tr><tr><td>32</td><td>R</td><td>11</td><td>20.0</td><td>0.015</td><td>17.7</td><td>LOS B</td><td>0.1</td><td>0.6</td><td>0.60</td><td>0.77</td><td>56.4</td></tr><tr><td>Approach</td><td></td><td>11</td><td>20.0</td><td>0.015</td><td>17.7</td><td>LOS B</td><td>0.1</td><td>0.6</td><td>0.60</td><td>0.77</td><td>56.4</td></tr><tr><td colspan="12">West: Thomas Mitchell Drive</td></tr><tr><td>21</td><td>L</td><td>39</td><td>6.1</td><td>0.022</td><td>13.5</td><td>NA¹</td><td>NA¹</td><td>NA¹</td><td>0.00</td><td>0.76</td><td>43.3</td></tr><tr><td>23</td><td>R</td><td>519</td><td>2.6</td><td>0.647</td><td>20.1</td><td>LOS B</td><td>6.8</td><td>49.0</td><td>0.76</td><td>1.14</td><td>53.1</td></tr><tr><td>Approach</td><td></td><td>558</td><td>3.2</td><td>0.647</td><td>19.6</td><td>LOS B</td><td>6.8</td><td>49.0</td><td>0.72</td><td>1.11</td><td>52.7</td></tr><tr><td>All Vehicles</td><td></td><td>1536</td><td>2.6</td><td>0.647</td><td>9.5</td><td>NA</td><td>6.8</td><td>49.0</td><td>0.27</td><td>0.53</td><td>70.4</td></tr></table>	Movement Performance - Vehicles												Mov ID	Turn	Demand Flow veh/s	HV %	Deq Sat. v/s	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queue	Effective Stop Rate per veh	Average Speed km/h	South: New England Highway (S)												24	L	262	6.0	0.149	13.0	NA ¹	NA ¹	NA ¹	0.00	0.69	59.1	25	T	705	0.3	0.362	8.0	LOS A	0.0	8.0	0.00	0.00	100.0	Approach		967	2.4	0.362	3.5	LOS A	0.0	8.0	0.00	0.19	88.5	North: New England Highway (N)												32	R	11	20.0	0.015	17.7	LOS B	0.1	0.6	0.60	0.77	56.4	Approach		11	20.0	0.015	17.7	LOS B	0.1	0.6	0.60	0.77	56.4	West: Thomas Mitchell Drive												21	L	39	6.1	0.022	13.5	NA ¹	NA ¹	NA ¹	0.00	0.76	43.3	23	R	519	2.6	0.647	20.1	LOS B	6.8	49.0	0.76	1.14	53.1	Approach		558	3.2	0.647	19.6	LOS B	6.8	49.0	0.72	1.11	52.7	All Vehicles		1536	2.6	0.647	9.5	NA	6.8	49.0	0.27	0.53	70.4	<table><tr><th colspan="12">Movement Performance - Vehicles</th></tr><tr><th>Mov ID</th><th>Turn</th><th>Demand Flow veh/s</th><th>HV %</th><th>Deq Sat. v/s</th><th>Average Delay sec</th><th>Level of Service</th><th>95% Back of Queue Vehicles veh</th><th>95% Back of Queue Distance m</th><th>Prop. Queue</th><th>Effective Stop Rate per veh</th><th>Average Speed km/h</th></tr><tr><td colspan="12">North: New England Highway (N)</td></tr><tr><td>1</td><td>T</td><td>854</td><td>15.9</td><td>0.403</td><td>0.0</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.00</td><td>100.0</td></tr><tr><td>Approach</td><td></td><td>854</td><td>15.9</td><td>0.403</td><td>0.0</td><td>LOS A</td><td>0.0</td><td>0.0</td><td>0.00</td><td>0.00</td><td>100.0</td></tr><tr><td colspan="12">North West: RT acceleration lane TMD</td></tr><tr><td>2</td><td>T</td><td>519</td><td>2.6</td><td>0.640</td><td>5.7</td><td>LOS A</td><td>4.1</td><td>29.5</td><td>0.77</td><td>0.63</td><td>75.6</td></tr><tr><td>Approach</td><td></td><td>519</td><td>2.6</td><td>0.640</td><td>5.7</td><td>LOS A</td><td>4.1</td><td>29.5</td><td>0.77</td><td>0.63</td><td>75.6</td></tr><tr><td>All Vehicles</td><td></td><td>1373</td><td>11.0</td><td>0.640</td><td>2.1</td><td>NA</td><td>4.1</td><td>29.5</td><td>0.29</td><td>0.24</td><td>89.7</td></tr></table>	Movement Performance - Vehicles												Mov ID	Turn	Demand Flow veh/s	HV %	Deq Sat. v/s	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queue	Effective Stop Rate per veh	Average Speed km/h	North: New England Highway (N)												1	T	854	15.9	0.403	0.0	LOS A	0.0	0.0	0.00	0.00	100.0	Approach		854	15.9	0.403	0.0	LOS A	0.0	0.0	0.00	0.00	100.0	North West: RT acceleration lane TMD												2	T	519	2.6	0.640	5.7	LOS A	4.1	29.5	0.77	0.63	75.6	Approach		519	2.6	0.640	5.7	LOS A	4.1	29.5	0.77	0.63	75.6	All Vehicles		1373	11.0	0.640	2.1	NA	4.1	29.5	0.29	0.24	89.7
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Appendix C

Midblock level of service (LoS) analysis

Highway Capacity Manual 2000

BENGALLA LINK ROAD, SOUTH OF MINE 2011

AM

TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET	
General Information	
Analyst	DAMZEN CHEE
Agency or Company	BMC
Date Performed	1/5/2012
Analysis Time Period	0600-0700 h weekdays
Site Information	
Highway	Bengalla Link Road
From/To	Denmark Road to Bengalla Mine
Jurisdiction	MSC
Analysis Year	2011 AM
☒ Operational (LOS) ☐ Design (v_d) ☐ Planning (LOS) ☐ Planning (v_p)	
Input Data	
	☒ Class I highway ☐ Class II highway Terrain ☐ Level ☒ Rolling Two-way hourly volume 359 veh/h (V) Directional split 77.23 NB/SB Peak-hour factor, PHF 0.88 (EX 12-9) % Trucks and buses, P_T 10 % % Recreational vehicles, P_R 0 % % No-passing zone 16 % Access points/km 3 /km
Average Travel Speed	
Grade adjustment factor, f_G (Exhibit 20-7)	0.71 (EX 20-7)
Passenger-car equivalents for trucks, E_T (Exhibit 20-9)	2.5 (EX 20-9)
Passenger-car equivalents for RVs, E_R (Exhibit 20-9)	1.1 (EX 20-9)
Heavy-vehicle adjustment factor, f_{HV} $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$	$= \frac{1}{1 + 0.1(2.5 - 1) + 0} = 0.87$
Two-way flow rate, v_p (pc/h) $v_p = \frac{V}{PHF \cdot f_G \cdot f_{HV}}$	$= \frac{359}{0.88 \times 0.71 \times 0.87} = 660$
v_p * highest directional split proportion 2 (pc/h)	$= 660 \times 0.77 = 508$
Free-Flow Speed from Field Measurement	Estimated Free-Flow Speed
Field measured speed, S_{FM} km/h	Base free-flow speed, BFFS 100 km/h
Observed volume, V_i veh/h	Adj. for lane width and shoulder width, f_{LS} (Exhibit 20-5) 9.9 km/h
Free-flow speed, FFS km/h	Adj. for access points, f_A (Exhibit 20-6) 2.0 km/h
$FFS = S_{FM} + 0.0125 \left(\frac{V_i}{f_{HV}} \right)$	Free-flow speed, FFS 93 km/h
Adj. for no-passing zones, f_{np} (km/h) (Exhibit 20-11)	$FFS = BFFS - f_{LS} - f_A = 100 - 9.9 - 2.0 = 93.1$
Average travel speed, ATS (km/h) $ATS = FFS - 0.0125 v_p - f_{np}$	$= 93 - (0.0125 \times 660) - 1.9 = 82.9$ km/h
Percent Time-Spent-Following	
Grade adjustment factor, f_G (Exhibit 20-8)	0.77 (EX 20-8)
Passenger-car equivalents for trucks, E_T (Exhibit 20-10)	1.8 (EX 20-10)
Passenger-car equivalents for RVs, E_R (Exhibit 20-10)	1.0 (EX 20-10)
Heavy-vehicle adjustment factor, f_{HV} $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$	$= \frac{1}{1 + 0.1(1.8 - 1) + 0} = 0.93$
Two-way flow rate, v_p (pc/h) $v_p = \frac{V}{PHF \cdot f_G \cdot f_{HV}}$	$= \frac{359}{0.88 \times 0.77 \times 0.93} = 570$
v_p * highest directional split proportion 2 (pc/h)	$= 570 \times 0.77 = 440$
Base percent time-spent-following, BPTSF (%) $BPTSF = 100[1 - \exp(-0.000879 v_p)]$	$= 39.4\%$
Adj. for directional distribution and no-passing zone, f_{dnp} (%) (Exhibit 20-12)	$= 11.4\%$ Assumed 80/20 split & extrapolated
Percent time-spent-following, PTSF (%) $PTSF = BPTSF + f_{dnp}$	$= 39.4 + 11.4 = 50.8\%$
Level of Service and Other Performance Measures	
Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)	C
Volume to capacity ratio, v/c $v/c = \frac{v_p}{V}$	$= \frac{508}{359} = 1.42$
Peak 15-min vehicle-kilometers of travel, $V_{kmT_{15}}$ (veh-km) $V_{kmT_{15}} = 0.25 V_i \left(\frac{V}{P_{HVF}} \right)$	
Peak-hour vehicle-kilometers of travel, $V_{kmT_{60}}$ (veh-km) $V_{kmT_{60}} = V \cdot L_i$	
Peak 15-min total travel time, TT_{15} (veh-h) $TT_{15} = \frac{V_{kmT_{15}}}{ATS}$	
Notes	
1. If $v_p \geq 3,200$ pc/h, terminate analysis—the LOS is F. 2. If highest directional split $v_p \geq 1,700$ pc/h, terminate analysis—the LOS is F.	

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Highway Capacity Manual 2000 **BENGALLA LINK ROAD, SOUTH OF MINE 2011 PM**

TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET	
General Information Analyst: <u>Dominic Chee</u> Agency or Company: <u>BMC</u> Date Performed: <u>1/5/2012</u> Analysis Time Period: <u>1600-1700h weekday</u> Site Information Highway: <u>Bengalla Link Road</u> From/To: <u>Dennan Road to Mine</u> Jurisdiction: <u>MSC</u> Analysis Year: <u>2011 PM</u>	
☒ Operational (LOS) ☐ Design (v_p) ☐ Planning (LOS) ☐ Planning (v_p)	
Input Data Shoulder width: 1.0 m Lane width: 3.5 m Lane width: 3.5 m Shoulder width: 1.0 m Segment length, L: 6.5 km ☒ Class I highway ☐ Class II highway Terrain: ☐ Level ☒ Rolling Two-way hourly volume: <u>197</u> veh/h (V) Directional split: <u>26</u> <u>174 NB/SB</u> Peak-hour factor, PHF: <u>0.88</u> (EX 20.9) % Trucks and buses, P_T: <u>6.6</u> % % Recreational vehicles, P_R: <u>0</u> % % No-passing zone: <u>16</u> % Access points/km: <u>3</u> /km	
Average Travel Speed	
Grade adjustment factor, f_g (Exhibit 20-7)	<u>0.71</u> (EX 20.7)
Passenger-car equivalents for trucks, E_T (Exhibit 20-8)	<u>2.5</u> (EX 20.8)
Passenger-car equivalents for RVs, E_R (Exhibit 20-9)	<u>1.1</u> (EX 20.9)
Heavy-vehicle adjustment factor, f_{HV} $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$	$= \frac{1}{1 + 0.066(2.5 - 1) + 0} = 0.91$
Two-way flow rate, v_p (pc/h) $v_p = \frac{V}{PHF \cdot f_g \cdot f_{HV}}$	$= \frac{197}{0.88 \times 0.71 \times 0.91} = 346$
v_p * highest directional split proportion ² (pc/h)	$= 346 \times 0.74 = 256$
Free-Flow Speed from Field Measurement	Estimated Free-Flow Speed
Field measured speed, S_{FM} (km/h)	Base free-flow speed, BFFS <u>100</u> km/h
Observed volume, V_f (veh/h)	Adj. for lane width and shoulder width, f_{LS} (Exhibit 20-5) <u>4.9</u> km/h
Free-flow speed, FFS (km/h)	Adj. for access points, f_A (Exhibit 20-6) <u>2.0</u> km/h
FFS = $S_{FM} + 0.0125 \left(\frac{V_f}{S_{FM}} \right)$	Free-flow speed, FFS <u>93</u> km/h
Adj. for no-passing zones, f_{np} (km/h) (Exhibit 20-11)	<u>1.8</u>
Average travel speed, ATS (km/h) $ATS = FFS - 0.0125 v_p - f_{np}$	$93 - (0.0125 \times 346) - 1.8 = 86.9$ km/h
Percent Time-Spent-Following	
Grade adjustment factor, f_g (Exhibit 20-8)	<u>0.77</u> (EX 20.8)
Passenger-car equivalents for trucks, E_T (Exhibit 20-10)	<u>1.8</u> (EX 20.10)
Passenger-car equivalents for RVs, E_R (Exhibit 20-10)	<u>1.0</u> (EX 20.10)
Heavy-vehicle adjustment factor, f_{HV} $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$	$= \frac{1}{1 + 0.066(1.8 - 1) + 0} = 0.95$
Two-way flow rate, v_p (pc/h) $v_p = \frac{V}{PHF \cdot f_g \cdot f_{HV}}$	$= \frac{197}{0.88 \times 0.77 \times 0.95} = 306$
v_p * highest directional split proportion ² (pc/h)	$= 306 \times 0.74 = 226$
Base percent time-spent-following, BPTSF (%)	<u>23.6</u> %
BPTSF = $100[1 - \exp(-0.000879 v_p)]$	
Adj. for directional distribution and no-passing zone, f_{dnp} (%) (Exhibit 20-12)	<u>17.3</u> %
Percent time-spent-following, PTSF (%) $PTSF = BPTSF + f_{dnp}$	<u>41</u> %
Level of Service and Other Performance Measures	
Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)	<u>B</u>
Volume to capacity ratio, w/c $w/c = \frac{v_p}{3200}$	
Peak 15-min vehicle-kilometers of travel, $VkmT_{15}$ (veh-km)	
$VkmT_{15} = 0.25 L \left(\frac{V}{PHF} \right)$	
Peak-hour vehicle-kilometers of travel, $VkmT_{60}$ (veh-km) $VkmT_{60} = V \cdot L$	
Peak 15-min total travel time, TT_{15} (veh-h) $TT_{15} = \frac{VkmT_{15}}{ATS}$	
Notes	
1. If $v_p \geq 3,200$ pc/h, terminate analysis—the LOS is F. 2. If highest directional split $v_p \geq 1,700$ pc/h, terminate analysis—the LOS is F.	

Highway Capacity Manual 2000 WYBONG ROAD, WEST OF BENGALLA LINK ROAD 2011 AM

TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET	
General Information Analyst: <u>Danien Chee</u> Agency or Company: <u>BMC</u> Date Performed: <u>1/5/2012</u> Analysis Time Period: <u>0600-0700h weekday</u>	
Site Information Highway: <u>Wybong Road</u> From/To: <u>Bengalla Road - Mangoola mine</u> Jurisdiction: <u>MSC</u> Analysis Year: <u>2011 AM</u>	
☒ Operational (LOS) ☐ Design (v_d) ☐ Planning (LOS) ☐ Planning (v_p)	
Input Data	
Shoulder width: <u>7.0</u> m Lane width: <u>3.25</u> m Lane width: <u>3.25</u> m Shoulder width: <u>7.0</u> m Segment length, L: <u>7</u> km	☒ Class I highway ☐ Class II highway Terrain: ☐ Level ☒ Rolling Two-way hourly volume: <u>132</u> veh/h Directional split: <u>63</u> / <u>137</u> Peak-hour factor, PHF: <u>0.88</u> % Trucks and buses, P_T : <u>7.5</u> % % Recreational vehicles, P_R : <u>0</u> % % No-passing zone: <u>20</u> % Access points/km: <u>3</u> /km
Average Travel Speed	
Grade adjustment factor, f_G (Exhibit 20-7)	<u>0.71 (EX 20-7)</u>
Passenger-car equivalents for trucks, E_T (Exhibit 20-9)	<u>2.5 (EX 20-9)</u>
Passenger-car equivalents for RVs, E_R (Exhibit 20-9)	<u>1.1 (EX 20-9)</u>
Heavy-vehicle adjustment factor, f_{HV} $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$	<u>$\frac{1}{1 + 0.075(2.5 - 1) + 0} = 0.90$</u>
Two-way flow rate, $^1 v_p$ (pc/h) $v_p = \frac{V}{PHF \cdot f_G \cdot f_{HV}}$	<u>$\frac{132}{0.88 \times 0.71 \times 0.9} = 235$</u>
v_p * highest directional split proportion ² (pc/h)	<u>$235 \times 0.63 = 148$</u>
Free-Flow Speed from Field Measurement	Estimated Free-Flow Speed
Field measured speed, S_{FM} km/h	Base free-flow speed, BFFS <u>100</u> km/h
Observed volume, V_f veh/h	Adj. for lane width and shoulder width, f_{LS} (Exhibit 20-5) <u>5.9</u> km/h
Free-flow speed, FFS km/h	Adj. for access points, f_A (Exhibit 20-6) <u>2.0</u> km/h
$FFS = S_{FM} + 0.0125 \left(\frac{V_f}{f_{HV}} \right)$	Free-flow speed, FFS <u>92.1</u> km/h
	$FFS = BFFS - f_{LS} - f_A = 100 - 5.9 - 2.0 = 92.1$
Adj. for no-passing zones, f_{np} (km/h) (Exhibit 20-11)	<u>1.3</u>
Average travel speed, ATS (km/h) $ATS = FFS - 0.0125 v_p - f_{np}$	<u>$92 - (0.0125 \times 235) - 1.3 = 87.8$</u>
Percent Time-Spent-Following	
Grade adjustment factor, f_G (Exhibit 20-8)	<u>0.77 (EX 20-8)</u>
Passenger-car equivalents for trucks, E_T (Exhibit 20-10)	<u>1.8 (EX 20-10)</u>
Passenger-car equivalents for RVs, E_R (Exhibit 20-10)	<u>1.0 (EX 20-10)</u>
Heavy-vehicle adjustment factor, f_{HV} $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$	<u>$\frac{1}{1 + 0.075(1.8 - 1) + 0} = 0.94$</u>
Two-way flow rate, $^1 v_p$ (pc/h) $v_p = \frac{V}{PHF \cdot f_G \cdot f_{HV}}$	<u>$\frac{132}{0.88 \times 0.77 \times 0.94} = 207$</u>
v_p * highest directional split proportion ² (pc/h)	<u>$207 \times 0.63 = 130$</u>
Base percent time-spent-following, BPTSF (%)	<u>16.6</u>
BPTSF = $100[1 - \exp(-0.000879 v_p)]$	
Adj. for directional distribution and no-passing zone, f_{dnp} (%) (Exhibit 20-12)	<u>13.4 using 70/30 split.</u>
Percent time-spent-following, PTSF (%) $PTSF = BPTSF + f_{dnp}$	<u>30%</u>
Level of Service and Other Performance Measures	
Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)	<u>B</u>
Volume to capacity ratio, v/c $v/c = \frac{v_p}{V}$	
Peak 15-min vehicle-kilometers of travel, $VkmT_{15}$ (veh-km)	
$VkmT_{15} = 0.25 L \left(\frac{V}{PHF} \right)$	
Peak-hour vehicle-kilometers of travel, $VkmT_{60}$ (veh-km) $VkmT_{60} = V \cdot L$	
Peak 15-min total travel time, TT_{15} (veh-h) $TT_{15} = \frac{VkmT_{15}}{ATS}$	
Notes	
1. If $v_p \geq 3,200$ pc/h, terminate analysis—the LOS is F. 2. If highest directional split $v_p \geq 1,700$ pc/h, terminate analysis—the LOS is F.	

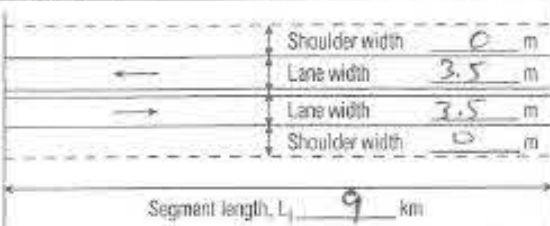
Highway Capacity Manual 2000

WYBONG ROAD, WEST OF BENGALLA LINK ROAD 2011 PM

TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET	
General Information Analyst: <u>Damien Chee</u> Agency or Company: <u>BMC</u> Date Performed: <u>2/5/2012</u> Analysis Time Period: <u>1600-1700h weekday</u>	
Site Information Highway: <u>Wybong Road</u> From/To: <u>Bengalla Road to Mangoola</u> Jurisdiction: <u>NSW</u> Analysis Year: <u>2011 PM</u>	
☒ Operational (LOS) ☐ Design (v_p) ☐ Planning (LOS) ☐ Planning (v_p)	
Input Data	
Diagram showing a two-way two-lane highway segment. The segment length is $L_s = 7$ km. The diagram indicates lane widths of 3.25 m and shoulder widths of 1.0 m on both sides. A north arrow is shown pointing upwards.	☒ Class I highway ☐ Class II highway Terrain: ☐ Level ☒ Rolling Two-way hourly volume: <u>112</u> veh/h (v) Directional split: <u>43</u> / <u>157</u> Peak-hour factor, PHF: <u>0.87</u> % Trucks and buses, P_T : <u>10</u> % % Recreational vehicles, P_R : <u>0</u> % % No-passing zone: <u>20</u> % Access points/km: <u>3</u> /km
Average Travel Speed	
Grade adjustment factor, f_g (Exhibit 20-7)	<u>0.71</u> (Ex 20-7)
Passenger-car equivalents for trucks, E_T (Exhibit 20-8)	<u>2.5</u> (Ex 20-8)
Passenger-car equivalents for RVs, E_R (Exhibit 20-9)	<u>1.1</u> (Ex 20-9)
Heavy-vehicle adjustment factor, f_{HV} $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$	<u>0.87</u> $= \frac{1}{1 + 0.1(2.5 - 1) + 0} = 0.87$
Two-way flow rate, v_p (pc/h) $v_p = \frac{V}{PHF \cdot f_g \cdot f_{HV}}$	<u>210</u> $= \frac{112}{0.87 \times 0.71 \times 0.87} = 210$
v_p * highest directional split proportion 2 (pc/h)	<u>120</u> $= 210 \times 0.57 = 120$
Free-Flow Speed from Field Measurement Estimated Free-Flow Speed	
Field measured speed, S_{FM} (km/h)	Base free-flow speed, BFFS: <u>100</u> km/h
Observed volume, V_f (veh/h)	Adj. for lane width and shoulder width, f_{LS} (Exhibit 20-5): <u>5.9</u> km/h
Free-flow speed, FFS (km/h)	Adj. for access points, f_A (Exhibit 20-6): <u>2.0</u> km/h
FFS = $S_{FM} + 0.0125 \left(\frac{V_f}{f_{FM}} \right)$	Free-flow speed, FFS: <u>92.1</u> km/h
	FFS = BFFS - f_{LS} - f_A = $100 - 5.9 - 2.0 = 92.1$
Adj. for no-passing zones, f_{np} (km/h) (Exhibit 20-11)	<u>0.6</u>
Average travel speed, ATS (km/h) ATS = FFS - $0.0125 v_p - f_{np}$	<u>88.8</u> $= 92.1 - (0.0125 \times 210) - 0.6 = 88.8$
Percent Time-Spent-Following	
Grade adjustment factor, f_g (Exhibit 20-8)	<u>0.77</u> (Ex 20-8)
Passenger-car equivalents for trucks, E_T (Exhibit 20-10)	<u>1.8</u> (Ex 20-10)
Passenger-car equivalents for RVs, E_R (Exhibit 20-10)	<u>1.0</u> (Ex 20-10)
Heavy-vehicle adjustment factor, f_{HV} $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$	<u>0.93</u> $= \frac{1}{1 + 0.1(1.8 - 1) + 0} = 0.93$
Two-way flow rate, v_p (pc/h) $v_p = \frac{V}{PHF \cdot f_g \cdot f_{HV}}$	<u>178</u> $= \frac{112}{0.87 \times 0.77 \times 0.93} = 178$
v_p * highest directional split proportion 2 (pc/h)	<u>101.3</u> $= 178 \times 0.57 = 101.3$
Base percent time-spent-following, BPTSF (%)	<u>14.5</u>
BPTSF = $100[1 - \exp(-0.000879 v_p)]$	
Adj. for directional distribution and no-passing zone, f_{dnp} (%) (Exhibit 20-12)	<u>11.8</u> using 60/40 split
Percent time-spent-following, PTSF (%) PTSF = BPTSF + f_{dnp}	<u>26.3%</u> $= 14.5 + 11.8 = 26.3\%$
Level of Service and Other Performance Measures	
Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)	<u>B</u>
Volume to capacity ratio, v/c $v/c = \frac{v_p}{S_{FM}}$	<u>0.300</u>
Peak 15-min vehicle-kilometers of travel, $V_{kmT_{15}}$ (veh-km)	
$V_{kmT_{15}} = 0.25 L_s \left(\frac{V}{PHF} \right)$	
Peak-hour vehicle-kilometers of travel, $V_{kmT_{60}}$ (veh-km) $V_{kmT_{60}} = V \cdot L_s$	
Peak 15-min total travel time, TT_{15} (veh-h) $TT_{15} = \frac{V_{kmT_{15}}}{S_{FM}}$	
Notes	
1. If $v_p \geq 3,200$ pc/h, terminate analysis—the LOS is F. 2. If highest directional split $v_p \geq 1,700$ pc/h, terminate analysis—the LOS is F.	

Highway Capacity Manual 2000

THOMAS MITCHELL DRIVE, W OF NEH 2011 AM

TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET	
General Information Analyst: <u>Damien Chee</u> Agency or Company: <u>BMC</u> Date Performed: <u>2/5/2012</u> Analysis Time Period: <u>0600-0700h Weekday</u> Site Information Highway: <u>TMD</u> From/To: <u>Glen Munro Road to NEH</u> Jurisdiction: <u>MCC</u> Analysis Year: <u>2011 AM</u>	
☒ Operational (LOS) ☐ Design (v _g) ☐ Planning (LOS) ☐ Planning (v _g)	
Input Data  Shoulder width: <u>0</u> m Lane width: <u>3.5</u> m Lane width: <u>3.5</u> m Shoulder width: <u>0</u> m Segment length, L₁: <u>9</u> km ☐ Class I highway ☒ Class II highway Terrain: ☒ Level ☐ Rolling Two-way hourly volume: <u>585</u> veh/h Directional split: <u>72</u> / <u>128</u> Peak-hour factor, PHF: <u>0.88</u> % Trucks and buses, P_T: <u>7.7</u> % % Recreational vehicles, P_R: <u>0</u> % % No-passing zone: <u>80</u> % Access points/km: <u>3</u> /km  Show North Arrow	
Average Travel Speed Grade adjustment factor, f_g (Exhibit 20-7) Passenger-car equivalents for trucks, E_T (Exhibit 20-9) Passenger-car equivalents for RVs, E_R (Exhibit 20-9) Heavy-vehicle adjustment factor, f_{HV} $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$ Two-way flow rate, v_g (pc/h) $v_g = PHF \cdot f_g \cdot f_{HV}$ v_g * highest directional split proportion² (pc/h) Free-Flow Speed from Field Measurement Field measured speed, S_{FM} _____ km/h Observed volume, V_T _____ veh/h Free-flow speed, FFS _____ km/h FFS = S_{FM} + 0.0125 ($\frac{V_T}{f_{HV}}$) Estimated Free-Flow Speed Base free-flow speed, BFFS _____ km/h Adj. for lane width and shoulder width, f_{LS} (Exhibit 20-5) _____ km/h Adj. for access points, f_A (Exhibit 20-6) _____ km/h Free-flow speed, FFS _____ km/h FFS = BFFS - f_{LS} - f_A	

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Highway Capacity Manual 2000 THOMAS MITCHELL DRIVE, W OF NEH 2011 PM

TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET	
General Information Analyst: <u>Damien Chee</u> Agency or Company: <u>BMC</u> Date Performed: <u>2/5/2012</u> Analysis Time Period: <u>1600-1700h weekday</u> Site Information Highway: <u>TMD</u> From/To: <u>Glen Murray Road to NEH</u> Jurisdiction: <u>MSC</u> Analysis Year: <u>2011 PM</u>	
☒ Operational (LOS) ☐ Design (v_p) ☐ Planning (LOS) ☐ Planning (v_p)	
Input Data Shoulder width: <u>0</u> m Lane width: <u>3.5</u> m Lane width: <u>3.5</u> m Shoulder width: <u>0</u> m Segment length, L: <u>9</u> km ☐ Class I highway ☒ Class II highway Terrain: ☒ Level ☐ Rolling Two-way hourly volume: <u>299</u> veh/h (V) Directional split: <u>22 / 78</u> Peak-hour factor, PHF: <u>0.88</u> % Trucks and buses, P_T: <u>11</u> % % Recreational vehicles, P_R: <u>0</u> % % No-passing zone: <u>80</u> % Access points/km: <u>3</u> /km	
Average Travel Speed	
Grade adjustment factor, f_G (Exhibit 20-7) _____ Passenger-car equivalents for trucks, E_T (Exhibit 20-9) _____ Passenger-car equivalents for RVs, E_R (Exhibit 20-9) _____ Heavy-vehicle adjustment factor, f_{HV} $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$ _____ Two-way flow rate, $^1 v_p$ (pc/h) $v_p = \frac{V}{PHF \cdot f_G \cdot f_{HV}}$ _____ v_p * highest directional split proportion 2 (pc/h) _____	
Free-Flow Speed from Field Measurement Field measured speed, S_{FM} _____ km/h Observed volume, V_f _____ veh/h Free-flow speed, FFS _____ km/h $FFS = S_{FM} + 0.0125 \left(\frac{V_f}{S_{FM}} \right)$ Estimated Free-Flow Speed Base free-flow speed, BFFS _____ km/h Adj. for lane width and shoulder width, f_{LS} (Exhibit 20-5) _____ km/h Adj. for access points, f_A (Exhibit 20-6) _____ km/h Free-flow speed, FFS _____ km/h $FFS = BFFS - f_{LS} - f_A$	
Adj. for no-passing zones, f_{np} (km/h) (Exhibit 20-11) _____ Average travel speed, ATS (km/h) $ATS = FFS - 0.0125 v_p - f_{np}$ _____	
Percent Time-Spent-Following	
Grade adjustment factor, f_G (Exhibit 20-8) <u>1.0</u> Passenger-car equivalents for trucks, E_T (Exhibit 20-10) <u>1.1</u> Passenger-car equivalents for RVs, E_R (Exhibit 20-10) <u>1.0</u> Heavy-vehicle adjustment factor, f_{HV} $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$ <u>$\frac{1}{1 + 0.1(1.1 - 1) + 0} = 0.99$</u> Two-way flow rate, $^1 v_p$ (pc/h) $v_p = \frac{V}{PHF \cdot f_G \cdot f_{HV}}$ <u>$\frac{299}{0.88 \times 1 \times 0.99} = 343$</u> v_p * highest directional split proportion 2 (pc/h) <u>$343 \times 0.78 = 268$</u> Base percent time-spent-following, BPTSF (%) <u>26</u> BPTSF = $100[1 - \exp(-0.000879 v_p)]$ Adj. for directional distribution and no-passing zone, f_{dnp} (%) (Exhibit 20-12) <u>29.5</u> Percent time-spent-following, PTSF (%) $PTSF = BPTSF + f_{dnp}$ <u>55.5</u>	
Level of Service and Other Performance Measures	
Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II) <u>C</u>	
Volume to capacity ratio, w/c $w/c = \frac{v_p}{3200}$ _____ Peak 15-min vehicle-kilometers of travel, $VkmT_{15}$ (veh-km) _____ $VkmT_{15} = 0.25L \left(\frac{V}{PHF} \right)$ Peak-hour vehicle-kilometers of travel, $VkmT_{60}$ (veh-km) $VkmT_{60} = V \cdot L$ _____ Peak 15-min total travel time, TT_{15} (veh-h) $TT_{15} = \frac{VkmT_{15}}{ATS}$ _____	
Notes 1. If $v_p \geq 3,200$ pc/h, terminate analysis—the LOS is F. 2. If highest directional split $v_p \geq 1,700$ pc/h, terminate analysis—the LOS is F.	

Highway Capacity Manual 2000

BENGALLA LINK ROAD, S OF MINE CUMULATIVE

TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET	
General Information Analyst: <u>Damien Choe</u> Agency or Company: <u>BMC</u> Date Performed: <u>2/9/2012</u> Analysis Time Period: <u>0600-0700h</u> Site Information Highway: <u>Bengalla Link Road</u> From/To: <u>Denman Road to Bengalla Mine</u> Jurisdiction: <u>MSC</u> Analysis Year: <u>YEAR 15</u>	
☐ Operational (LOS) ☐ Design (v_p) ☒ Planning (LOS) ☐ Planning (v_p)	
Input Data ☒ Class I highway Terrain: ☐ Level ☒ Rolling Two-way hourly volume: <u>831</u> veh/h (V) Directional split: <u>71</u> / <u>29</u> NB/SB Peak-hour factor, PHF: <u>0.88</u> % Trucks and buses, P_T: <u>5.4</u> % % Recreational vehicles, P_R: <u>0</u> % % No-passing zone: <u>16</u> % Access points/km: <u>3</u> /km ☐ Class II highway Two-way hourly volume: <u>831</u> veh/h (V) Directional split: <u>71</u> / <u>29</u> NB/SB Peak-hour factor, PHF: <u>0.88</u> % Trucks and buses, P_T: <u>5.4</u> % % Recreational vehicles, P_R: <u>0</u> % % No-passing zone: <u>16</u> % Access points/km: <u>3</u> /km	
Average Travel Speed	
Grade adjustment factor, f_g (Exhibit 20-7)	<u>0.93 (EX 20-7)</u>
Passenger-car equivalents for trucks, E_T (Exhibit 20-9)	<u>1.9 (EX 20-9)</u>
Passenger-car equivalents for RVs, E_R (Exhibit 20-9)	<u>1.1 (EX 20-9)</u>
Heavy-vehicle adjustment factor, f_{HV} $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$	<u>0.95</u>
Two-way flow rate, V_p (pc/h) $V_p = \frac{V}{PHF \cdot f_g \cdot f_{HV}}$	<u>1069</u>
v_p * highest directional split proportion ² (pc/h)	
Free-Flow Speed from Field Measurement	Estimated Free-Flow Speed
Field measured speed, S_{FM} km/h	Base free-flow speed, BFFS <u>100</u> km/h
Observed volume, V_f veh/h	Adj. for lane width and shoulder width, f_{LS} (Exhibit 20-5) <u>9.9</u> km/h
Free-flow speed, FFS km/h	Adj. for access points, f_A (Exhibit 20-6) <u>2</u> km/h
$FFS = S_{FM} + 0.0125 \left(\frac{V_f}{V_{FM}} \right)$	Free-flow speed, FFS <u>93</u> km/h
	$FFS = BFFS - f_{LS} - f_A$
Adj. for no-passing zones, f_{np} (km/h) (Exhibit 20-11)	<u>1.71 extrapolated</u>
Average travel speed, ATS (km/h) $ATS = FFS - 0.0125 v_p - f_{np}$	<u>78 km/h</u>
Percent Time-Spent-Following	
Grade adjustment factor, f_g (Exhibit 20-8)	<u>0.94</u>
Passenger-car equivalents for trucks, E_T (Exhibit 20-10)	<u>1.5</u>
Passenger-car equivalents for RVs, E_R (Exhibit 20-10)	<u>1.0</u>
Heavy-vehicle adjustment factor, f_{HV} $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$	<u>0.994</u>
Two-way flow rate, V_p (pc/h) $V_p = \frac{V}{PHF \cdot f_g \cdot f_{HV}}$	<u>1031</u>
v_p * highest directional split proportion ² (pc/h)	<u>732</u>
Base percent time-spent-following, BPTSF (%) $BPTSF = 100[1 - \exp(-0.000879 v_p)]$	<u>59.6</u>
Adj. for directional distribution and no-passing zone, f_{dnp} (%) (Exhibit 20-12)	<u>7.54</u>
Percent time-spent-following, PTSF (%) $PTSF = BPTSF + f_{dnp}$	<u>67.14</u>
Level of Service and Other Performance Measures	
Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)	<u>D</u>
Volume to capacity ratio, w/c $w/c = \frac{V_p}{S_{AT}}$	
Peak 15-min vehicle-kilometers of travel, $VkmT_{15}$ (veh-km) $VkmT_{15} = 0.254 \left(\frac{V_p}{p_{15}} \right)$	
Peak-hour vehicle-kilometers of travel, $VkmT_{60}$ (veh-km) $VkmT_{60} = V \cdot L_1$	
Peak 15-min total travel time, TT_{15} (veh-h) $TT_{15} = \frac{VkmT_{15}}{ATS}$	
Notes	
1. If $v_p \geq 3,200$ pc/h, terminate analysis—the LOS is F. 2. If highest directional split $v_p \geq 1,700$ pc/h, terminate analysis—the LOS is F.	

CASE
(YR 15)
AM
MINE

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Highway Capacity Manual 2000 **BENGALLA ROAD, S OF MINE CUMULATIVE CASE PM (YEAR 15)**

TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	Damien Chee	Highway	BENGALLA LINE ROAD
Agency or Company	BMC	From/To	Dunman Road - Bengalla Mine
Date Performed	2/7/2012	Jurisdiction	MSC
Analysis Time Period	1600-1700h weekday	Analysis Year	YEAR 15
☐ Operational (LOS)	☐ Design (v_p)	☒ Planning (LOS)	☐ Planning (v_p)
Input Data			
Shoulder width 1.0 m Lane width 3.5 m Lane width 3.5 m Shoulder width 1.0 m Segment length, L, 6.5 km		☒ Class I highway ☐ Class II highway Terrain ☐ Level ☒ Rolling Two-way hourly volume 671 veh/h (V) Directional split 32 / 68 NB/SB Peak-hour factor, PHF 0.81 % Trucks and buses, P_T 4.2 % % Recreational vehicles, P_R 0 % % No-passing zone 16 % Access points/km 3 /km	
Average Travel Speed			
Grade adjustment factor, f_G (Exhibit 20-7)		0.93	
Passenger-car equivalents for trucks, E_T (Exhibit 20-8)		1.4	
Passenger-car equivalents for RVs, E_R (Exhibit 20-9)		1.1	
Heavy-vehicle adjustment factor, f_{HV} $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$		0.96	
Two-way flow rate, $^1 v_p$ (pc/h) $v_p = \frac{V}{PHF \cdot f_G \cdot f_{HV}}$		854	
v_p * highest directional split proportion ² (pc/h)		580	
Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Field measured speed, S_{FM} km/h		Base free-flow speed, BFFS 100 km/h	
Observed volume, V_1 veh/h		Adj. for lane width and shoulder width, f_{LS} (Exhibit 20-5) 4.9 km/h	
Free-flow speed, FFS km/h		Adj. for access points, f_A (Exhibit 20-6) 2 km/h	
FFS = $S_{FM} + 0.0125 \left(\frac{V_1}{f_{HV}} \right)$		Free-flow speed, FFS 93 km/h	
FFS = $BFFS - f_{LS} - f_A$			
Adj. for no-passing zones, f_{np} (km/h) (Exhibit 20-11)		1.91	
Average travel speed, ATS (km/h) $ATS = FFS - 0.0125 v_p - f_{np}$		80.5	
Percent Time-Spent-Following			
Grade adjustment factor, f_G (Exhibit 20-8)		0.94	
Passenger-car equivalents for trucks, E_T (Exhibit 20-10)		1.5	
Passenger-car equivalents for RVs, E_R (Exhibit 20-10)		1.0	
Heavy-vehicle adjustment factor, f_{HV} $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$		0.96	
Two-way flow rate, $^1 v_p$ (pc/h) $v_p = \frac{V}{PHF \cdot f_G \cdot f_{HV}}$		845	
v_p * highest directional split proportion ² (pc/h)		575	
Base percent time-spent-following, BPTSF (%) $BPTSF = 100[1 - \exp(-0.000879 v_p)]$		52.42	
Adj. for directional distribution and no-passing zone, f_{dnp} (%) (Exhibit 20-12)		8.17 extrapolated	
Percent time-spent-following, PTSF (%) $PTSF = BPTSF + f_{dnp}$		60.6	
Level of Service and Other Performance Measures			
Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)		C	
Volume to capacity ratio, w/c $w/c = \frac{v_p}{3,200}$			
Peak 15-min vehicle-kilometers of travel, $VkmT_{15}$ (veh-km) $VkmT_{15} = 0.25 L \left(\frac{V}{PHF} \right)$			
Peak-hour vehicle-kilometers of travel, $VkmT_{60}$ (veh-km) $VkmT_{60} = V \cdot L$			
Peak 15-min total travel time, TT_{15} (veh-h) $TT_{15} = \frac{VkmT_{15}}{ATS}$			
Notes			
1. If $v_p \geq 3,200$ pc/h, terminate analysis—the LOS is F.			
2. If highest directional split $v_p \geq 1,700$ pc/h, terminate analysis—the LOS is F.			

Highway Capacity Manual 2000 WYBONG ROAD, W OF BENGALLA ROAD CUMULATIVE

TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET	
General Information Analyst: <u>Damien Chee</u> Agency or Company: <u>BMC</u> Date Performed: <u>21/7/2012</u> Analysis Time Period: <u>0600-0700h weekday</u> Site Information Highway: <u>Wybong Road</u> From/To: <u>Bennalla Road to Mangala</u> Jurisdiction: <u>MSC</u> Analysis Year: <u>YEAR 15</u>	
☐ Operational (LOS) ☐ Design (v_d) ☒ Planning (LOS) ☐ Planning (v_p)	
Input Data	
Shoulder width: 1 m Lane width: 3.25 m Lane width: 3.25 m Shoulder width: 1 m Segment length, L_s: 7 km	☒ Class I highway ☐ Class II highway Terrain: ☐ Level ☒ Rolling Two-way hourly volume: <u>163</u> veh/h Directional split: <u>70/30</u> EB/WB Peak-hour factor, PHF: <u>0.81</u> % Trucks and buses, P_T: <u>6.0</u> % % Recreational vehicles, P_R: <u>0</u> % % No-passing zone: <u>20</u> % Access points/km: <u>3</u> /km
Average Travel Speed	
Grade adjustment factor, f_g (Exhibit 20-7)	<u>0.71</u>
Passenger-car equivalents for trucks, E_T (Exhibit 20-9)	<u>2.5</u>
Passenger-car equivalents for RVs, E_R (Exhibit 20-9)	<u>1.1</u>
Heavy-vehicle adjustment factor, f_{HV} $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$	<u>0.92</u>
Two-way flow rate, v_p (pc/h) $v_p = \frac{V}{PHF \cdot f_g \cdot f_{HV}}$	<u>283</u>
v_p * highest directional split proportion ² (pc/h)	<u>198</u>
Free-Flow Speed from Field Measurement	Estimated Free-Flow Speed
Field measured speed, S_{FM} km/h	Base free-flow speed, BFFS <u>100</u> km/h
Observed volume, V_f veh/h	Adj. for lane width and shoulder width, f_{LS} (Exhibit 20-5) <u>5.9</u> km/h
Free-flow speed, FFS km/h	Adj. for access points, f_A (Exhibit 20-6) <u>2</u> km/h
$FFS = S_{FM} + 0.0125 \left(\frac{V_f}{f_{HV}} \right)$	Free-flow speed, FFS <u>92.1</u> km/h
Adj. for no-passing zones, f_{np} (km/h) (Exhibit 20-11)	<u>0.65</u> but need to adapt 1.3 to be same as last car
Average travel speed, ATS (km/h) $ATS = FFS - 0.0125 v_p - f_{np}$	<u>87.26</u>
Percent Time-Spent-Following	
Grade adjustment factor, f_g (Exhibit 20-8)	<u>0.77</u>
Passenger-car equivalents for trucks, E_T (Exhibit 20-10)	<u>1.8</u>
Passenger-car equivalents for RVs, E_R (Exhibit 20-10)	<u>1.0</u>
Heavy-vehicle adjustment factor, f_{HV} $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$	<u>0.95</u>
Two-way flow rate, v_p (pc/h) $v_p = \frac{V}{PHF \cdot f_g \cdot f_{HV}}$	<u>253</u>
v_p * highest directional split proportion ² (pc/h)	<u>177</u>
Base percent time-spent-following, BPTSF (%) $BPTSF = 100 [1 - \exp(-0.000879 v_p)]$	<u>19.9</u>
Adj. for directional distribution and no-passing zone, f_{dnp} (%) (Exhibit 20-12)	<u>13.4</u>
Percent time-spent-following, PTSF (%) $PTSF = BPTSF + f_{dnp}$	<u>33.3</u>
Level of Service and Other Performance Measures	
Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)	<u>B</u>
Volume to capacity ratio, v/c $v/c = \frac{v_p}{3200}$	
Peak 15-min vehicle-kilometers of travel, $VkmT_{15}$ (veh-km) $VkmT_{15} = 0.25 L_s \left(\frac{V}{PHF} \right)$	
Peak-hour vehicle-kilometers of travel, $VkmT_{60}$ (veh-km) $VkmT_{60} = V \cdot L_s$	
Peak 15-min total travel time, TT_{15} (veh-h) $TT_{15} = \frac{VkmT_{15}}{ATS}$	
Notes	
1. If $v_p \geq 3,200$ pc/h, terminate analysis—the LOS is F. 2. If highest directional split $v_p \geq 1,700$ pc/h, terminate analysis—the LOS is F.	

Highway Capacity Manual 2000

WYBONG ROAD, WEST OF BENGALLA RD CUMULATIVE

CASE

PM
(YEAR 15)

TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET	
General Information Analyst: <u>Damien Chee</u> Agency or Company: <u>BMC</u> Date Performed: <u>2/7/2012</u> Analysis Time Period: <u>1600-1700h weekday</u>	
Site Information Highway: <u>Wybong Road</u> From/To: <u>W of Bengalla Rd</u> Jurisdiction: <u>MSC</u> Analysis Year: <u>YEAR 15</u>	
☐ Operational (LOS) ☐ Design (v_p) ☒ Planning (LOS) ☐ Planning (v_p)	
Input Data	
	☒ Class I highway ☐ Class II highway Terrain: ☐ Level ☒ Rolling Two-way hourly volume: <u>142</u> veh/h (v) Directional split: <u>66 / 34</u> Peak-hour factor, PHF: <u>0.88</u> % Trucks and buses, P_T : <u>07.7</u> % % Recreational vehicles, P_R : <u>0</u> % % No-passing zone: <u>20</u> % Access points/km: <u>3</u> /km
Average Travel Speed	
Grade adjustment factor, f_G (Exhibit 20-7)	<u>0.71</u>
Passenger-car equivalents for trucks, E_T (Exhibit 20-9)	<u>2.5</u>
Passenger-car equivalents for RVs, E_R (Exhibit 20-9)	<u>1.1</u>
Heavy-vehicle adjustment factor, f_{HV} $f_w = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$	<u>0.896</u>
Two-way flow rate, $^1 v_p$ (pc/h) $v_p = \frac{V}{PHF \cdot f_G \cdot f_w}$	<u>254</u>
v_p * highest directional split proportion 2 (pc/h)	
Free-Flow Speed from Field Measurement	Estimated Free-Flow Speed
Field measured speed, S_{FM} km/h	Base free-flow speed, BFFS <u>100</u> km/h
Observed volume, V_i veh/h	Adj. for lane width and shoulder width, f_{LS} (Exhibit 20-5) <u>5.9</u> km/h
Free-flow speed, FFS km/h	Adj. for access points, f_A (Exhibit 20-6) <u>2</u> km/h
FFS = $S_{FM} + 0.0125 \left(\frac{V_i}{f_w} \right)$	Free-flow speed, FFS <u>92.1</u> km/h
	FFS = BFFS - f_{LS} - f_A
Adj. for no-passing zones, f_{np} (km/h) (Exhibit 20-11)	<u>0.71</u>
Average travel speed, ATS (km/h) $ATS = FFS - 0.0125 v_p - f_{np}$	<u>88.2</u>
Percent Time-Spent-Following	
Grade adjustment factor, f_G (Exhibit 20-8)	<u>0.77</u>
Passenger-car equivalents for trucks, E_T (Exhibit 20-10)	<u>1.8</u>
Passenger-car equivalents for RVs, E_R (Exhibit 20-10)	<u>1.0</u>
Heavy-vehicle adjustment factor, f_{HV} $f_w = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$	<u>0.94</u>
Two-way flow rate, $^1 v_p$ (pc/h) $v_p = \frac{V}{PHF \cdot f_G \cdot f_w}$	<u>223</u>
v_p * highest directional split proportion 2 (pc/h)	
Base percent time-spent-following, BPTSF (%) $BPTSF = 100[1 - \exp(-0.000879 v_p)]$	<u>17.8</u>
Adj. for directional distribution and no-passing zone, f_{dnp} (%) (Exhibit 20-12)	<u>13.4</u>
Percent time-spent-following, PTSF (%) $PTSF = BPTSF + f_{dnp}$	<u>31.2</u>
Level of Service and Other Performance Measures	
Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II)	<u>B</u>
Volume to capacity ratio, v/c $v/c = \frac{v_p}{3200}$	
Peak 15-min vehicle-kilometers of travel, $VkmT_{15}$ (veh-km) $VkmT_{15} = 0.25 L \left(\frac{V}{PHF} \right)$	
Peak-hour vehicle-kilometers of travel, $VkmT_{60}$ (veh-km) $VkmT_{60} = V \cdot L$	
Peak 15-min total travel time, TT_{15} (veh-h) $TT_{15} = \frac{VkmT_{15}}{ATS}$	
Notes	
1. If $v_p \geq 3200$ pc/h, terminate analysis—the LOS is F. 2. If highest directional split $v_p \geq 1,700$ pc/h, terminate analysis—the LOS is F.	

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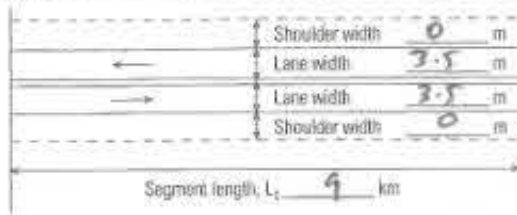
Highway Capacity Manual 2000 THOMAS MITCHELL DRIVE, W OF NEH CUMULATIVE

TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET	
General Information Analyst: <u>Damien Chee</u> Agency or Company: <u>BMC</u> Date Performed: <u>2/7/2012</u> Analysis Time Period: <u>0600-0700h</u> Site Information Highway: <u>TMD</u> From/To: <u>W OF NEH</u> Jurisdiction: <u>MSC</u> Analysis Year: <u>YEAR 15</u>	
☐ Operational (LOS) ☐ Design (v _p) ☒ Planning (LOS) ☐ Planning (v _p)	
Input Data Shoulder width: <u>0</u> m Lane width: <u>3.5</u> m Lane width: <u>3.5</u> m Shoulder width: <u>0</u> m Segment length, L₁: <u>9</u> km ☐ Class I highway ☒ Class II highway Terrain: ☒ Level ☐ Rolling Two-way hourly volume: <u>930</u> veh/h Directional split: <u>31</u> / <u>169</u> CB/WB Peak-hour factor, PHF: <u>0.88</u> % Trucks and buses, P_T: <u>0.4</u> % % Recreational vehicles, P_R: <u>0</u> % % No-passing zone: <u>80</u> % Access points/km: <u>3</u> /km	
Average Travel Speed	
Grade adjustment factor, f _g (Exhibit 20-7) _____ Passenger-car equivalents for trucks, E _T (Exhibit 20-9) _____ Passenger-car equivalents for RVs, E _R (Exhibit 20-9) _____ Heavy-vehicle adjustment factor, f _{HV} $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$ _____ Two-way flow rate, v _p (pc/h) $v_p = \frac{V}{PHF} \cdot f_{HV}$ _____ v _p * highest directional split proportion ² (pc/h) _____ Free-Flow Speed from Field Measurement Field measured speed, S_{FM} _____ km/h Observed volume, V_f _____ veh/h Free-flow speed, FFS $FFS = S_{FM} + 0.0125 \left(\frac{V_f}{S_{FM}} \right)$ _____ km/h Adj. for no-passing zones, f_{np} (km/h) (Exhibit 20-11) _____ Average travel speed, ATS (km/h) $ATS = FFS - 0.0125 v_p - f_{np}$ _____ Estimated Free-Flow Speed Base free-flow speed, BFFS _____ km/h Adj. for lane width and shoulder width, f_{LS} (Exhibit 20-5) _____ km/h Adj. for access points, f_A (Exhibit 20-6) _____ km/h Free-flow speed, FFS _____ km/h FFS = BFFS - f_{LS} - f_A _____	
Percent Time-Spent-Following	
Grade adjustment factor, f _g (Exhibit 20-8) <u>1.00</u> Passenger-car equivalents for trucks, E _T (Exhibit 20-10) <u>1.1</u> Passenger-car equivalents for RVs, E _R (Exhibit 20-10) <u>1.0</u> Heavy-vehicle adjustment factor, f _{HV} $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$ <u>0.99</u> Two-way flow rate, v _p (pc/h) $v_p = \frac{V}{PHF} \cdot f_{HV}$ <u>1067</u> v _p * highest directional split proportion ² (pc/h) _____ Base percent time-spent-following, BPTSF (%) <u>60.9</u> BPTSF = 100 [1 - exp(-0.000879 v _p)] Adj. for directional distribution and no-passing zone, f _{dnp} (%) (Exhibit 20-12) <u>12.6</u> Percent time-spent-following, PTSF (%) $PTSF = BPTSF + f_{dnp}$ <u>73.5</u>	
Level of Service and Other Performance Measures	
Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II) <u>D</u>	
Volume to capacity ratio, v/c $v/c = \frac{v_p}{S_{FM}}$ <u>0.300</u>	
Peak 15-min vehicle-kilometers of travel, VkmT ₁₅ (veh-km) $VkmT_{15} = 0.25 L \left(\frac{V}{PHF} \right)$ _____	
Peak-hour vehicle-kilometers of travel, VkmT ₆₀ (veh-km) $VkmT_{60} = V \cdot L$ _____	
Peak 15-min total travel time, TT ₁₅ (veh-h) $TT_{15} = \frac{VkmT_{15}}{ATS}$ _____	
Notes 1. If v _p ≥ 3,200 pc/h, terminate analysis—the LOS is F. 2. If highest directional split v _p ≥ 1,700 pc/h, terminate analysis—the LOS is F.	

CUMULATIVE
CASE
(YEAR 15)
AMNOT REQUIRED
FOR CLASS II

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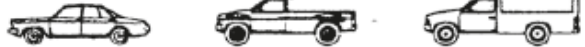
Highway Capacity Manual 2000 THOMAS MITCHELL DRIVE, W OF NEH CUMULATIVE

TWO-WAY TWO-LANE HIGHWAY SEGMENT WORKSHEET	
General Information Analyst: <u>Damien Chee</u> Agency or Company: <u>BMC</u> Date Performed: <u>2/2/2012</u> Analysis Time Period: <u>1600-1700</u>	
Site Information Highway: <u>TMD</u> From/To: <u>W OF NEH</u> Jurisdiction: <u>MSC</u> Analysis Year: <u>YEAR 15</u>	
☐ Operational (LOS) ☐ Design (v_p) ☒ Planning (LOS) ☐ Planning (v_p)	
Input Data  ☐ Class I highway ☒ Class II highway Terrain: ☒ Level ☐ Rolling Two-way hourly volume: <u>779</u> veh/h Directional split: <u>68</u> / <u>32</u> EB/WB Peak-hour factor, PHF: <u>0.81</u> % Trucks and buses, P_T: <u>5.6</u> % % Recreational vehicles, P_R: <u>0</u> % % No-passing zone: <u>80</u> % Access points/km: <u>3.0</u> /km	
Average Travel Speed Grade adjustment factor, f_G (Exhibit 20-7) Passenger-car equivalents for trucks, E_T (Exhibit 20-9) Passenger-car equivalents for RVs, E_R (Exhibit 20-10) Heavy-vehicle adjustment factor, f_{HV} $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$ Two-way flow rate, $^1 v_p$ (pc/h) $v_p = \frac{V}{PHF \cdot f_G \cdot f_{HV}}$ v_p * highest directional split proportion 2 (pc/h) Free-Flow Speed from Field Measurement Field measured speed, S_{FM} _____ km/h Observed volume, V_f _____ veh/h Free-flow speed, FFS _____ km/h $FFS = S_{FM} + 0.0125 \left(\frac{V_f}{f_{HV}} \right)$ Estimated Free-Flow Speed Base free-flow speed, BFFS _____ km/h Adj. for lane width and shoulder width, f_{LS} (Exhibit 20-5) _____ km/h Adj. for access points, f_A (Exhibit 20-6) _____ km/h Free-flow speed, FFS _____ km/h $FFS = BFFS - f_{LS} - f_A$	
Percent Time-Spent-Following Grade adjustment factor, f_G (Exhibit 20-7) Passenger-car equivalents for trucks, E_T (Exhibit 20-9) Passenger-car equivalents for RVs, E_R (Exhibit 20-10) Heavy-vehicle adjustment factor, f_{HV} $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$ Two-way flow rate, $^1 v_p$ (pc/h) $v_p = \frac{V}{PHF \cdot f_G \cdot f_{HV}}$ v_p * highest directional split proportion 2 (pc/h) Base percent time-spent-following, BPTSF (%) $BPTSF = 100[1 - \exp(-0.000879v_p)]$ Adj. for directional distribution and no-passing zone, f_{dnp} (%) (Exhibit 20-12) Percent time-spent-following, PTSF (%) $PTSF = BPTSF \cdot f_{dnp}$	
Level of Service and Other Performance Measures Level of service, LOS (Exhibit 20-3 for Class I or 20-4 for Class II) Volume to capacity ratio, v/c $v/c = \frac{v_p}{3,200}$ Peak 15-min vehicle-kilometers of travel, $VkmT_{15}$ (veh-km) $VkmT_{15} = 0.25V \left(\frac{V}{PHF} \right)$ Peak-hour vehicle-kilometers of travel, $VkmT_{60}$ (veh-km) $VkmT_{60} = V \cdot L_1$ Peak 15-min total travel time, TT_{15} (veh-h) $TT_{15} = \frac{VkmT_{15}}{ATS}$	
Notes 1. If $v_p \geq 3,200$ pc/h, terminate analysis—the LOS is F. 2. If highest directional split $v_p \geq 1,700$ pc/h, terminate analysis—the LOS is F.	

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Appendix D

Austroads vehicle classes

Level 1	Level 2		Level 3	AUSTROADS Classification		
Length (indicative)	Axles and Axle Groups		Vehicle Type			
Type	Axles	Groups	Typical Description	Class	Parameters	Typical Configuration
Short up to 5.5m	LIGHT VEHICLES					
		1 or 2	Short Sedan, Wagon, 4WD, Utility, Light Van, Bicycle, Motorcycle, etc	1	$d(1) \leq 3.2\text{m}$ and axles = 2	
Medium 5.5m to 14.5m	3, 4 or 5	3	Short - Towing Trailer, Caravan, Boat, etc	2	groups = 3 $d(1) \geq 2.1\text{m}$, $d(1) \leq 3.2\text{m}$, $d(2) \geq 2.1\text{m}$ and axles = 3, 4 or 5	
	HEAVY VEHICLES					
	2	2	Two Axle Truck or Bus	3	$d(1) > 3.2\text{m}$ and axles = 2	
	3	2	Three Axle Truck or Bus	4	axles = 3 and groups = 2	
	> 3	2	Four Axle Truck	5	axles > 3 and groups = 2	
Long 11.5m to 19.0m	3	3	Three Axle Articulated Three axle articulated vehicle, or Rigid vehicle and trailer	6	$d(1) > 3.2\text{m}$, axles = 3 and groups = 3	
	4	> 2	Four Axle Articulated Four axle articulated vehicle, or Rigid vehicle and trailer	7	$d(2) < 2.1\text{m}$ or $d(1) < 2.1\text{m}$ or $d(1) > 3.2\text{m}$ axles = 4 and groups > 2	
	5	> 2	Five Axle Articulated Five axle articulated vehicle, or Rigid vehicle and trailer	8	$d(2) < 2.1\text{m}$ or $d(1) < 2.1\text{m}$ or $d(1) > 3.2\text{m}$ axles = 5 and groups > 2	
	≥ 6	> 2	Six Axle Articulated Six axle articulated vehicle, or Rigid vehicle and trailer	9	axles = 6 and groups > 2 or axles > 6 and groups = 3	
Medium Combination 17.5m to 36.5m	> 6	4	B Double B Double, or Heavy truck and trailer	10	groups = 4 and axles > 6	
	> 6	5 or 6	Double Road Train Double road train, or Medium articulated vehicle and one dog trailer (M.A.D.)	11	groups = 5 or 6 and axles > 6	
Large Combination Over 33.0m	> 6	> 6	Triple Road Train Triple road train, or Heavy truck and three trailers	12	groups > 6 and axles > 6	