APPENDIX 12

Traffic and Transport Impact Assessment

DRAFT

TRAFFIC AND TRANSPORT IMPACT ASSESSMENT

FOR

INVINCIBLE SOUTHERN EXTENSION PROJECT

AT

CASTLEREAGH HIGHWAY CULLEN BULLEN

Ref. 15233r

14 June 2016

Prepared By

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1.0 INTRODUCTION

1.1 Introduction

Shoalhaven Coal Pty Ltd (trading as Castlereagh Coal), part of the Manildra Group of companies (Manildra), owns the Invincible Colliery located south east of Cullen Bullen in the Lithgow Local Government Area (refer to **Figure 1**).

Shoalhaven Coal is seeking to extend open cut mining operations to the south of the existing approved mining area (the Proposed Mining Extension Area).

A modification of the existing Invincible Project Approval (07/0127) will be sought under section 75W of the Environmental Planning and Assessment Act 1979 (EP&A Act) to obtain approval for the proposed modified project (the Proposed Modification).

An environmental Impact Statement (EIS) has been prepared to accompany this application.

This Traffic and Transport Assessment has been prepared by Transport and Urban Planning Pty Ltd on behalf of Umwelt (Australia) Pty Limited (Umwelt) as part of the environmental assessment for the Project. The Traffic and Transport Impact Assessment has been undertaken in accordance with indicative Environmental Assessment Requirements (SEARs) for mining developments.

1.2 Authority Requirements

The Indicative Secretary's Environmental Assessment Requirements (SEARS) for road transport include;

- Identify transport modes and routes for key inputs/outputs to the development;
- Assess road impacts, including the capacity, condition, safety and efficiency of the local and State road network, with regard to Council's requirements; and
- Consider any relevant government policies.

1.3 Structure of this Report

This report has been prepared to support the EIS, to assess the road transport and traffic impacts associated with the Project.

The assessment has been undertaken in accordance with the requirements of Roads and Traffic Authority's Guide to Traffic Generating Developments October 2002, addressing those matters identified in the (indicative) SEARS.

Other technical standards/publications referenced in this assessment include:

- Austroads Guide to Road Design (2008 - 2014) and RMS supplements (various dates from 2009).
- Austroads Guide to Traffic Management (2008 - 2014) and RMS supplements (various dates from 2009).

The remaining sections of this report address the following;

- Section 2 – provides an overview of the existing approved operations at the mine and describes the Project;
- Section 3 – examines the existing traffic conditions on the road network;
- Section 4 – evaluates the traffic impacts of the Project; and
- Section 5 – presents conclusions.

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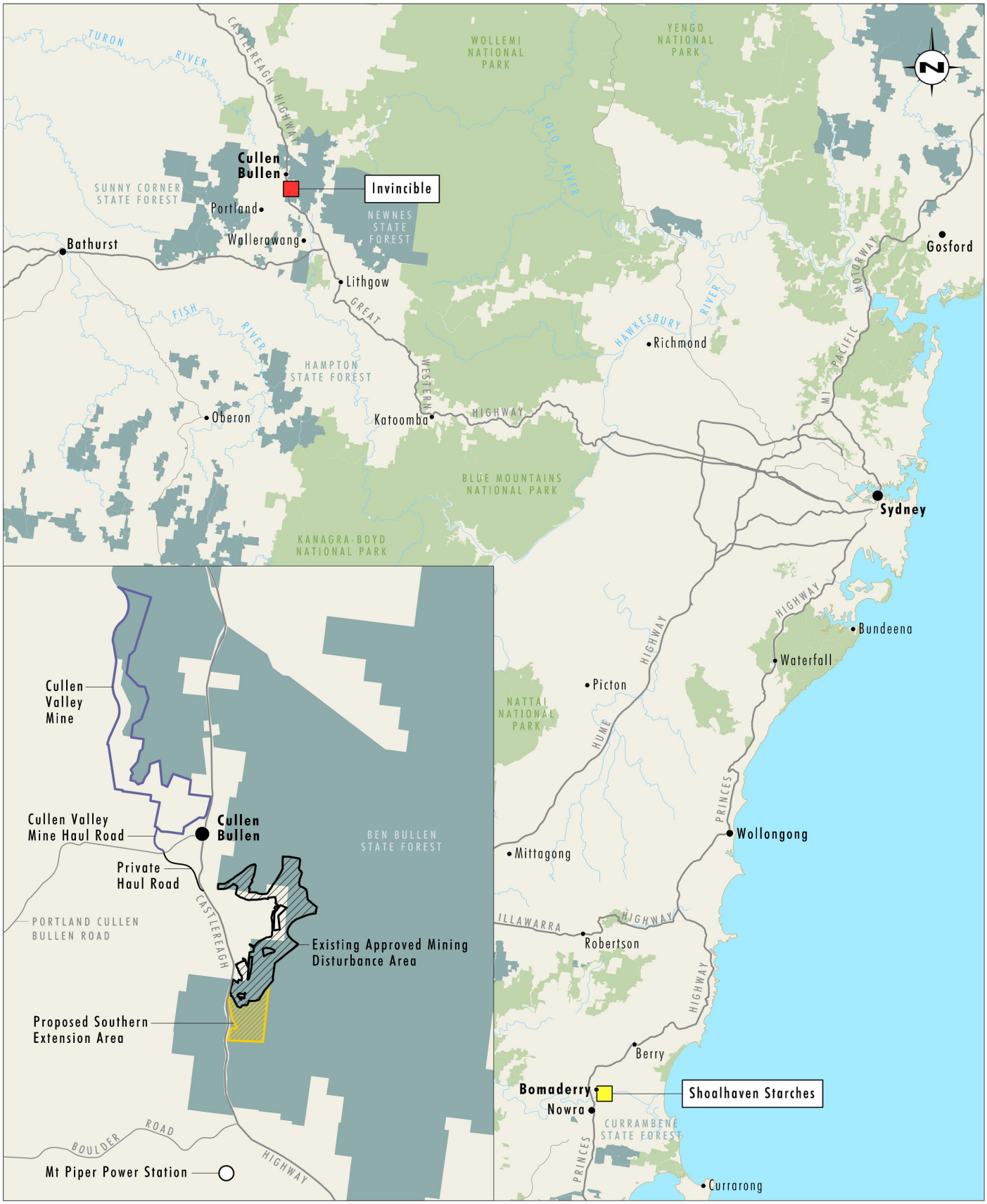

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FIGURE 1

INVINCIBLE SOUTHERN EXTENSION PROJECT
CASTLEREAGH HIGHWAY, CULLEN BULLEN

SITE LOCATION

JOB NO.15233

2.0 APPROVED OPERATIONS AND PROJECT

2.1 Existing Approved Operations

Invincible Colliery currently operates under Project Approval 07/0127, granted on 4 December 2008. This project approved open cut mining and highwall mining. Coal is approved to be extracted from all seams down to and including the Lithgow seam.

The available coal within the approved mining area has been exhausted and the operation is currently under care and maintenance. The existing approval currently limits mining to eight years from the date of grant of the approval (ie. to 4 December 2016). The Project approval authorises ongoing rehabilitation activities after the date of approved mining.

The existing operations have been an approved production rate of 1.2 Million tonnes per annum (Mtpa) product coal.

Product coal is approved to be transported from the site by truck via the Castlereagh Highway. Until operations stopped, coal was supplied to the Mount Piper Power Station, Wallerawang Power Station and up to 0.2 Mtpa was supplied to other domestic sources.

Approved hours of operation are 7.00am-10.00pm Monday to Saturday (except public holidays). Mining in West, Renown (Central) and South Pits is not permitted between 6.00pm and 7.00am.

Existing approved mine infrastructure include site offices, car parks, workshop, bathhouse, Coal Preparation Plant, coal crushing and screening area, suite access and haul roads, fine rejects storage and water management system.

There are two surface mining leases that apply to Invincible's operations, ML 1635 (23 hectares) and ML 1638 (450 hectares). CCL 702 (1,840) is a subsurface mining lease which underlies much of the area to the north and east of Invincible Colliery. Mining Lease Application 431 covers the Proposed Mining Extension Area to the south of the existing Invincible open cut area.

Invincible colliery is predominantly located within Ben Bullen State Forest with parts of the northern area of the mine owned by Shoalhaven Coal.

2.2 Invincible Southern Extension Project

The Invincible Southern Extension Project (the Project) is an extension of open cut mining operations to the south of the existing approved mining area at Invincible Colliery.

The Project includes:

- Extending the period in which mining can continue to 31 December 2024.
- Extending the open cut mining area immediately south of the existing mining disturbance area (refer to **Figure 2**). Extraction of coal from all seams down to, and including the Lithgow seam. No highwall mining or open cut mining in any other areas of Invincible is proposed as part of the Project
- Continued use of existing Invincible infrastructure (including operation of, and maintenance work on, the existing Coal Preparation Plant)
- Use of existing open cut voids and former underground workings for water storage
- No change to currently approved mining production rates

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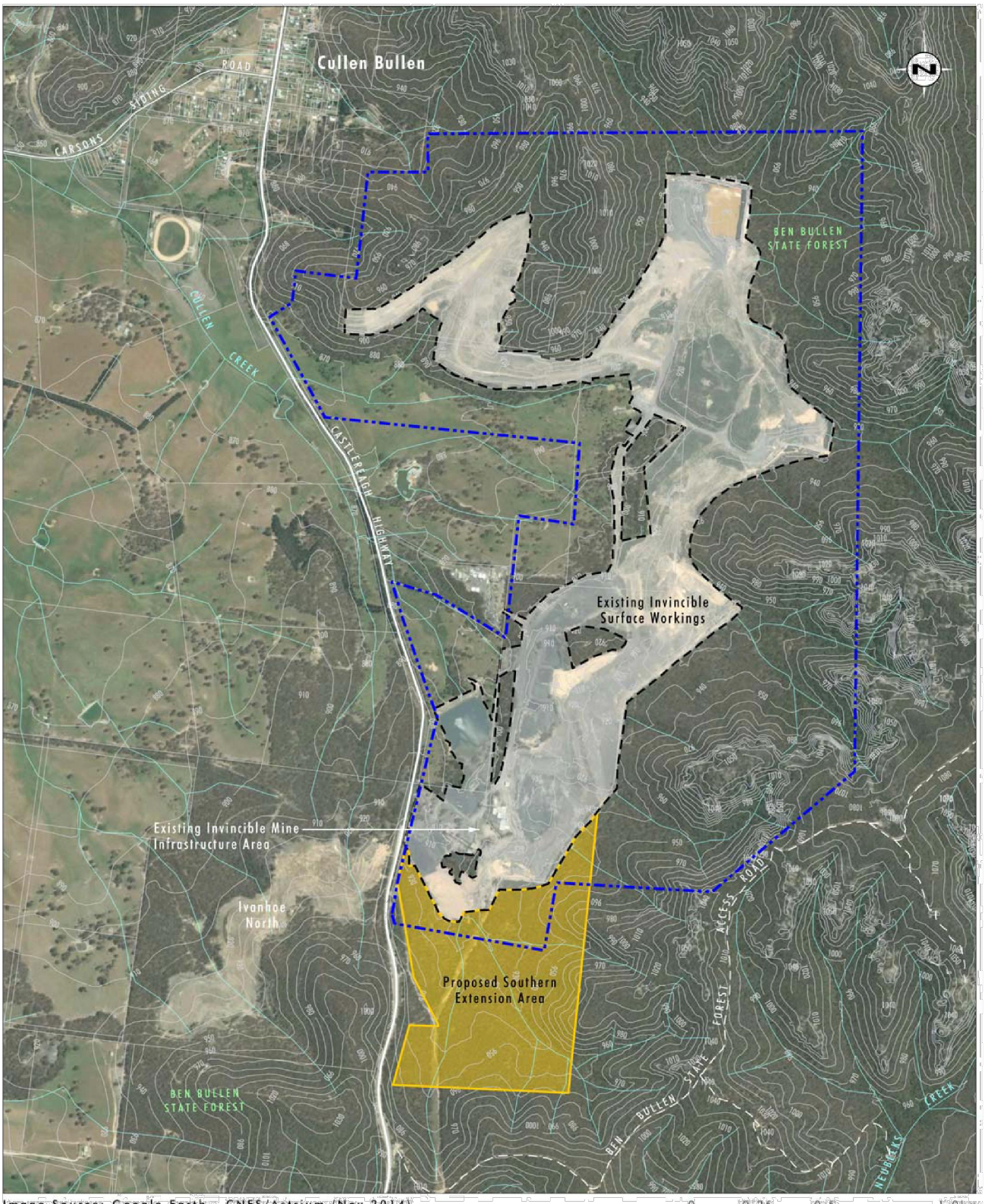

Image Source: Google Earth - CNES/Astrium (Nov 2014)
Data Source: LPI (2016), Forest Corporation of NSW (2015)
Note: Contour Interval 10m

Legend
- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- Invincible Project Approval Boundary (PA07/0127)

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FIGURE 2

INVINCIBLE SOUTHERN EXTENSION PROJECT
CASTLEREAGH HIGHWAY, CULLEN BULLEN

PROPOSED MODIFICATION

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- No change to currently approved transport arrangements
- Rehabilitation of the Southern Extension Area and existing disturbance areas at Invincible

The key features of the Project are shown on **Figure 2**.

The Proponent, Castlereagh Coal, is part of the Manildra Group of companies. The Purpose of the Project is to provide Manildra's Shoalhaven Starches with a reliable and cost effect source of nut coal for its Bomaderry operations on the NSW South Coast. The proposed modification will provide access to an additional approximately 371 kt of Nut coal from the Lithgow seam and, at current requirements; this would provide approximately 4 years supply of nut coal for use at the Shoalhaven Starches plant. Coal from the Lidsdale and Irondale seams which is unsuitable for use in Shoalhaven Starches plant will be sold to the Mount Piper Power Station.

The 8 year extension to the life of mining operations is to provide Shoalhaven Starches with flexibility of either sourcing coal from existing suppliers (with the ability to source coal from Invincible in the event of supply issues) or source coal solely from Invincible for approximately 4 years within this period. The eight year extension of mine life will also enable Castlereagh Coal and Shoalhaven Starches to fully investigate options of using coal from the Lidsdale and Irondale seams at the Bomaderry plant. This assessment has assumed a conservative mining scenario of up to maximum limits of production to provide a conservative assessment of impacts over the life of the Project.

Table 1 - Comparison of Existing approved operations at Invincible and the Southern Extension Project.

	Existing Approved Operations	Southern Extension Project
Resource Tonnes	Defined by existing footprint. Approved reserves have been mined.	Approximately 2.7Mt run-of-mine (ROM) coal.
Mining Methods	Highwall and Open Cut	Open Cut only
Target Seams	All seams down to Lithgow Seam (Irondale, Lidsdale and Lithgow)	All seams down to Lithgow seam (Irondale, Lidsdale and Lithgow)
Mining Rate	1.2 Mtpa Product Coal	Up to 1.2 Mtpa Product Coal
Mining Life	To December 2016 (8 years from date of approval)	Up to 8 years depending on production rate and commencement date
Open Cut Mining Area	152 ha.	Approximately 53 hectares of additional disturbance (204 hectares in total)
Operational Workforce	35 full time personnel.	Approximately 35 full time personnel.

	Existing Approved Operations	Southern Extension Project
Hours of operations	7am – 10pm Monday to Saturday (excl. public holidays). Mining in south pits not permitted between 6pm and 10pm.	7:00am-10.00pm Monday to Saturday (excl. public holidays). Mining and coal washery operations will not occur between 6pm and 10pm (operations limited to truck loading and maintenance activities only during this period)
Blasting	Blasting between 9:00 am and 3:00 pm Monday to Friday, inclusive.	Blasting between 9:00 am and 3:00 pm Monday to Friday, inclusive. Blasts sizes limited to manage potential risks to dwellings, pagoda and cliffline formations and other infrastructure.
Transport	Road Transport 7 am – 9:30 pm Monday to Saturday, excluding Sundays and public holidays.	Road Transport 7 am – 9:30 pm Monday to Saturday, excluding Sundays and public holidays.
Rehabilitation	Commitment to rehabilitate existing disturbance areas.	Project will include the rehabilitation of existing disturbance areas and the Southern Extension Area.

3.0 EXISTING TRAFFIC CONDITIONS

3.1 Transport Routes

The Project involves the majority of the coal being transported by trucks from the Invincible Mine to Mount Piper Power Station and a small quantity from the Mine to Bomaderry (Nowra).

The existing road network that provides access to the Invincible Mine and Mount Piper Power Station includes Castlereagh Highway, Invincible Mine Access Road, Boulder Road and Mount Piper Power Station Access Road.

The transport routes between Invincible Mine and Bomaderry involve the RMS's State road and highway road network including Castlereagh Highway, Great Western Highway, State roads and Motorways in Sydney metropolitan area and Princes Highway. **Figure 3** shows the transport routes adjacent the mine.

3.2 Description of Existing Roads

The Castlereagh Highway adjacent the Invincible Mine at Cullen Bullen is predominantly a two lane rural road constructed to a highway standard, with significant traffic management upgrades at principal intersections and other locations.

In the two lane sections, Castlereagh Highway has 2 travel lanes (one in each direction), wide sealed shoulders with marked centreline and edgelines, together with guideposts and reflectors. Guardrail and wire fencing is provided in those sections where required, together with advisory warning signs and directional signposting.

The horizontal alignment is a mixture of straight sections with large radius curves and the vertical alignment consists of sections of modest grades.

The speed limit in this section of the Highway is 100km/h.

The distance between Invincible Mine Access Road and Boulder Road is approximately 2.8kms.

In the section between Invincible Mine Access Road and Boulder Road sections of two lanes are provided in each direction, to cater for truck movements travelling between the Mine and Boulder Road. These two lane sections allow other vehicles to overtake slower vehicles including the trucks.

The two lane sections include between:

- The mine and Boulder Road for a distance of 1.6kms in a southerly direction; and
- Boulder Road and the mine in the northerly direction for a distance of 1.6kms.

The Invincible Mine Access Road intersects Castlereagh Highway on its eastern side and forms a channelised intersection. The Invincible Mine Access Road provides vehicle access to the mine's infrastructure and has separate road carriageway for inbound and outbound vehicles.

Ivanhoe Mine Access Road also intersects Castlereagh Highway on the western side. Ivanhoe Mine is closed and currently undergoing rehabilitation. As such the Access Road is not currently used.

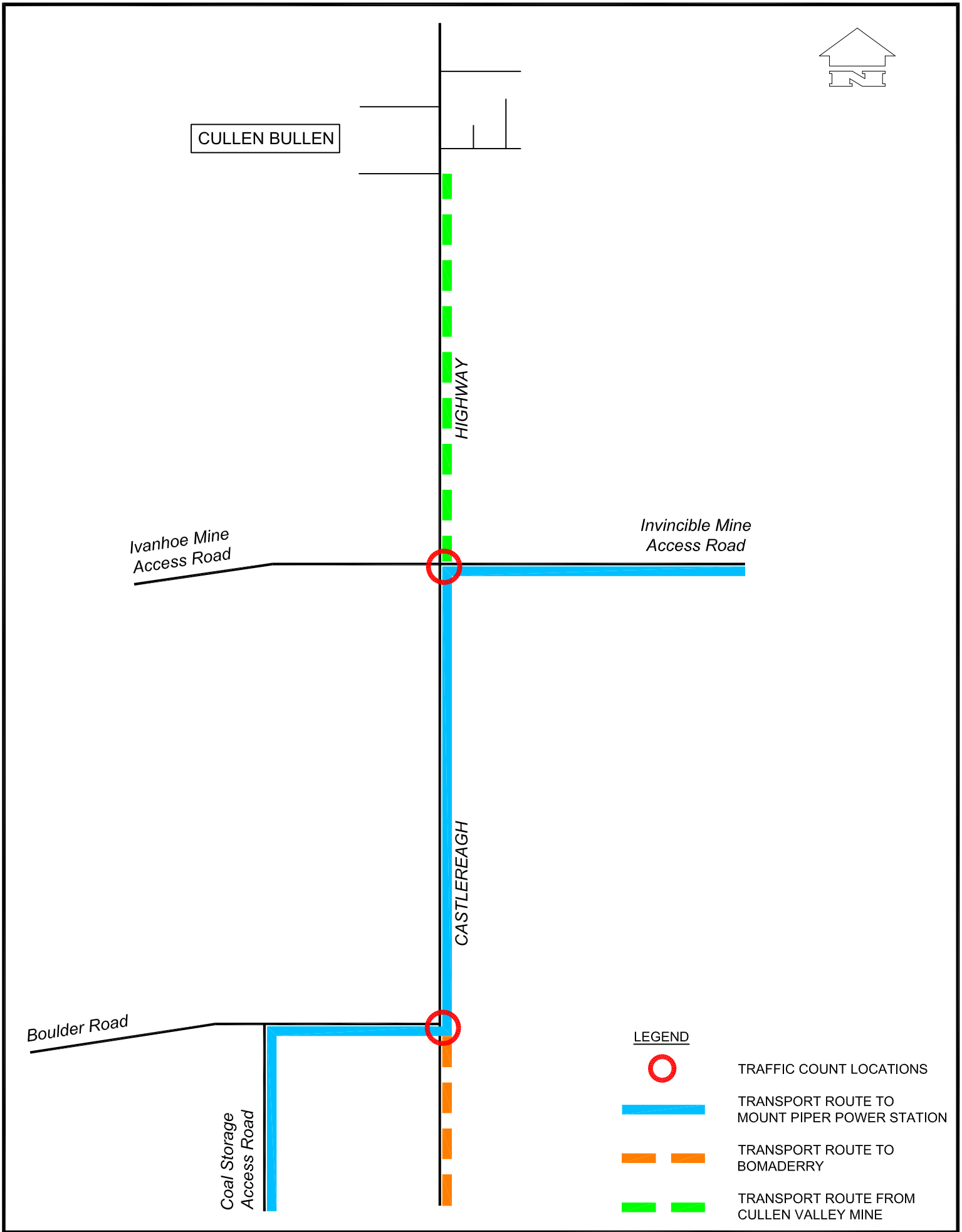

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FIGURE 3

INVINCIBLE SOUTHERN EXTENSION PROJECT
CASTLEREAGH HIGHWAY, CULLEN BULLEN

PRINCIPAL ROAD, TRANSPORT ROUTES & TRAFFIC COUNT LOCATIONS

JOB NO.15233

Boulder Road forms a Channelised T junction intersection with Castlereagh Highway on its western side. Boulder Road provides a road link to Portland and also vehicle access to Mount Piper Power Station. In the section adjacent Mount Piper Power Station, Boulder Road is a two lane road (single lane in each direction) and has a posted speed limit of 60km/h.

The access road to the coal storage area for the Mount Piper Power Station is located approximately 280 metres west of the Castlereagh Highway. This access road forms a T junction with Boulder Road.

The principal intersections are shown in **Figure 3** and are described below. Appendix 1 shows aerial photographs of the intersections.

Castlereagh Highway/Invincible Mine Access Road/Ivanhoe Mine Access Road

Invincible Mine Access Road forms a cross junction intersection with Castlereagh Highway. The speed limit at the intersection is 100km/h. Channelisation at this intersection includes:

- A CHR right turn lane treatment which is 170 metres long including taper, in the southern approach of Castlereagh Highway for right turn into Invincible Mine.

- A CHL left turn lane treatment, 185 metres long including taper in the southern approach of the Castlereagh Highway for the left turn into Ivanhoe Mine;

- A left turn acceleration lane 1.6kms long in the southern leg of Castlereagh Highway for the left turn out of Invincible Mine. This is constructed as an auxiliary lane, with the left turn required to give way;

- A CHR right turn lane, 65 metres long including taper in the northern approach of Castlereagh Highway for the right turn into Ivanhoe Mine;

- Invincible Mine's Access Road has separate carriageways with a wide grassed median separating the inbound vehicles from those vehicles exiting the Mine.

- Ivanhoe Mine Access Road provides single lanes in each direction with flaring at the intersection.

Sight distance to and from Invincible Mine's Access Road in Castlereagh Highway is approximately 250 metres in the northern approach and in excess of 300 metres in the southern approach. Advance warning signs including truck warnings signs are provided in both approaches of Castlereagh Highway. The available sight distance is considered to be satisfactory.

Castlereagh Highway/Boulder Road

Boulder Road forms a T junction intersection with Castlereagh Highway. The speed limit at the intersection is 100km/h. The existing channelisation at the intersection includes:

- A CHR right turn lane treatment, 140 metres long including taper, in the northern approach of Castlereagh Highway for the right turn into Boulder Road.

- A CHL left turn lane treatment, 240 metres long including taper, in the southern approach of Castlereagh Highway for the left turn into Boulder Road.

- A left turn acceleration lane in the northern leg of Castlereagh Highway 1.6km long for the left turn out of Boulder Road. This is constructed as a protected left turn lane allowing the vehicles to turn left without the need to give way.

- Two approach lanes in Boulder Road.

Sight distance to and from Boulder Road in Castlereagh Highway is approximately 300 metres in the northern approach and 250 metres in the southern approach.

Advance Directional Signs are provided in both approaches of Castlereagh Highway, together with an 85km/h curve warning sign approaching the intersection in southern approach.

Boulder Road/Access Road to Mount Piper's Power Station Coal Area

The Access Road to the coal storage area forms a T junction intersection with Boulder Road on its eastern side. The speed limit at the intersection is 60km/h. The channelisation at the intersection includes;

- A CHL left turn lane 90 metres long including taper in the western approach of Boulder road for the left turn into the Access Road for the coal storage area.

- A CHR right turn lane 110 metres long including taper in the eastern approach of Boulder Road for the right turn into the Access Road for the coal storage area.

- Two approach lanes in the Coal Storage Access Road.

Sight distance at the intersection is good. Sight distance to and from the intersection in Boulder Road is 150 metres in the eastern approach and 180 metres in the western approach.

3.3 Existing Traffic Conditions on the Road Network

Traffic counts on the road network were undertaken as part of this assessment to establish current traffic volumes using the road network. This included intersection traffic counts undertaken on Tuesday 15 March 2016 between the hours of 6.00am – 9.00am (AM period) and 1.00pm – 6.00pm (PM period) at the principal intersections of;

- Castlereagh Highway/Invincible Mine Access Road/Ivanhoe Mine Access Road

- Castlereagh Highway/Boulder Road; and

- Boulder Road at Mount Piper Power Station Coal Access Road.

Figure 3 shows the count locations.

As noted previously, both Invincible Mine and the adjacent Ivanhoe Mine are under care and maintenance and no vehicles accessed these mines during the traffic counts.

In addition, the Coal Access Road at Mount Piper Station was closed at the time of the counts (i.e. Power station did not receive any coal on that day) so counts only recorded through traffic using Boulder Road at that intersection.

Tables 3.1 and 3.2 show the hourly volumes using the Castlereagh Highway during the 6.00am – 9.00am period and the 1.00pm – 6.00pm period as recorded in the traffic counts at Invincible Mine and also at Boulder Road. Table 3.3 shows the hourly volumes using Boulder Road during the same periods.

For the purpose of describing the traffic volume directions, Castlereagh Highway runs north south and Boulder Road east west.

Reference to Table 3.1 shows that Castlereagh Highway at Invincible Mine in the AM peak period (6.00am-9.00am) carries two way volumes in the order of 78vph to 133vh. In the afternoon/PM period two way volumes were in the order of 121-149vph. Traffic volumes in each direction were evenly split and two way heavy vehicles (Austroads Class 3-12) numbered 4-8vph in the AM period and 7-9vph in the PM period.

Reference to Table 3.2 show that Castlereagh Highway on the approaches to Boulder Road carries two way traffic volumes of 118-166vph in the AM period (6.00am-9.00am). During the afternoon PM period (1.00pm-6.00pm) two way traffic volumes are in the order of 144-188vph. The northbound direction (from Lithgow) approaching Boulder Road generally carries the higher volumes and a portion of this traffic turns into Boulder Road. Heavy vehicles (Austroad Classes 3-12) number 3-9vph (two way) in the AM period and 7-12vph (two way) in the PM period.

Two way traffic volumes in Boulder Road (Table 3.3) are in the order of 55-97vph in the AM period (6.00am-9.00am) and 59-123vph in the afternoon PM period (1.00pm-6.00pm). Two way heavy vehicles (Austroad Class 3-12) number 0-2vph in the AM period and 1-8vph in the PM period. The peak hours are the 6.00am-7.00am and 3.00pm-4.00pm periods which coincide with shift change times at Mount Piper Power Station.

TABLE 3.1

HOURLY TRAFFIC VOLUMES IN CASTLEREAGH HIGHWAY AT INVINCIBLE MINE

Time	Direction of Travel		
	North	**South**	**Total**
AM			
6.00am – 7.00am	40 (7)	38 (1)	78 (8)
7.00am – 8.00am	47 (3)	60 (1)	107 (4)
8.00am – 9.00am	69 (2)	64 (4)	133 (6)
PM			
1.00pm – 2.00pm	75 (3)	71 (4)	146 (7)
2.00pm – 3.00pm	70 (3)	62 (6)	132 (9)
3.00pm – 4.00pm	77 (3)	72 (4)	149 (7)
4.00pm – 5.00pm	77 (2)	56 (5)	133 (7)
5.00pm – 6.00pm	64 (2)	57 (6)	121 (8)

Source: Traffic Counts Tuesday 15 March 2016

Where: 40 is total vehicles
(7) is number of heavy vehicles

TABLE 3.2

HOURLY TRAFFIC VOLUMES IN CASTLEREAGH HIGHWAY AT BOULDER ROAD

Time	Direction of Travel		
	North	South	Total
AM			
6.00am – 7.00am	111 (8)	40 (1)	151 (9)
7.00am – 8.00am	60 (2)	58 (1)	118 (3)
8.00am – 9.00am	101 (4)	65 (5)	166 (9)
PM			
1.00pm – 2.00pm	105 (8)	79 (4)	184 (12)
2.00pm – 3.00pm	96 (5)	63 (6)	159 (11)
3.00pm – 4.00pm	108 (3)	80 (4)	188 (7)
4.00pm – 5.00pm	91 (3)	53 (4)	144 (7)
5.00pm – 6.00pm	100 (2)	54 (7)	154 (9)

Source: Traffic Counts Tuesday 15 March 2016

Where: 111 is total vehicles
(8) is number of heavy vehicles

TABLE 3.3

HOURLY TRAFFIC VOLUMES IN BOULDER ROAD WEST OF CASTLEREAGH HIGHWAY

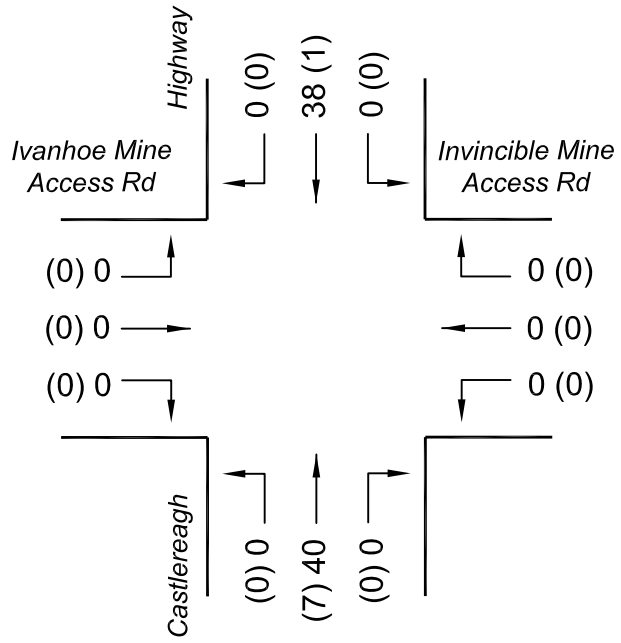
Time	Direction of Travel		
	East	West	Total
AM			
6.00am – 7.00am	29 (0)	68 (0)	97 (0)
7.00am – 8.00am	27 (0)	28 (0)	55 (0)
8.00am – 9.00am	21 (0)	39 (2)	61 (2)
PM			
1.00pm – 2.00pm	35 (3)	27 (5)	62 (8)
2.00pm – 3.00pm	38 (3)	21 (2)	59 (5)
3.00pm – 4.00pm	88 (2)	35 (0)	123 (2)
4.00pm – 5.00pm	33 (0)	27 (1)	60 (1)
5.00pm – 6.00pm	26 (1)	39 (0)	65 (1)

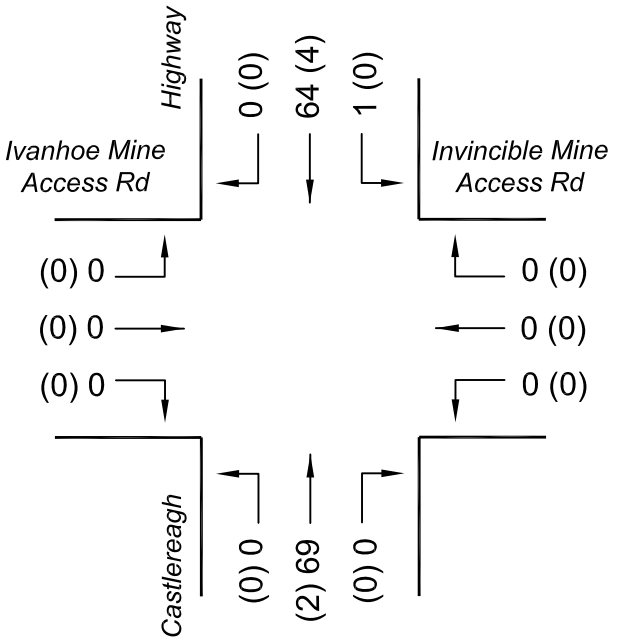
Source: Traffic Counts Tuesday 15 March 2016

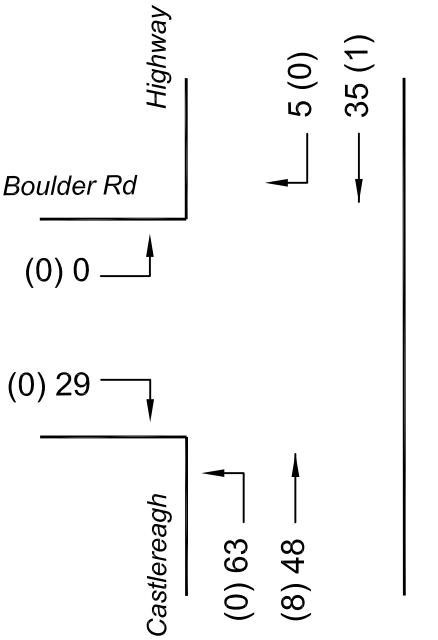
Where: 29 is total vehicles
(0) is number of heavy vehicles

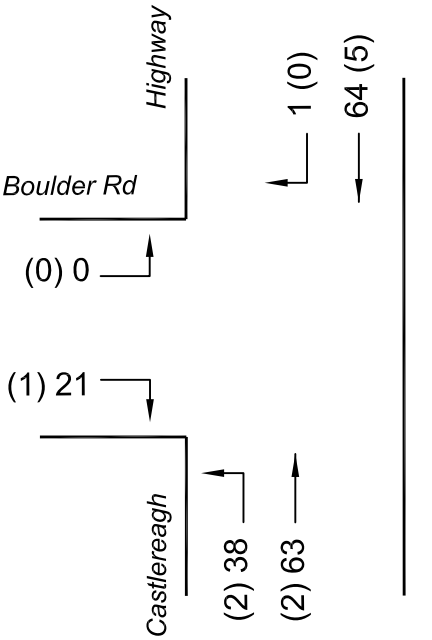
Figures 4 and **5** show the peak hour intersection volumes at the Castlereagh Highway/Invincible Mine Access Road intersection and Castlereagh Highway/Boulder Road intersection during the AM and PM peak hours, respectively. The AM peak hour at both intersections occurs between 8.00am and 9.00am. The PM peak hours at the intersections occurs at slightly different times between 3.00pm-4.00pm at Boulder Road and 3.15pm-4.15pm at Invincible Mine Access Road.

The PM peak hour traffic volumes represent the highest volumes using both intersections during the 6am – 9am and 1pm – 6pm periods of the traffic counts.









AM PEAK HOUR
6:00 - 7:00

AM PEAK HOUR
8:00 - 9:00

KEY

344 TOTAL VEHICLES

(27) HEAVY VEHICLES

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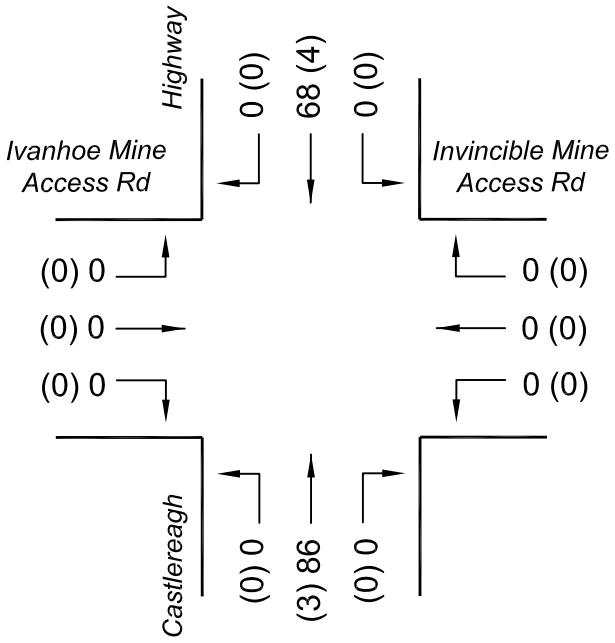
FIGURE 4

INVINCIBLE SOUTHERN EXTENSION PROJECT

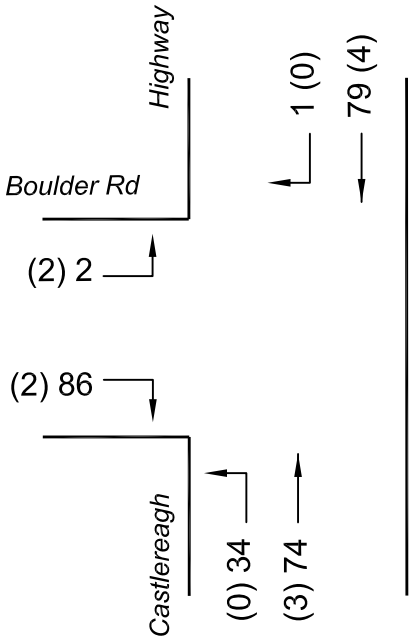
CASTLEREAGH HIGHWAY, CULLEN BULLEN

EXISTING AM PEAK HOUR TRAFFIC VOLUMES

JOB NO.15233



PM PEAK HOUR
3:15 - 4:15



PM PEAK HOUR
3:00 - 4:00

KEY
344 TOTAL VEHICLES
(27) HEAVY VEHICLES

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FIGURE 5
INVINCIBLE SOUTHERN EXTENSION PROJECT
CASTLEREAGH HIGHWAY, CULLEN BULLEN
EXISTING PM PEAK HOUR TRAFFIC VOLUMES
JOB NO.15233

The intersection volumes for 6.00am-7.00am hour is also shown in **Figure 4**. This period will coincide with the arrival of the Invincible workforce, during the operational and construction phases.

Existing traffic conditions at both the Invincible Mine Access Road intersection with Castlereagh Highway and Boulder Road intersection with Castlereagh Highway are good in the weekday AM and PM peak hours. As previously noted, very small numbers of vehicles are currently entering and exiting the Invincible Mine at the present time, as well as the adjacent Ivanhoe Mine.

Traffic conditions at the adjacent Boulder Road intersection are considered to be good with low vehicle delays to the minor traffic movements that are subject to priority control, which is consistent with a Level of Service A operation.

3.4 Road Crashes

Road crash statistics for the 5 year period between 1 July 2010 and 30 June 2015 for Castlereagh Highway between Boulder Road and Carson's Sidings Road at Cullen Bullen were obtained from the RMS.

During this period there were a total of 9 crashes including 1 fatal and 4 injury crashes as well as 4 non injury crashes.

There were 3 crashes at the Boulder Road / Castlereagh Highway intersection including a fatal head on crash, (with fatigue nominated as a factor), a right angle intersection crash (injury crash) and a single vehicle run off the road (non injury) crash.

The other 2 injury crashes involved single vehicle run off the road crashes on curves between Boulder Road and the Invincible Mine Access Road.

Two (2) of the non injury crashes occurred in / near the Cullen Bullen village, one of which was a rear end crash and the other a run off the road crash.

The remaining 2 non injury crashes involved single vehicles running off the road approximately 400 metres north of Boulder Road.

Speed was a contributing factor in 4 crashes and fatigue in 3 of the crashes. Cars (light vehicles) were involved in 7 of the crashes and heavy vehicles in 2 crashes.

The existing design, geometry and traffic management in the Castlereagh Highway does not appear to have been a factor in the above crashes.

3.5 Historical Traffic Growth

There is no recent published AADT traffic volumes for Castlereagh Highway near the Project site available. Historical AADT volumes as published by the RMS between 1976 to 2005 are available and provide some guidance on traffic growth during this period, which could be used as a guide for future growth.

The RMS counting station on Castlereagh Highway north of Boulder Road (Station 99.254) recorded total growth of 52.1% between 1976 and 2005.

This provides an average lineal growth of 1.7% per year over this 29 year period.

4.0 ASSESSMENT OF IMPACTS OF PROJECT

4.1 Traffic Generation in Operational Phase

The Project in its operational phase will employ 35 full time staff generally between 7.00am and 6.00pm. In addition up to 4 contractors will be employed on a part time basis. Visitors to the mine are expected to average approximately 5 per day.

Employees and contractors will generally arrive between 6am – 7am and depart between 6pm and 7pm. Arrival and departures of employees and contractors are expected to be 25% to / from the north and 75% to / from the south divided between Lithgow and Portland.

Transport hours for coal haulage will be 7.00am – 9.30pm Monday to Saturday, excluding Sundays and public holidays.

The Project is proposing to transport 1,150,000 tonnes of coal per year to Mount Piper Power Station and 85,000 tonnes of nut coal per year to Bomaderry (Nowra).

Transport vehicles will be articulated semi trailer vehicles or similar, with average loads of 30 tonnes.

Based on 300 days of transportation per year the traffic generation for the above coal product is 138 loads per day with 128 loads to Mount Piper Power Station and 10 loads per day to Bomaderry.

In addition up to 5,000 tonnes of coal per month (60,000 tonnes per year) from the Cullen Valley mine (north of Invincible mine) may be transported to Invincible mine for processing. While the Cullen Valley mine is currently in care and maintenance, possible production of this mine is being taken into account for the assessment of the Invincible Project. Adopting the same parameters above this will generate another 7 loads per day on average.

Additional heavy vehicles coming to the mine will include deliveries and maintenance vehicles and these are expected to average 4-5 vehicles per day.

Based on the above and assuming a 100% driver rate for employees / contractors at the mine (due to the relatively small workforce), the Project, on a weekday, is expected to generate:

- 39 employee trips at shift time changes with a total of 78 two way trips per day (ie. 39 in / 39 out). These will be light vehicle trips;
- Up to 5 visitor trips per day which will also be light vehicle trips (ie. 5 in / 5 out);
- 145 coal haulage loads per day (ie. 145 in / 145 out) which will be heavy vehicles (ie. 19 metre long semi trailer vehicles);
- Up to 5 heavy vehicles (ie. Austroad Class 3-12) associated with maintenance and deliveries (ie. 5 in / 5 out).

Consent is being sought for year period beginning 2017 for a 4 year period, but the actual commencement date may be delayed on a worst case scenario for up to 4 years.

4.2 Additional Traffic Generation in Construction Phase

Additional vehicle movements associated with construction include:

- 10 additional employees associated with maintenance work on the CHPP during day time operations for approximately 3 months; and
- One (1) additional heavy vehicle (semi trailer) per day;

In addition there will be up to 24 low loader vehicles delivering heavy equipment to the mine during the construction period, prior to operations commencing.

The maintenance employee trips arrival and departure trips to / from the mine are expected to occur at the same time as the operational workforce.

4.3 Traffic Impacts in Construction Phase

The major traffic impact in the construction phase will be associated with the additional employee / contractor trips arriving at the mine between 6am and 7am. This is expected to occur in the first 3 months of operation during the maintenance of the CHPP. It is assumed that the full operational workforce will be on site (ie. 39 personnel) plus the 10 additional maintenance employees.

This will generate up to 49 light vehicle trips entering the Invincible Mine between 6am – 7am.

As noted in Section 4.1, consent is being sought for commencement in 2017, but it is possible that the Project's start date could be delayed by up to 4 years ie. 2021.

Based on the historical traffic growth on Castlereagh Highway noted in Section 3.5 of 1.7% lineal growth per year and rounding this up to 2% per year, background traffic growth of 10% has been added to 2016 volumes to derive 2021 base volumes at the principal intersections in Castlereagh Highway at Invincible Mine Access Road and at Boulder Road.

Figure 6 shows the predicted 2021 traffic volumes at the above intersection during the 6am – 7am weekday period. Also shown are the workforce trips assigned to the road network based on the assignment detailed in Section 4.1.

To examine the impacts of the additional traffic associated with the Project on the principal intersections on the adjacent road network traffic modelling using the SIDRA 7.0 software package has been undertaken for 2021 AM 6am – 7am hour. The modelling has adopted the existing traffic management at both intersections as well as the traffic volumes shown on **Figure 6** for the Invincible Mine Access Road intersection. Small volumes of traffic have been adopted in the model for the Ivanhoe Access Road, to account for some usage of this leg of the intersection

SIDRA assess the operational performance of intersections under traffic signal, roundabout or sign control. The best criteria for assessing intersections controlled by traffic signals are Level of Service (LS), Degree of Saturation (DS) and Average Vehicle Delay (AVD). Table 4.1 shows the Level of Service Criteria for intersections as presented in the RMS (formerly RTA) Guide to Traffic Generating Developments.

For intersections controlled by Give Way / Stop signs, the Level of Service of the intersection is determined by the movement with the highest average vehicle delay

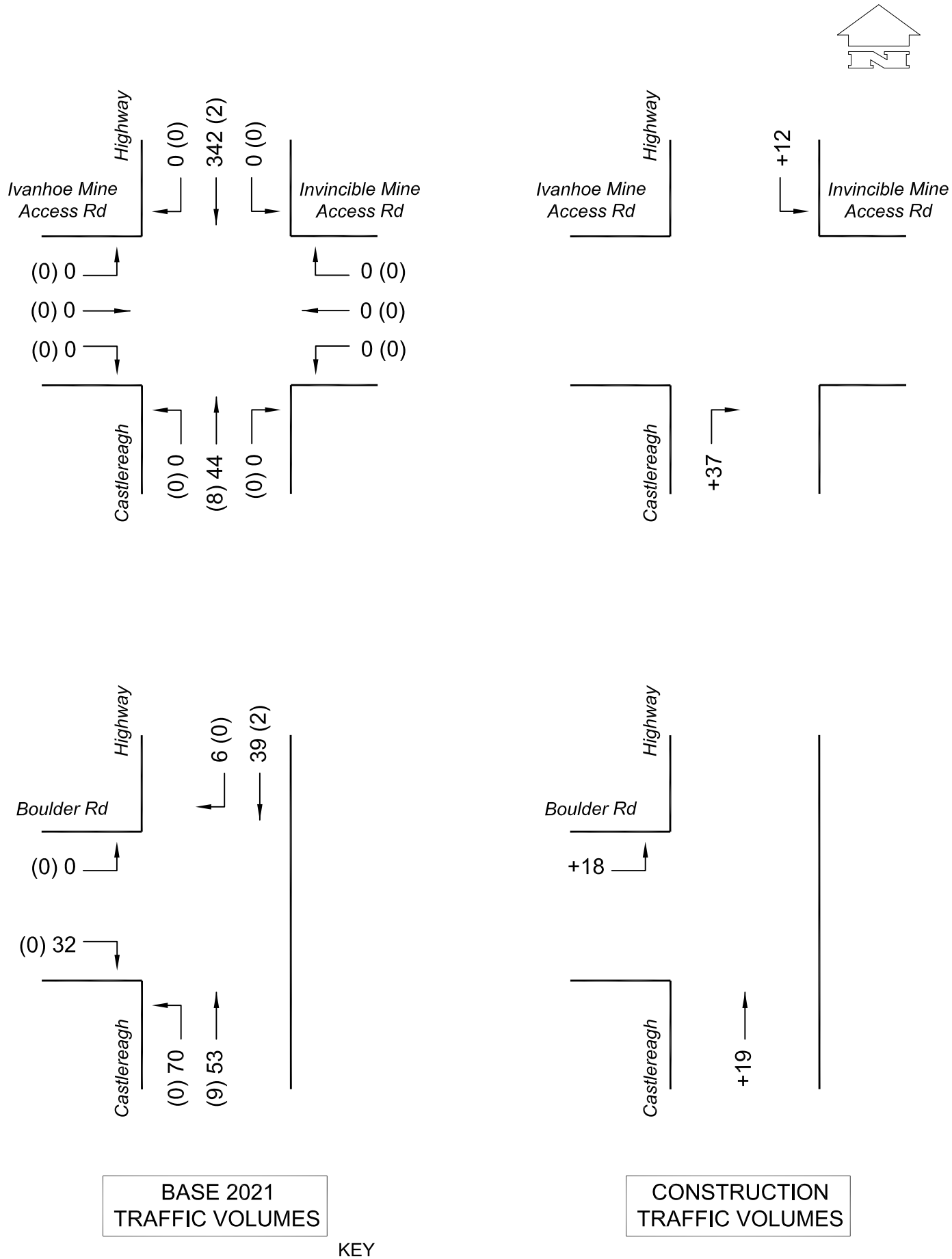

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FIGURE 6

INVINCIBLE SOUTHERN EXTENSION PROJECT
CASTLEREAGH HIGHWAY, CULLEN BULLEN

2021 CONSTRUCTION TRAFFIC VOLUMES IN 6am - 7am HOUR

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(highest movement delay) and not the average vehicle delay for all vehicles using the intersection.
RMS Guidelines indicate that a Level of Service D operation, or better (ie. A, B, C or D) is desirable design criteria for intersections.

TABLE 4.1

LEVEL OF SERVICE CRITERIA FOR INTERSECTIONS

Level of Service	Average Delay per Vehicle (secs/veh)	Traffic Signals, Roundabout	Give Way & Stop Signs
A	<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	>70	Intersection is oversaturated	Oversaturated, requires other control mode

Source: Table 4.2 Guide to Traffic Generating Developments October 2002. Roads and Traffic Authority

The results of the modelling for the Castlereagh Highway intersection at Invincible Mine Access Road and at Boulder Road are shown in Tables 4.2 and 4.3 respectively. Reference to these tables show that both intersections will operate at a very good level of service (Level of Service A operation) with very low vehicle delays occurring at both intersections.

The SIDRA modelling outputs are contained in Appendix 2.

TABLE 4.2

SIDRA MODELLING RESULTS FOR CASTLEREAGH HIGHWAY AND INVINCIBLE MINE ACCESS ROAD IN 2021 FOR BASE CASE (WITHOUT PROJECT) AND WITH CONSTRUCTION TRAFFIC FROM PROJECT

Criteria	2021 Base Case	2021 With Project
	6am-7am	6am-7am
LS	A	A
DS	0.027	0.030
AVD (secs)	0.6	3.3
HMD (secs)	9.4	10.0
Highest 95th% Queue Length	0.0	0.9

Where: *LS* *Level of Service*
DS *Degree of Saturation*
AVD *Average Vehicle Delay*
HMD *Highest Movement Delay*
Highest 95th% Queue Length – Longest 95th% Queue Length in Metres at the Intersection

TABLE 4.3

SIDRA MODELLING RESULTS FOR CASTLEREAGH HIGHWAY AND BOULDER ROAD IN 2021 FOR BASE CASE (WITHOUT PROJECT) AND WITH CONSTRUCTION TRAFFIC FROM PROJECT

Criteria	2021 Base Case	2021 With Project
	6am-7am	6am-7am
LS	A	A
DS	0.045	0.045
AVD (secs)	4.3	4.1
HMD (secs)	8.3	8.3
Highest 95th% Queue Length	1.3	1.3

Where: LS Level of Service
DS Degree of Saturation
AVD Average Vehicle Delay
HMD Highest Movement Delay
Highest 95th% Queue Length – Longest 95th% Queue Length in Metres at the Intersection

4.4 Traffic Impacts in Operational Phase

4.4.1 Daily Volumes of Coal Trucks

The most significant traffic impacts in the operational phase of the Project will be road transport associated with coal haulage from Invincible Mine.

As noted in Section 4.1 on an average weekday up to 155 truck loads will be generated from the Mine with:

- 138 loads travelling between Invincible Mine and Mount Piper Power Station (ie. total of 276 truck trips per day with return trips based on 138 inbound and 138 outbound movements);

- 10 loads per day travelling between Invincible Mine and Bomaderry (ie. total of 20 truck trips per day with return trips based on 10 in / 10 out; and

- Potentially 7 loads per day entering Invincible Mine from Cullen Valley Mine (ie. total of 14 truck trips per day with return trips based on 7 in / 7 out.

Figure 7 shows the estimated daily truck trips assigned to the road network on an average day.

4.4.2 Impacts of the Road Network

The majority of the coal truck trips (approximately 93%) will occur on the adjacent road network to Invincible Mine using Castlereagh Highway and a short section of Boulder Road to Mount Piper Power Station, as well as Castlereagh Highway north of the Mine to Cullen Valley Mine.

This level of coal truck trips has previously occurred in the Castlereagh Highway with the surrounding mines and Mount Piper Power Station.

Castlereagh Highway is constructed to a high standard with a high level of traffic management including the intersection treatments at principal intersections. The impacts of the coal trucks using these roads will be the same, as what has previously occurred on the road network and is assessed as satisfactory.

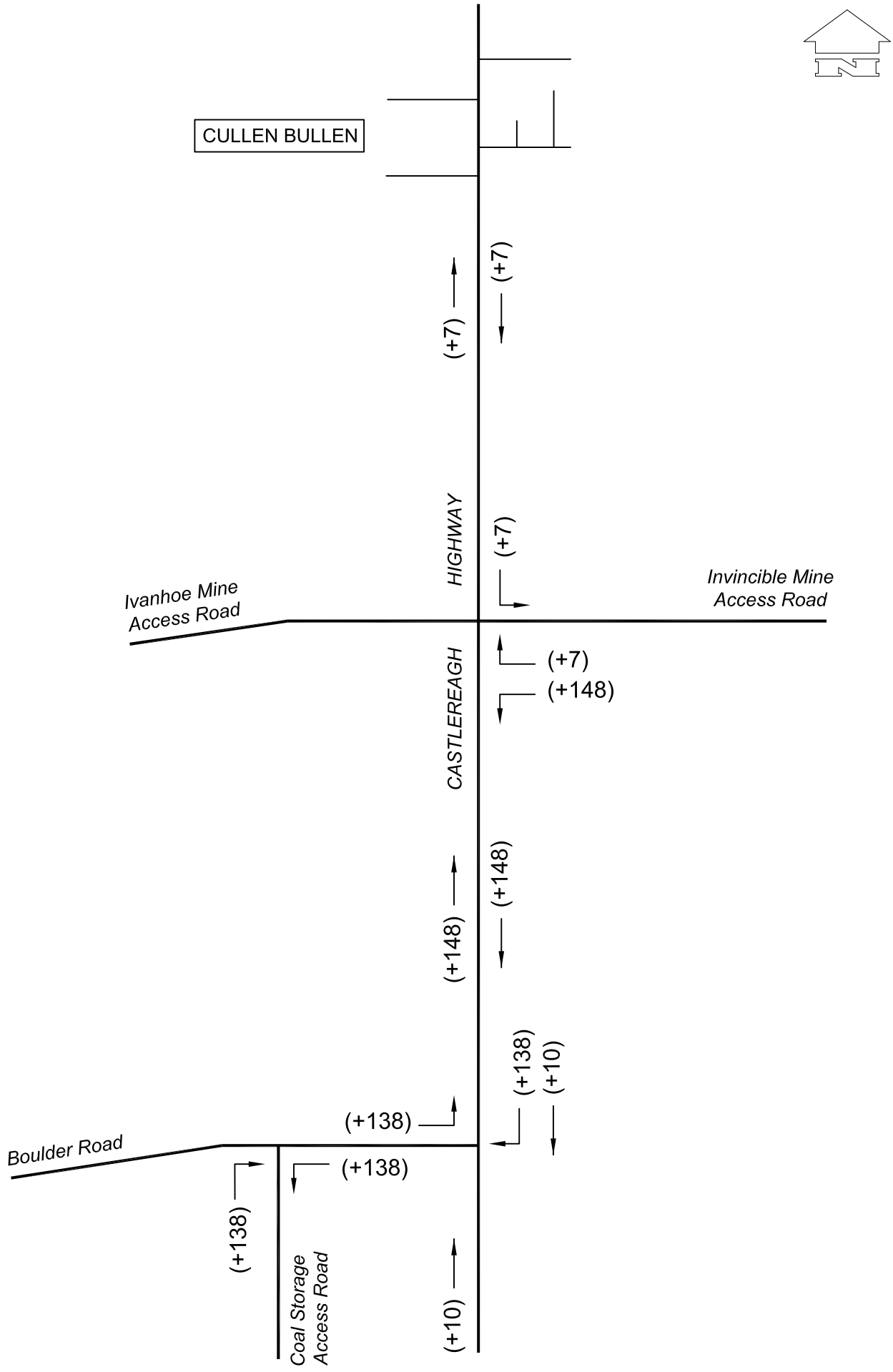

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FIGURE 7

INVINCIBLE SOUTHERN EXTENSION PROJECT
CASTLEREAGH HIGHWAY, CULLEN BULLEN

COAL TRUCK VOLUMES ON AVERAGE DAY

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Ten (10) loads of coal per day (ie. 20 truck trips with return trips) will travel from Invincible Mine to Bomaderry via Castlereagh Highway and Great Western Highway and other state roads and highways.

These trucks will use the state highway and road network which is provided to facilitate road trips by all classes of vehicles including heavy vehicles within the state of NSW.

The additional 10 truck trips in each direction using the highway network will comprise a very small proportion of trips including heavy vehicle trips using these state highways on a daily basis, which is confirmed by traffic volume data published by the RMS on their website.

The RMS counting stations in Great Western Highway at Hartley (Station 6192) and west of Mount Victoria (Section 6188) record 2015 average daily traffic volumes of 9,831 vehicles per day and 11, 174 vehicles per day respectively.

Heavy vehicles accounted for 18% and 16% of the daily volumes at these locations. The additional trucks from the Project represent around 0.2% of the total existing traffic using the Great Western Highway.

Therefore the impacts of the additional 10 truck trips travelling in each direction on the state highway network is considered to be very minor.

4.4.3 Impacts on Principal Intersections

Coal transportation will occur between a 14.5 hour period between 7am and 9.30pm for 300 days per year.

Average hourly truck loads based on 14.5 hours is calculated to be 10.7 loads per hour, say 11 loads. With a return trip an average hour will generate 11 inbound and 11 outbound truck trips to and from the mine, in one hour.

A busy hour on a busy day may generate up to 19 truck loads per hour with 19 inbound / 19 outbound truck trips to and from the mine.

To assess the impact of the truck trips during a busy hour at the principal intersections on the adjacent road network SIDRA traffic modelling has been undertaken for the peak hour at these intersection which currently occurs between 3pm – 4pm at Boulder Road intersection and between 3.15pm – 4.15pm at the Invincible Mine Access Road intersection.

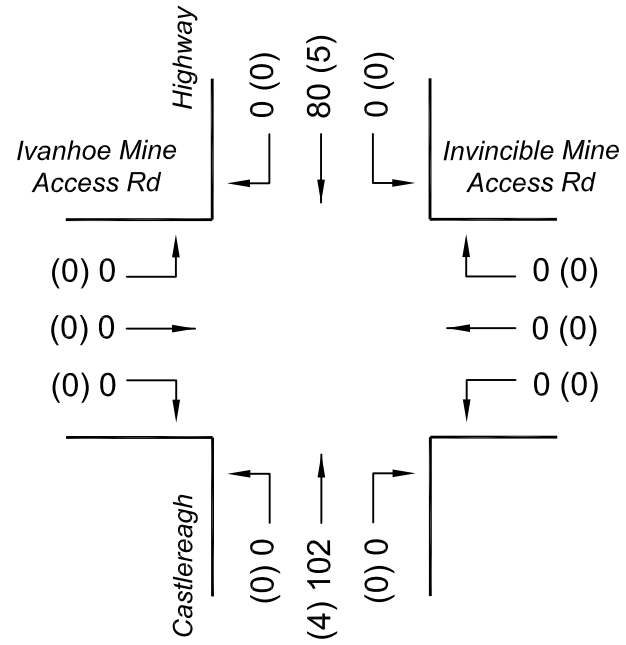
The modelling has been undertaken for the year 2024 as this year would represent a conservative assessment when allowing for future background traffic growth on the road network and the possibility that the Project start date may be delayed.

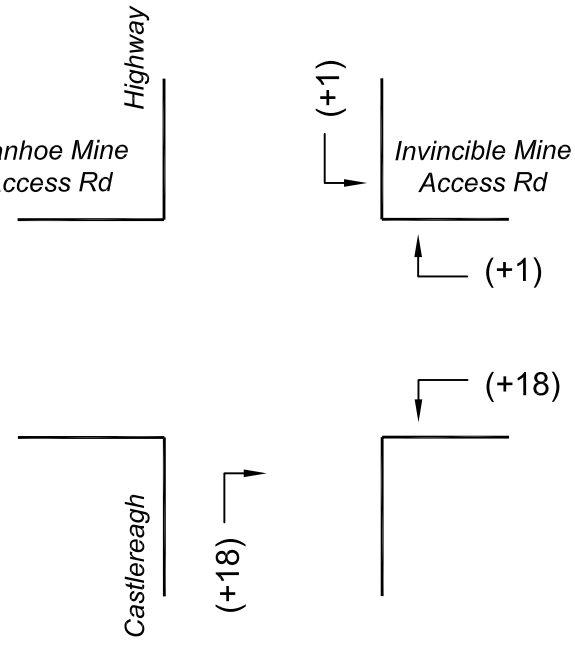
Figure 8 shows the future base 2024 traffic volumes during the peak hour for the principal intersections, as well as the additional coal truck movements assigned to the road network during a busy hour.

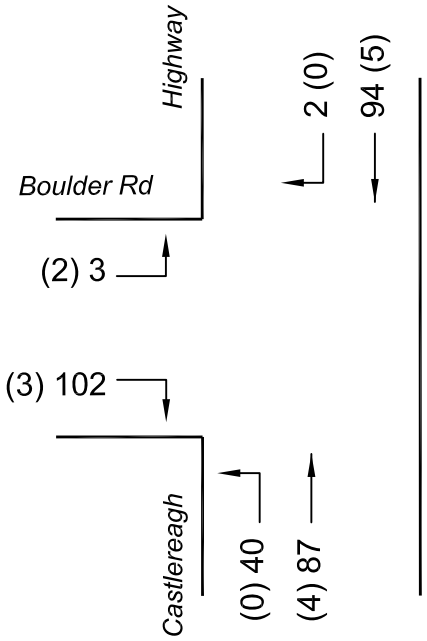
The results of the modelling are shown in Tables 4.4 and 4.5 for the Castlereagh Highway intersections with Invincible Mine Access Road and Boulder Road respectively.

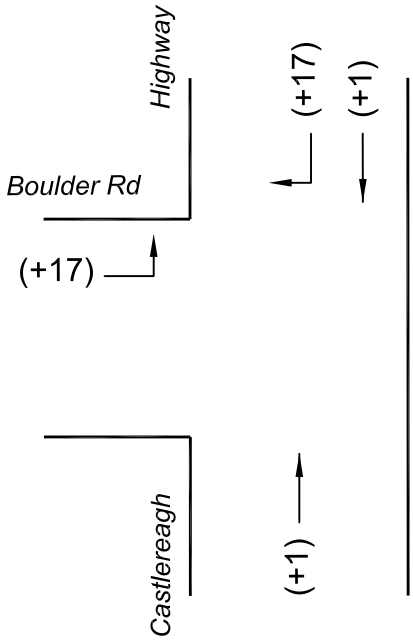
Reference to these tables reveals that both intersection will continue to operate at a reasonably good level of service (Level of Service A or B operation) with the additional truck movements associated with the Project, during a busy hour.

It is therefore concluded that the impacts associated with the traffic generated by the Project will be satisfactory and the principal intersections will continue to operate at a good level of service.









BASE 2024
TRAFFIC VOLUMES

COAL TRUCK TRAFFIC VOLUMES
DURING A BUSY HOUR

KEY

344 TOTAL VEHICLES
(27) HEAVY VEHICLES

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FIGURE 8

INVINCIBLE SOUTHERN EXTENSION PROJECT
CASTLEREAGH HIGHWAY, CULLEN BULLEN

2024 OPERATIONAL TRAFFIC VOLUMES DURING A BUSY HOUR

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The full results of the SIDRA modelling are contained in Appendix 2.

TABLE 4.4

SIDRA MODELLING RESULTS FOR CASTLEREAGH HIGHWAY AND INVINCIBLE MINE ACCESS ROAD IN 2024 FOR BASE CASE (WITHOUT PROJECT) AND WITH CONSTRUCTION TRAFFIC FROM PROJECT

Criteria	2024 Base Case	2024 With Project
	3.15-4.15pm	3.15-4.15pm
LS	A	B
DS	0.056	0.056
AVD (secs)	0.3	1.9
HMD (secs)	10.9	15.6
Highest 95th% Queue Length	0.1	2.5

Where: LS Level of Service
DS Degree of Saturation
AVD Average Vehicle Delay
HMD Highest Movement Delay
Highest 95th% Queue Length – Longest 95th% Queue Length in Metres at the Intersection

TABLE 4.5

SIDRA MODELLING RESULTS FOR CASTLEREAGH HIGHWAY AND BOULDER ROAD IN 2024 FOR BASE CASE (WITHOUT PROJECT) AND WITH CONSTRUCTION TRAFFIC FROM PROJECT

Criteria	2024 Base Case	2024 With Project
	3pm-4pm	3pm-4pm
LS	A	A
DS	0.139	0.146
AVD (secs)	3.6	4.2
HMD (secs)	8.3	10.9
Highest 95th% Queue Length	5.1	5.3

Where: LS Level of Service
DS Degree of Saturation
AVD Average Vehicle Delay
HMD Highest Movement Delay
Highest 95th% Queue Length – Longest 95th% Queue Length in Metres at the Intersection

4.5 Oversize and Over Mass Vehicles

Oversize vehicles delivering mining equipment for the Project will access the mine during the construction phase. In addition it would be expected that during the operational phase, oversize vehicles will occasionally deliver equipment to the mine.

All oversize vehicles delivering equipment or materials to the mine will have the appropriate permits as required.

4.6 Impacts on Road Safety

The Project is not expected to have any adverse impacts on road safety on the road network.

Invincible Mine already has approval to transport the volume of coal from the mine by road under its existing approval.

In addition the principal intersections that will be used by the coal trucks are constructed to a high standard, as is the section of Castlereagh Highway adjacent the Project site.

Those small number of trucks that will travel between the mine and Bomaderry will use the state highway and state road network, which is constructed and maintained to a standard to accommodate heavy vehicles.

4.7 Summary

The assessment of the traffic impacts of the Project has found that the impacts will be satisfactory and that no mitigation measures are considered to be required to reduce / ameliorate the impacts.

The road network adjacent the Project site including the principal intersection is constructed to a high standard that can easily accommodate the truck movements generated by the Project.

An assessment of future traffic conditions with the Project in place indicates that the principal intersections will have adequate capacity to accommodate the demand and a good level of service will be maintained with minimal vehicle delay.

5.0 CONCLUSIONS

This report documents an assessment of the road transport and traffic impacts of the Invincible Southern Extension Project.

Invincible Mine is located adjacent the Castlereagh Highway at Cullen Bullen north west of Lithgow.

The Project is seeking an extension of open cut mining operations to the south of the existing approved mining area at Invincible Colliery. The Project includes no change to the current approved mining production rates or to the current approved transport arrangements.

The Project will employ up to 35 full time staff plus up to 4 contractors and proposes to operate between 7am – 10pm Monday to Saturday. Road transport will operate between 7am – 9.30pm on the same days.

The assessment has found that the existing road network including principal intersections adjacent the Project site is constructed to a high standard and can easily accommodate the expected employee and coal truck trips generated by the Project.

The assessment of the traffic impacts of the Project has concluded that these impacts will be satisfactory and no mitigation measures are required, due to the Project.

REFERENCES

1. Austroads Guide to Road Design (2008 – 2014)

2. Austroads Guide to Road Safety – Version 1 Dec 2010

3. Austroads Guide to Traffic Management (2008 – 2014)

4. RTA (now RMS) Austroads Guide Supplements – Austroads Guide to Traffic Management – (Various dates from 2009 onwards)

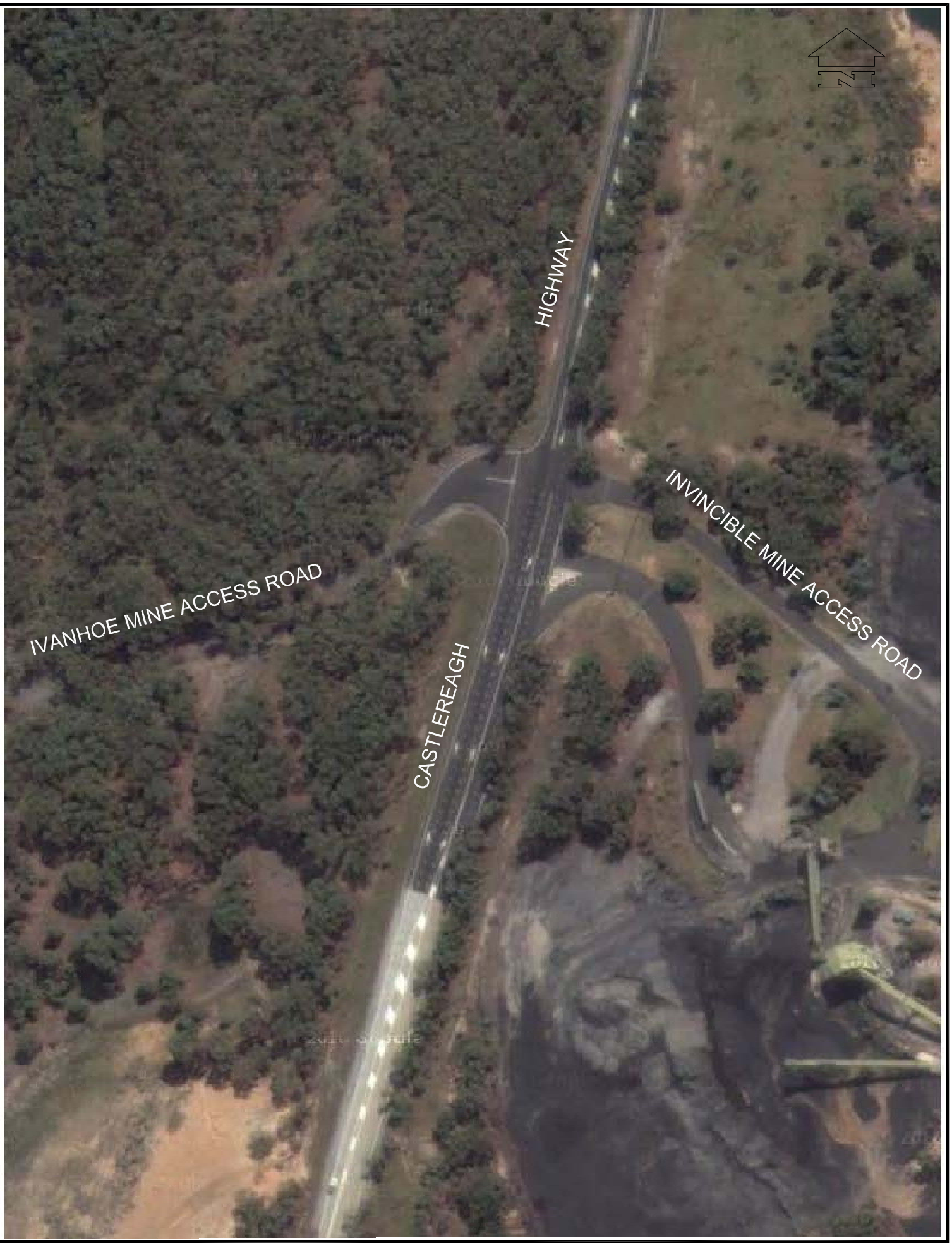
5. RTA (now RMS) Supplement to Austroads Guide to Road Design Parts 1-5, 6 and 8 (various dates from 2009 onwards)

6. RMS Supplements to Austroads Guide to Road Safety

7. RTA/RMS Traffic Volumes Data for Western Region and RMS Traffic Volume Viewer

APPENDIX 1

AERIAL PHOTOGRAPHS OF PRINCIPAL INTERSECTIONS



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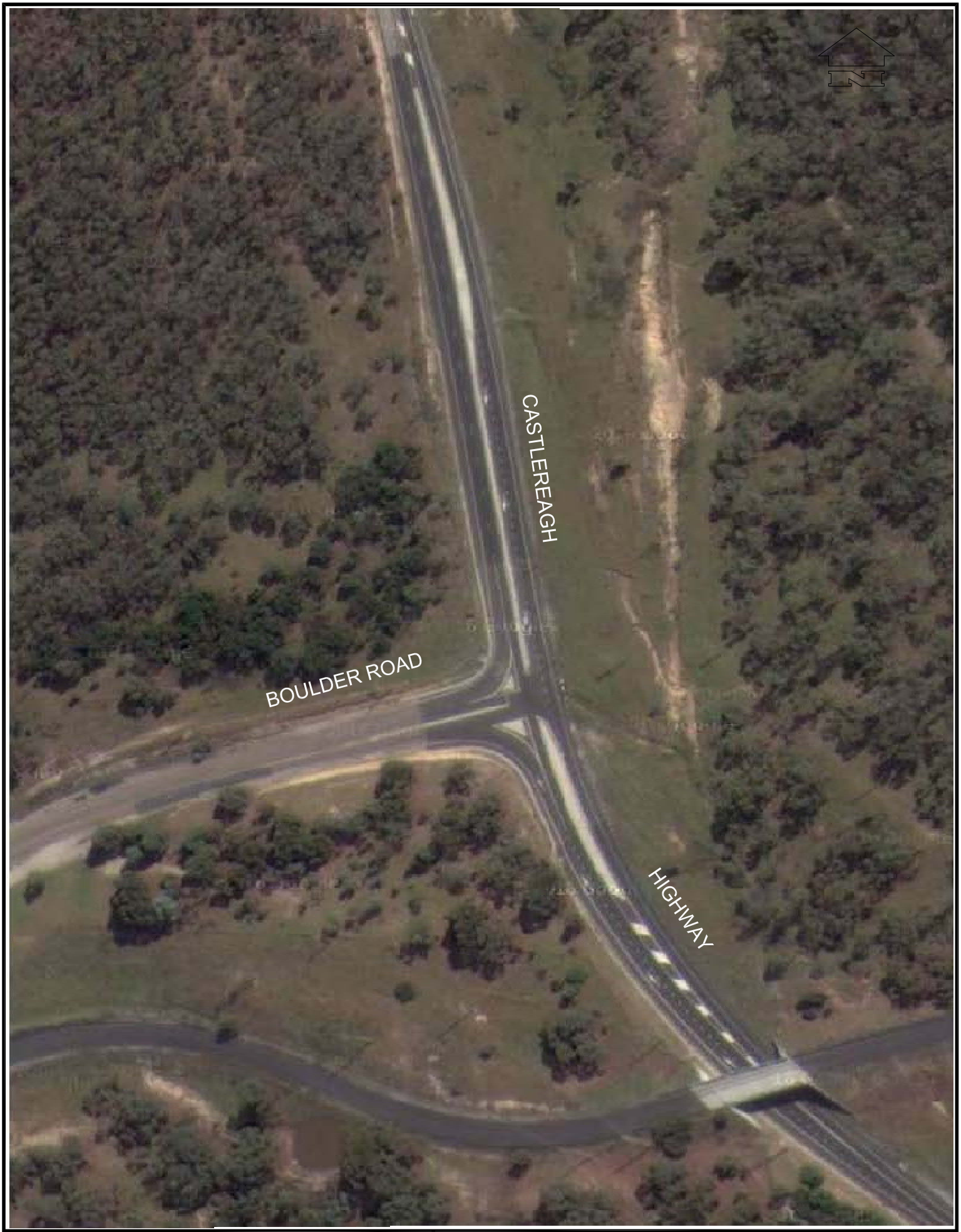
APPENDIX 1A

INVINCIBLE SOUTHERN EXTENSION PROJECT
CASTLEREAGH HIGHWAY, CULLEN BULLEN

INTERSECTION OF CASTLEREAGH HIGHWAY, IVANHOE MINE & INVINCIBLE MINE ACCESS ROADS

JOB NO.15233



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APPENDIX 1B

INVINCIBLE SOUTHERN EXTENSION PROJECT
CASTLEREAGH HIGHWAY, CULLEN BULLEN

INTERSECTION OF CASTLEREAGH HIGHWAY & BOULDER ROAD

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APPENDIX 1C

INVINCIBLE SOUTHERN EXTENSION PROJECT
CASTLEREAGH HIGHWAY, CULLEN BULLEN

INTERSECTION OF CASTLEREAGH HIGHWAY & COAL STORAGE ACCESS ROAD

JOB NO.15233

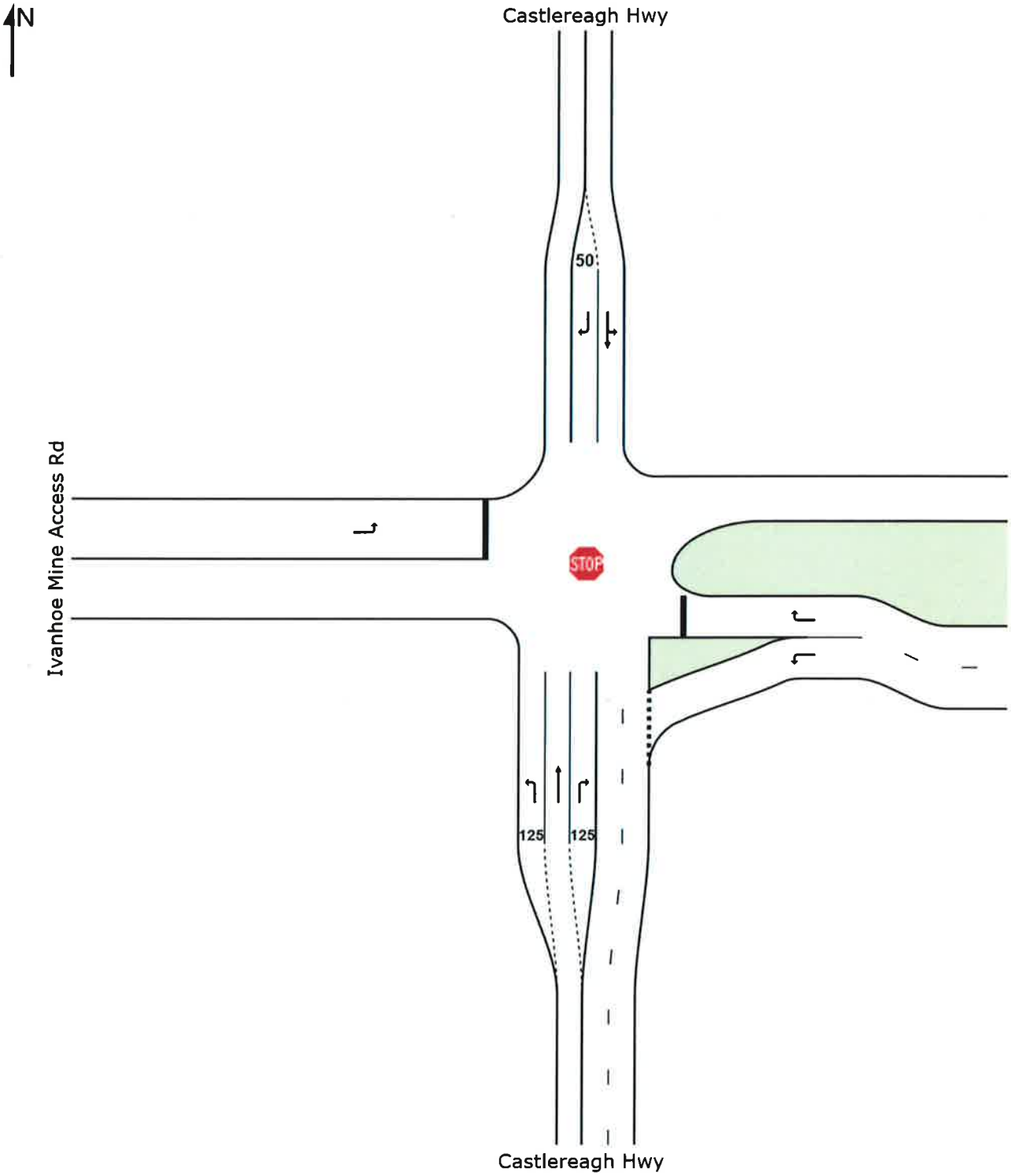
APPENDIX 2

SIDRA MODELLING OUTPUTS

SITE LAYOUT

Site: 101 [Castlereagh Hwy & Invincible Mine Access Rd 2021 Base]

2021 6am -7am Base
Stop (Two-Way)



MOVEMENT SUMMARY

Site: 101 [Castlereagh Hwy & Invincible Mine Access Rd 2021 Base]

2021 6am -7am Base
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total 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: Castlereagh Hwy											
1	L2	1	0.0	0.001	7.8	LOS A	0.0	0.0	0.00	0.66	75.3
2	T1	46	18.2	0.027	0.0	LOS A	0.0	0.0	0.00	0.00	100.0
3	R2	1	0.0	0.001	8.4	LOS A	0.0	0.0	0.14	0.58	62.7
Approach		48	17.4	0.027	0.4	NA	0.0	0.0	0.00	0.03	98.0
East: Invincible Mine Access Rd											
4	L2	1	0.0	0.001	5.8	LOS A	0.0	0.0	0.15	0.50	62.0
6	R2	1	0.0	0.002	9.4	LOS A	0.0	0.0	0.29	0.82	59.2
Approach		2	0.0	0.002	7.6	LOS A	0.0	0.0	0.22	0.66	60.6
North: Castlereagh Hwy											
7	L2	1	0.0	0.024	7.8	LOS A	0.0	0.0	0.00	0.02	88.3
8	T1	44	4.8	0.024	0.0	LOS A	0.0	0.0	0.00	0.02	99.5
9	R2	1	0.0	0.001	8.2	LOS A	0.0	0.0	0.13	0.59	62.6
Approach		46	4.5	0.024	0.4	NA	0.0	0.0	0.00	0.03	97.9
West: Ivanhoe Mine Access Rd											
10	L2	1	0.0	0.001	8.2	LOS A	0.0	0.0	0.13	0.90	59.8
Approach		1	0.0	0.001	8.2	LOS A	0.0	0.0	0.13	0.90	59.8
All Vehicles		98	10.8	0.027	0.6	NA	0.0	0.0	0.01	0.05	96.0

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Castlereagh Hwy & Invincible Mine Access Rd 2021 CP]

2021 6am -7am Construction Traffic
Stop (Two-Way)

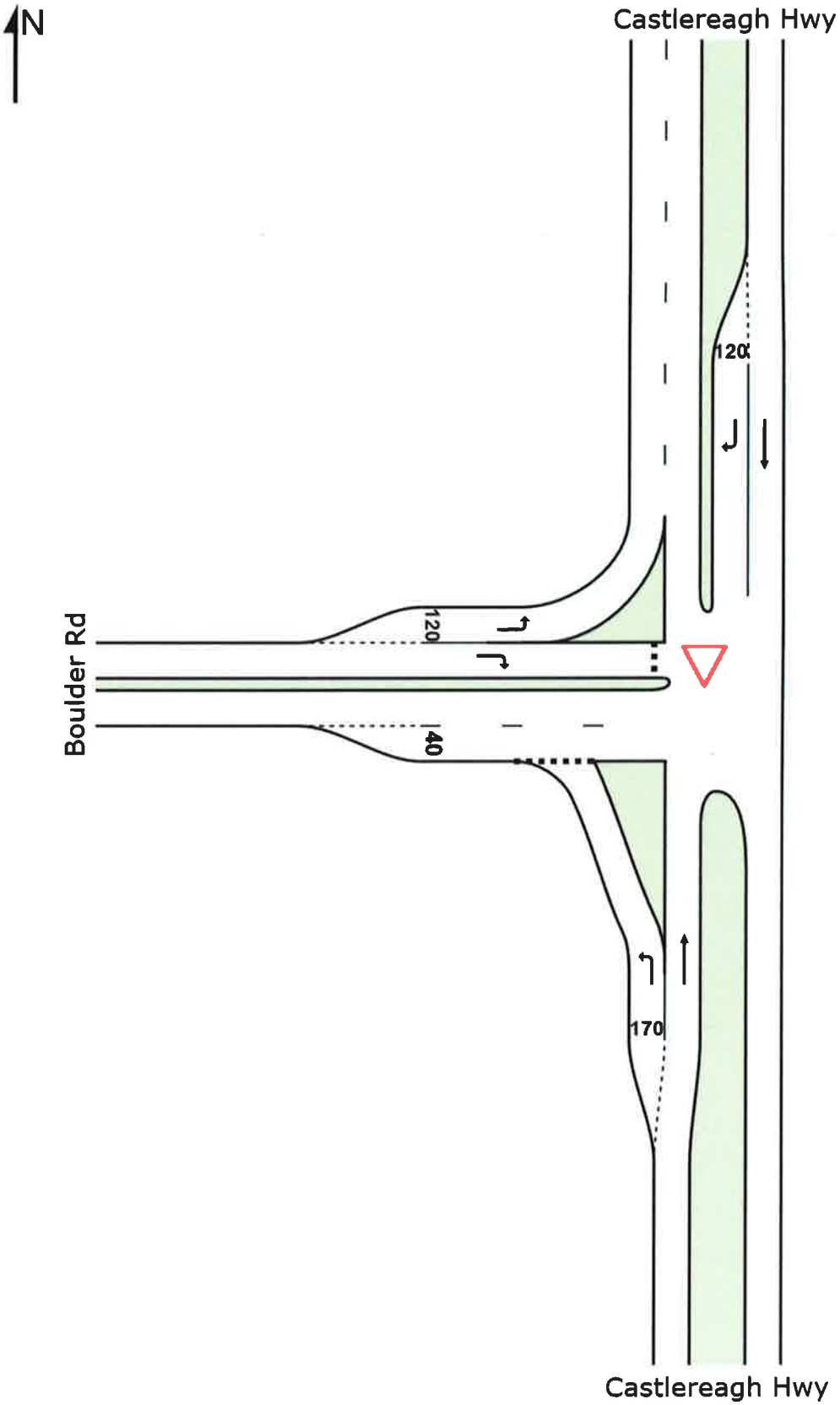
Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Castlereagh Hwy											
1	L2	1	0.0	0.001	7.8	LOS A	0.0	0.0	0.00	0.66	75.3
2	T1	46	18.2	0.027	0.0	LOS A	0.0	0.0	0.00	0.00	100.0
3	R2	40	0.0	0.024	8.5	LOS A	0.1	0.9	0.17	0.59	62.6
Approach		87	9.6	0.027	4.0	NA	0.1	0.9	0.08	0.28	78.2
East: Invincible Mine Access Rd											
4	L2	1	0.0	0.001	5.8	LOS A	0.0	0.0	0.15	0.50	62.0
6	R2	1	0.0	0.002	10.0	LOS A	0.0	0.0	0.35	0.80	58.8
Approach		2	0.0	0.002	7.9	LOS A	0.0	0.0	0.25	0.65	60.3
North: Castlereagh Hwy											
7	L2	14	0.0	0.030	7.8	LOS A	0.0	0.0	0.00	0.16	84.8
8	T1	44	4.8	0.030	0.0	LOS A	0.0	0.0	0.00	0.16	95.0
9	R2	1	0.0	0.001	8.2	LOS A	0.0	0.0	0.13	0.59	62.6
Approach		59	3.6	0.030	2.0	NA	0.0	0.0	0.00	0.17	91.6
West: Ivanhoe Mine Access Rd											
10	L2	1	0.0	0.001	8.2	LOS A	0.0	0.0	0.13	0.90	59.8
Approach		1	0.0	0.001	8.2	LOS A	0.0	0.0	0.13	0.90	59.8
All Vehicles		149	7.0	0.030	3.3	NA	0.1	0.9	0.05	0.24	82.5

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

SITE LAYOUT

Site: 101 [Castlereagh Hwy & Boulder Rd - 2021 Base]

2021 6am -7am Base
Giveway / Yield (Two-Way)



MOVEMENT SUMMARY

Site: 101 [Castlereagh Hwy & Boulder Rd - 2021 Base]

2021 6am -7am Base
Giveway / Yield (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total 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: Castlereagh Hwy											
1	L2	74	0.0	0.045	8.3	LOS A	0.2	1.3	0.04	0.63	63.3
2	T1	56	17.0	0.031	0.0	LOS A	0.0	0.0	0.00	0.00	100.0
Approach		129	7.3	0.045	4.8	LOS A	0.2	1.3	0.02	0.36	75.2
North: Castlereagh Hwy											
8	T1	41	5.1	0.022	0.0	LOS A	0.0	0.0	0.00	0.00	100.0
9	R2	6	0.0	0.004	8.1	LOS A	0.0	0.1	0.17	0.59	62.2
Approach		47	4.4	0.022	1.1	NA	0.0	0.1	0.02	0.08	92.5
West: Boulder Rd											
10	L2	1	0.0	0.001	5.6	LOS A	0.0	0.0	0.00	0.53	54.9
12	R2	34	0.0	0.038	6.8	LOS A	0.2	1.2	0.34	0.56	60.9
Approach		35	0.0	0.038	6.8	LOS A	0.2	1.2	0.33	0.56	60.7
All Vehicles		212	5.5	0.045	4.3	NA	0.2	1.3	0.07	0.33	75.4

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Castlereagh Hwy & Boulder Rd - 2021 CP]

2021 6am -7am Construction Traffic
Giveway / Yield (Two-Way)

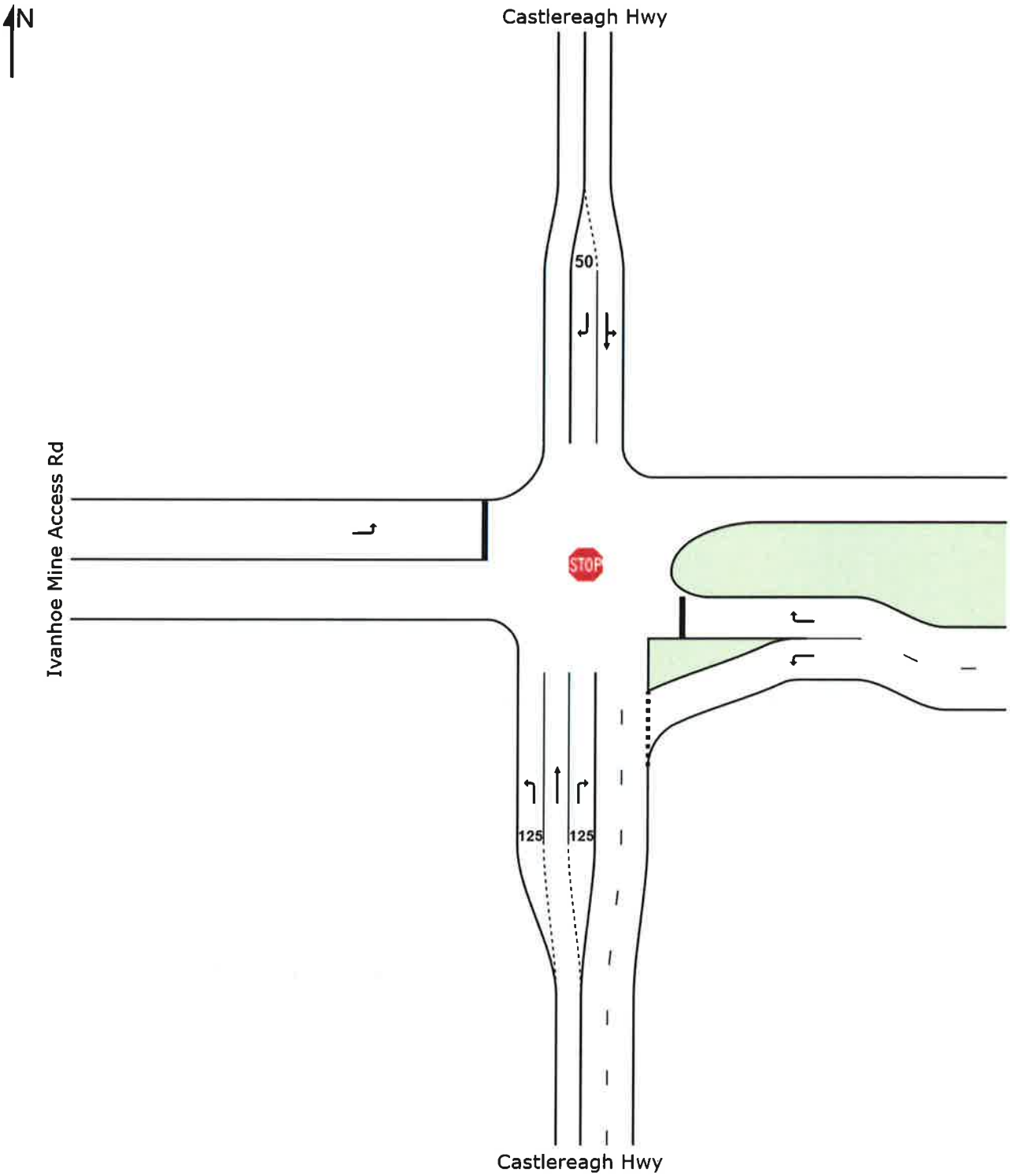
Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Castlereagh Hwy											
1	L2	74	0.0	0.045	8.3	LOS A	0.2	1.3	0.04	0.63	63.3
2	T1	76	12.5	0.042	0.0	LOS A	0.0	0.0	0.00	0.00	100.0
Approach		149	6.3	0.045	4.1	LOS A	0.2	1.3	0.02	0.31	77.7
North: Castlereagh Hwy											
8	T1	41	5.1	0.022	0.0	LOS A	0.0	0.0	0.00	0.00	100.0
9	R2	6	0.0	0.004	8.2	LOS A	0.0	0.1	0.20	0.58	62.1
Approach		47	4.4	0.022	1.1	NA	0.0	0.1	0.03	0.08	92.5
West: Boulder Rd											
10	L2	20	0.0	0.011	5.6	LOS A	0.0	0.0	0.00	0.53	54.9
12	R2	34	0.0	0.039	7.0	LOS A	0.2	1.3	0.36	0.56	60.8
Approach		54	0.0	0.039	6.5	LOS A	0.2	1.3	0.23	0.55	58.5
All Vehicles		251	4.6	0.045	4.1	NA	0.2	1.3	0.06	0.32	74.7

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

SITE LAYOUT

Site: 101 [Castlereagh Hwy & Invincible Mine Access Rd 2024 Base]

2021 - 315pm-415pm Base
Stop (Two-Way)



MOVEMENT SUMMARY

Site: 101 [Castlereagh Hwy & Invincible Mine Access Rd 2024 Base]

2021 - 315pm-415pm Base
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total 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: Castlereagh Hwy											
1	L2	1	0.0	0.001	7.8	LOS A	0.0	0.0	0.00	0.66	75.3
2	T1	107	3.9	0.056	0.0	LOS A	0.0	0.0	0.00	0.00	100.0
3	R2	1	0.0	0.001	8.5	LOS A	0.0	0.0	0.21	0.56	62.4
Approach		109	3.8	0.056	0.2	NA	0.0	0.0	0.00	0.01	99.1
East: Invincible Mine Access Rd											
4	L2	1	0.0	0.001	6.0	LOS A	0.0	0.0	0.22	0.49	61.7
6	R2	1	0.0	0.002	10.9	LOS A	0.0	0.1	0.42	0.79	58.1
Approach		2	0.0	0.002	8.4	LOS A	0.0	0.1	0.32	0.64	59.8
North: Castlereagh Hwy											
7	L2	1	0.0	0.045	7.8	LOS A	0.0	0.0	0.00	0.01	88.5
8	T1	84	6.3	0.045	0.0	LOS A	0.0	0.0	0.00	0.01	99.7
9	R2	1	0.0	0.001	8.4	LOS A	0.0	0.0	0.21	0.58	62.2
Approach		86	6.1	0.045	0.2	NA	0.0	0.0	0.00	0.02	98.8
West: Ivanhoe Mine Access Rd											
10	L2	1	0.0	0.001	8.5	LOS A	0.0	0.0	0.21	0.86	59.8
Approach		1	0.0	0.001	8.5	LOS A	0.0	0.0	0.21	0.86	59.8
All Vehicles		199	4.8	0.056	0.3	NA	0.0	0.1	0.01	0.02	98.0

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Castlereagh Hwy & Invincible Mine Access Rd 2024 Operations]

2021 - 315pm-415pm Operational Traffic
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total 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: Castlereagh Hwy											
1	L2	1	0.0	0.001	7.8	LOS A	0.0	0.0	0.00	0.66	75.3
2	T1	107	3.9	0.056	0.0	LOS A	0.0	0.0	0.00	0.00	100.0
3	R2	20	94.7	0.019	11.2	LOS A	0.1	2.0	0.27	0.57	57.5
Approach		128	18.0	0.056	1.8	NA	0.1	2.0	0.04	0.09	89.4
East: Invincible Mine Access Rd											
4	L2	20	94.7	0.026	7.6	LOS A	0.1	2.5	0.28	0.50	44.5
6	R2	2	50.0	0.006	15.6	LOS B	0.0	0.3	0.49	0.85	46.8
Approach		22	90.5	0.026	8.4	LOS A	0.1	2.5	0.30	0.53	44.7
North: Castlereagh Hwy											
7	L2	1	0.0	0.045	7.8	LOS A	0.0	0.0	0.00	0.01	88.5
8	T1	84	6.3	0.045	0.0	LOS A	0.0	0.0	0.00	0.01	99.7
9	R2	2	50.0	0.002	9.9	LOS A	0.0	0.1	0.24	0.58	59.5
Approach		87	7.2	0.045	0.3	NA	0.0	0.1	0.01	0.02	98.0
West: Ivanhoe Mine Access Rd											
10	L2	1	0.0	0.001	8.5	LOS A	0.0	0.0	0.21	0.86	59.8
Approach		1	0.0	0.001	8.5	LOS A	0.0	0.0	0.21	0.86	59.8
All Vehicles		239	20.7	0.056	1.9	NA	0.1	2.5	0.05	0.11	84.1

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
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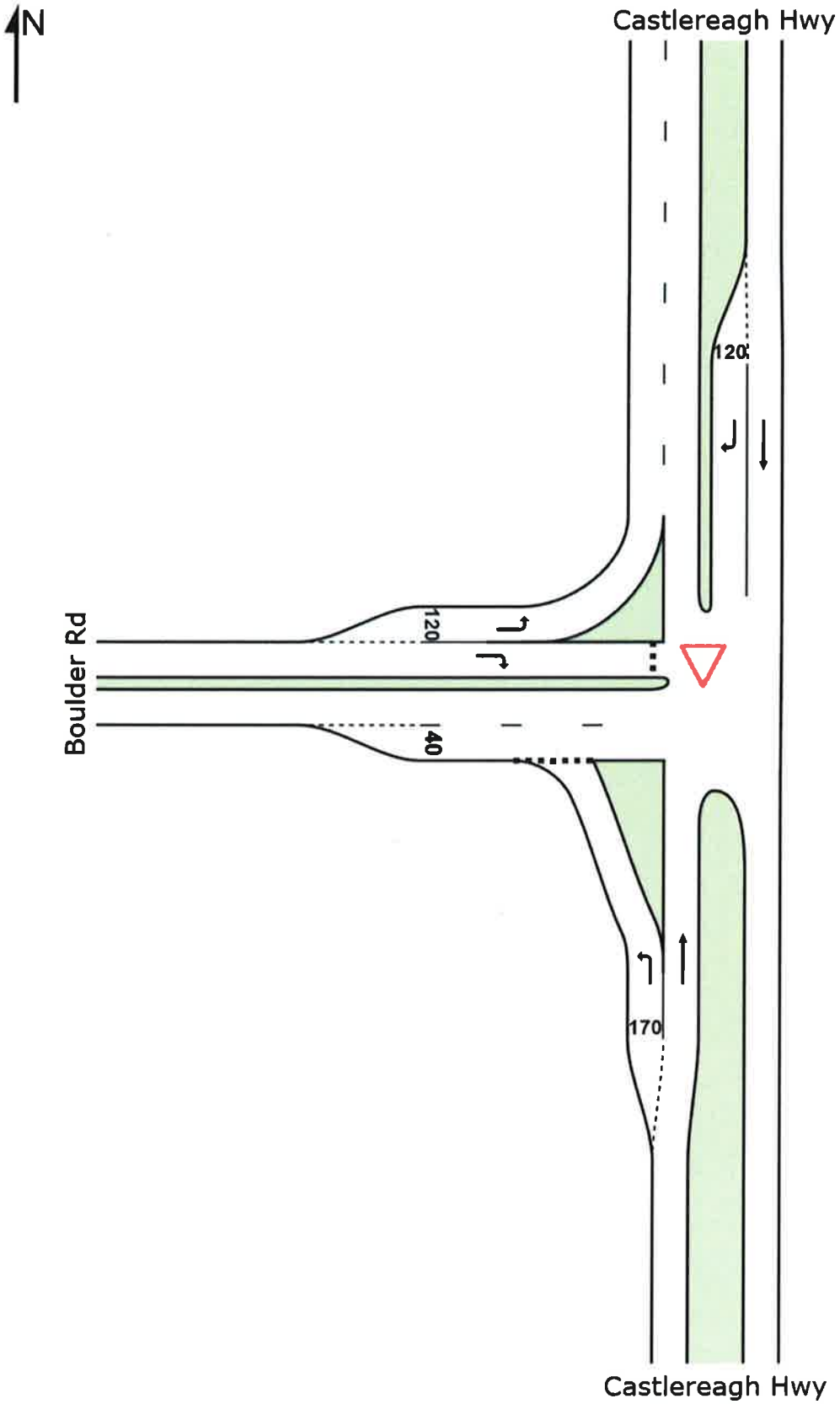
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

SITE LAYOUT

Site: 101 [Castlereagh Hwy & Boulder Rd - 2024 Base]

2024 3pm-4pm Base
Giveway / Yield (Two-Way)



MOVEMENT SUMMARY

Site: 101 [Castlereagh Hwy & Boulder Rd - 2024 Base]

2024 3pm-4pm Base
Giveway / Yield (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total 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: Castlereagh Hwy											
1	L2	42	0.0	0.026	8.3	LOS A	0.1	0.7	0.02	0.63	63.4
2	T1	92	4.6	0.048	0.0	LOS A	0.0	0.0	0.00	0.00	100.0
Approach		134	3.1	0.048	2.6	LOS A	0.1	0.7	0.01	0.20	84.6
North: Castlereagh Hwy											
8	T1	99	5.3	0.052	0.0	LOS A	0.0	0.0	0.00	0.00	100.0
9	R2	2	0.0	0.001	8.2	LOS A	0.0	0.0	0.22	0.57	62.0
Approach		101	5.2	0.052	0.2	NA	0.0	0.0	0.00	0.01	98.7
West: Boulder Rd											
10	L2	3	66.7	0.002	6.3	LOS A	0.0	0.0	0.00	0.49	52.6
12	R2	107	2.9	0.139	7.9	LOS A	0.7	5.1	0.45	0.63	58.8
Approach		111	4.8	0.139	7.8	LOS A	0.7	5.1	0.44	0.63	58.6
All Vehicles		345	4.3	0.139	3.6	NA	0.7	5.1	0.14	0.28	76.9

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

▽ Site: 101 [Castlereagh Hwy & Boulder Rd - 2024 Operations]

2024 3pm-4pm Operational Traffic
Giveway / Yield (Two-Way)

Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total 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: Castlereagh Hwy											
1	L2	42	0.0	0.026	8.4	LOS A	0.1	0.7	0.09	0.61	63.1
2	T1	93	5.7	0.049	0.0	LOS A	0.0	0.0	0.00	0.00	100.0
Approach		135	3.9	0.049	2.6	LOS A	0.1	0.7	0.03	0.19	84.5
North: Castlereagh Hwy											
8	T1	100	6.3	0.053	0.0	LOS A	0.0	0.0	0.00	0.00	100.0
9	R2	20	89.5	0.018	10.9	LOS A	0.1	1.9	0.28	0.59	57.1
Approach		120	20.2	0.053	1.8	NA	0.1	1.9	0.05	0.10	88.9
West: Boulder Rd											
10	L2	21	95.0	0.019	6.6	LOS A	0.0	0.0	0.00	0.48	51.7
12	R2	107	2.9	0.146	8.3	LOS A	0.7	5.3	0.48	0.65	58.5
Approach		128	18.0	0.146	8.0	LOS A	0.7	5.3	0.40	0.62	57.2
All Vehicles		383	13.7	0.146	4.2	NA	0.7	5.3	0.16	0.31	73.8

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

APPENDIX 13

Economic Impact Assessment

cadence|economics

ECONOMIC IMPACT ASSESSMENT OF THE INVINCIBLE SOUTHERN EXTENSION PROJECT

REPORT FOR CASTLEREAGH COAL PTY LTD

AUGUST 2016

Table of contents

Summary Report

Shoalhaven Coal Pty Ltd, trading as Castlereagh Coal (Castlereagh Coal), operates the Invincible Colliery (Invincible), an open cut coal mine located approximately 25 kilometres north-west of Lithgow in NSW. The township of Cullen Bullen is located approximately 3 kilometres north-west of the Invincible mine infrastructure area. Castlereagh Coal is part of the Manildra Group (Manildra), an integrated and diverse agribusiness.

Castlereagh Coal purchased Invincible in 2015 to secure a continued supply of specialty nut coal for Manildra's Shoalhaven Starches Plant at Bomaderry on the NSW south coast. This nut coal is critical in securing the energy supply to what is the largest wheat starch and gluten plant of its kind in the world. Manildra directly employs approximately 600 full-time equivalent workers in New South Wales, across regional centres in Nowra, Manildra, Narrandera and Gunnedah.

Mining activities at Invincible have been undertaken since 1901 and activities at Invincible are currently regulated by project approval PA07-0127 (Invincible Project Approval) granted pursuant to the *Environmental Planning and Assessment Act 1979* (EP&A Act) in 2008. Invincible has been on 'care and maintenance' since 2013 having largely exhausted the approved coal reserves. The Invincible Project Approval provides for continued rehabilitation of the approved mining operations.

Castlereagh Coal proposes to modify the Invincible Project Approval under Section 75W of the EP&A Act to extend the life of mining operations at Invincible and obtain approval to extend the open cut mining operations to an area immediately south of the existing operations, referred to as the Southern Extension Area. The proposed modification is known as the Invincible Southern Extension Project (the Project).

Coal from the Project will service two clients. Based on the current mine plan, approximately 2,336 kilotons (kts) of thermal coal (essentially the crushed Run-of-Mine (ROM) product) will be supplied to the nearby Mount Piper power station and 288 kts of nut coal (a specialty washed and sized coal product) will service the Shoalhaven Starches Plant at Bomaderry over the life of the Project. The modification application will seek approval for an extension of mining activities over an eight year period which provides for flexibility in the supply options for specialty coal to the Shoalhaven Starches Plant over the life of the Project.

This report provides an Economic Impact Assessment (EIA) of the Project, estimating the net benefits of the Project to New South Wales broadly and also the local benefits to the Lithgow-Mudgee region. The EIA uses the economic assessment framework set out in the *Guidelines for the economic assessment of mining and coal seam gas proposals* (the Guidelines) released by the NSW Government in December 2015. This assessment has assumed a conservative mining scenario of up to maximum limits of production over a four year period (2017 to 2020) to provide an assessment of impacts over the life of the Project, as outlined in the accompanying Environmental Assessment (EA).

The Project is shown in this report to confer net benefits to New South Wales. Based on the methodology established in the Guidelines the estimated net benefit of the Project to New South Wales is $79.7 million

in net present value terms over the life of the Project using a 7 percent real discount rate (NPV terms). This equates to a benefit-cost ratio of 38.0. The magnitude of the benefits derived by New South Wales from the recommencement of mining at the Invincible Colliery are largely driven because the Project:

- is owned by Manildra, a 100 percent New South Wales based company;
- is economically viable given the relatively high value of nut coal, with a stable client, and relatively low extraction costs; and
- has non-significant environmental impacts as assessed in the EA.

The net benefits to New South Wales are shown in the report to be robust under systematic sensitivity analysis undertaken (consistent with the Guidelines). Compared with the net benefits of $79.7 million in NPV terms estimated under the central case assumptions presented in the report, the lower bound net benefit is estimated to be $47.9 million in NPV terms. The upper bound estimate of the net benefits is $110.6 million in NPV terms.

In terms of local area effect, the Project is estimated to confer a net benefit of $8.8 million to the Lithgow-Mudgee in NPV terms. This is driven largely by:

- benefits to employees of which, as stated in the Social Impact and Opportunity Assessment (SIOA) accompanying the EA, 80 percent are expected to be drawn from the local area which is currently experiencing relatively high levels of unemployment.
    - In the Lithgow-Mudgee area the unemployment rate in the March quarter of just over 8 percent compared with the state-wide average of just under 6 percent.
- benefits to local suppliers of which, as stated in the SIOA accompanying the EA, are expected to provide 20 percent of the mine's inputs to production.

Again, the report shows that the estimated local effects are robust under the sensitivity analysis conducted with positive net benefits under both the low and high case scenarios considered. The net benefits to the local region range from $6.11 to $11.72 million in NPV terms on the range of sensitivities considered.

1. Introduction

Cadence Economics was commissioned by Umwelt (Australia) Pty Ltd to undertake an Economic Impact Assessment (EIA) of the Project. The Project is a modification of the Invincible Project Approval which is being sought under Section 75W of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The EIA is based on the framework established in the *Guidelines for the economic assessment of mining and coal seam gas proposals* (the Guidelines) released by the New South Wales (NSW) Government in December 2015 (the Guidelines).[1]

Data inputs for the analysis presented in this report are derived primarily from:

- The *Social Opportunity and Impact Assessment* (SOIA) undertaken by Umwelt (Australia);
- The *Environmental Assessment* (EA) undertaken by Umwelt (Australia); and
- Data provided by the project proponents Castlereagh Coal, including a detailed mine cost analysis undertaken by Palaris Australia.

Cadence Economics has not verified the information in these studies.

The Project

Shoalhaven Coal Pty Ltd, trading as Castlereagh Coal (Castlereagh Coal), operates the Invincible Colliery (Invincible), an open cut coal mine located approximately 25 kilometres north-west of Lithgow in NSW (refer to Figure 1). The township of Cullen Bullen is located approximately 3 kilometres north-west of the Invincible mine infrastructure area. Invincible is currently in care and maintenance. Castlereagh Coal is part of the Manildra Group (Manildra), an integrated and diverse agribusiness.

Shoalhaven Coal purchased Invincible in 2015 to secure a continued supply of specialty nut coal for Manildra's Shoalhaven Starches Plant at Bomaderry on the NSW south coast.

Castlereagh Coal proposes to modify the Invincible Project Approval under Section 75W of the EP&A Act to extend the life of mining operations at Invincible and obtain approval to extend the open cut mining operations to an area immediately south of the existing operations, referred to as the Southern Extension Area.

The Project includes:

- Extending the period in which mining can continue for a period of 8 years from approval of the modification application.
- Extending the open cut mining area immediately south of the existing mining disturbance area (refer to Figure 1). Extraction of coal from all seams down to, and including the Lithgow seam. No high-wall mining or open cut mining in any other areas of Invincible is proposed as part of the Project.
- Continued use of existing Invincible infrastructure (including operation of, and maintenance work on, the existing Coal Preparation Plant).

[1] New South Wales Government (2015).

- Use of existing open cut voids and former underground workings for water storage.
- No change to currently approved mining production rates.
- No change to currently approved product coal transport arrangements with coal to be transported from the site by road truck to either the Shoalhaven Starches Plant or Mt Piper Power Station.
- Rehabilitation of the proposed Southern Extension Area and all existing disturbance areas at Invincible by reshaping mining areas to remove voids and revegetating the reshaped landform with locally endemic woodland and forest communities.

The eight year extension to the life of mining operations is to provide Shoalhaven Starches with flexibility of accessing nut coal from Invincible along with other suppliers or to source nut coal solely from Invincible. The eight year extension of mine life will also enable Castlereagh Coal and Shoalhaven Starches to fully investigate options of using coal from the Lidsdale and Irondale seams at the Shoalhaven Starches Plant. This EIA assesses the net economic impacts of the Southern Extension Project over the four years 2017 to 2020, reflecting the current plan for extraction.

A comparison of the existing approved operations at Invincible and the Southern Extension Project is provided in Table 1 below.

Table 1: Comparison of existing and approved operations at Invincible and the Southern Extension Project

	Existing Approved Operations	Southern Extension Project
Resource Tonnes	Defined by existing footprint. Approved reserves have been mined.	Approximately 2,739 kts ROM coal
Mining Methods	Highwall and Open Cut	Open Cut only
Target Seams	All seams down to Lithgow Seam (Irondale, Lidsdale and Lithgow).	All seams down to Lithgow Seam (Irondale, Lidsdale and Lithgow).
Mining Rate	Up to 1.2 Mtpa ROM Coal.	Up to 1.2 Mtpa ROM Coal.
Production Rate	Up to 1.2 Mtpa Product Coal.	Up to 1.2 Mtpa Product Coal.
Mining Life	To December 2016 (8 years from date of approval).	Up to 8 years from date of approval.
Disturbance Area	165 ha	Approximately 50 ha of additional disturbance.
Operational Workforce	35 full time personnel.	Approximately 35 full time personnel.
Hours of operations	7.00 am – 10.00 pm Monday to Saturday (excl. public holidays). Mining in south pits not permitted between 6.00 pm and 10.00 pm.	7:00 am-10.00 pm Monday to Saturday (excl. public holidays). Mining and coal washery operations will not occur between 6.00 pm and 10.00 pm (operations limited to truck loading and maintenance activities only during this period).
Blasting	Blasting between 9:00 am and 5:00 pm Monday to Saturday, inclusive. No more than: • 2 blasts per day; or • 5 blasts per week averaged over a 12 month period.	Blasting between 9:00 am and 5:00 pm Monday to Saturday, inclusive. No more than: • 2 blasts per day; or • 5 blasts per week averaged over a 12 month period. Blasts sizes limited to manage potential risks to private residences, pagoda and cliffline formations, historical sites and other infrastructure.
Transport	Road Transport 7.00 am – 9:30 pm Monday to Saturday, excluding Sundays and public holidays. No more than 146 laden coal truck movements from the site per day (averaged over a week). No more than 16 laden coal truck movements per hour.	Road Transport 7.00 am – 9:30 pm Monday to Saturday, excluding Sundays and public holidays. No more than 146 laden coal truck movements from the site per day (averaged over a week). No more than 16 laden coal truck movements per hour.
Tailings Management	Coarse tailings are co-disposed with overburden. Fine tailings are dried in drying ponds; dry tailings are then either mixed with product coal or co-disposed with overburden.	Coarse tailings are co-disposed with overburden. Fine tailings are dried in drying ponds; dry tailings are then either mixed with product coal or co-disposed with overburden.

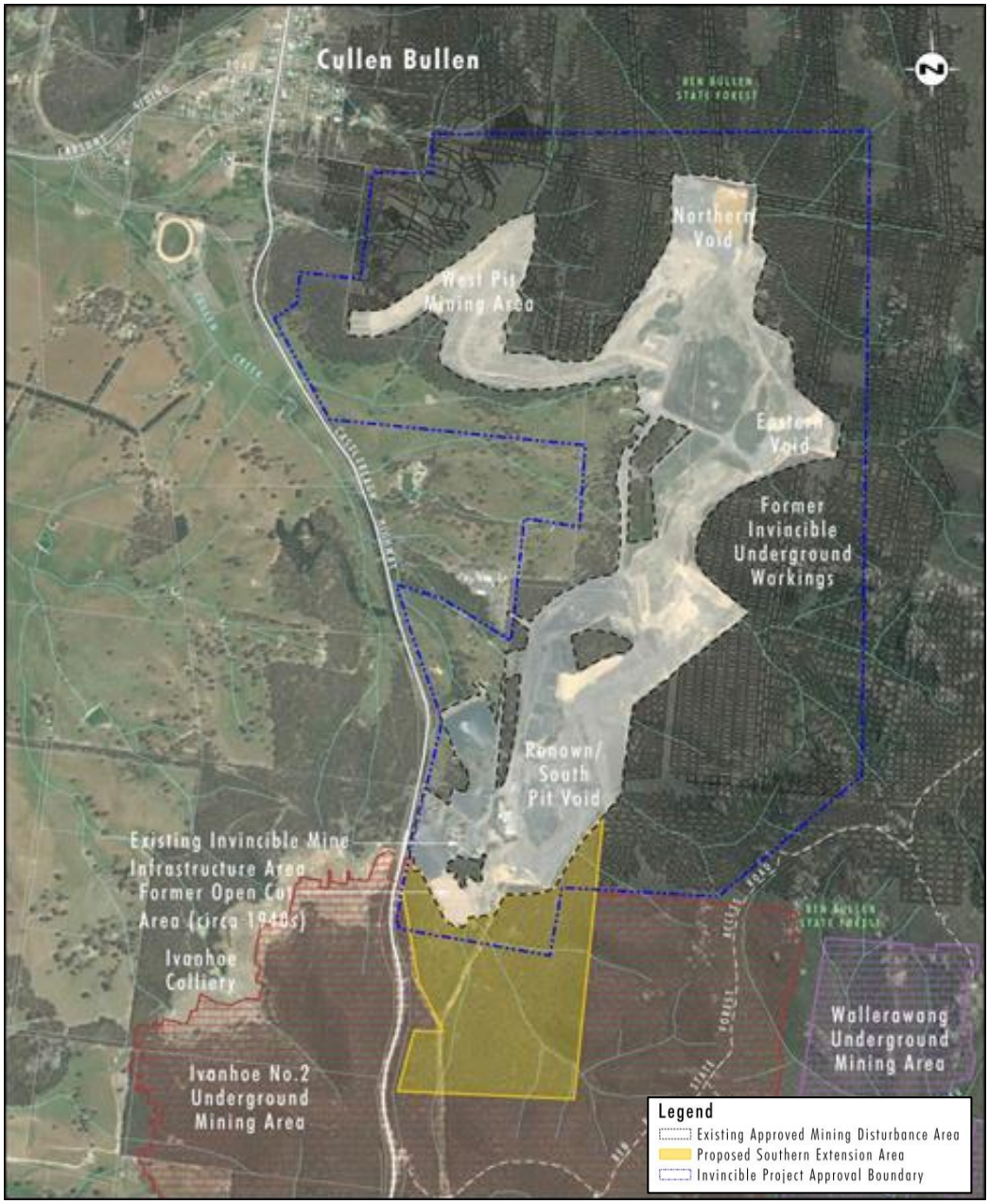
Source: Based on information provided in the EA undertaken by Umwelt (Australia).

Castlereagh Coal also acquired the Cullen Valley Mine and associated assets from Coalpac in 2015. Cullen Valley is currently under care and maintenance. There are remaining approved resources at Cullen Valley however Castlereagh Coal does not have any immediate plans to recommence mining operations at

Cullen Valley. The Southern Extension Project does not seek any changes to the approved operations at Cullen Valley.

This assessment has assumed a conservative mining scenario of up to maximum limits of production over a four year period to provide a conservative assessment of impacts over the life of the Project. Under this scenario, the Project would extract approximately 2,700 kts Run-of-Mine (ROM) coal, which equates to approximately 2,600 kts of product coal, over the period 2017 to 2020.

Figure 1: Invincible Southern Extension Project



Source: EA undertaken by Umwelt Australia.

Under the central case assumptions of the Project (as outlined later in this report) it is expected the proponent will expend $5.5 million of capital and generate revenue of $139 million in NPV terms.

As noted above, the primary resource target is the high value nut coal which will be transported to Manildra's Shoalhaven Starches Plant in Bomaderry NSW to be used as a critical input into the starch production process. The thermal coal will be transported a short distance to the Mt Piper Power Station consistent with previous operations at Invincible.

The Shoalhaven Starches Plant at Bomaderry is the largest wheat starch and gluten plant of its kind in the world and is a critical component of Manildra's integrated agribusiness. The Shoalhaven Starches Plant processes quality flour from Manildra's four flour mills in the NSW and supplies the domestic and export markets with a range of gluten, starch, glucose, ethanol and stockfeed products crucial to a wide variety of industries from food and confectionery to brewing and building. Manildra directly employs approximately 771 FTE and contributes $168 million of direct value added[2] to the NSW economy, mainly in regional centres in Nowra, Manildra, Narrandera and Gunnedah.

Maintaining a consistent, cost effective and reliable supply of energy is critical to ensuring the ongoing operation of the Shoalhaven Starches Plant. The characteristics of speciality nut coal from Invincible meet the specific coal quality requirements for use in the Plant. Any change in coal quality, or a change in energy supply, would require significant capital and plant upgrades, in addition to material operational impacts.

This assessment has assumed the speciality nut coal required at the Shoalhaven Starches Plant will be sourced from the target Lithgow Seam within the Southern Extension Area over the next four years however Castlereagh Coal will investigate options of washing coal from other seams to increase the volume of nut coal that can be obtained from the Southern Extension Area. With the opportunity to further assess other coal resources for suitability to supply Shoalhaven Starches in the future.

Along with mitigating the risks in Manildra's integrated production process, the Project's mine design includes elements which mitigate potential environmental impacts and make use of currently under-utilised infrastructure resources and access to coal resources that are unlikely to be mined but for the Project. For example the disturbance footprint avoids any additional impact on threatened ecological communities and will be set back at least 210 metres from all pagoda formations found in the area to minimise potential impacts on the Broad-headed snake which is listed as being endangered under the NSW *Threatened Species Conservation Act 1995*.

The Project is also located as far as practicable from surrounding private residences and the township of Cullen Bullen, which minimises potential amenity impacts associated with mining on these areas.

In addition, the Project will make use of existing coal washery and loading infrastructure at Invincible and Castlereagh Coal has also purchased second-hand mining equipment, decreasing the costs of the Project development.

[2] Deloitte Access Economics (2014).

2. Cost-Benefit Analysis

The Guidelines released by the NSW Government in December 2015 set out the cost-benefit analysis (CBA) framework to measure the net benefits to the NSW community. This approach has been adopted in the economic analysis outlined in this report. Table 2 provides a summary of how these net benefits are measured.

Table 2: Cost Benefit Analysis framework as defined in the Guidelines

Direct Benefits	Indirect Benefits	Indirect Costs
The net benefits that accrue to NSW from the direct operations of the proposed mine	The net benefits that are generated for parties that economically interact with the proposed mine	Social costs generated by the proposed mine, borne by the NSW community
Includes: • Net producer surplus attributable to NSW • Royalties payable • Company tax attributable to NSW	Includes: • Net economic benefits to landowners • Net economics benefits to NSW employees • Net economic benefits to NSW suppliers	Includes: • Net environmental, social and transport-related costs • Net public infrastructure costs • Loss of surplus to other industries

Source: NSW Government (2015).

The direct benefits are those that accrue to the project proponent and payments made to government. The indirect benefits are those that accrue to economic agents that engage with the project proponent. These include employees, suppliers and land owners. The indirect costs are the costs borne by the community of NSW, through environmental and social impacts or public infrastructure costs.

A major emphasis of the Guidelines is on transparency of assumptions made. The remainder of this section describes in detail the assumptions underpinning the CBA.

Baseline case

The starting point for any CBA is the baseline case, or counterfactual. This scenario considers all costs and benefits if the Project does not proceed. In this case, the baseline case reflects the situation arising if the Invincible mine closes and the site is progressively rehabilitated over a 5 year period.

Under the baseline case, there is an economic cost borne by the project proponent arising from Castlereagh Coal's obligation to rehabilitate existing open cut mining area at the Invincible Colliery. The real cost of rehabilitating the land is $2.32 million in NPV terms using a real 7 percent discount rate (NPV terms).[3] This is shown in Table 3 as a loss of producer surplus.

[3] All figures in this report are in real 2016 dollars and net present values are derived using a real 7 percent discount rate unless otherwise specified.

The proponent will also pay Council Rates of $180,000 per annum despite the fact that the mine is under care and maintenance. This figure is included in the net producer surplus estimate in Table 3 and is not material to the analysis (as discussed below).

Offsetting these rehabilitation costs to some extent are the estimated benefits to suppliers undertaking the rehabilitation ($1.08 million in NPV terms), and an increase in land values, post-rehabilitation ($0.07 million in NPV terms).

Overall, should the Project not go ahead, the overall loss to NSW economy is estimated to be $1.17 million in NPV terms.

Table 3: Net Benefits of the Baseline case

Benefits	Total NPV ($m)	Costs	Total NPV ($m)
Direct benefits		**Direct costs**	
1. Net producer surplus attributed to NSW	-2.32		
2. Royalties, Payroll tax and Council rates	0.0		
3. Company income tax apportioned to NSW	0.0		
Total direct benefits	**-2.32**	Total direct costs	-
Indirect benefits		**Indirect costs**	
1. Net economic benefit to existing landholders	0.0	1. Air quality	
2. Net economic benefit to NSW workers	0.0	2. Greenhouse gas emissions	
3. Net economic benefit to NSW suppliers	1.08	3. Visual amenity	
		4. Transport impact	
		5. Net public infrastructure cost	
		6. Surface water impact	
		8. Residual value of land	0.07
		7. Biodiversity impact	
		8. Noise impact	
		9. Loss of surplus to other industries	
		10. Water	
		11. Aboriginal cultural heritage	
		12 Historical heritage	
Total indirect benefits	1.08	Total indirect costs	
Total economic benefit of	-1.24	Total economic cost of project	**0.07**
NPV of project	**-1.17**		

Source: Cadence Economics estimates based on the EA and information provided by Castlereagh Coal. Note: all NPV figures are in 2016 dollars and derived using a 7 percent real discount rate.

Project case – central case assumptions

Under the assumption that the Project goes ahead, the Invincible Colliery will produce an additional 2,624 kts of coal consisting of 288 kts of nut coal and 2,336 kts of thermal coal over the four year period 2017 to 2020 as summarised in Table 4.

The real nut coal price over the life of the Project is assumed to be $110 per tonne. This is based on the existing (2016) price of nut coal paid by Shoalhaven Starches. The real price of thermal coal is assumed to be $56 per tonne over the life of the project. This is based on the existing (2016) price of thermal coal paid by the Mount Piper power station as supplied by Castlereagh Coal. For the purposes of this CBA, these prices represent the 'central case' assumptions underpinning the analysis.

Based on the production and real price assumptions, the Project will generate real revenue of $139.0 million real revenue in NPV terms through the sale of thermal and nut coal as shown in Table 4.

Table 4: Central Project case – Run-on-mine, coal output, real price and revenue

	Total Project	2017	2018	2019	2020
Output - ROM (kts)	2,739	732	688	1,002	317
Output - Net coal saleable					
Nut Coal (kts)	288	*86*	*86*	*86*	*31*
Thermal Coal (kts)	2,336	*612*	*568*	*882*	*273*
Total saleable (kts)	2,624	*698*	*654*	*968*	*305*
Real price reference ($2016)					
Nut Coal ($ per tonne)		*110*	*110*	*110*	*110*
Thermal Coal ($ per tonne)		*56*	*56*	*56*	*56*
Real project revenue (NPV*) ($M2016)	139.0	43.7	41.2	58.7	18.7

Source: Cadence Economics estimates based on the EA and information provided by Castlereagh Coal. * NPV in 2016 dollars based on a 7 percent real discount rate.

Under the central case assumptions, from the real revenue of $139 million in NPV terms, operating costs are estimated to be $64.3 million in NPV terms, as summarised in Table 5. The Project proponent will also incur $0.4 million of end of life costs and biodiversity offset charges of $3.1 million in NPV terms.[4]

[4] For the purposes of the EIA biodiversity offset costs have been based on the option of acquisition and management of land based offsets. It is acknowledged that there are a number of offsetting options available under the Framework Biodiversity Assessment process which will be determined in consultation with relevant authorities through the assessment process

Table 5: Central Project case – Summary of Project financials ($ million)

	Project (NPV*)	2017	2018	2019	2020	2021
Total Revenue ($m)	139.0	43.7	41.2	58.7	18.7	-
Operating Costs ($m)	64.3	20.6	20.7	21.6	10.5	1.7
End of life costs ($m)	0.4	-	-	-	-	0.5
Mitigating Costs - Noise	0.019	0.020	-	-	-	-
Biodiversity – Offsets ($m)	3.1	2.5	-	-	1.0	-
Net operating revenue ($m)	71.3	20.5	20.4	37.2	7.2	-2.2
Depreciation ($m)	1.4	0.4	0.4	0.4	0.4	-
Royalties ($m)	11.2	3.5	3.3	4.8	1.5	-
Private Royalties ($m)	3.9	1.1	1.2	1.7	0.6	-
Residual value of capital ($m)	2.9	-	-	-	3.9	-
Residual value of land ($m)	-	-	-	-	-	-

Source: Cadence Economics estimates based on information provided by Castlereagh Coal included in the Palaris Australia assessment of mine costs. * NPV in 2016 dollars based on a 7 percent real discount rate.

Direct Benefits

Based on the Guidelines, the direct benefits to NSW of the Project are derived from three elements:

- The net producer surplus generated by the project that is attributable to NSW.
- The share of company tax payments that are attributable to NSW.
- Other tax payments such as royalties and payroll tax that are paid to the NSW and local government.

Based on the revenue and cost data, the Project is estimated to generate $52.6 million in total direct economic benefits to NSW in NPV terms, as outlined in Table 6. These benefits are comprised of $35.2 million of producer surplus, $5.6 million in company tax attributable to NSW and $11.8 million in NPV terms paid to the NSW Government in royalty payments and payroll tax and the Local Government Area (LGA) rates.

Table 6: Summary of the direct benefits of the Project ($ million)

Net financial benefit	NPV*
Net producer surplus attributable to NSW	35.2
Company income tax attributable to NSW	5.6
Payments to the NSW and local Government	11.8
Total financial benefit attributable to NSW	52.6

Source: Cadence Economics estimated based on information provided in the EA and by Castlereagh Coal included in the Palaris Australia assessment of mine cost. * NPV in 2016 dollars and based on a 7 percent real discount rate.

Net producer surplus

Consistent with the Guidelines, the net producer surplus of the Project are the private benefits, or profits, generated that are attributable to NSW. In this case the total net producer surplus generated is attributable to NSW as the project proponent Castlereagh Coal is 100 percent NSW-owned. This is estimated to be $35.2 million in NPV terms as summarised in Table 7.

Table 7: Estimate of net producer surplus ($ million)

Net producer surplus	NPV*
Operating revenue (coal sale revenue minus operating costs)	71.3
Royalties	11.2
Payroll tax	0.5
Council rates	0.0
Private royalties	3.9
Corporations tax	17.8
Capital costs	5.5
Residual value of capital	2.9
Residual value of land	0.0
Net producer surplus	35.2
Net producer surplus attributable to NSW	35.2

Source: Cadence Economics estimated based on information provided in the EA and by Castlereagh Coal included in the Palaris Australia assessment of mine costs. * NPV in 2016 dollars based on a 7 percent real discount rate.

Company tax (NSW share)

The company tax payments made to the Australian Government are levied on the profits generated by the Project as summarised in Table 8. It is estimated the Project will generate $57.6 million in total profit in NPV terms over the period 2017 to 2021 (including the final year of rehabilitation activity). At a corporate tax rate of 30 percent and a depreciation rate of 7.5 percent, the company tax estimate is $17.8 million in NPV terms, of which $5.7 million is attributable to NSW (based on a NSW population share of 32% which is consistent with the Guidelines).

Table 8: Company income tax attributable to NSW ($ million)

Corporations tax paid to NSW	NPV*
Total Revenue	139.0
Operating Costs	64.3
End of life costs	0.4
Mitigating Costs - Noise	0.019
Biodiversity - Offsets	3.1
Net operating revenue	71.3
Depreciation	1.4
Royalties	11.2
Private Royalties	3.9
Residual value of capital	2.9
Residual value of land	-
Total profit	57.6
Company tax	17.8
Company tax attributable to NSW	5.7

Source: Cadence Economics estimated based on information provided in the EA and by Castlereagh Coal included in the Palaris assessment of mine costs. * NPV in 2016 dollars based on a 7 percent real discount rate.

Royalties and other payments to the NSW and local government

In total the Project is expected to generate $11.8 million in payments to the NSW Government in NPV terms, the majority of which is made up of coal royalties of $11.2 million as summarised in Table 9.

The coal royalties are applied at a rate of 8.2% of revenue after allowable washing and crushing deductions. After the deductions of $3.50 per tonne for washing nut coal and $0.50 per tonne for crushing and screening thermal coal are applied to sales, the royalty rate is applied and equates to $137.1 million in NPV terms.

The proponent will also pay $180,000 in rates to the Lithgow City Council, these payments are the same under the Project case and baseline case so therefore have no impact on the net benefits estimated under the Project.

Table 9: Payments made to NSW and local government

Basis of payment	
Royalties	
Revenue ($m NPV*)	139.0
Discount	1.9
Revenue - for royalty base ($m NPV)	137.1
Royalty rate	8.2%
Royalties payable ($m NPV)	11.2
Other payments to Government	
Payroll tax ($m NPV)	0.51
Total payments to Government ($m NPV)	11.8

Source: Cadence Economics estimated based on information provided in the EA and by Castlereagh Coal included in the Palaris assessment of mine costs. * NPV based on a 7 percent real discount rate in 2016 dollars.

Indirect Benefits to NSW

Consistent with the Guidelines, the indirect benefits of the Project accrue to agents including:

- Employees
- Suppliers
- Private royalty holders
- Land owners.

As summarised in Table 10, the total indirect benefits are estimated to be $27.9 million in NPV terms. The main source of these benefits is the $6.1 million in benefits to employees and $21.8 million in benefits to suppliers in NPV terms.

There are no anticipated benefits to land owners as a result of the Project development.

The private royalties payable under a private agreement are assumed to generate no net benefit to NSW, as they are paid to a foreign-controlled entity (Centennial Coal whose parent company is Banpu, a Thai-based company).

Table 10: Summary of indirect benefits, ($ million)

Indirect benefits	NPV*
Employee benefits	6.1
Supplier benefits	21.8
Private Royalties	0.0
Land owner	0.0
Total Indirect Benefit	27.9

Source: Cadence Economics estimated based on information provided in the EA, SOIP and by Castlereagh Coal. * NPV based on a 7 percent real discount rate in 2016 dollars.

Benefit to employees

Consistent with the Guidelines, a key factor in determining the benefit to employees centred on assumptions based on the employment conditions of those employees that are employed under the Project. For example, those persons employed under the Project scenario that are drawn from the existing pool of employed labour, with comparable employment conditions, would receive no net employee benefits. On the other hand, those employees at the Project who were unemployed would generate a net employee benefit.

Analysis from the SIOA shows the project will employ 33 to 35 staff over the life of the Project, as outlined in Table 11, including seven administration staff and between 5 to 6 maintenance employees.

Table 11: Direct staff requirement, Southern Extension Project, 2017 - 2020

Year	Production	Administration	Maintenance	Total
2017	22	7	6	35
2018	22	7	6	35
2019	22	7	6	35
2020	21	7	5	33

Source: Social Impact and Opportunities Assessment.

To determine the economic benefits to employees, the following assumptions have been made:

- Administration and maintenance employees are assumed to be drawn from existing employment in the mining sector because of their specialised skills including mine planning engineers, geologists and trade based (e.g. electricians). As such, it is assumed that these employees do not generate a net employee benefit as they were previously employed under similar conditions.
- The additional 21 to 22 production staff for the duration of the project will be drawn from the ranks of the unemployed. As discussed below, the Lithgow-Mudgee region has relatively high unemployment compared with NSW. In addition several coal operations in the region have laid-off a large number of employees over the past few years. It is therefore a reasonable assumption that unskilled and moderately skilled persons suitable for production roles would be available from within the local area and who are currently unemployed.

The estimated employee benefits that accrue to these production staff is therefore the difference between the wage they receive and the Newstart Allowance, as summarised in Table 12.

In real terms, the production staff will earn wages of $7.4 million in NPV terms over the operational phase of the mine. This compares with the Newstart Allowance of $1.3 million in NPV terms resulting in a $6.1 million in NPV terms net employee benefit.

Table 12: Summary of real net employee benefits, 2017 – 2020

Indirect benefits –Employee	NPV*	2017	2018	2019	2020
Total production employees		22	22	22	21
Real average wage ($)		100,476	100,476	100,476	100,476
Real employee wages ($m)	$7.4	$2.2	$2.2	$2.2	$2.1
Real Newstart Allowance ($m)^	$1.3	$0.4	$0.4	$0.4	$0.4
Real net employee benefit ($m)	$6.1	$1.8	$1.8	$1.8	$1.7

Source: Cadence Economics estimated based on information provided in the SOIP. * NPV in 2016 dollars based on a 7 percent real discount rate. ^ Includes Rent Assistance

Benefit to suppliers

Consistent with the Guidelines, the economic benefit to suppliers is estimated as a producer surplus generated from goods and services from NSW firms servicing the Project. As summarised in Table 13, based on the mine cost data provided by Palaris Australia, the Project is estimated to require $50.1 million in NPV terms in intermediate inputs over its life-cycle (including end-of-life rehabilitation).

The estimated economic benefit to suppliers (producer surplus or value added) is based on the Cadence Economics Regional Input-Output Model (CERIOM). This model was customised to generate a NSW-specific Input-Output table so as to not include benefits generated in other Australian states.

The producer surplus estimates are based on Type I multipliers which only relate to direct value added generated by NSW suppliers. This methodology does not account for second round, nor induced consumption, effects. As a result the total supplier benefits are estimated to be $21.8 million in NPV terms.

Table 13: Summary of benefits to suppliers, 2017 – 2021

Indirect benefits –suppliers	NPV*	2017	2018	2019	2020	2021
Real intermediate inputs ($m)	$50.1	$16.4	$16.5	$17.3	$6.5	$1.7
Value added ratio		0.436	0.436	0.436	0.436	0.436
Real supplier benefits ($m)	$21.8	$7.2	$7.2	$7.6	$2.8	$0.7

Source: Cadence Economics estimated based on information provided in the SOIP and in the Palaris assessment of mine costs.
* NPV in 2016 dollars based on a 7 percent real discount rate.

Indirect Costs to NSW

Consistent with the Guidelines, the indirect costs of the Project are classified as:

- Net public infrastructure costs
- Estimated loss of surplus to other industries
- Net environmental, social and transport-related costs
- Net environmental costs

Loss of surplus to other industries

Consistent with information outlined in the EA, it is assumed that no losses will be generated in other industries in NSW as a result of Project approval. As outlined in the EA, the Project is unlikely to have any impact on agricultural or forestry activities on adjoining land. As discussed in the EA, the Forestry Corporation will be compensated for any losses associated with the use of the Southern Extension Area through Forestry Permit fees.

Net public infrastructure costs

Consistent with information outlined in the SIOP, it is assumed that there are no net public infrastructure costs. Currently there are no requirements to undertake roadworks, nor install utility or other infrastructure outside of the project area.

Net environmental, social and transport-related costs

Table 14 provides a summary of the environmental impacts generated by the Project. A number of these impacts have been measured quantitatively, like greenhouse gas emissions and traffic impacts from temporary road closures. Some of these environmental impacts have been included in the operating costs of the proponent as either management costs in the case of biodiversity or mitigation measures, as in the case of noise impacts. Some are discussed in qualitative terms such as visual amenity and Aboriginal heritage.

Table 14: Summary of environmental impacts

Scope of environmental costs	Assessment type	Discussion
Greenhouse gas emissions	Quantitative	Based on scope 1 and 2 emissions
Air quality	Quantitative	Nil impact
Residual value of land	Quantitative	Measures the value forgone from society's potential value for the use of mine area land.
Biodiversity impact	Quantitative	Measured as the likely Biodiversity costs to be incurred by Castlereagh Coal.
Transport/ traffic impacts	Quantitative	Measured as the increase in travel times associated with temporary closures of the Castlereagh Highway due during blasting.
Ambient noise impact	Quantitative	Measured as the mitigation costs from implementing noise mitigation measures to one residence to reduce impacts.
Visual amenity	Qualitative	Minor visual impacts associated with mining but similar to those of existing operations.
Water impact	Qualitative	No impacts on other groundwater water users. Water discharge quality and quantity managed to avoid negative impacts on downstream environment and users.
Aboriginal cultural heritage	Qualitative	Impacts to some less-archaeologically significant sites on the Southern Extension Area managed in consultation with Aboriginal groups. No impact to high-archaeologically significant sites.
Non-Aboriginal heritage	Qualitative	Nil impacts

Source: Based on information provided in the EA.

Greenhouse gas emissions

The greenhouse gas assessment is summarised in the EA and used as the basis of the deriving the indirect costs shown in Table 15. The EA states that the Project will generate 182,625 tonnes of Scope 1 and 2,712 tonnes of Scope 2 greenhouse gas emissions. The real economic cost per tonne of these emissions has been priced at $12.10 which is the current average price paid for emissions reductions under the Australian Government's Emissions Reduction fund. This price is a market-based mechanism of carbon abatement prevailing in May 2016.[5]

It is noted that 100 percent of the costs have been apportioned to NSW for the purposes of the assessment however it is widely acknowledged that climate change is a global issue and different parts of Australia and the world are predicted to experience different levels of impacts. Apportioning all the costs of climate change impacts associated with the Project's greenhouse gas emissions is considered likely to overstate the cost of these impacts to NSW.

Table 15: Greenhouse gas emissions

	NPV*	2017	2018	2019	2020
Greenhouse gas emissions					
Scope 1 (tonnes)		48,822	45,870	66,783	21,149
Scope 2 (tonnes)		725	681	991	314
Real price ($ per tonne)		$12.10	$12.10	$12.10	$12.10
Real costs ($m)	$1.9	$0.60	$0.56	$0.82	$0.26

Source: Cadence Economics estimated based on information provided in the EA. * NPV in 2016 dollars based on a 7 percent real discount rate.

Air quality

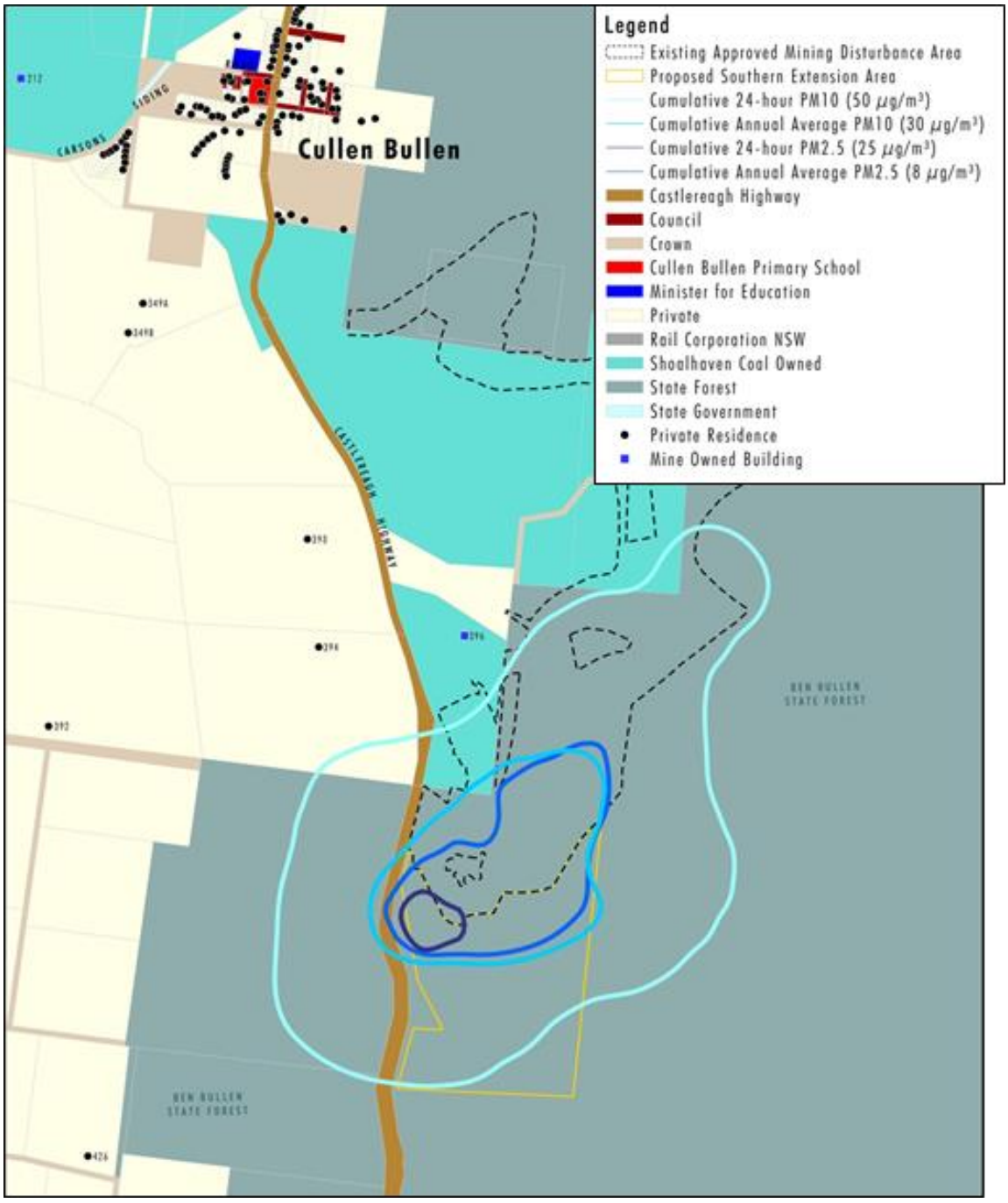
Based on information contained in the EA,[6] the Project will produce particulate matter of less than 10 micro metres in diameter (PM_{10}) and less than 2.5 micro metres in diameter ($PM_{2.5}$) during the operational phase of the Project.

The assessment of air quality impacts associated with the Project indicates that PM_{10} and $PM_{2.5}$ impacts associated with the project will not result in the exceedance of currently established air quality criteria at any residence or sensitive receiver as shown in Figure 2. While there may be a minor increase in PM_{10} and $PM_{2.5}$ levels at some of the closest residences, an analysis of the Air Quality Impact Assessment indicates the Project will have a nil or negligible economic impact as a result of reduced air quality.

[5] Department of the Environment (2016).

[6] Jacobs (2016).

Figure 2: Predicted Air Quality Impact contours at maximum production



Source: Jacobs (2016)

Residual value of land

The residual value of land captures its economic value in its alternate use, and the value placed on that use by society. As outlined above, under the baseline scenario Castlereagh Coal has an obligation to rehabilitate the existing disturbance area at the Invincible mine.

The Southern Extension Project will increase the disturbance area and reduce the available existing woodland area over the life of the Project. As outlined in Table 16, the Project reduces the area of available woodland by 47.5 Hectares (Ha) by the end of mining operations in 2020. By 2051, under both the baseline and Project cases, the area of woodland rehabilitated will be the same.

However, for the purposes of this assessment it is assumed that the rehabilitated woodland is not as valuable as it would have been if not disturbed. Currently, a proxy for the value of woodland area is $5,000 per Hectare (Ha), which is informed by woodland credits purchased through the NSW Government's BioBanking scheme.[7] To account for a reduction in the quality of woodland after rehabilitation, a 50% discount has been applied to the woodland value under the baseline scenario and 75% in the Project case. The higher value attributed to the Project case is based on the higher biodiversity value associated with the rehabilitation commitments proposed when compared to the existing approval requirements.

Based on the information relating to woodland disturbance outlined in Table 16 and the real costs discussed, the residual value of land in the Project case is $170 in NPV terms. Under the baseline, the land is valued at $72,687, resulting in the net cost of the Project of $72,516 in NPV terms.

Table 16: Area of woodland disturbance (hectares)

	Base case Woodland area	Change in Woodland	Project Woodland area	Change in Woodland
2016	47.5		47.5	
2017	47.5	0.0	35.6	-11.9
2018	47.5	0.0	23.8	-11.9
2019	47.5	0.0	11.9	-11.9
2020	47.5	0.0	0.0	-11.9
2021	47.5	0.0	0.0	0.0
2026	47.5	0.0	0.0	0.0
2031	54.5	7.0	7.0	7.0
2036	110.1	55.6	101.5	94.5
2041	174.5	64.4	166.1	64.6
2046	176.8	2.2	176.8	10.6
2051	182.1	5.3	182.1	5.3

Source: EA undertaken by Umwelt Australia

Biodiversity and ecological impacts

As discussed in the EA, no significant ecological constraints have been identified in relation to the Southern Extension Area. The Project has been designed to limit any adverse impacts on the ecologically sensitive pagodas located directly to the east of the Southern Extension Area. These formations are typically smaller in scale and are associated with much drier vegetation communities than the more significant terrain features associated with the more northerly pagodas. To mitigate any potential

[7] NSW Government, Office of Environment & Heritage, Biobanking Public Register, accessed July 2016.

adverse impacts, the disturbance footprint of the Project will be set back at least 210 metres from all pagoda formations found in the area to minimise potential impacts to threatened species habitat. In addition, blasting will be designed to meet relevant criteria at pagoda formations over the life of mining, and will be monitored by Castlereagh Coal.

A number of vegetation communities and species will be affected or potentially affected as mining related disturbance extends into the Southern Extension Area. These impacts require offsetting pursuant to the NSW Framework for Biodiversity Assessment (FBA). Castlereagh Coal has committed to implementing a biodiversity offset strategy to meet the obligations of the FBA. As part of the biodiversity offset strategy the proponent will require offsets for vegetation communities identified in Table 17.

Table 17: Vegetation types requiring offsets

Biometric Vegetation Type	Area to be Impacted (ha)	Credits Required
CW117 - Brittle Gum - Broad-leaved Peppermint - Red Stringybark open forest in the north-western part (Yass to Orange) of the South Eastern Highlands Bioregion (Moderate/Good)	8.24	542
CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes (Moderate/Good)	36.5	2,714
CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes (Moderate/Good_High)	0.62	30
CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes (Moderate/Good_Medium)	2.25	99
CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes (Moderate/Good_Easement)	1.65	50

Source: EA undertaken by Umwelt Australia.

In addition the offset strategy will also require offsets for a number of vulnerable species including the Broad-headed snake, Capertee stringybark and the Squirrel glider. The offset credit requirements for these species, calculated in accordance with the FBA are outlined in Table 18.

Table 18: Species credits required

Common Name	Species Name	Species Credits Required
Broad-headed snake	*Hoplocephalus bungaroides*	388
Capertee stringybark	*Eucalyptus cannonii*	312
Squirrel glider	*Petaurus norfolcensis*	1047

Source: EA undertaken by Umwelt Australia.

As outlined above, Castlereagh Coal has committed to implementing a biodiversity offset strategy to meet the obligations of the FBA. Based on information provided by Umwelt Australia, it is estimated this strategy will cost $3.5 million over the life of the project, this will include an estimated $2.5 million to purchase the appropriate credits required (as outlined above) and $1.0 million in 2020 to manage the offsets in perpetuity.

In NPV terms, the total costs are estimated to be $3.1 million. As outlined above, the EIA has assumed the costs associated with biodiversity offsets on the basis of acquisition and management of land based offsets. It is acknowledged that the FBA provides for a range of offsetting options for major projects and Castlereagh Coal will determine the most appropriate form of biodiversity offset in consultation with relevant authorities as part of the assessment of the Project.

The biodiversity offsets required under the Baseline case are common to both the base case and Project case and relate to existing approved disturbance activities.

Transport/traffic impacts

The Project is expected to generate some traffic delays along the Castlereagh Highway adjacent to the Invincible Colliery. These delays will be caused by the blasting requirements of the mine operations which will require the temporary closure of Castlereagh Highway when blasting is undertaken within 500m of this road.

There will be up to five blasts per week each of a 15 minute duration, for 52 weeks of the year.

To estimate the economic costs of these delays, the value of the wait time by users of the Castlereagh Highway has been adopted from Transport for NSW (updated to 2016 dollars).[8] Based on Transport for NSW figures, a real cost of $41.54 is applied per hour of delay. To mitigate the delay costs, the community will be informed of blast times allowing them to change travel patterns. No account has been taken of this mitigation in these estimates. In addition, it is assumed that blasting is undertaken up to the maximum limits of blasting allowable under the Invincible Project Approval.

Hourly traffic volumes on the Castlereagh Highway are summarised in Table 19. This is based on figures provided by Umwelt Australia which shows that, on average, 140 vehicles use the Castlereagh Highway each hour during times most likely to be affected by blasting activities. It is therefore assumed that over a 15 minute period, 35 (25% of 140) vehicles will be affected by these activities and that vehicles arrive to the road closure site uniformly over the 15 minute period (i.e. the average time these 35 vehicles are delayed is 7.5 minutes).

Table 19: Hourly traffic volumes along the Castlereagh Highway adjacent to the Invincible Mine

Time	Direction of Travel		
	North	South	Total
1.00pm – 2.00pm	75	71	146
2.00pm – 3.00pm	70	62	132
3.00pm – 4.00pm	77	72	149
4.00pm – 5.00pm	77	56	133
Average	74.8	65.3	140.0
Vehicles affected	18.7	16.3	35.0

Source: EA undertaken by Umwelt Australia.

[8] Transport for NSW (2013).

Table 20 outlines the annual travel-time cost under the Project case. Based on the information summarised in Table 19, it is estimated that the total annual wait time that travellers along the Castlereagh Highway is 1,138 hours per year. This is based on 260 blasts per year, the number of vehicles affected of 35 (140 vehicles use the road per hour and a road closure time of 15 minutes) and the average time of delay of 7.5 minutes.

Based on these assumptions, the Project is estimated to impose a real annual travel-time cost of $47,256, or just over $160,000 in NPV terms.

There are no travel time costs under the Baseline case.

Table 20: Annual travel-time cost

Road closure (Minutes)	15.0
Average time delay (Minutes)	7.5
Vehicles effected	35
Number of blasts per week	5
Number of blasts per Year	260
Wait time (Hours)	1,138
Real average hourly value – rural ($2016)	$41.54
Annual travel-time cost	$47,256

Source: Cadence Economics based on information provided by Umwelt Australia, Transport for NSW (2013)

Visual amenity

The EA contains an assessment of the likely visual impacts of the Project on surrounding private landowners and key public vantage points, paying particular attention to the creation of any new landforms and minimising the impacts of the Project on surrounding areas.

The Project proponent has taken steps to mitigate the potential costs of visual impacts, through a commitment to progressive rehabilitation and undertaking the obligation to mitigate existing disturbance areas within the Invincible site.

As a result of these mitigation measures it not expected the Project will generate significant visual amenity impacts.

There are no visual amenity impacts in the Baseline case.

Ambient noise impact

The EA contains a detailed noise impact assessment which has been undertaken for the Project.

It concludes that no privately owned residences will exceed the acquisition criteria set under the existing Invincible Project Approval. One residence, which currently has acquisition rights under the Invincible Project Approval, is expected to qualify for voluntary mitigation rights under the application of the NSW Voluntary Land Acquisition and Mitigation Policy.

To measure the economic costs of the ambient noise impacts to this property, the EA states a cost of $20,000 is to be paid to the proponent to mitigate this impact. This cost has been included in the operational costs of the mine.

There are no ambient noise impacts in the Baseline case.

Surface Water and Groundwater impact

The EA contains a detailed surface water and groundwater impact assessment for the Project.

The Project is not predicted to have any significant impacts on either surface water or groundwater resources. Any discharges from the site will be managed to meet the NSW Environment Protection Authority mandated quality requirements in the Environment Protection Licence for the site and the quantity of water discharged will be managed to ensure he downstream environment is not adversely impacted.

The Project will use water management assets used for previous mining activities on the Invincible site to provide temporary water storage. The current environmental management plan for the mine includes a water management plan that will operate in accordance with the conditions of the Project approval.

There are no surface water or groundwater impacts in the Baseline case.

Aboriginal cultural heritage

The EA contains a comprehensive Aboriginal Cultural Heritage and Archaeological Assessment for the Project, undertaken in consultation with 6 registered Aboriginal parties. The Project was found to have an impact on six Aboriginal sites located in the Southern Extension Area (refer to Table 21). The Project is not predicted to have any impact on sites located outside the existing approved disturbance footprint or the Southern Extension Area.

Table 21: Registered sites within the vicinity of the Southern Extension Area site

Harm	Site
Located within the Southern Extension Area subject to impacts as a result of proposed works	IC 1
	IC 2
	45-1-0069
	45-1-0070
	45-1-2708
	45-1-2714
Located within areas that are subject to currently approved mining activities associated with the current open cut pit.	IC 3
	IC 4
	IC 5
	IC ST

Source: EA undertaken by Umwelt Australia.

Management measures developed in consultation with the registered Aboriginal parties will be implemented in relation to these sites as well as any additional sites which may be identified during the

life of the Project. The costs associated with these management measures are included in production costs.

There are no impacts on Aboriginal heritage in the Baseline case that are not also common to the Project case.

Non-Aboriginal heritage

No items of non-Aboriginal heritage are located within the Southern Extension Area. Heritage items located outside the Southern Extension Area will not be adversely impacted by the Project.

Impacts on other land uses

As outlined in the EA, Invincible is located in a rural environment and is surrounded by vegetated parcels of Crown Land, State Forest and Castlereagh Coal owned land.

The Southern Extension Area is located primarily in vegetated parcels of Ben Bullen State Forest. The proposed activities in the Southern Extension Area are consistent with historical open cut mining operations at Invincible which have been undertaken in Ben Bullen State Forest. Parts of the Southern Extension Area are significantly impacted by subsidence from past underground mining in the area and would require disturbance for rehabilitation purposes, irrespective of the Project.

The southern extent of Gardens of Stone National Park is located approximately 9 km to the north of the Southern Extension Area. The eastern extent of Wollemi National Park is located approximately 13 km north-east of the Southern Extension Area. In 2005, the area of Ben Bullen State Forest in which the Southern Extension Area (and existing Invincible workings) is located was proposed as a State Conservation Area by three environmental groups as part of the Gardens of Stone Stage 2 Proposal. It is noted that mining is permissible within State Conservation Areas in accordance with an applicable mining lease. The Southern Extension Area is located in existing mining leases and the area subject to mining lease application MLA 431.

The areas to the east and north of Invincible within Ben Bullen State Forest contain significant landforms and geological and biodiversity features and are primarily managed for recreation and conservation. The Project has been designed to specifically avoid direct impact on these areas with a range of controls to be implemented to minimise potential indirect impacts.

The Southern Extension Area and surrounding land is currently used primarily for firewood collection, and recreational use such as trail bike riding. Access to the Southern Extension Area for these uses is generally from the south via the power line easement. Located to the south and east of the Southern Extension Area are tracks providing access into areas of Ben Bullen State Forest located to the east and north of Invincible. These tracks are utilised for a variety of uses including recreation (i.e. bush walking, trail bike riding) and are accessed off the Castlereagh Highway to the south of the Southern Extension Area. Overall visitation levels to these areas are thought to be extremely low and there are no formal bushwalking trails in Ben Bullen State Forest.

The Project will result in the exclusion of public access to the Southern Extension Area and immediate surrounds being restricted for safety reasons. This exclusion will limit firewood collection and trail bike

riding in the exclusion area which will extend up to 50 m from the edge of the pit. This exclusion area will not apply to the main access road through Ben Bullen State Forest which runs along the ridgeline to the south and east of the Southern Extension Area. Parts of this access road will be closed temporarily during blasts to prevent access within 500 m of blast areas. These closures will last approximately 15 minutes and will be managed in accordance with the exclusion protocols contained in the Blast Management Plan.

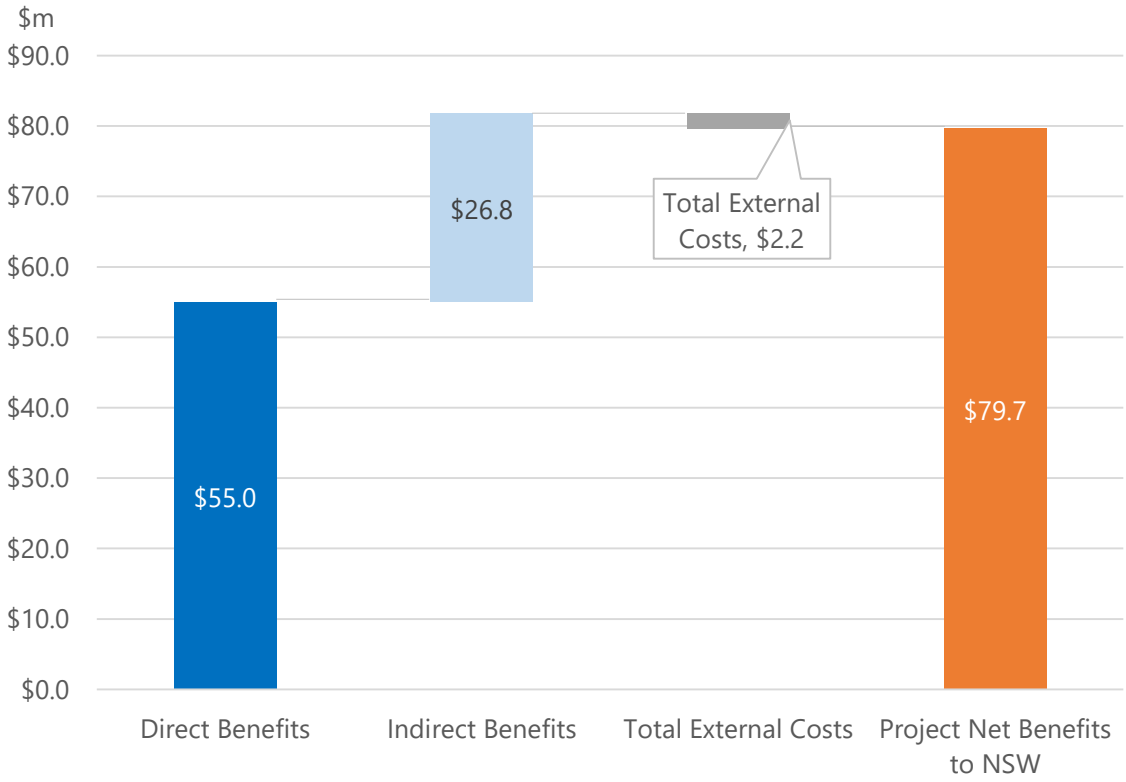
The Project is unlikely to have any impact on agricultural or forestry activities on adjoining land. As discussed above, the Forestry Corporation will be compensated for any losses associated with the use of the Southern Extension Area through Forestry Permit fees.

Invincible has coexisted with existing and previous land uses and the Project is considered compatible with existing surrounding land uses. The Project's impacts on the recreational value of surrounding areas is considered to be similar to that of the existing approved development and the overall timeframe for rehabilitation of impacts from mining associated with the Project will be similar to that for the existing disturbance areas. Alternate areas are available for recreation purposes and the overall economic impact of the Project on recreational uses of Ben Bullen State Forest is considered to be negligible.

Cost-Benefit Analysis results

Consistent with the Guidelines, the CBA for the Project is based on comparing the net direct and indirect benefits and subtracting the indirect costs of the Project identified above against the baseline scenario. Summarised in Figure 3, the estimated net benefit to NSW is $79.7 million in NPV terms.

Figure 3: Summary of the net benefits of the Project* under central case assumptions ($ million)**



Source: Cadence Economics estimated based on information from various sources. * Estimated as the benefits of the Project less the baseline scenario. ** NPV in 2016 dollars based on a 7 percent real discount rate.

Table 22 details the economic benefits of the Project Case against that of the Baseline scenario. Direct benefits of the Project are estimated to be $55.0 million in NPV terms. The Project is also expected to generate total indirect benefits of $26.8 million in NPV terms, comprised of $6.1 million of worker benefits and $20.8 million of supplier benefits in NPV terms.

The Project is expected to generate modest indirect costs on the NSW community of $5.3 million, including $1.9 million of Greenhouse gas emissions and $0.2 million of transport/ traffic costs from road closures. The costs of biodiversity and noise have been internalised and are subtracted from the estimated net direct benefits in Table 22.

Table 22: Estimated net benefits of the Project ($ million)

Benefits	NPV	Costs	NPV
Direct benefits		**Direct costs**	
1. Net producer surplus attributed to NSW	37.6		
2. Royalties, payroll tax and Council rates	11.8		
3. Company income tax apportioned to NSW	5.7		
Total direct benefits	55.0	Total direct costs	-
Indirect benefits		**Indirect costs**	
1. Net economic benefit to existing landholders	0.0	1. Air quality	0.0
2. Net economic benefit to NSW workers	6.1	2. Greenhouse gas emissions	-1.9
3. Net economic benefit to NSW suppliers	20.8	3. Visual amenity	
		4. Transport impact	-0.2
		5. Net public infrastructure cost	
		6. Surface water impact	
		8. Residual value of land	-0.1
		7. Biodiversity impact^	-3.1
		8. Noise impact^	-0.018
		9. Loss of surplus to other industries	
		10. Water	
		11. Aboriginal cultural heritage	
		12 Historical heritage	
Total indirect benefits	26.8	Total indirect costs	-5.3
Total economic benefit of	81.8	Total external costs	-2.2
NPV of project - ($'M)	**79.7**		
BCR (benefit cost ratio)	**38.0**		

Source: Cadence Economics estimated based on information from various sources. * Estimated as the benefits of the Project less the baseline scenario. ** NPV in 2016 dollars based on a 7 percent real discount rate. Note: ^ Biodiversity impacts and noise impacts have been internalised. These are included in the operational costs for the mine and netted off the estimated direct benefits.

CBA – Sensitivity analysis

As outlined above the analysis relies on a number of modelling assumptions. Consistent with the Guidelines, Table 23 provides a summary of the systematic sensitivity analysis undertaken for the Project. The sensitivity analysis considers both changes in real discount rates (from a low of 4 percent and a high of 10 percent) as well as revenue and cost assumptions. Under the low case sensitivity, revenue (i.e. the coal price) is reduced by 25 percent and costs (operational, labour and environmental) increased by 25

percent. Under the high case scenario, revenue is increased by 25 percent and costs reduced by 25 percent.

The capital cost requirement, of $5.5 million in NPV terms has not been changed for the purposes of the sensitivity analysis, as the bulk of these costs have already been incurred and are therefore relatively certain.

As the Project is relatively short-lived, the sensitivity of the central case results to changes in the discount rate is not significant.

When revenue and cost assumptions are altered, the estimated net benefit of the Project ranges from $44.4 million in NPV terms (using a 10 percent real discount rate) to $118.4 million in NPV terms (using a 4 percent real discount rate). The sensitivity analysis shows the robustness of the net benefits generated to the NSW community.

We can also infer from the sensitivity analysis how large the non-quantified negative externalities would need to be before the project is no longer a net benefit to the NSW community. Using the most conservative estimate, the Low Case with a 10 percent real discount rate, these externalities would need to be $44.4 million in NPV terms before the Project would return a net negative return to NSW.

Table 23: Net benefits of the Project – sensitivity analysis ($ million, 2016 dollars)

Scenario	Net benefit of the Project – NPV ($M)		
Discount rate	*7%*	*4%*	*10%*
Central Case	79.7	85.6	74.4
Direct Benefits	55.0	59.2	51.2
Indirect Benefits	26.8	28.6	25.2
Indirect (Environmental costs)	-2.2	-2.2	-2.1
Low Case – higher costs and lower revenue	47.9	51.7	44.4
Direct Benefits	13.6	15.1	12.3
Indirect Benefits	35.0	37.3	32.9
Indirect (Environmental costs)	-0.8	-0.8	-0.7
High Case – lower costs and higher revenue	110.6	118.4	103.6
Direct Benefits	93.6	100.2	87.7
Indirect Benefits	19.7	21.0	18.5
Indirect (Environmental costs)	-2.7	-2.8	-2.6

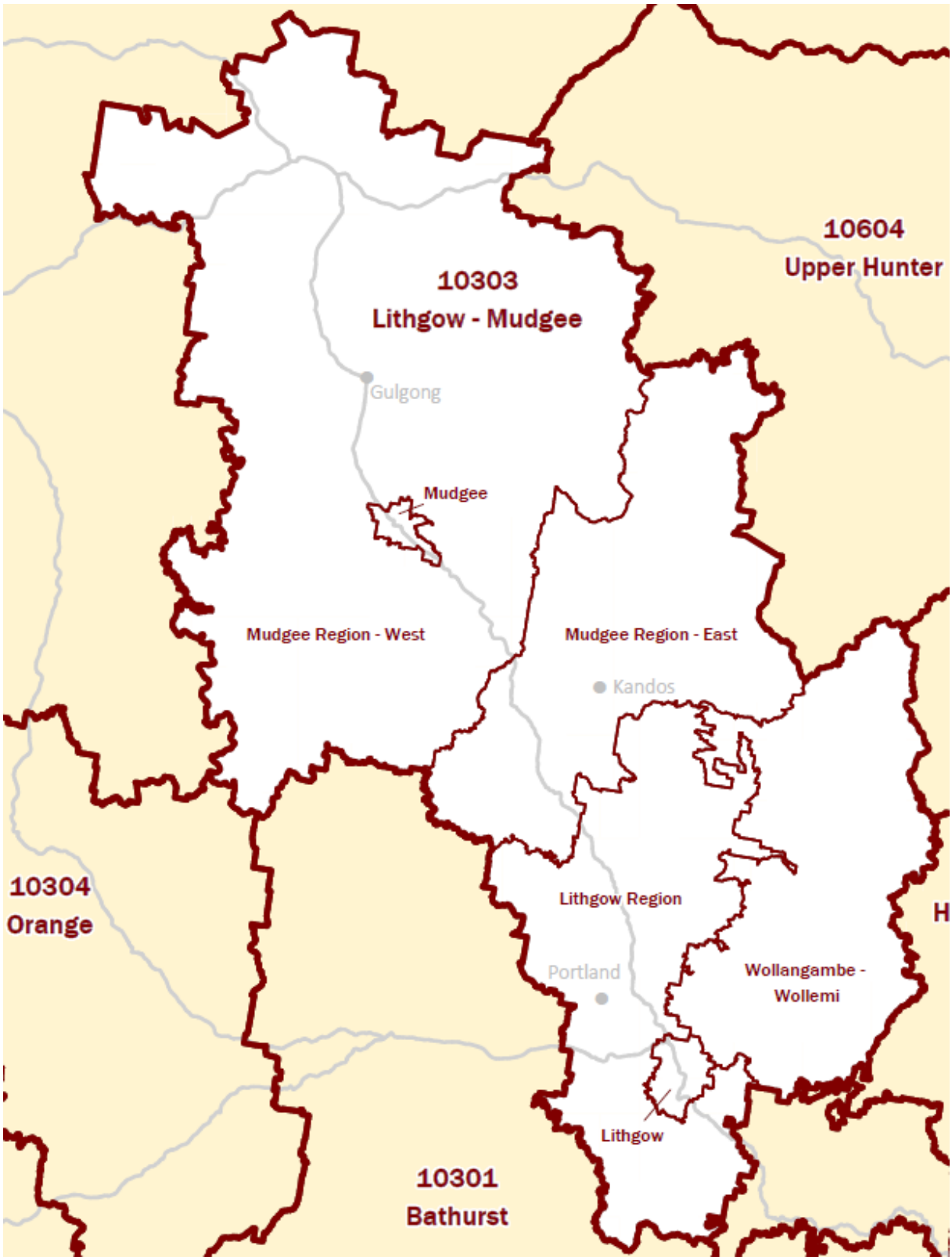
Source: Cadence Economics estimated based on information from various sources. * Estimated as the benefits of the Project less the baseline scenario.

3. Local Effects Analysis

Consistent with the Guidelines, the local effects analysis (LEA) uses a similar framework to the CBA presented in the previous section, but is focussed on the net economic impacts to the local community. The Guidelines refer to the local area as being consistent with the relevant Statistical Area (SA3) as defined by the Australia Bureau of Statistics. In the case of this Project the Lithgow-Mudgee SA3 area is used for the LEA.

As shown in Figure 4, the region is located to the South West of the Upper Hunter local region and includes the regional centres of Lithgow and Mudgee. The Mt Piper Power Station, the destination of the thermal coal output, is located 2 km to the south of the Invincible mine. The Invincible Colliery is located approximately 3 km south east from the small community of Cullen Bullen and approximately 10 km north east of Portland (indicated on the map).

Figure 4: Lithgow Mudgee SA3 local area



Source: Australian Bureau of Statistics cat. no. 1270.0.55.001, *Australian Statistical Geography Standard Volume 1 – New South Wales Maps (July 2011)*

Underpinning the LEA are the assumptions that:

- No net producer surplus accrues to the region (and that costs biodiversity and noise, being internalised, are met by those outside the region).
- All council rates accrue to the region.
- No company income tax accrues to the region.
- As outlined in the SIOA, Castlereagh Coal will endeavour to employ as many people as possible from the local area and source services locally where practicable and cost effective. It is expected that 80 percent of the workforce requirement of the mine and 20 percent of intermediate inputs will be supplied from the local region.
    - As a result of these assumptions, it is expected the Project will generate indirect benefits to local suppliers and employees of $9.0 million in NPV terms over the Baseline case, as outlined in Table 24.
- Transport, costs associated with the residual value of land and noise are borne by the region.
- No greenhouse gas emissions costs are attributable to the region.

Based on these assumptions, the Project is estimated to confer a net benefit on the region of $8.77 million in NPV terms.

Table 24: Estimated Local Effects Analysis of the Project

Benefits	Total NPV** ($M)	Costs	Total NPV ($M)
Direct benefits		**Direct costs**	
1. Net producer surplus attributed to NSW	0.0		
2. Royalties, payroll tax and Council rates	0.0		
3. Company income tax apportioned to NSW	0.0		
Total direct benefits	**0.0**	Total direct costs	**-**
Indirect benefits		**Indirect costs**	
1. Net economic benefit to existing landholders	0.0	1. Air quality	
2. Net economic benefit to local workers	4.85	2. Greenhouse gas emissions	
3. Net economic benefit to local suppliers	4.15	3. Visual amenity	
		4. Transport impact	-0.16
		5. Net public infrastructure cost	
		6. Surface water impact	
		8. Residual value of land	-0.07
		7. Biodiversity impact*	
		8. Noise impact*	-0.019
		9. Loss of surplus to other industries	
		10. Water	
		11. Aboriginal cultural heritage	
		12 Historical heritage	
Total indirect benefits	9.0	Total indirect costs	-0.25
Total economic benefit of	9.0	Total economic cost of project	-0.23
NPV of project - ($'M)	**8.77**		
BCR (benefit cost ratio)	**38.71**		

Note: * Biodiversity impacts and Noise impacts have been assessed at the expense to mitigate these impacts. These are costs are included in the operational costs for the mine and netted off the direct benefits. **NPV in 2016 dollars based on a 7 percent real discount rate.

LEA – Sensitivity analysis

As outlined above the LEA relies on a number of modelling assumptions. Consistent with the Guidelines, Table 25 provides a summary of the systematic sensitivity analysis undertaken for the Project. The sensitivity analysis considers both changes in real discount rates (from a low of 4 percent and a high of 10 percent) as well as revenue and cost assumptions. Under the low case sensitivity, revenue (i.e. the coal price) is reduced by 25 percent and costs (operational, labour and environmental) increased by 25 percent. Under the high case scenario, revenue is increased by 25 percent and costs reduced by 25 percent.

As the Project is relatively short-lived, the sensitivity of the LEA under the central case assumptions to changes in the discount rate is not significant.

When revenue and cost assumptions are altered, the estimated net benefit of the Project ranges from $5.69 million (high case scenario, in NPV terms using a 10 percent real discount rate) to $12.56 million (low case scenario, in NPV terms using a 4 percent real discount rate). The sensitivity analysis shows the robustness of the net benefits generated to the local community.

We can also infer from the sensitivity analysis how large the non-quantified negative externalities would need to be before the project is no longer a net benefit to the local community. Using the most conservative estimate, the high case with a 10% discount rate, these externalities would need to impose an unquantifiable cost to the Lithgow-Mudgee community of $5.69 million before the Project would return a net negative return to local region (noting that the high case scenario results in lower benefits to employees and suppliers).

Table 25: Net Benefits of the Project Case – Sensitivity analysis

Scenario	Net benefit of the Project – NPV ($M)		
Discount rate	*7%*	*4%*	*10%*
Central Case	8.77	9.50	8.17
Low Case – higher costs and lower revenue	11.72	12.56	10.98
High Case – lower costs and higher revenue	6.11	6.61	5.69

Source: Cadence Economics estimated based on information from various sources. * Estimated as the benefits of the Project less the baseline scenario.

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