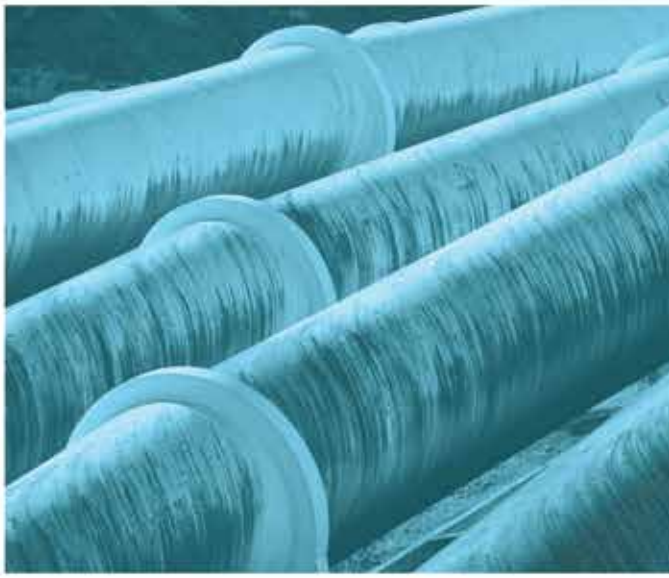



Wongawilli Colliery Modification Report

PA 09_0161 MOD 2 - North West Mains Development
Volume 5 - Appendices G to H

Prepared for Wollongong Coal Limited
December 2020

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Appendix G

Traffic impact assessment

FINAL REPORT

TRAFFIC IMPACT ASSESSMENT

FOR

MODIFICATION 2

WONGAWILLI COLLIERY

Ref. 20011r

10 November, 2020

Prepared By

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EXECUTIVE SUMMARY

This report documents the assessment of traffic and road transport impacts of Modification 2 for Wongawilli Colliery.

Wongawilli Colliery (the Colliery) is an underground coal mine located approximately 15 kilometres (km) south-west of Wollongong within the Wollongong and Wingecarribee local government areas (LGAs). The site is owned and operated by Wollongong Coal Pty Limited (Wollongong Coal). Wollongong Coal is majority owned by Jindal Steel and Power Limited (JSPL).

This environmental assessment (EA) has been prepared to accompany a modification application (MOD2) to the existing Project Approval (PA) for the underground coal mine (PA 09_0161) originally approved in November 2011 and subsequently modified in December 2015 (MOD1).

MOD2 is sought under section 4.55(2) of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act).

MOD2 seeks to extend the life of the Colliery by 5 years to enable Wollongong Coal to continue development of the approved North West Mains Development (NWMD). Furthermore, the modification largely seeks approval to extend the length of the approved NWMD alignment to access the existing Wongawilli Ventilation Shaft 1 and minor surface activities.

With the recommencement of mining operation, workers will travel to and from the Colliery on a daily basis, plus maintenance contractors/vehicles and delivery vehicles. Mining operations will be undertaken 7 days a week.

The Colliery is located off Jersey Farm Road via Wongawilli Road and West Dapto Road from the Princes Highway.

The traffic impacts of MOD2 will be lower than the current approval for the mine, due to the reduction of the workforce from 300 full time equivalent personnel (as approved) to 150 full time equivalent personnel.

The highest traffic generation of the mine will occur on weekdays with up to 122 two way light vehicle trips per day (61 inbound trips / 61 outbound trips) associated with the workers and visitors and 20 two way heavy vehicle trips per day (10 inbound trips / 10 outbound trips) associated with deliveries and maintenance vehicles.

The largest traffic impacts will occur at shift change over times which will occur between 6.30am – 7.30am and 2.30pm to 3.30pm.

The assessment of the traffic impacts has found that the impacts of the additional traffic associated with Modification 2 will be minor and traffic conditions on the adjacent road network to the mine will remain satisfactory.

MOD2 is not expected to have any negative impacts on other road users and or on road safety on the road network.

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EXECUTIVE SUMMARY

FIGURES

APPENDICES

GLOSSARY

ADT	-	Average Daily Volume (7 day average)
AWT	-	Average Weekday Volume (5 day average)
AUL	-	Auxiliary left turn lane treatment
AUR	-	Auxiliary right turn lane treatment
AVD	-	Average vehicle delay per vehicle in seconds
BAL	-	Basic left turn treatment
BAR	-	Basic right turn treatment
CHR	-	Channelised right treatment/lane
DPIE	-	Department of Planning, Infrastructure and Environment
DS	-	Degree of Saturation, a measure of intersection performance based on the ratio of demand flow to capacity
HMD	-	Highest Movement Delay in seconds
Light Vehicles	-	Austroads 1 and 2 vehicle classifications and motorbikes
LS	-	Level of Service, a measure of intersection performance based on vehicle delay. There are six levels of service from A to F, where Level of Service A represents very good conditions and spare capacity and Level of Service F represents oversaturated conditions.
Heavy Vehicles	-	Austroads 3-12 vehicle classifications
SEARs	-	Secretary's Environmental Assessment Requirements
SIDRA	-	SIDRA Intersection Traffic Model
SSD	-	State Significant Development
TfNSW	-	Transport for NSW (previously RMS and RTA)
vpd	-	Vehicles per day
vph	-	Vehicles per hour
95^{th}% queue	-	95^{th} percentile queue length in metres

1.0 INTRODUCTION

1.1 Background

The Colliery is an underground coal mine located approximately 15km south west of Wollongong. The Colliery is operated by Wongawilli Coal Pty Ltd, which is an entity of Wollongong Coal.

The Colliery operates under Project Approval 09-0161 which was extended by Modification 1 which permits mining until 31 December 2020. The Colliery is currently under care and maintenance.

Wollongong Coal propose to recommence mining under and as such are seeking to modify Condition 5 of the Project Approval 09-0161 to extend the time limitation for mining operations until 31 December 2025. MOD 2 would enable North West Main Development to be completed and allow for minor surface improvements.

All coal from the Colliery will be transport by rail. With the recommencement of mining operation, workers will travel to and from the Colliery on a daily basis, plus maintenance contractors/vehicles and delivery vehicles. Mining operations will be undertaken 7 days a week.

The Colliery is located off Jersey Farm Road via Wongawilli Road and West Dapto Road from the Princes Highway. **Figure 1** shows the location.

This report documents the traffic and road transport impacts of the proposed modification.

1.2 Authority Requirements

No SEARS were issued for the proposed modification by Department of Planning Industry and Environment and there are no specific authority requirements for road transport and traffic.

1.3 Structure of this Report

This report has been prepared to assess the road transport and traffic impacts associated with the proposed modifications to the Project Approval for the Colliery and will inform the preparation of the Environmental Assessment (EA).

The assessment has been undertaken in accordance with the requirements of Roads and Traffic Authority's, now Transport for NSW (TfNSW) *Guide to Traffic Generating Developments October 2002*.

Other technical standards/publications referenced in this assessment include;

- Austroads Guide to Road Design and RMS supplements.
- Austroads Guide to Traffic Management and RMS supplements.
- Austroads Guide to Traffic Management Part 12. Traffic Impacts of Developments.

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FIGURE 1

MODIFICATION 2

WONGAWILLI COLLIERY

LOCATION

JOB NO.20011

6.11.20

The remaining sections of this report address the following;

- Section 2 – describes the existing approval and the proposed Modification;
- Section 3 – examines the existing traffic conditions on the road network;
- Section 4 – evaluates the traffic impacts of the proposed Modification; and
- Section 5 – presents conclusions.

2.0 CURRENT APPROVAL AND PROPOSED MODIFICATION 2

Table 2.1 details the current approval for the Colliery as modified, together with the changes proposed as part of Modification 2.

The modification project is shown in **Figure 2**.

TABLE 2.1

DETAILS OF CURRENT APPROVAL FOR PROJECT AND PROPOSED MODIFICATION 2

Element	The Colliery (Currently approved Project)	MOD2
Operating hours	24 hours per day, seven days per week Unloading from coal handling / train loading infrastructure occurring during normal operational hours: • 7am to 6pm Monday to Friday • 8am to 4 pm Saturday • no time on Sundays and public holidays	Conveyance of coal from the Wongawilli upper pit top to the lower pit top to be restricted to normal operational hours.
Coal seams	Bulli and Wongawilli Coal Seams	No change
Extraction rate	2 million tonnes per annum	No change
Approval period ending	31 December 2020	31 December 2025
Mine life	9 years consisting of 4 years (original consent), plus 5 years (MOD1)	Coal extraction until 31 December 2025, representing an extension of the approved mine life by 5 years
Mining method	Longwall and first workings mining methods	First working mining methods only.
Underground workings	Four 5.5 m wide by 3.6 m high roadways Access from existing portals	Minor alignment changes to the western end of the approved NWMD, Additional first workings proposed to enable access to the existing Wongawilli Shaft 1.

Element	The Colliery (Currently approved Project)	MOD2
Mine infrastructure, coal stockpiles and product transport	Wongawilli lower and upper pit top facilities and coal handling / load out infrastructure to rail	No change to rail transport requirements. No change to Wongawilli pit top administration and workshop facilities. Additional access to the NWMD via existing Portals W9 and W10. Relocation of crusher, sizer, and screen to underground. Improvements to the coal conveyance network including the construction of a new section of coal conveyor, approximately 60 m in length and coal storage bin. Extension of the Wongawilli lower pit top noise wall.
Rail transport requirements	No transport of coal by road. Train movements restrictions: • 8 train movements (calendar year average) a day • 10 train movements (max. weekly rolling average) a day • 3 train movements a night during normal operations • 4 train movements a night during advertised campaigns, with a maximum of 10 such campaigns per year	Maximum of 4 train movements a day. No train movements at night.
Waste management	Waste rock to be stored underground in two of the four Western Driveage roadways. Waste rock which does come to the surface to be utilised for ballast or fill underground or used on the surface for landscaping and rehabilitation	Waste rock to be stored underground within existing and NWMD workings. Maintain approval for waste rock to be utilised on the surface for landscaping and rehabilitation purposes
Mine ventilation	Mine portals and vent shafts including: • two portals for personnel and materials • one portal for coal extraction • two portals into the NWMD • Wongawilli Shaft 1, Nebo Shaft 3 and 4 Existing Nebo area portals (Wonga Belts and Wonga Track) and ventilation shafts (Vent Shaft 3 and 4) are proposed to be closed off and rehabilitated so will no longer be in use	Revised NWMD will reduce future ventilation shaft requirements via relying on the existing Wongawilli 1 ventilation shaft. Four portals into the NWMD.
Workforce	Approved for up to 300 FTEs and contract personnel	Employment of up to 150 FTEs

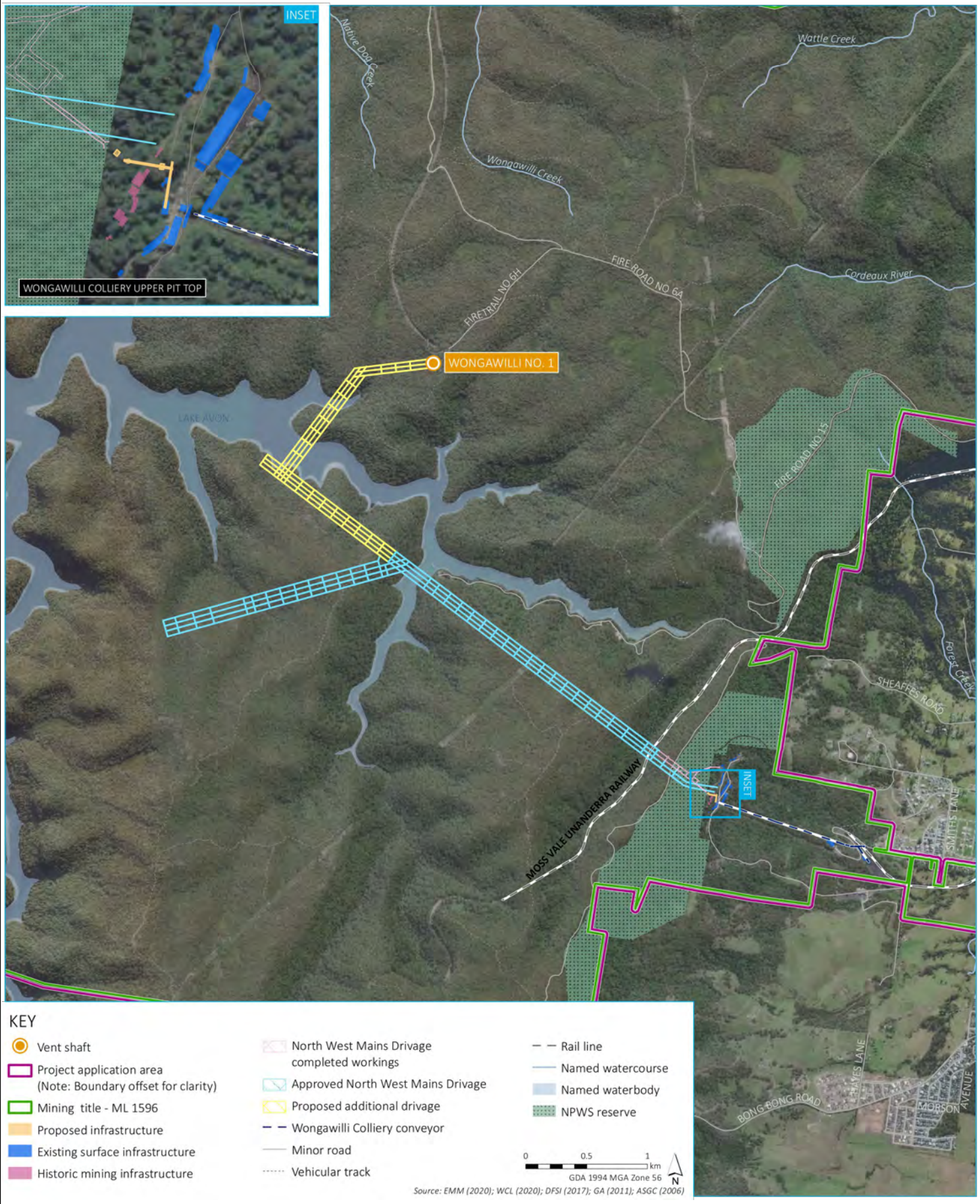

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FIGURE 2

MODIFICATION 2

WONGAWILLI COLLIERY

MODIFICATION 2 PROJECT

JOB NO.20011

6.11.20

All the coal produced by the colliery will be transported by rail.

For the road transport and traffic impacts associated with the proposed Modification 2, these impacts will be workers trips to and from the Colliery, as well as deliveries and maintenance trips.

The proposed shift times and number of workers at the Colliery are detailed in Table 2.2 below.

TABLE 2.2

DETAILS OF SHIFT TIMES AND NUMBER OF WORKERS

Shift	Number of Workers and Staff
Monday to Friday	
Day Shift (7.00am to 3.00pm)	26
Afternoon Shift (3.00pm to 11.00pm)	15
Night Shift (11.00pm to 7.00am)	15
Saturday and Sundays	
Day Time Shift Only (7.00am to 3.00pm)	6

Deliveries and maintenance vehicle trips are expected to number 60 per week (i.e. 60 in/60 out) with a maximum of up to 10 deliveries/maintenance vehicle trips on a weekday (i.e. 10 in/10 out).

Delivery and maintenance vehicles will typically be small to large rigid trucks and some 19 metre long articulated trucks.

3.0 EXISTING AND FUTURE CONDITIONS

3.1 Principle Road Network and Traffic Controls

The principle road network that services Wongawilli Colliery include;

- Jersey Farm Road;
- Wongawilli Road/West Dapto Road;
- Shone Avenue; and
- Darkes Road.

Jersey Farm Road and the Colliery Access Road provides the direct access to the Colliery. Jersey Farm Road is a two lane sealed road and in the section between Wongawilli Road and the Colliery Access Road is generally 6.5 to 7.0 metres wide with no kerb and gutter and grass shoulders.

The railway line into Wongawilli Colliery crosses Jersey Farm Road at the Colliery Access Road. Railway level crossing lights are provided at the level crossing in Jersey Farm Road and in the Colliery Access Road.

Wongawilli Road/West Dapto Road is a two lane sealed road that connects between the village of Wongawilli and the Princes Highway at West Dapto.

The section between Jersey Farm Road and Shone Avenue is generally 6.2 metres wide with no centreline or edgeline marking.

The section between Shone Avenue and Darkes Road is a two lane sealed road, 6.2 to 7.0 metres wide with centreline and edgeline marking.

The section between Darkes Road and Princes Highway is a two lane sealed road with centreline and edgeline markings. The sealed road width is generally between 6.2 and 7.0 metres, with widening to provide additional lanes at several intersections. A railway level crossing is provided in West Dapto Road approximately 150 metres west of the Princes Highway intersection. Facilities at the level crossing include flashing lights, boom gates, signage and road marking.

Another level crossing is provided in West Dapto Road approximately 500 metres west of Redalls Road. Facilities at the level crossing include flashing lights, signage and road markings.

The section of West Dapto Road between the Princes Highway and Reddalls Road is an approved 25m / 26m B-double route.

New residential subdivisions are being constructed with access to Wongawilli Road and West Dapto Road between Jersey Farm Road and Darkes Road. The existing development in the eastern section of West Dapto Road is predominantly industrial.

The speed limit in Wongawilli Road and West Dapto Road is a mixture of 60km/h and 80km/h.

Shone Avenue links the residential suburb of Horsley to Wongawilli Road/West Dapto Road. Shone Avenue is a two lane road with centreline marking and edgelines. The railway line to Wongawilli Colliery crosses Shone Avenue, some 30 metres from

Wongawilli Road/West Dapto Road. Flashing lights, road marking and signage are provided at the level crossing. The speed limit in Shone Avenue is 60km/h.

Darkes Road links between West Dapto Road and the Princes Highway at Dapto. Darkes Road is a two lane sealed rural road that passes through a semi rural environment. It has a railway level crossing approximately 100 metres north west of the Princes Highway which is controlled by flashing lights, boom gates, signage and road marking. The speed limit in Darkes Road is 80km/h.

Principle intersections along Wongawilli Road/West Dapto Road include;

- Jersey Farm Road - A cross junction intersection with stop sign control in Murray Farm Road;
- Shone Avenue - A T junction intersection with Give Way control in Shone Avenue;
- Smiths Lane - A T junction intersection with Stop Sign Control in Smiths Lane;
- Rainbird Drive - A T junction intersection with an AUL lane for the left turn into Rainbird Drive from West Dapto Road and Give Way control in Rainbird Drive;
- Darkes Road - A T junction intersection with Give Way control on Darkes Road;
- Sheaffes Road - A T junction intersection with Stop Sign control in Sheaffes Road;
- Redalls Road - A T junction intersection with an AUR lane treatment for the right turn into Redalls Road from West Dapto Road and Stop Sign control on Redalls Road;
- Wyllie Road - A T junction intersection with Priority Control on Wyllie Road;
- Princes Highway - West Dapto Road forms a cross junction intersection with Princes Highway under traffic signal control.

Sight distance at the above sign controlled intersections has been examined and is considered to meet Austroads sight distance requirements for the posted speed limit at the intersections.

Figure 3 shows the traffic controls on the principle road network adjacent Wongawilli Colliery.

3.2 Existing Traffic Conditions

3.2.1 Traffic Counts

Traffic counts were undertaken on the road network adjacent Wongawilli Colliery to establish current traffic conditions.

LEGEND

- TRAFFIC CONTROL SIGNALS
- ROUNDABOUT
- GIVE WAY / PRIORITY CONTROL
- (S) STOP SIGN
- RAIL LEVEL CROSSING

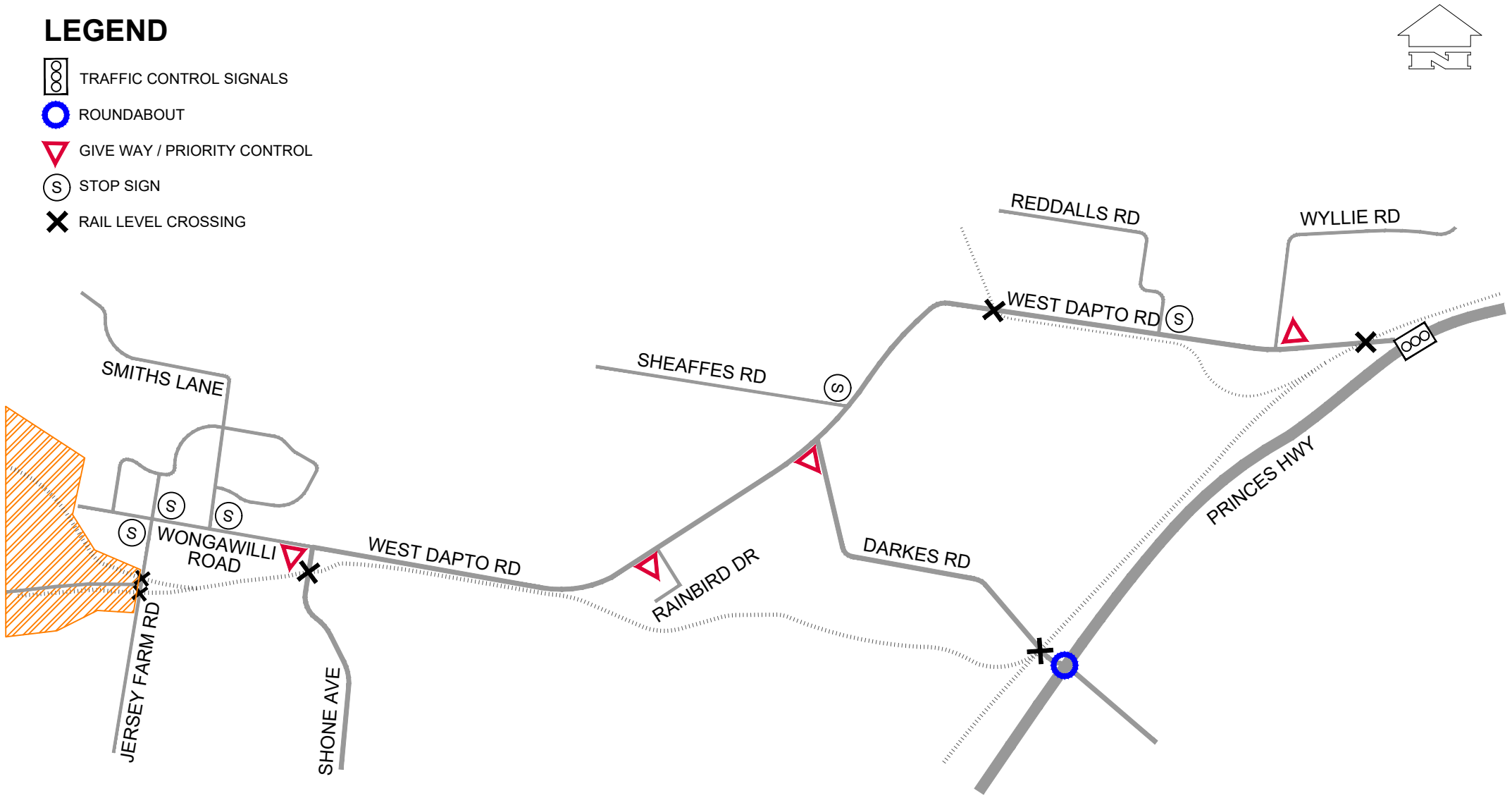

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FIGURE 3

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WONGAWILLI COLLIERY

TRAFFIC CONTROLS

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This included volume and vehicle classification counts on Jersey Farm Road, Wongawilli Road/West Dapto Road, Shone Avenue and Darkes Road.

In addition, intersection volume and turning counts were undertaken during the AM and PM periods at the intersections of Wongawilli Road/Jersey Farm Road and Wongawilli Road/ West Dapto Road and Shone Avenue.

The volume and vehicle classification counts were undertaken for the week between 25 and 31 August 2020.

The intersection counts were undertaken on Thursday 27 August 2020 between 6.00am-8.00am and 2.00pm-4.00pm, which are the times that will coincide with the shift time changes at Wongawilli Colliery.

The count locations are shown in **Figure 4**.

3.2.2 Daily Traffic Volumes

Figure 5 shows a summary of the daily volume and vehicle classification counts.

Table 3.1 shows the daily volume and vehicle classifications of vehicles using Jersey Farm Road, south of Wongawilli Road.

Reference to Table 3.1 shows that on a typical weekday (5 day average) two way volumes number 70 vehicles per day (vpd). Heavy vehicles (Austroads Classes 3 to 12) represent around 15.1% of total vehicles.

The majority of the vehicles using Jersey Farm Road would be generated by Wongawilli Colliery.

TABLE 3.1

JERSEY FARM ROAD SOUTH OF WONGAWILLI ROAD
5 DAY AVERAGE AND 7 DAY AVERAGE TRAFFIC VOLUMES
AND VEHICLE CLASSIFICATION

Direction of Travel	5 Day Average (Weekday)	7 Day Average (ADT)
North	35	32
South	35	32
Total	70	64
Proportion of [1]Heavy Vehicles	15.1%	13.6%

Source: Traffic Counts 25-31 August 2020

[1]Heavy Vehicles – Austroads 3-12 vehicle classifications

Table 3.2 shows the daily volumes and vehicle classifications of vehicles using Wongawilli Road, west of Shone Avenue.

Reference to Table 3.2 shows that on a typical weekday two way volumes in this section of Wongawilli Road number 3259vpd. Heavy vehicles (Austroads Classes 3 to 12) represent around 14.1% of total vehicles.

LEGEND

DAILY VOLUME AND VEHICLE CLASSIFICATION COUNT

AM AND PM INTERSECTION COUNT

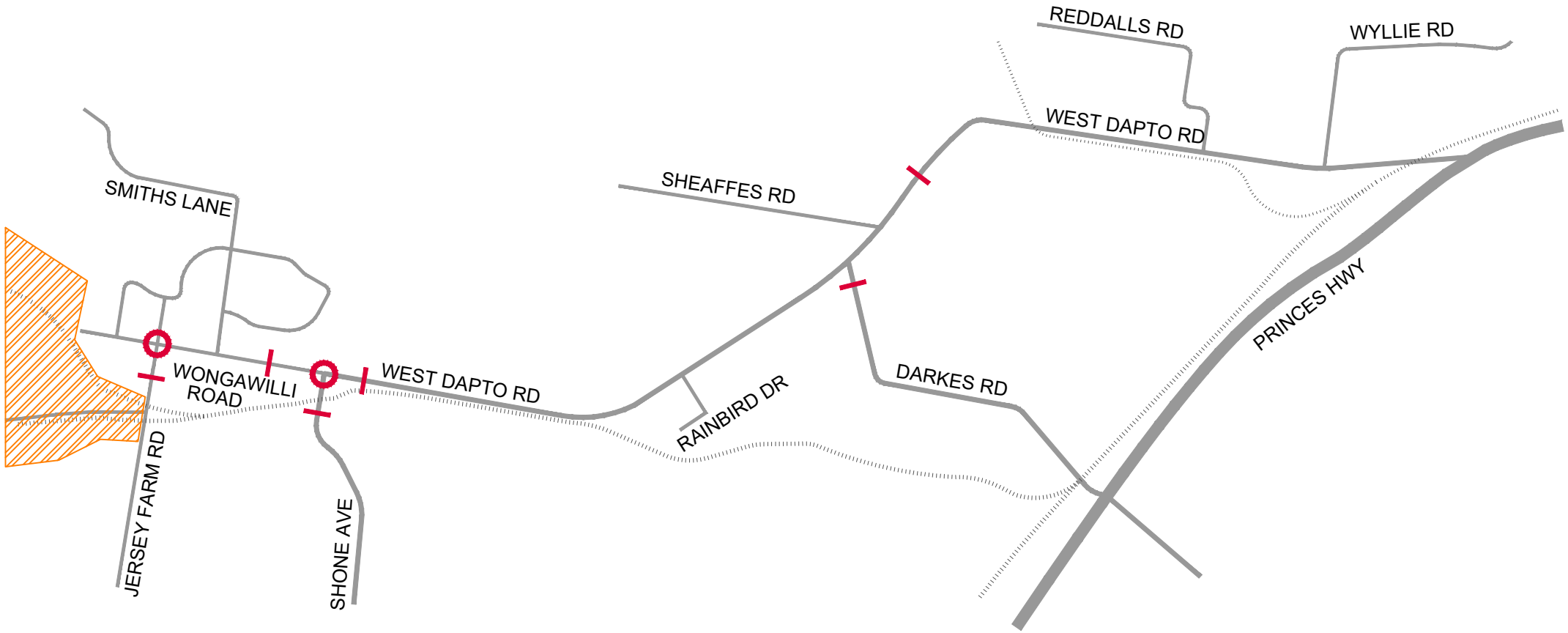

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FIGURE 4

MODIFICATION 2

WONGAWILLI COLLIERY

TRAFFIC COUNT LOCATIONS

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WHERE

AWT - AVERAGE WEEKLY VOLUME (5 DAY) TWO WAY

ADT - AVERAGE DAILY VOLUME (7 DAY) TWO WAY

1429 - DIRECTIONAL WEEKDAY VOLUME (5 DAY)

7.3% - PERCENTAGE OF HEAVY VEHICLES (AUSTROADS CLASS 3-12)

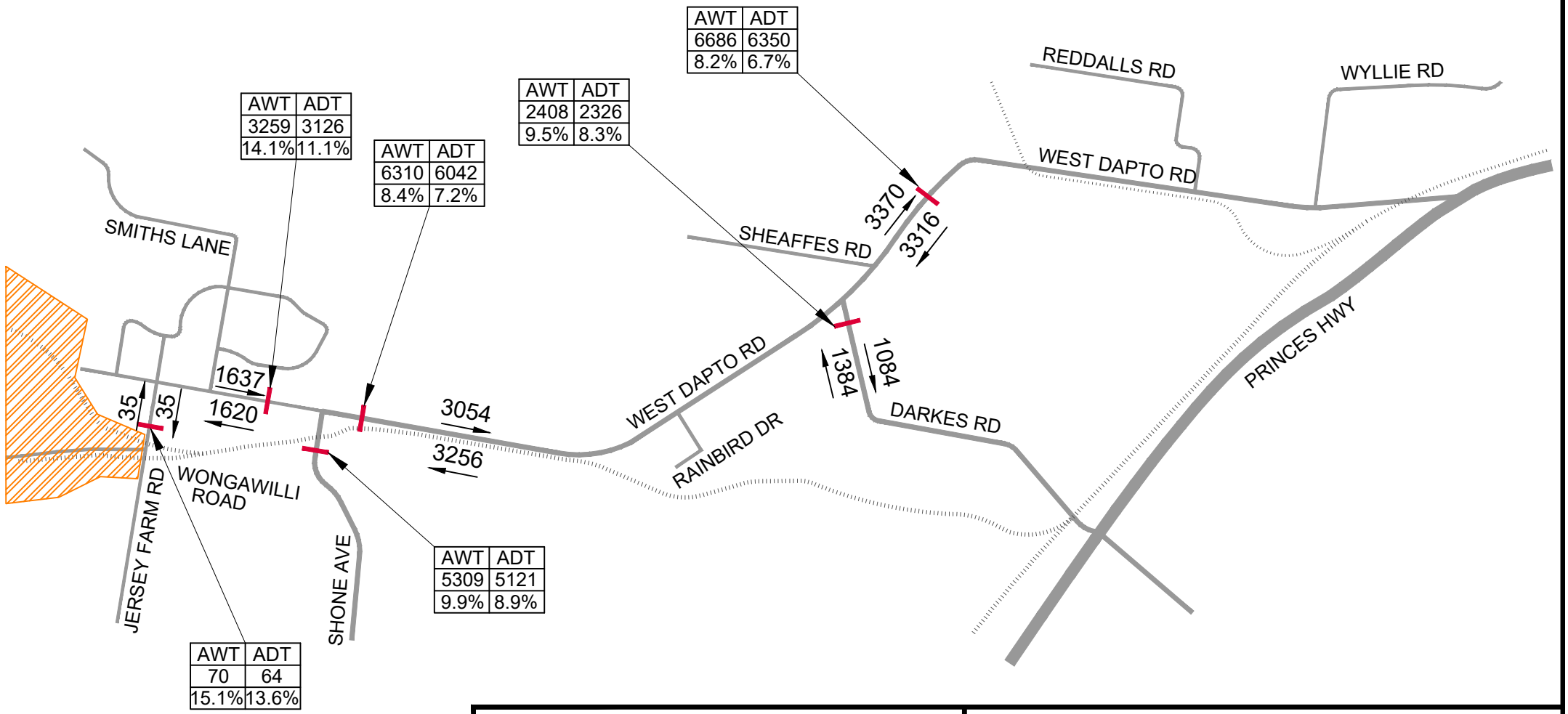

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FIGURE 5

MODIFICATION 2

WONGAWILLI COLLIERY

WEEKDAY AND DAILY TRAFFIC VOLUMES

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TABLE 3.2

WONGAWILLI ROAD WEST OF SHONE AVENUE
5 DAY AVERAGE AND 7 DAY AVERAGE TRAFFIC VOLUMES
AND VEHICLE CLASSIFICATION

Direction of Travel	5 Day Average (Weekday)	7 Day Average (ADT)
East	1637	1568
West	1620	1558
Total	3259	3126
Proportion of [1]Heavy Vehicles	14.1%	11.1%

Source: Traffic Counts 25-31 August 2020

[1]Heavy Vehicles – Austroads 3-12 vehicle classifications

Table 3.3 and 3.4 show the daily volumes and vehicle classifications of vehicles using West Dapto Road, east of Shone Avenue and north east of Sheaffes Road, respectively.

Reference to Tables 3.3 and 3.4 shows that typical weekday volumes number:

- 6,310vpd east of Shone Avenue; and
- 6,686vpd north east of Sheaffes Road.

Heavy vehicles (Austroads Classes 3 to 12) represent around 8.4% and 8.2% of total vehicles in this section of West Dapto Road.

The higher volumes using West Dapto Road, east of Shone Avenue reflect those vehicles generated by the Horsley residential subdivisions that use West Dapto Road to reach the Princes Highway.

TABLE 3.3

WEST DAPTO ROAD EAST OF SHONE AVENUE
5 DAY AVERAGE AND 7 DAY AVERAGE TRAFFIC VOLUMES
AND VEHICLE CLASSIFICATION

Direction of Travel	5 Day Average (Weekday)	7 Day Average (ADT)
East	3054	2937
West	3256	3105
Total	6310	6042
Proportion of [1]Heavy Vehicles	8.4%	7.2%

Source: Traffic Counts 25-31 August 2020

[1]Heavy Vehicles – Austroads 3-12 vehicle classifications

TABLE 3.4

WEST DAPTO ROAD NORTH EAST OF SHEAFFES ROAD
5 DAY AVERAGE AND 7 DAY AVERAGE TRAFFIC VOLUMES
AND VEHICLE CLASSIFICATION

Direction of Travel	5 Day Average (Weekday)	7 Day Average (ADT)
East	3370	3213
West	3316	3137
Total	6686	6350
Proportion of [1]Heavy Vehicles	8.2%	6.7%

Source: Traffic Counts 25-31 August 2020

[1]Heavy Vehicles – Austroads 3-12 vehicle classifications

Table 3.5 shows the daily volume and vehicle classifications of vehicles using Shone Avenue, south of West Dapto Road.

Reference to Table 3.5 shows that on a typical weekday, two way volumes in Shone Avenue number 5309vpd. Heavy vehicles (Austroads Classes 3 to 12) represent around 9.9% of total vehicles.

TABLE 3.5

SHONE AVENUE SOUTH OF WEST DAPTO ROAD
5 DAY AVERAGE AND 7 DAY AVERAGE TRAFFIC VOLUMES
AND VEHICLE CLASSIFICATION

Direction of Travel	5 Day Average (Weekday)	7 Day Average (ADT)
North	2558	2482
South	2751	2639
Total	5309	5121
Proportion of [1]Heavy Vehicles	9.9%	8.9%

Source: Traffic Counts 25-31 August 2020

[1]Heavy Vehicles – Austroads 3-12 vehicle classifications

Table 3.6 shows the daily volume and vehicle classification of vehicles using Darkes Road, south of West Dapto Road.

Reference to Table 3.6 shows that two way traffic volumes on a typical weekday number 2408vpd. Heavy vehicles (Austrodas Classes 3 to 12) represent around 9.5% of total vehicles.

TABLE 3.6

DARKES ROAD SOUTH OF WEST DAPTO ROAD
5 DAY AVERAGE AND 7 DAY AVERAGE TRAFFIC VOLUMES
AND VEHICLE CLASSIFICATION

Direction of Travel	5 Day Average (Weekday)	7 Day Average (ADT)
North	1324	1279
South	1084	1047
Total	2408	2326
Proportion of [1]Heavy Vehicles	9.5%	8.3%

Source: Traffic Counts 25-31 August 2020

[1]Heavy Vehicles – Austroads 3-12 vehicle classifications

3.2.3 Weekday AM and PM Peak Hour Traffic Volumes at Intersection

The one (1) hour periods between 6.30am – 7.30am (AM) and 2.30pm – 3.30pm (PM) will coincide with the shift time changes at Wongawilli Colliery.

Figures 6 and **7** show the intersection volumes for the 6.30-7.30am period and 2.30-3.30pm period respectively for the intersections of;

- Wongawilli Road/Jersey Farm Road; and
- Wongawilli Road/West Dapto Road/Shone Avenue.

Reference to **Figures 6** and **7** shows that;

- Traffic volumes using the Wongawilli Road/Jersey Farm Road are relatively low during the 6.30-7.30am period and the 2.30-3.30pm period; and
- Traffic volumes using the Wongawilli Road/West Dapto Road/Shone Avenue intersection are higher reflecting the traffic generated by residential development in the area that uses this intersection. The main traffic movements at this intersection are the left turn into Shone Avenue from West Dapto Road and the right turn out of Shone Avenue into West Dapto Road to travel east.

It should be noted that the actual AM and PM peak hours at both intersections does not occur at the same times, as the AM and PM hours that will coincide with the future shift time changes at Wongawilli Colliery. In this regard;

- The AM peak hour occurs between 7.00am-8.00am at the Wongawilli Road/West Dapto Road/Shone Avenue intersection; and
- The PM peak hour occurs between 3.00pm-4.00pm at both intersections.

A review of traffic conditions on the road network adjacent Wongawilli Colliery, including at the above intersections indicates that conditions are generally satisfactory.

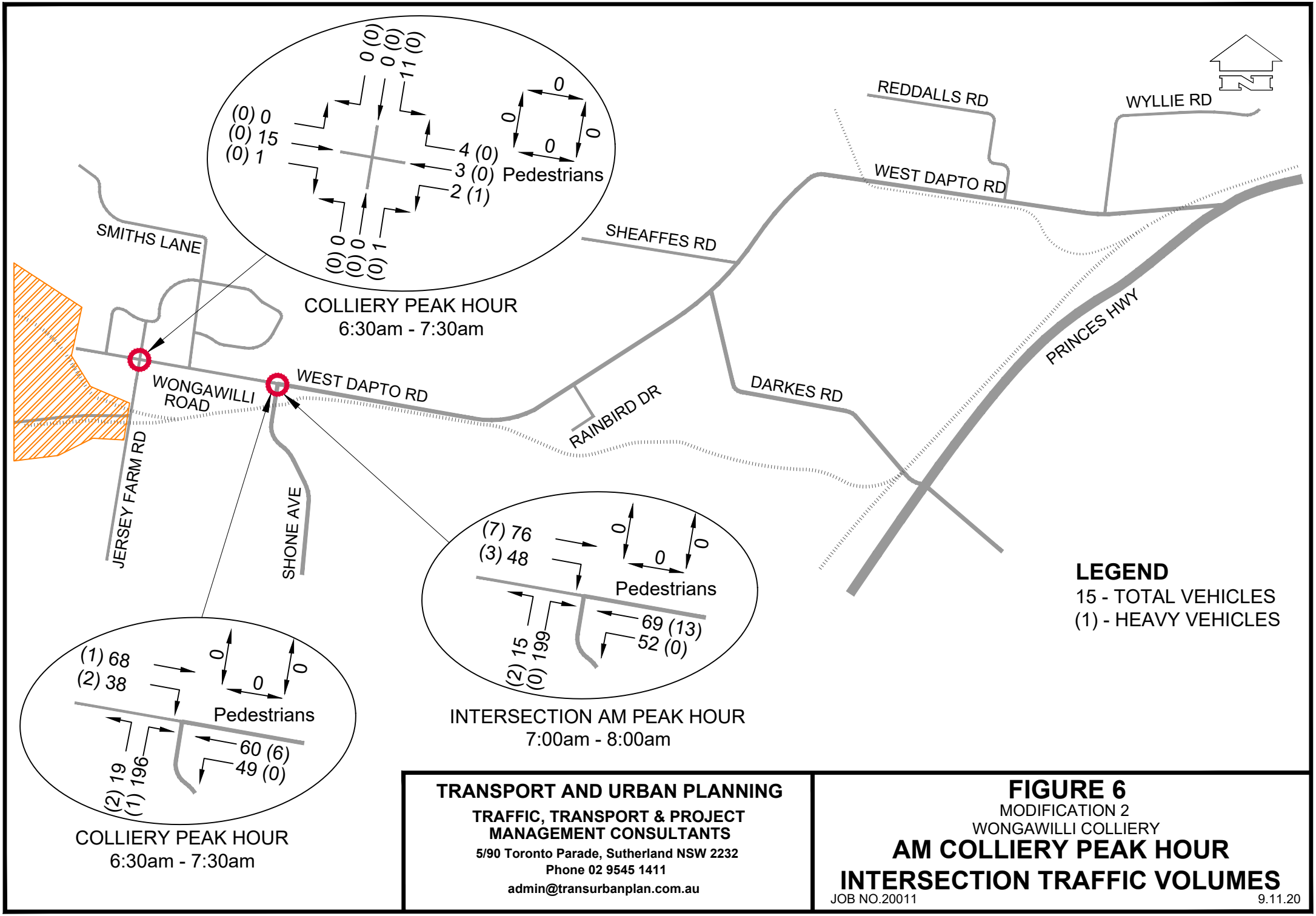

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FIGURE 6

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WONGAWILLI COLLIERY

AM COLLIERY PEAK HOUR INTERSECTION TRAFFIC VOLUMES

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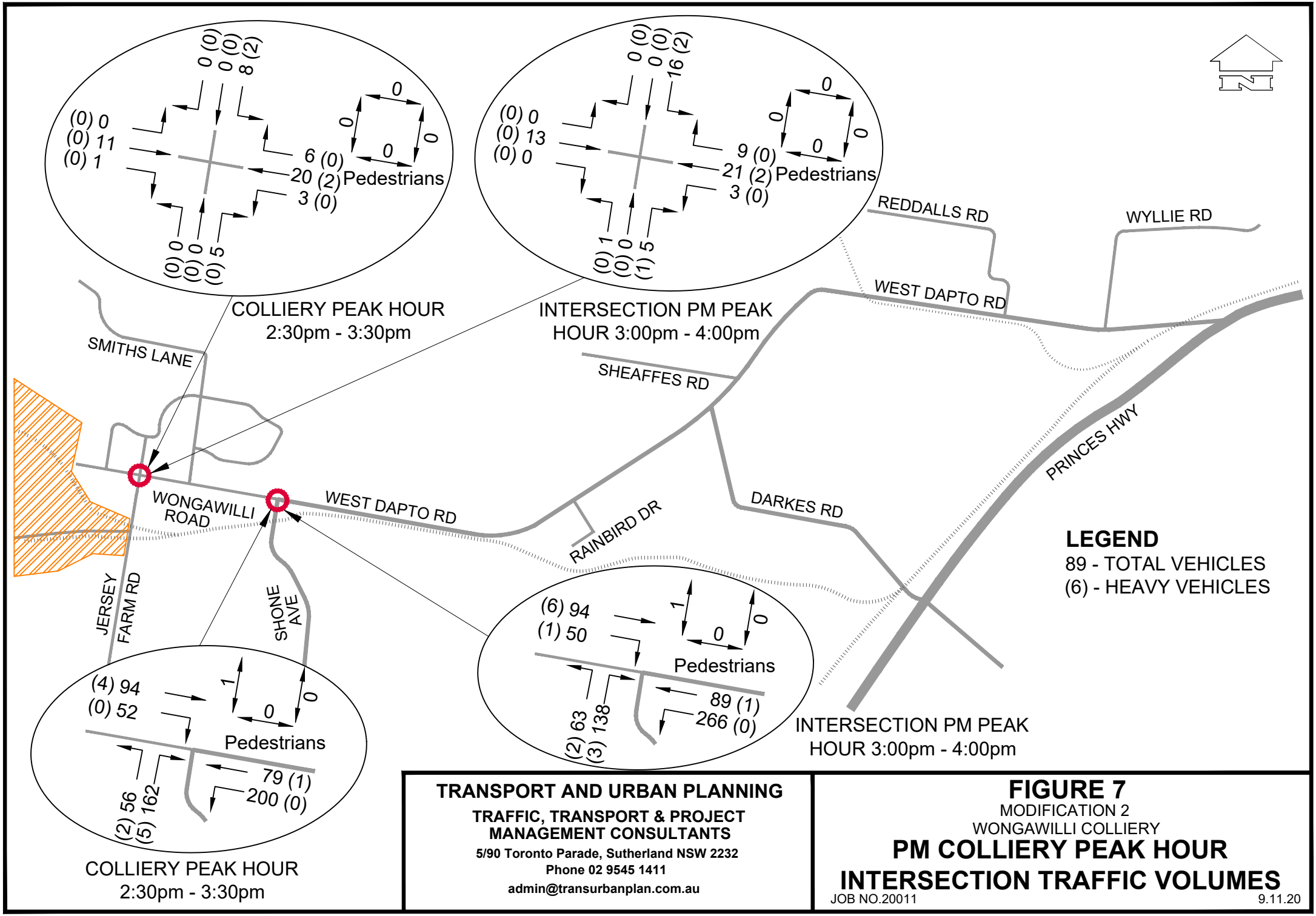

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FIGURE 7

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WONGAWILLI COLLIERY

PM COLLIERY PEAK HOUR INTERSECTION TRAFFIC VOLUMES

JOB NO.20011

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Both the Wongawilli Road/Jersey Farm Road/West Dapto Road/Shone Avenue intersection operate with relatively low vehicle delays consistent with Level of Service A operation.

3.3 Road Safety

Road crash statistics were provided by TfNSW for the Wongawilli Road/West Dapto Road route, including intersections between Wongawilli Village and the Princes Highway for the 3 year period between 1 October 2016 and 30 September 2019.

During this period there was a total of 7 crashes including 4 injury crashes on this route.

Six (6) of the crashes were mid block crashes (i.e. non intersection crashes) involving;

- 1 hit animal (non injury);
- 1 hit fixed object (non injury);
- 3 off road type crashes (3 injury crashes); and
- 1 head on crash (injury crash).

The intersection crash occurred at Wongawilli Road/West Dapto Road/Shone Avenue intersection and was a right angle non injury crash.

A review of the crashes has found that there is no identifiable pattern to the crashes that occurred over this 3 year period.

3.4 Bus Routes

Premier Illawarra operates bus route 32 between Dapto and Wongawilli which provides a weekday peak hour service to Wongawilli. This bus route uses Shone Avenue, Wongawilli Road and Smiths Lane and returns the same way.

Premier Illawarra also operate a number of school bus services which use West Dapto Road and Wongawilli Road, as well as Shone Avenue.

3.5 West Dapto Residential Development

West Dapto is being developed as a series of linked residential urban areas with new subdivisions being developed at Wongawilli, Horsley and Sheaffes.

Wollongong City Council has developed the West Dapto Access Strategy and is undertaking transport and road upgrade works in stages, in various parts of the West Dapto urban release area with a number of projects already completed including the Princes Highway / West Dapto Road intersection and upgrades to Shone Avenue.

As part of the current projects, Council is proposing to upgrade Wongawilli Road between the Community Hall at Wongawilli and Shone Avenue, to provide safer access for pedestrians, cyclists, residents and visitors.

Future works include the upgrading of West Dapto Road, between Shone Avenue and Princes Highway.

3.6 Bicycles

Wollongong City Council is developing cycle routes in the Horsley subdivision areas including on Shone Avenue, as well as in the other urban release areas of West Dapto.

Future cycleway links are proposed in City of Wollongong Bike Plan (2014 – 2018) in Wongawilli Road and West Dapto Road, as well as in Darkes Road and Sheaffes Road.

4.0 ASSESSMENT OF TRAFFIC IMPACT OF MODIFICATION 2

4.1 Traffic Generation

The traffic generation and traffic impacts of Modification 2 will be lower than the current approval for the Colliery, due to the reduction of the workforce from 300 full time equivalent personnel (as approved) to 150 full time equivalent personnel.

The maximum traffic generation of Modification 2 will occur on weekdays based on the following estimated number of vehicle trips;

- 112 two way light vehicle trips per day associated with the weekday workforce of 56 personnel, (56 inbound trips/56 outbound trips);
- 10 two way visitor trips in light vehicles per day based on 5 visitors per day (5 inbound trips/5 outbound trips);
- Up to 20 two way delivery/maintenance vehicle trips based on 10 delivery / maintenance vehicles per day (i.e. heavy vehicle trips) (10 inbound trips/10 outbound trips).

4.2 Assessment of Traffic Impacts

The largest traffic impacts of Modification 2 will occur at the workers shift change over times which will occur on weekdays between 6.30am-7.30am and 2.30pm-3.30pm. Table 2.2 provides the number of workers and staff for each shift.

Based on one (1) vehicle trip per worker, the estimated traffic generation during these hours will be;

- AM Colliery peak (6.30am-7.30am) a total of 43 trips with 27 inbound trips and 16 outbound trips, which include workers trips (26 inbound trips/26 outbound trips) plus one (1) delivery vehicle (one (1) inbound trip, one (1) outbound trip);
- PM Colliery peak (2.30pm-3.30pm), a total of 34 trips with 17 inbound trips and 17 outbound trips which include workers trips and one (1) visitor trip (16 inbound trips / 16 outbound trips) and one (1) delivery vehicle (one (1) inbound trip / one (1) outbound trip).

The majority of these trips are expected to arrive/depart via Wongawilli Road/West Dapto Road to and from the Princes Highway, with a small proportion of worker trips using Shone Avenue and Darkes Road.

Figures 8 and **9** show the traffic generated by the Wongawilli Colliery during the AM and PM Colliery peak hours assigned to the road network.

Reference to **Figures 8** and **9** shows that the additional volumes using Wongawilli Road/West Dapto Road would number between 34-43vph in the AM Colliery peak hour and 26-34vph in the PM Colliery peak hour.

The impact of this additional traffic on the road network would be relatively minor given that increase in both the AM and PM Colliery peak hours is less than one (1) vehicle a minute.

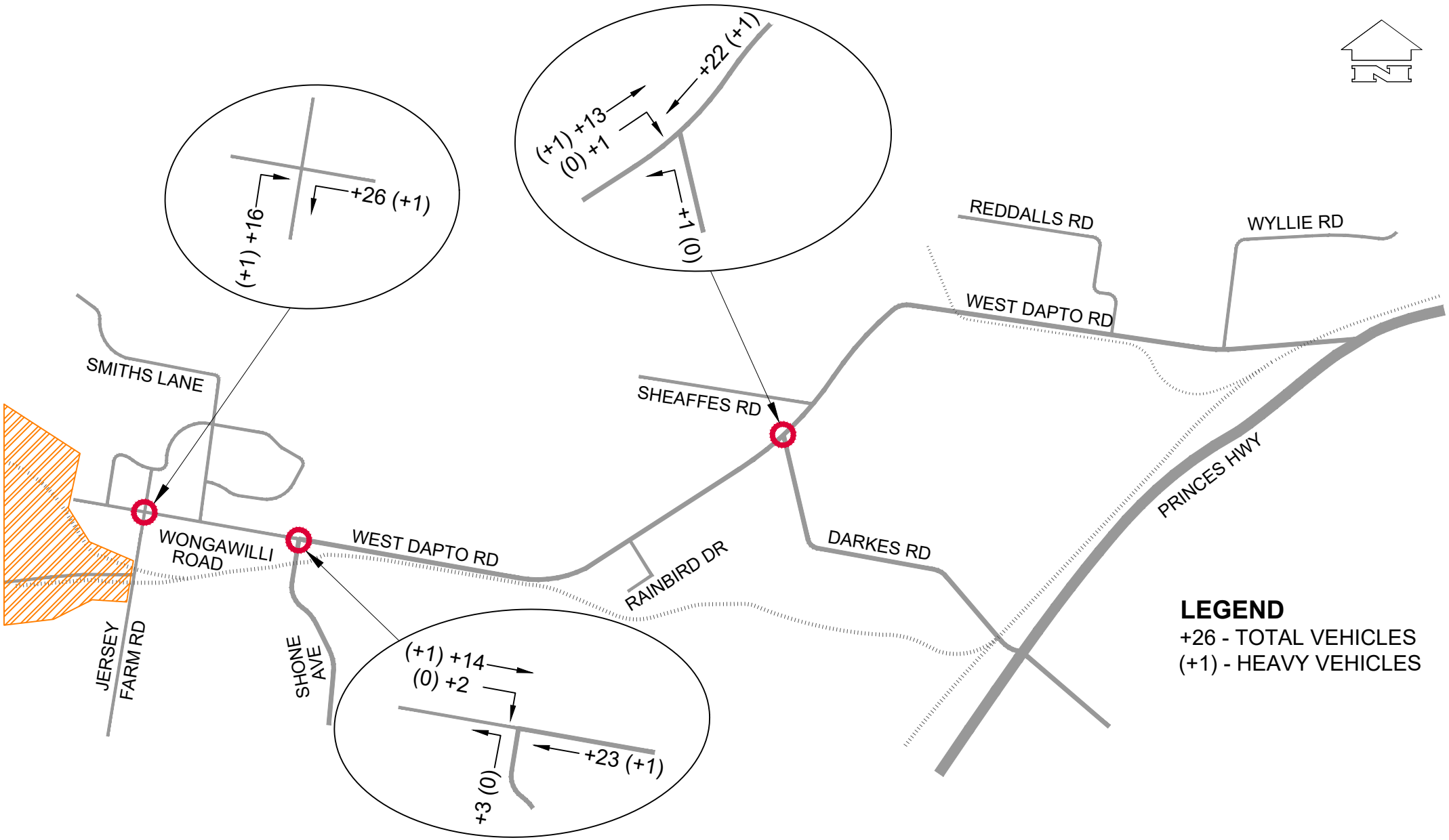

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FIGURE 8

MODIFICATION 2

WONGAWILLI COLLIERY

ADDITIONAL TRAFFIC VOLUMES FROM MODIFICATION 2 IN AM COLLIERY PEAK HOUR

JOB NO.20011

9.11.20

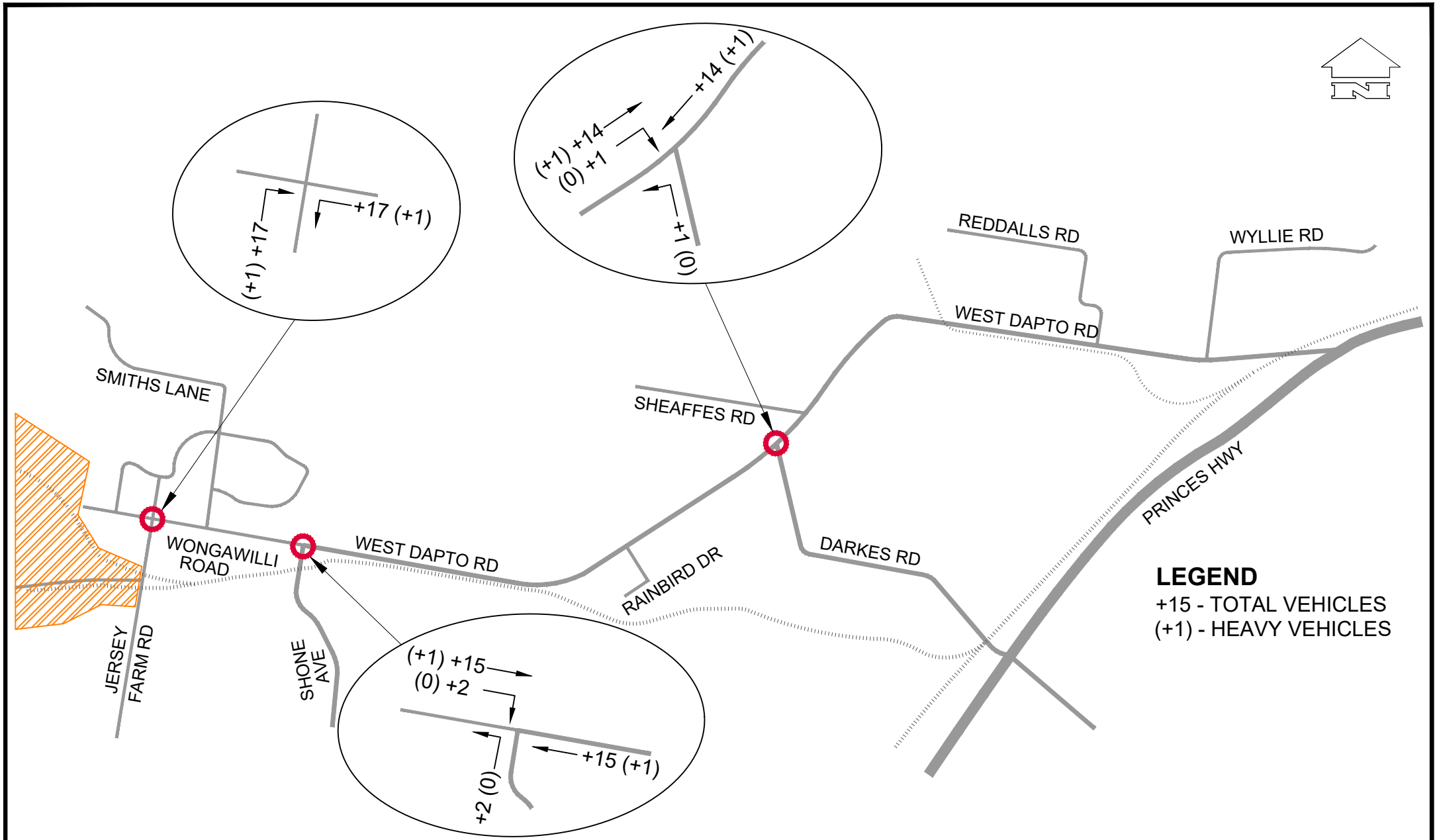

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FIGURE 9

MODIFICATION 2

WONGAWILLI COLLIERY

ADDITIONAL TRAFFIC VOLUMES FROM MODIFICATION 2 IN PM COLLIERY PEAK HOUR

JOB NO.20011

9.11.20

To examine the impacts of the additional traffic from the Modification 2 on the critical intersections in Wongawilli Road/West Dapto Road, traffic modelling has been undertaken using the SIDRA 8 software package.

SIDRA 8 assesses the operational performance of intersections under traffic signal roundabout or sign control. The best criteria for assessing intersections controlled by sign control 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 reproduced from the RTA's Guide to Traffic Generating Developments. The desirable design criteria for intersections is a Level of Service D or better.

For intersections controlled by Give Way/Stop signs, the Level of Service of the intersection is determined by the movement with the highest movement (average) vehicle delay (HMD) and not the average vehicle delay for all vehicles using the intersection.

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 & spare capacity	Acceptable delays & spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity & 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

Source: Table 4.1 RTA Guide to Traffic Generating Developments, October 2002

The modelling has been undertaken for the intersections of Wongawilli Road/Jersey Farm Road and Wongawilli Road / West Dapto Road / Shone Avenue.

The results of the modelling are shown in Tables 4.2 and 4.3 and extracts of the SIDRA modelling outputs are contained in Appendix 1.

Reference to Tables 4.2 and 4.3 shows that both intersections with Modification 2 in place will continue to operate at a very good level of service (Level of Service A operation) with low vehicle delays and minimal changes to existing conditions.

Based on this, the traffic impacts of Modification 2 are assessed as satisfactory.

TABLE 4.2

SIDRA MODELLING RESULT FOR WONGAWILLI ROAD / JERSEY FARM ROAD IN WEEKDAY COLLIERY PEAK HOURS FOR EXISTING CONDITIONS AND WITH MODIFICATION 2

Criteria	Existing Conditions		With Modification 2	
	AM Colliery Peak	PM Colliery Peak	AM Colliery Peak	PM Colliery Peak
LS	A	A	A	A
DS	0.010	0.016	0.020	0.026
AVD (secs)	4.1	3.3	5.3	4.6
HMD (secs)	8.1	8.1	8.1	8.1
95th% Queue Length (metres)	0.3	0.3	0.5	0.6

Where: *LS* - *Level of Service*
DS - *Degree of Saturation*
AVD - *Average Vehicle Delay in seconds*
HMD - *Highest Movement Delay in seconds*
95th% Queue Length - *95th%ile Queue Length in metres*

TABLE 4.3

SIDRA MODELLING RESULT FOR WONGAWILLI ROAD / WEST DAPTO ROAD / SHONE AVENUE IN WEEKDAY COLLIERY PEAK HOURS FOR EXISTING CONDITIONS AND WITH MODIFICATION 2

Criteria	Existing Conditions		With Modification 2	
	AM Colliery Peak	PM Colliery Peak	AM Colliery Peak	PM Colliery Peak
LS	A	A	A	A
DS	0.193	0.209	0.202	0.217
AVD (secs)	4.3	4.6	4.1	4.5
HMD (secs)	6.3	7.1	6.5	7.3
95th% Queue Length (metres)	5.0	5.7	5.3	5.9

Where: *LS* - *Level of Service*
DS - *Degree of Saturation*
AVD - *Average Vehicle Delay in seconds*
HMD - *Highest Movement Delay in seconds*
95th% Queue Length - *95th%ile Queue Length in metres*

4.3 Road Safety and Impact on other Road Users

Modification 2 is not expected to have any negative impacts on road safety on the road network adjacent Wongawilli Colliery, or negative impacts on other road users.

The actual traffic increase associated with Modification 2 is relatively small and traffic conditions at intersections and on the road network are expected to remain satisfactory with little or no change to the existing level of service and vehicle delay as compared to existing conditions.

4.4 Internal Operation

No changes are proposed to the existing vehicles access roads within the colliery and the parking provided for the workforce and equipment. Sufficient off street parking is provided to accommodate the workforce proposed for Modification 2.

5.0 CONCLUSIONS

This report documents the traffic and road transport impacts of the proposed Modification 2 at Wongawilli Colliery.

When compared to the approved operation at Wongawilli Colliery, the road and traffic impacts of Modification 2 will be lower than the current approval for the Colliery, due to the reduction of the workforce from 300 (as approved) to 150 full time equivalent personnel.

The assessment has concluded that the traffic increase associated with Modification 2 will be relatively small and traffic conditions on the road network will remain satisfactory.

APPENDIX 1

EXTRACTS OF SIDRA MODELLING OUTPUTS

MOVEMENT SUMMARY

Site: 101 [Wongawilli Rd & Jersey Farm Rd - Ex AM]

Ex AM
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles												
Mov ID	Turn	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	Aver. No. Cycles	Average Speed km/h
South: Jersey Farm Rd												
1	L2	1	0.0	0.003	8.0	LOS A	0.0	0.1	0.03	1.01	0.03	51.9
2	T1	1	0.0	0.003	7.8	LOS A	0.0	0.1	0.03	1.01	0.03	51.7
3	R2	1	0.0	0.003	7.6	LOS A	0.0	0.1	0.03	1.01	0.03	51.4
Approach		3	0.0	0.003	7.8	LOS A	0.0	0.1	0.03	1.01	0.03	51.7
East: Wongawilli Rd												
4	L2	2	50.0	0.005	6.1	LOS A	0.0	0.2	0.06	0.38	0.06	52.9
5	T1	3	0.0	0.005	0.0	LOS A	0.0	0.2	0.06	0.38	0.06	56.6
6	R2	4	0.0	0.005	5.6	LOS A	0.0	0.2	0.06	0.38	0.06	54.5
Approach		9	11.1	0.005	3.8	NA	0.0	0.2	0.06	0.38	0.06	54.8
North: Jersey Farm Rd												
7	L2	11	0.0	0.010	8.1	LOS A	0.0	0.3	0.06	0.95	0.06	51.8
8	T1	1	0.0	0.010	7.8	LOS A	0.0	0.3	0.06	0.95	0.06	51.5
9	R2	1	0.0	0.010	7.5	LOS A	0.0	0.3	0.06	0.95	0.06	51.2
Approach		13	0.0	0.010	8.0	LOS A	0.0	0.3	0.06	0.95	0.06	51.7
West: Wongawilli Rd												
10	L2	1	0.0	0.009	5.5	LOS A	0.0	0.0	0.01	0.07	0.01	57.7
11	T1	15	0.0	0.009	0.0	LOS A	0.0	0.0	0.01	0.07	0.01	59.3
12	R2	1	0.0	0.009	5.5	LOS A	0.0	0.0	0.01	0.07	0.01	57.0
Approach		17	0.0	0.009	0.7	NA	0.0	0.0	0.01	0.07	0.01	59.1
All Vehicles		42	2.4	0.010	4.1	NA	0.0	0.3	0.04	0.48	0.04	55.2

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 [Wongawilli Rd & Jersey Farm Rd - Ex PM]

Ex PM
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles												
Mov ID	Turn	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	Aver. No. Cycles	Average Speed km/h
South: Jersey Farm Rd												
1	L2	1	0.0	0.007	8.1	LOS A	0.0	0.2	0.11	0.93	0.11	52.1
2	T1	1	0.0	0.007	7.8	LOS A	0.0	0.2	0.11	0.93	0.11	51.8
3	R2	5	0.0	0.007	7.7	LOS A	0.0	0.2	0.11	0.93	0.11	51.5
Approach		7	0.0	0.007	7.7	LOS A	0.0	0.2	0.11	0.93	0.11	51.6
East: Wongawilli Rd												
4	L2	3	0.0	0.016	5.6	LOS A	0.0	0.3	0.03	0.19	0.03	56.6
5	T1	20	10.0	0.016	0.0	LOS A	0.0	0.3	0.03	0.19	0.03	58.1
6	R2	6	0.0	0.016	5.5	LOS A	0.0	0.3	0.03	0.19	0.03	55.9
Approach		29	6.9	0.016	1.7	NA	0.0	0.3	0.03	0.19	0.03	57.5
North: Jersey Farm Rd												
7	L2	8	0.0	0.007	8.1	LOS A	0.0	0.2	0.05	0.97	0.05	51.8
8	T1	1	0.0	0.007	7.8	LOS A	0.0	0.2	0.05	0.97	0.05	51.5
9	R2	1	0.0	0.007	7.6	LOS A	0.0	0.2	0.05	0.97	0.05	51.2
Approach		10	0.0	0.007	8.0	LOS A	0.0	0.2	0.05	0.97	0.05	51.7
West: Wongawilli Rd												
10	L2	1	0.0	0.007	5.6	LOS A	0.0	0.0	0.02	0.09	0.02	57.5
11	T1	11	0.0	0.007	0.0	LOS A	0.0	0.0	0.02	0.09	0.02	59.1
12	R2	1	0.0	0.007	5.6	LOS A	0.0	0.0	0.02	0.09	0.02	56.8
Approach		13	0.0	0.007	0.9	NA	0.0	0.0	0.02	0.09	0.02	58.8
All Vehicles		59	3.4	0.016	3.3	NA	0.0	0.3	0.04	0.39	0.04	55.9

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 [Wongawilli Rd & Jersey Farm Rd - AM & Mod 2]

AM with Mod 2
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles												
Mov ID	Turn	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	Aver. No. Cycles	Average Speed km/h
South: Jersey Farm Rd												
1	L2	1	0.0	0.020	8.0	LOS A	0.1	0.5	0.08	0.96	0.08	52.0
2	T1	1	0.0	0.020	7.8	LOS A	0.1	0.5	0.08	0.96	0.08	51.8
3	R2	17	5.9	0.020	7.9	LOS A	0.1	0.5	0.08	0.96	0.08	51.2
Approach		19	5.3	0.020	7.9	LOS A	0.1	0.5	0.08	0.96	0.08	51.3
East: Wongawilli Rd												
4	L2	28	7.1	0.020	5.6	LOS A	0.0	0.2	0.02	0.52	0.02	53.6
5	T1	3	0.0	0.020	0.0	LOS A	0.0	0.2	0.02	0.52	0.02	55.3
6	R2	4	0.0	0.020	5.6	LOS A	0.0	0.2	0.02	0.52	0.02	53.3
Approach		35	5.7	0.020	5.1	NA	0.0	0.2	0.02	0.52	0.02	53.8
North: Jersey Farm Rd												
7	L2	11	0.0	0.010	8.1	LOS A	0.0	0.3	0.06	0.95	0.06	51.8
8	T1	1	0.0	0.010	7.9	LOS A	0.0	0.3	0.06	0.95	0.06	51.5
9	R2	1	0.0	0.010	7.5	LOS A	0.0	0.3	0.06	0.95	0.06	51.2
Approach		13	0.0	0.010	8.0	LOS A	0.0	0.3	0.06	0.95	0.06	51.7
West: Wongawilli Rd												
10	L2	1	0.0	0.009	5.6	LOS A	0.0	0.0	0.02	0.07	0.02	57.7
11	T1	15	0.0	0.009	0.0	LOS A	0.0	0.0	0.02	0.07	0.02	59.3
12	R2	1	0.0	0.009	5.6	LOS A	0.0	0.0	0.02	0.07	0.02	57.0
Approach		17	0.0	0.009	0.7	NA	0.0	0.0	0.02	0.07	0.02	59.1
All Vehicles		84	3.6	0.020	5.3	NA	0.1	0.5	0.04	0.60	0.04	53.8

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.

MOVEMENT SUMMARY

Site: 101 [Wongawilli Rd & Jersey Farm Rd - PM & Mod 2]

PM & Mod 2
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	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	Aver. No. Cycles	Average Speed km/h
South: Jersey Farm Rd												
1	L2	1	0.0	0.025	8.1	LOS A	0.1	0.6	0.14	0.92	0.14	52.1
2	T1	1	0.0	0.025	7.9	LOS A	0.1	0.6	0.14	0.92	0.14	51.8
3	R2	22	4.5	0.025	7.9	LOS A	0.1	0.6	0.14	0.92	0.14	51.3
Approach		24	4.2	0.025	7.9	LOS A	0.1	0.6	0.14	0.92	0.14	51.4
East: Wongawilli Rd												
4	L2	20	5.0	0.026	5.6	LOS A	0.0	0.3	0.02	0.33	0.02	55.2
5	T1	20	10.0	0.026	0.0	LOS A	0.0	0.3	0.02	0.33	0.02	56.9
6	R2	6	0.0	0.026	5.5	LOS A	0.0	0.3	0.02	0.33	0.02	54.8
Approach		46	6.5	0.026	3.2	NA	0.0	0.3	0.02	0.33	0.02	55.9
North: Jersey Farm Rd												
7	L2	8	0.0	0.008	8.1	LOS A	0.0	0.2	0.05	0.97	0.05	51.8
8	T1	1	0.0	0.008	7.9	LOS A	0.0	0.2	0.05	0.97	0.05	51.5
9	R2	1	0.0	0.008	7.6	LOS A	0.0	0.2	0.05	0.97	0.05	51.2
Approach		10	0.0	0.008	8.0	LOS A	0.0	0.2	0.05	0.97	0.05	51.7
West: Wongawilli Rd												
10	L2	1	0.0	0.007	5.6	LOS A	0.0	0.0	0.02	0.09	0.02	57.5
11	T1	11	0.0	0.007	0.0	LOS A	0.0	0.0	0.02	0.09	0.02	59.1
12	R2	1	0.0	0.007	5.6	LOS A	0.0	0.0	0.02	0.09	0.02	56.8
Approach		13	0.0	0.007	0.9	NA	0.0	0.0	0.02	0.09	0.02	58.8
All Vehicles		93	4.3	0.026	4.6	NA	0.1	0.6	0.05	0.52	0.05	54.5

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.

MOVEMENT SUMMARY

▽ Site: 101 [West Dapto Rd & Shone Ave Ex AM]

Ex AM
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	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	Aver. No. Cycles	Average Speed km/h
South: Shone Ave												
1	L2	19	0.0	0.193	5.8	LOS A	0.7	5.0	0.26	0.61	0.26	52.9
3	R2	196	0.5	0.193	6.3	LOS A	0.7	5.0	0.26	0.61	0.26	52.3
Approach		215	0.5	0.193	6.3	LOS A	0.7	5.0	0.26	0.61	0.26	52.3
East: West Dapto Rd												
4	L2	49	0.0	0.060	5.5	LOS A	0.0	0.0	0.00	0.27	0.00	56.0
5	T1	60	10.0	0.060	0.0	LOS A	0.0	0.0	0.00	0.27	0.00	57.5
Approach		109	5.5	0.060	2.5	NA	0.0	0.0	0.00	0.27	0.00	56.8
West: Wongawilli Rd												
11	T1	68	1.5	0.061	0.2	LOS A	0.2	1.6	0.16	0.21	0.16	57.6
12	R2	38	5.3	0.061	5.9	LOS A	0.2	1.6	0.16	0.21	0.16	55.1
Approach		106	2.8	0.061	2.2	NA	0.2	1.6	0.16	0.21	0.16	56.7
All Vehicles		430	2.3	0.193	4.3	NA	0.7	5.0	0.17	0.43	0.17	54.5

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.

MOVEMENT SUMMARY

▽ Site: 101 [West Dapto Rd & Shone Ave Ex PM]

Ex PM
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	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	Aver. No. Cycles	Average Speed km/h
South: Shone Ave												
1	L2	56	3.6	0.209	5.9	LOS A	0.8	5.7	0.26	0.63	0.26	52.5
3	R2	162	3.1	0.209	7.1	LOS A	0.8	5.7	0.26	0.63	0.26	52.0
Approach		218	3.2	0.209	6.8	LOS A	0.8	5.7	0.26	0.63	0.26	52.1
East: West Dapto Rd												
4	L2	200	0.0	0.151	5.6	LOS A	0.0	0.0	0.00	0.42	0.00	54.9
5	T1	79	1.3	0.151	0.0	LOS A	0.0	0.0	0.00	0.42	0.00	56.3
Approach		279	0.4	0.151	4.0	NA	0.0	0.0	0.00	0.42	0.00	55.2
West: Wongawilli Rd												
11	T1	94	4.3	0.088	0.5	LOS A	0.3	2.4	0.27	0.22	0.27	57.1
12	R2	52	0.0	0.088	6.4	LOS A	0.3	2.4	0.27	0.22	0.27	54.9
Approach		146	2.7	0.088	2.6	NA	0.3	2.4	0.27	0.22	0.27	56.3
All Vehicles		643	1.9	0.209	4.6	NA	0.8	5.7	0.15	0.45	0.15	54.4

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 [West Dapto Rd & Shone Ave - AM & Mod2]

AM with Mod 2
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles												
Mov ID	Turn	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	Aver. No. Cycles	Average Speed km/h
South: Shone Ave												
1	L2	22	0.0	0.202	5.8	LOS A	0.8	5.3	0.29	0.63	0.29	52.8
3	R2	196	0.5	0.202	6.5	LOS A	0.8	5.3	0.29	0.63	0.29	52.2
Approach		218	0.5	0.202	6.5	LOS A	0.8	5.3	0.29	0.63	0.29	52.3
East: West Dapto Rd												
4	L2	49	0.0	0.072	5.5	LOS A	0.0	0.0	0.00	0.22	0.00	56.4
5	T1	83	8.4	0.072	0.0	LOS A	0.0	0.0	0.00	0.22	0.00	57.9
Approach		132	5.3	0.072	2.1	NA	0.0	0.0	0.00	0.22	0.00	57.3
West: Wongawilli Rd												
11	T1	82	2.4	0.070	0.2	LOS A	0.2	1.7	0.17	0.19	0.17	57.7
12	R2	40	5.0	0.070	6.0	LOS A	0.2	1.7	0.17	0.19	0.17	55.3
Approach		122	3.3	0.070	2.1	NA	0.2	1.7	0.17	0.19	0.17	56.9
All Vehicles		472	2.5	0.202	4.1	NA	0.8	5.3	0.18	0.40	0.18	54.8

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.

MOVEMENT SUMMARY

▽ Site: 101 [West Dapto Rd & Shone Ave PM & Mod 2]

PM & Mod 2
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles												
Mov ID	Turn	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	Aver. No. Cycles	Average Speed km/h
South: Shone Ave												
1	L2	58	3.4	0.217	5.9	LOS A	0.8	5.9	0.29	0.64	0.29	52.4
3	R2	162	3.1	0.217	7.3	LOS A	0.8	5.9	0.29	0.64	0.29	51.8
Approach		220	3.2	0.217	6.9	LOS A	0.8	5.9	0.29	0.64	0.29	52.0
East: West Dapto Rd												
4	L2	200	0.0	0.159	5.6	LOS A	0.0	0.0	0.00	0.40	0.00	55.0
5	T1	94	2.1	0.159	0.0	LOS A	0.0	0.0	0.00	0.40	0.00	56.4
Approach		294	0.7	0.159	3.8	NA	0.0	0.0	0.00	0.40	0.00	55.5
West: Wongawilli Rd												
11	T1	109	4.6	0.098	0.5	LOS A	0.4	2.7	0.27	0.21	0.27	57.2
12	R2	54	0.0	0.098	6.5	LOS A	0.4	2.7	0.27	0.21	0.27	55.1
Approach		163	3.1	0.098	2.5	NA	0.4	2.7	0.27	0.21	0.27	56.5
All Vehicles		677	2.1	0.217	4.5	NA	0.8	5.9	0.16	0.43	0.16	54.5

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.

Appendix H

Surface water impact assessment

HYDRO ENGINEERING & CONSULTING PTY LTD

REPORT

Wongawilli Colliery

Surface Water Technical Report

Prepared for: Wongawilli Coal Pty Ltd

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Revision	Description	Author	Reviewer	Approved	Date
a	Interim Draft Report	CAW	TSM / EMM	TSM	16/10/2020
b	Draft Report	CAW	TSM / EMM	TSM	12/11/2020
c	Report	CAW	TSM	TSM	16/11/2020

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1.0 INTRODUCTION

1.1 PROJECT OVERVIEW

Wongawilli Colliery (WWC) is an underground coal mine owned and operated by Wongawilli Coal Pty Ltd, which is an entity of Wollongong Coal Pty Ltd (Wollongong Coal) and is located approximately 15 kilometres (km) south-west of Wollongong, New South Wales (refer Figure 1). Extensive underground mining has been undertaken within the WWC mining lease areas, with coal extracted from both the Bulli Coal Seam and the Wongawilli Coal Seam. The extracted coal is transferred by rail to the Port Kembla Coal Terminal (PKCT) as unwashed Run of Mine (ROM) product for shipment to international customers.

The Nebo Project Area (mine lease [ML] 1596) was granted approval in November 2011 by the NSW Planning Assessment Commission (PAC) under Project Approval 09-0161. Modification 1 was approved in November 2015 for the continued operation of the Nebo Project until December 2020. Longwall and pillar extraction within the Nebo Project Area were completed in early 2019 and WWC is currently in care and maintenance.

Wollongong Coal propose to re-commence mining in 2020 under the existing Project Approval 09-0161 with the intention of completing the North West Mains Development (NWMD), located within the North West Domain of the Nebo Project Area. The NWMD was approved under Project Approval 09-0161 and was referred to as the 'Western Driveage' in the *Nebo Project Area Environmental Assessment* (EA) (ERM, 2010).

The proposed modification (Modification 2) is seeking to extend the life of the mine by 5 years to enable Wollongong Coal to continue development of the approved NWMD. The NWMD has commenced, with approximately 500 metres developed within the Bulli Coal Seam. Modification 2 largely seeks approval to extend the length of the NWMD approximately 2.9 km to access the existing Wongawilli Ventilation Shaft 1, with construction of a new section of coal conveyor system, approximately 60 m in length, at the Wongawilli Colliery upper pit top (refer Figure 2). The NWMD would continue to be extracted via first workings mining method using two continuous miners. Wollongong Coal committed in 2019 to no longer undertake mining via longwall extraction methods, as such no longwall mining is proposed as part of the Modification application.

1.2 MODIFICATION OVERVIEW

The proposed modification will allow for the completion of the approved NWMD, comprising approximately 4,500 m of the remaining underground mains heading with an additional driveage extension of approximately 2.9 km to the existing Wongawilli Ventilation Shaft 1. The connection to this shaft will minimise the potential requirements for new ventilation infrastructure in the Metropolitan 'Special Areas'.

The modification proposes to utilise the existing Wongawilli Colliery pit top infrastructure, with the exception of minor changes to replace a portion of the upper pit top conveyor network and relocation of the crusher, sizer and screen to underground. The replacement of a portion of the upper pit top conveyor network is proposed to improve the conveying of coal from the NWMD to the existing coal handling and train loading facilities located at the lower pit top. All aspects of the modification fall within the existing Project Application Area.

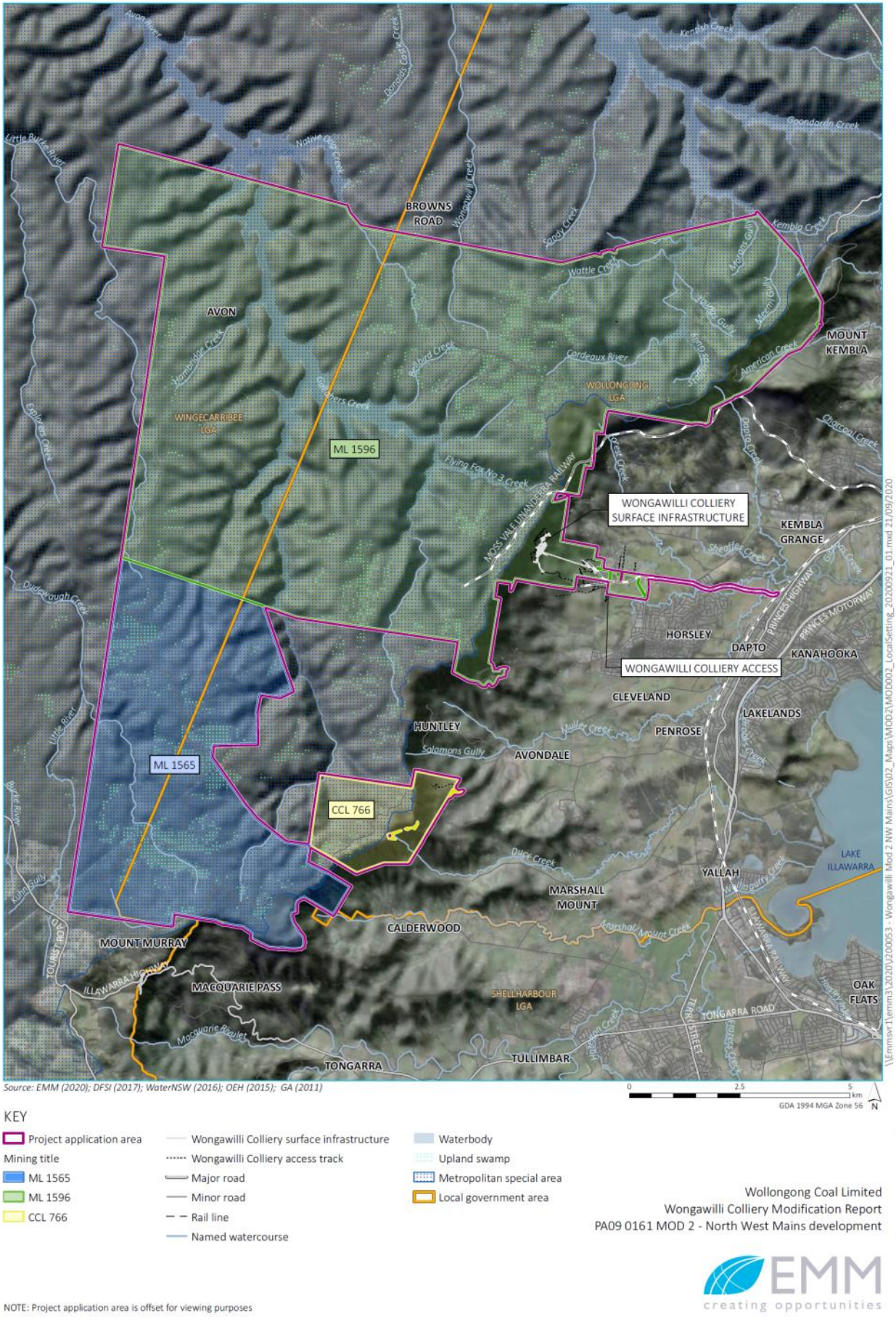

Figure 1 Regional Location

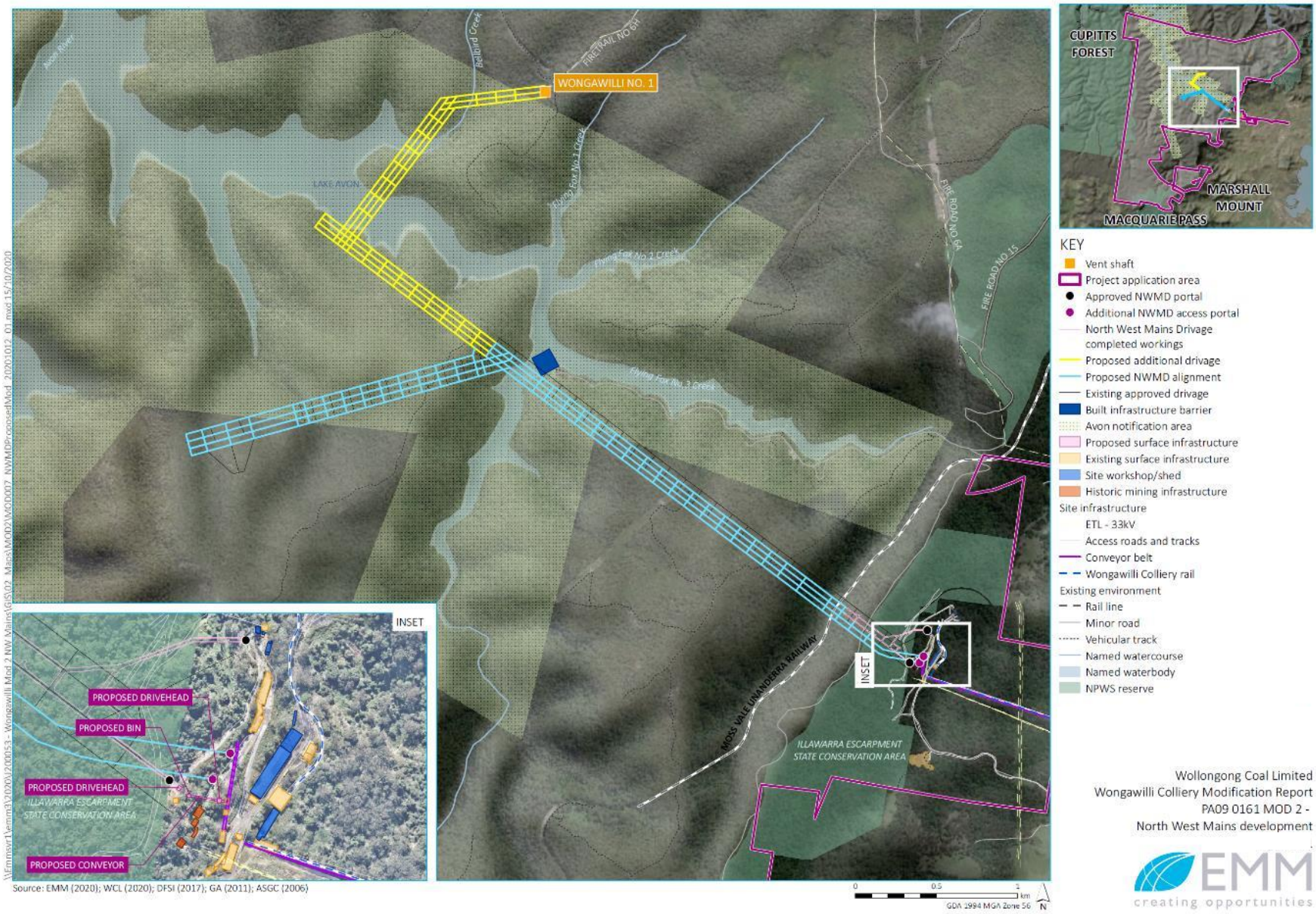

Figure 2 Project Area Overview

1.3 STUDY REQUIREMENTS AND SCOPE

Hydro Engineering & Consulting Pty Ltd (HEC) was commissioned by Wollongong Coal to prepare a Surface Water Technical Report (SWTR) in support of the Modification Report required to modify Condition 5 of Project Approval 09-016. The SWTR outlines the current surface water context for both the natural environment and the Wongawilli Colliery pit top, reflects any legislative or standard changes since submission of the 2010 EA and provides an updated impact assessment to support the required Modification Report for the proposed Project Approval 09-0161 Modification 2. The SWTR builds upon the Technical Specialist reports provided as a component of the 2010 EA, specifically the *NRE Wongawilli Colliery Nebo Panels 1 to 6 Surface Water Assessment* (GeoTerra, 2010a) and the *NRE Wongawilli Colliery Surface Water Management* (WRM, 2010). The SWTR addresses the NWMD area and the Wongawilli Colliery, referred to as the Project Area herein.

1.4 RELEVANT LEGISLATION / STANDARDS

The following legislation, guidelines and licences have been considered in the preparation of this SWTR:

- *Environmental Planning and Assessment Act 1979*;
- *Mining Act 1992* and *Protection of the Environment Operations Act (NSW) 1997;*
- *Water Management Act 2000*;
- *Water NSW Act 2014;*
- *National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality* (Australian and New Zealand Environment Conservation Council [ANZECC] and the Agriculture and Resource Management Council of Australia and New Zealand [ARMCANZ], 2000) and the *NSW Government Water Quality and River Flow Objectives* (Office of Environment and Heritage [OEH], 2006);
- *Australian and New Zealand Water Quality Guidelines* (ANZG, 2018);
- *Australian Drinking Water Guidelines 2011* (ADWG) (NHMRC, 2018);
- *Managing Urban Stormwater Soils and Construction – Volume 2E Mines and Quarries* (NSW Department of Environment and Climate Change [DECC], 2008) and *Managing Urban Stormwater, Soils and Construction* (Landcom, 2004) (collectively referred to as the 'Blue Book');
- *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011*;
- *Neutral or Beneficial Effect on Water Quality Assessment Guideline* (WaterNSW, 2015); and
- *Environment Protection Licence 1087*.

The key legislative changes and guidelines relating to surface water management which have been implemented since submission of the 2010 EA include the *WaterNSW Act 2014, State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011, Neutral or Beneficial Effect on Water Quality Assessment Guideline* (WaterNSW, 2015), *Australian and New Zealand Water Quality Guidelines* (ANZG, 2018) and the *Australian Drinking Water Guidelines* (NHMRC, 2018).

1.4.1 WaterNSW Act 2014

The *Water NSW Act 2014* defines the functions and objectives of WaterNSW. The NWMD area is located predominately in the Lake Avon catchment area, as shown in Figure 2. Lake Avon is located within the Metropolitan Special Area, declared under the *Water NSW Act 2014* and managed by WaterNSW. In relation to activities undertaken within the Lake Avon catchment, the principal objective of WaterNSW under the Act is to ensure that declared catchment areas and water

management works in such areas are managed and protected so as to promote water quality, the protection of public health and public safety, and the protection of the environment. This objective has been considered in the assessment of potential impacts to the Lake Avon catchment associated with the proposed Modification.

1.4.2 State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011 and Neutral or Beneficial Effect on Water Quality Assessment Guideline

The *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011* aims to:

- provide for healthy water catchments that will deliver high quality water while permitting development that is compatible with that goal,
- provide that a consent authority must not grant consent to a proposed development unless it is satisfied that the proposed development will have a neutral or beneficial effect on water quality, and
- support the maintenance or achievement of the water quality objectives for the Sydney drinking water catchment.

The *Neutral or Beneficial Effect on Water Quality Assessment Guideline* (WaterNSW, 2015) was developed in response to the *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011* and aims to ensure that all development in the Sydney drinking water catchment will have a neutral or beneficial effect on water quality.

The proposed Modification activities have been assessed against the requirements of the *Neutral or Beneficial Effect on Water Quality Assessment Guideline* in Section 4.4 of this SWTR.

1.4.3 Australian and New Zealand Water Quality Guidelines and the Australian Drinking Water Guidelines

The *Australian New Zealand Water Quality Guidelines* (ANZG, 2018) have been developed to progressively supersede the ANZECC & ARMCANZ (2000) Guidelines, with revisions provided for aquatic ecosystem default guideline values. Where updated default guideline values are yet to be published under the ANZG (2018) Guidelines, adoption of the ANZECC & ARMCANZ (2000) Guideline default values is recommended. The *Australian New Zealand Water Quality Guidelines* (ANZG, 2018) have been considered in the assessment of baseline water quality characteristics of the surface water systems within and adjacent to the Project Area and in the assessment of the Wongawilli Colliery water storages and licensed discharge (refer Section 2.5).

The ADWG (NHMRC, 2018), updated in August 2018, provide a framework for the management of drinking water supplies and provide guideline values (both aesthetic and health-related) for drinking water supply sources. The ADWG has been considered in the assessment of the baseline water quality characteristics of surface water systems within the Lake Avon catchment area (refer Section 2.5.1).

2.0 BASELINE SURFACE WATER RESOURCES

2.1 CATCHMENT OVERVIEW

The Project Area is divided into two distinct catchments by the Illawarra Escarpment State Conservation Area. The NWMD area is located predominately in the Lake Avon catchment area as shown in Figure 2. Lake Avon is one of four dams located in the Upper Nepean catchment that make up the Upper Nepean water supply scheme for Sydney (WaterNSW, 2020). Lake Avon is located within the Metropolitan Special Area, declared under the *Water NSW Act 2014* and managed by WaterNSW. The Metropolitan Special Area has high biodiversity values with access restricted to protect biodiversity and water quality in these areas.

The approved and proposed driveages of the NWMD will partly underlie Gallahers Creek, which forms the western arm of Lake Avon, and tributaries of Gallahers Creek and Lake Avon. The NWMD area is predominantly comprised of shallow colluvium which directly overlies the Hawkesbury Sandstone, Bald Hill Claystone and Bulgo Sandstone (GeoTerra, 2010a).

The Wongawilli Colliery is located on the eastern edge of the Illawarra Escarpment State Conservation Area (refer Figure 3). The Wongawilli Colliery pit top is contained within the catchment area of Robins Creek. Robins Creek is a tributary of Mullet Creek which flows into Lake Illawarra – a large coastal lagoon approximately 10 km to the east of the pit top.

2.2 CLIMATE

2.2.1 Temperature, Wind Speed and Humidity

Long-term climate records for the Bureau of Meteorology (BoM) weather station at Albion Park (Shellharbour Airport – No. 068241) are summarised in Table 1. Albion Park (Shellharbour Airport) is located approximately 12 km to the south-east of the Wongawilli Colliery and is the closest weather station to the Project Area (refer Figure 3).

Table 1 Summary of Regional Climatic Variables

Site Number		**068241**
Site Name		Albion Park
Latitude (degrees)		-34.56
Longitude (degrees)		150.79
Period of data		1999 - 2020
Mean Monthly Minimum Temperature (ºC)	**Minimum**	6.2 (Jul)
	Maximum	17.2 (Feb)
Mean Monthly Maximum Temperature (ºC)	**Minimum**	17.8 (Jul)
	Maximum	27.1 (Jan)
Mean 9 am Wind Speed (km/hr)	**Minimum**	8.1 (Mar)
	Maximum	15.3 (Sep)
Mean 9 am Relative Humidity (%)	**Minimum**	57 (Sep)
	Maximum	76 (Mar)

Table 1 illustrates that the region experiences a temperate climate with mean monthly maximum temperatures ranging from 17.8 degrees Celsius (ºC) in July to 27.1ºC in January. Mean monthly minimum temperatures range from 6.2ºC in July to 17.2ºC in February.

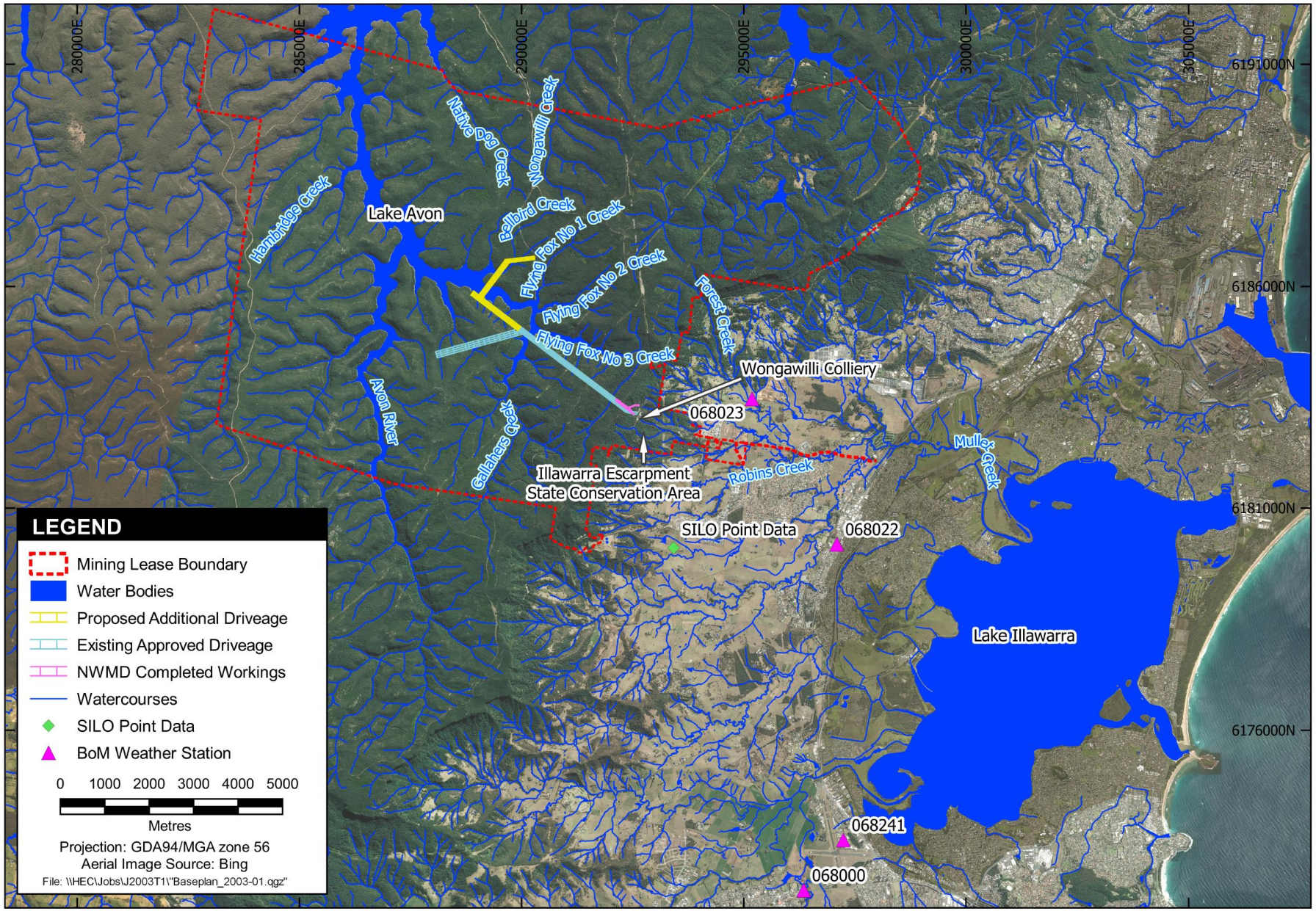

Figure 3 Regional Weather and Rainfall Stations

2.3.2 Rainfall and Evaporation

Long-term climate records from four BoM rainfall stations are available for the Project Area region and are shown in Figure 3. The nearest station to the Project Area with long term records is Dapto West (068023), though this station was closed in 1987. Albion Park Post Office (068000) is located approximately 3 km to the south of the Wongawilli Colliery and is the closest weather station to the Project Area that is open.

The long-term average monthly rainfall recorded at the BoM rainfall stations is summarised in Table 2 in comparison with average monthly rainfall and pan evaporation obtained from SILO Point Data[1] for a point to the south of the Wongawilli Colliery pit top (refer Figure 3).

The data summarised in Table 2 shows that the average annual rainfall recorded at Dapto West (closest rainfall station to the site) over the period 1898 – 1987 was 1,189 millimetres (mm) with the highest monthly rainfall occurring in March on average. Average annual pan evaporation has been slightly higher than annual average rainfall, with average monthly pan evaporation exceeding rainfall from August to February and average rainfall exceeding evaporation for the remaining months.

[1] SILO Point Data is a system which provides synthetic data sets for a specified point by interpolation between surrounding point records held by the Bureau of Meteorology – refer https://www.longpaddock.qld.gov.au/silo/point-data/

Table 2 Summary of Regional Average Rainfall and Evaporation

Site	Dapto Bowling Club	Dapto West	Albion Park Post Office	Albion Park (Shellharbour Airport)	SILO Point Data	
	Average Rainfall (mm)				Average Rainfall (mm)	Average Pan Evaporation (mm)
Site Number	068022	068023	068000	068241	-	
Latitude	-34.50	-34.47	-34.57	-34.56	-34.50	
Longitude	150.79	150.77	150.78	150.79	150.75	
Data Period	1906 - 2019	1898 - 1987	1892 - present	1999 - present	1889 - 2020	
January	106.2	123.5	103.3	74.3	117.4	187.3
February	123	130.2	125.3	145.5	142.3	150.2
March	129.3	140.9	131.5	120.7	141.3	133.1
April	106.1	106.7	99.9	71.5	106.7	99.7
May	93.7	101.7	91.2	53.1	93.7	73.1
June	110.5	101.3	106.8	90.6	114.9	58.6
July	55.1	78.6	70.3	54.2	74.8	66.5
August	68.4	70.9	68.6	52.7	72.7	93.3
September	57.3	59.6	59.3	42.7	64.1	121.8
October	79.4	85.8	76.4	65.7	81.8	151.2
November	88.1	92.3	84.3	80.2	90.6	168.0
December	87.8	97.6	78.6	63.0	91.2	196.6
Annual	**1,105**	**1,189**	**1,096**	**893**	**1,192**	**1,500**

2.3 CATCHMENTS AND SURFACE WATER RESOURCES

2.3.1 NWMD Catchment

The approved and proposed first workings of the NWMD are located predominately within the Lake Avon catchment of the Metropolitan Special Area. Lake Avon catchment comprises a proportion of the Upper Nepean catchment which covers almost 900 square kilometres of mostly pristine bushland on the Illawarra Plateau south of Sydney.

The approved and proposed driveages will partly underlie Gallahers Creek, which forms the western arm of Lake Avon, and tributaries of Gallahers Creek and Lake Avon, as shown in Figure 4. The Lake Avon catchment is bounded to the east by the Illawarra Escarpment and to the west by the divide between the Avon and Nepean Rivers. Gallahers Creek flows in a north-northeast direction from the escarpment into Lake Avon and is a fourth-order stream at its confluence with Lake Avon. A number of headwater streams flow into Gallahers Creek including Bellbird Creek and Flying Fox Creek No. 1, 2 and 3.

The headwater streams which flow into Gallahers Creek and Lake Avon in the NWMD area are interspersed with boulders, with a gradient of approximately 1V:5H and bordered with Coachwood Warm Temperate Rainforest and Wet Sclerophyll Forest (Biosis, 2014). Water pools were found to be interspersed along the reach of headwater streams (Biosis, 2014).

The catchment area of the Avon River to Lake Avon is approximately 4,940 hectares (ha) and the catchment area of Gallahers Creek to the confluence with the Avon River is approximately 3,213 ha.

Mapping of coastal upland swamps (HydroSimulations, 2019) identifies one swamp area overlying the proposed alignment of the NWMD and one overlying the approved NWMD. Two upland swamps are monitored for water level in the surrounding region of the NWMD at sites PA and P20 shown on Figure 4. Swamp P20 is located in the headwaters of Bellbird Creek while swamp PA is located in the headwaters of a tributary of the Avon River. Further detail on the coastal upland swamps, including water level monitoring data for P20, is provided in SLR (2020).

2.3.2 Wongawilli Colliery Pit Top

The Wongawilli Colliery pit top is contained within the catchment area of Robins Creek, as shown in Figure 5. Robins Creek is a tributary of Mullet Creek which flows into Lake Illawarra – a large coastal lagoon approximately 10 km to the east of the pit top.

Surface elevations vary greatly across from the site, from 250 m elevation Australian Height Datum (AHD) at the upper pit top to 50 m AHD at the coal stockpile area. Upstream of the Wongawilli Colliery, the catchment area is heavily forested and relatively undisturbed. Runoff from the catchment flows either north or south around the pit top areas to tributaries of Robins Creek. The tributaries of Robins Creek are second-order streams to the downstream boundary of the Wongawilli Colliery surface infrastructure.

The catchment area of the northern tributary of Robins Creek to the Mine Dam is approximately 57.8 ha and the catchment area of the southern tributary of Robins Creek to LDP4 is approximately 94.8 ha.

2.3.3 Licensed Discharge Points

The Wongawilli Colliery is subject to an Environment Protection Licence (EPL) No. 1087 which allows for discharge from the Wongawilli Colliery to surface waters. The locations of the Licensed Discharge Points (LDPs) are shown in Figure 5 and summarised in Table 3 along with the licensed discharge limit. Water quality limits for discharge at LDP1 and LDP2 are specified in EPL 1087 and are summarised in Section 2.4.2.

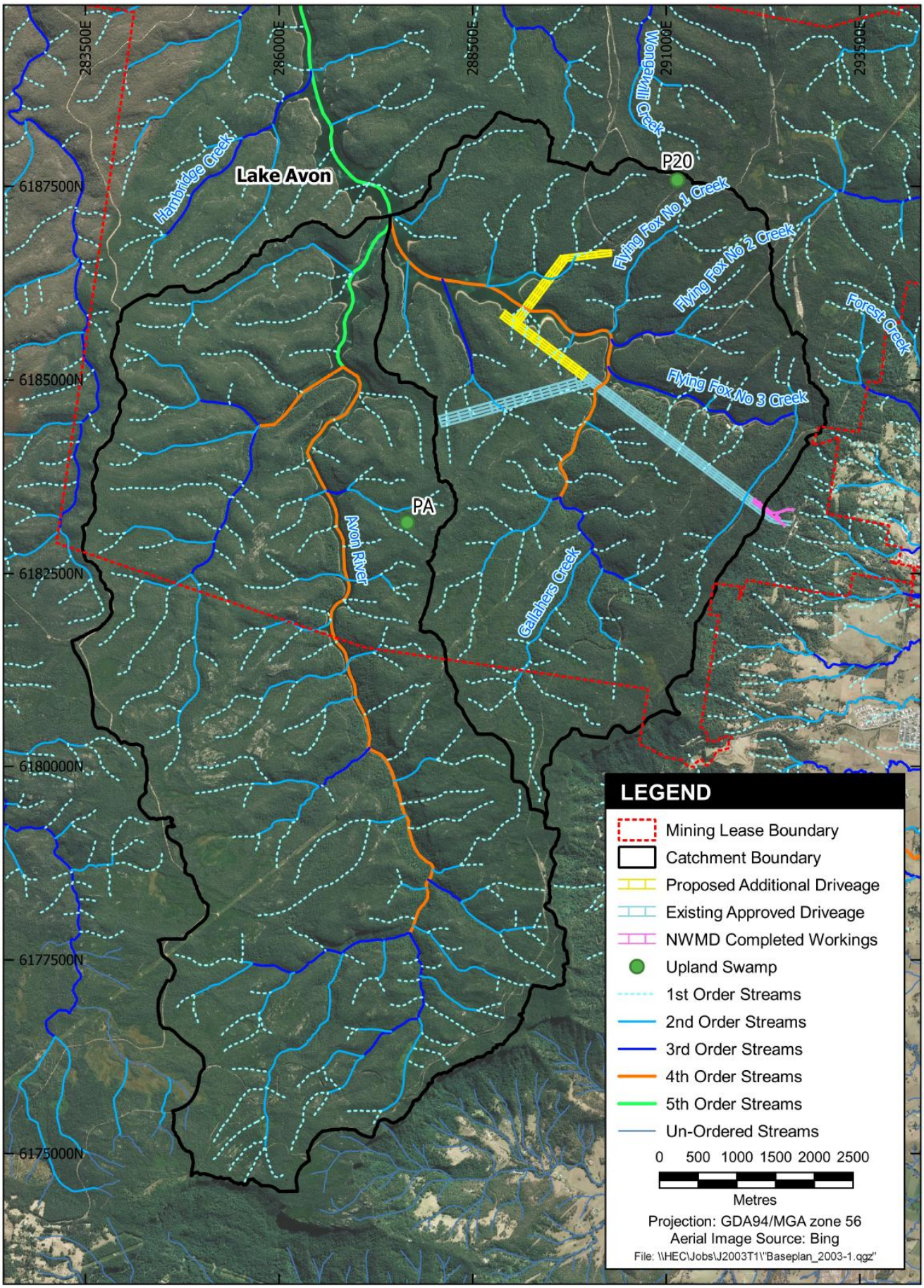

Figure 4 NWMD Surface Water Systems

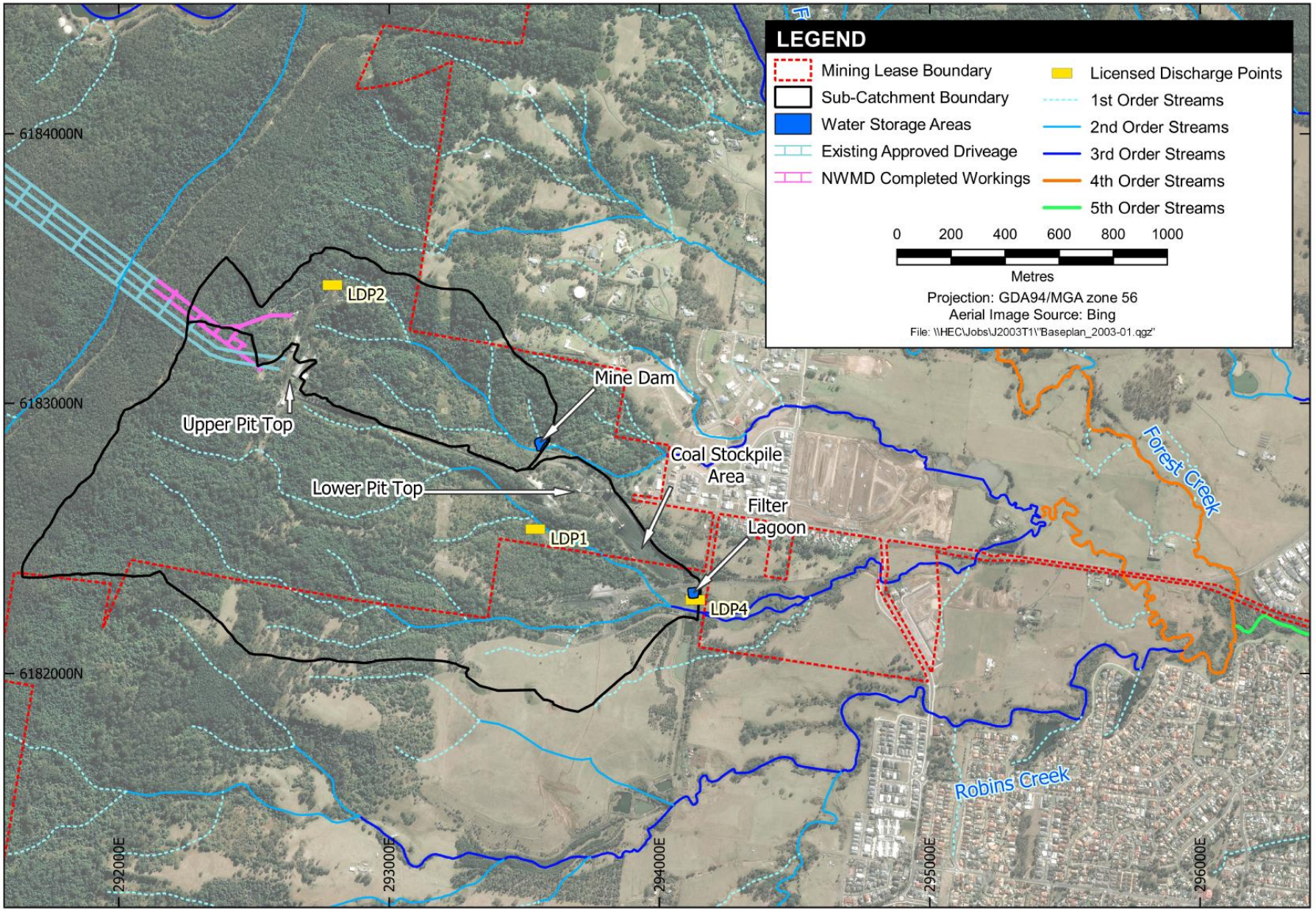

Figure 5 Wongawilli Colliery Surface Water Systems

Table 3 EPL 1087 Licensed Discharge Points

LDP	Description	Discharge Limit
1	STP discharge from secondary stabilisation lagoon to Robins Creek	30 kilolitres per day
2	Mine water discharge from open drain at transport portal to tributary of Robins Creek	10,000 kilolitres per day
4	Overflow from coal sedimentation / filter pond to Robins Creek	-

Two additional LDPs, LDP7 and LDP8, are included in the EPL 1087 though these are located outside of the Project Area. According to the Wongawilli Colliery Annual Review reports, discharge to these LDPs only occurs during periods of very high groundwater inflow to the underground mine areas.

2.4 SURFACE WATER MONITORING PROGRAM

2.4.1 Program Description

Monitoring of surface water systems in the vicinity of the NWMD area was undertaken from September 2009 to May 2019 at the sites shown in Figure 6 and Table 4. Water quality monitoring was undertaken for two suites of parameters:

- Field analysis: pH, electrical conductivity (EC), dissolved oxygen (DO) and temperature.
- Laboratory analysis: dissolved organic carbon, total dissolved solids, dissolved sodium, dissolved calcium, dissolved potassium, dissolved magnesium, chloride, fluoride, sulphate, total metals, total phosphorus and total nitrogen.

Table 4 Surface Water Monitoring Program

Site	Watercourse	Period of Record	Type of Monitoring
AV1, AV2, AV3, AV4, AV5, AV6, AV7	Avon River	Jul 2011 – May 2016	Water quality – quarterly to six monthly field and laboratory sampling
AVD1	Upper Lake Avon	May 2012 – Dec 2012	Water quality – quarterly to six monthly field and laboratory sampling
GC1, GC2, GC3, GC4, GC5, GC6	Gallahers Creek	Jul 2011 – May 2016	Water quality – quarterly to six monthly field and laboratory sampling
Bellbird Ck US	Bellbird Ck	Apr 2010 – Mar 2015	Water quality – monthly to six monthly laboratory sampling
Bellbird CK DS		Apr 2010 – May 2019	Water quality – monthly to six monthly laboratory sampling

Water quality monitoring is also undertaken by WaterNSW at one site on Flying Fox Creek No. 3 (E604) and on the Avon River (E610) - refer Figure 6 for site locations. Grab samples have been collected approximately every six months since June 2009 with records available for a range of constituents including physicochemical properties, nutrients and some metals. The water quality records for these sites are summarised in Section 2.5.1.

The discharge rates and the quality of discharge at LDP1 and LDP2 are also required to be monitored in accordance with EPL 1087. The water quality records for the Wongawilli Colliery Mine Dam and LDP2 discharge are summarised in Section 2.5.2.

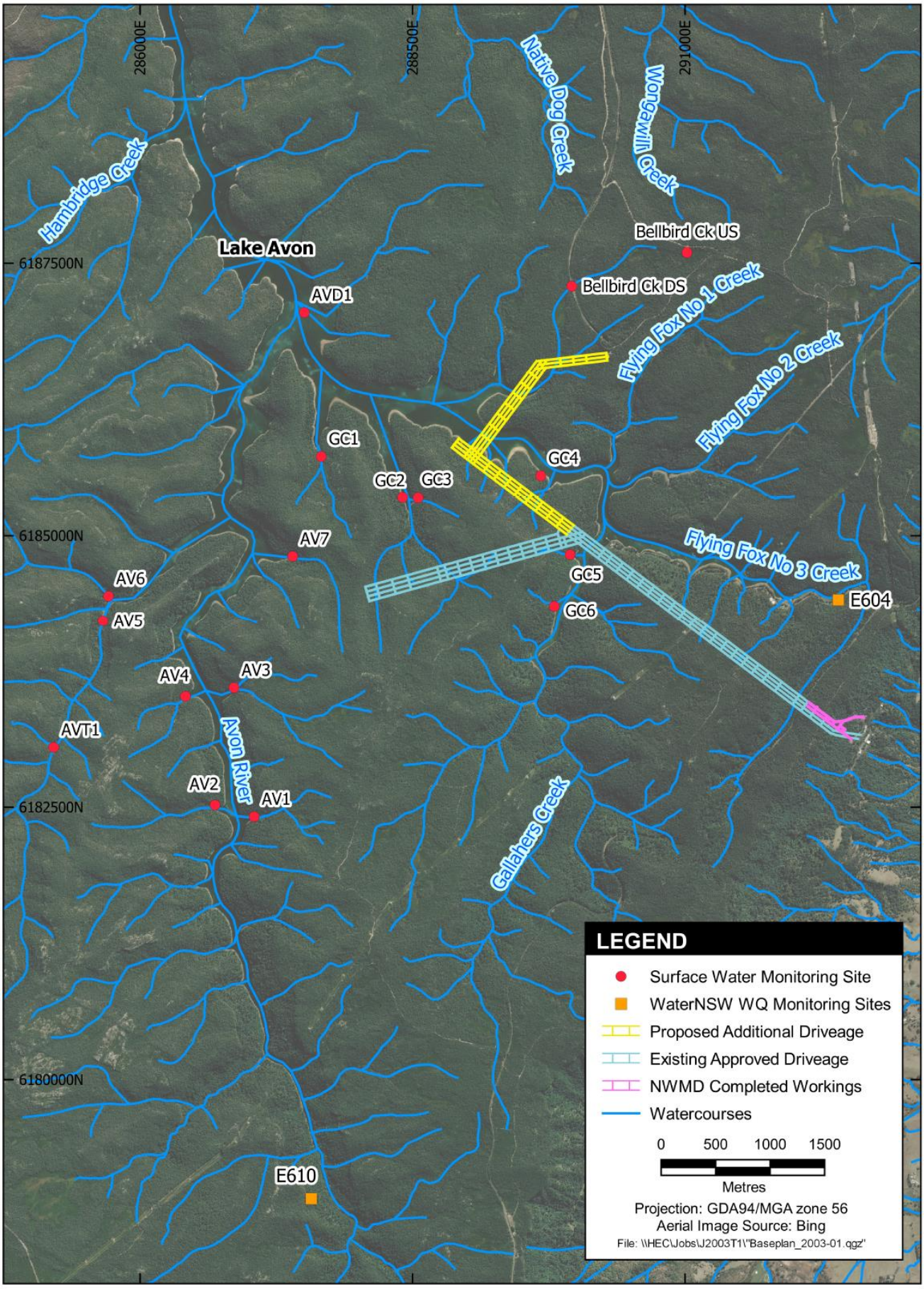

Figure 6 NWMD Surface Water Monitoring Sites

2.4.2 Water Quality Objectives

The *NSW Water Quality and River Flow Objectives* (OEH, 2006) have been developed to guide plans and actions to achieve healthy waterways in NSW. Each objective is based on providing the appropriate water quality for the environment and the different beneficial uses of the water. They are based on measurable environmental values, which are those values or uses of water that the community regards as important for a healthy ecosystem for public benefit, welfare, safety or health.

The target level of protection applied to most waterways in NSW is that for 'slightly to moderately disturbed' ecosystems, for which ANZG (2018) recommends adoption of the default guideline values for aquatic ecosystems at the 95% species protection level as water quality objectives. Updated default guideline values for toxicants have been published by ANZG (2018) and are adopted in the assessment of baseline water quality data presented in Section 2.5. Updated default guideline values are yet to be published as part of ANZG (2018) for physicochemical constituents and, as such, the water quality results for physicochemical constituents have been assessed against the ANZECC & ARMCANZ (2000) default trigger values slightly disturbed aquatic ecosystems in south-east Australian upland and lowland rivers. Upland rivers are defined as those above 150 m altitude which comprises the surface water systems within the Lake Avon catchment. Lowland rivers are defined as those at less than 150 m altitude which comprises the surface water systems in the mid to lower region of the Wongawilli Colliery.

As the Lake Avon catchment surface water monitoring sites are located in a water supply catchment, the water quality results have also been assessed against the ADWG (NHMRC, 2018) for these sites. The ADWG pertain specifically to 'health related' water quality parameters including metals, pesticides and synthetic organic compounds.

Land use in the vicinity of the Wongawilli Colliery includes rural use and, as such, the water quality results for the Wongawilli Colliery water monitoring sites have also been assessed against the ANZECC & ARMCANZ (2000) recommended guideline values for irrigation.

Table 5 summarises the relevant water quality objectives for the surface water monitoring sites in the NWMD and Wongawilli Colliery catchments.

Table 5 Water Quality Objectives for the Project Area

Parameter (mg/L unless otherwise specified)	ANZG (2018)	ANZECC & ARMCANZ (2000)			NHMRC (2018)	
	Aquatic Ecosystems (95 percent species protection level)	Upland Rivers (NSW)	Lowland Rivers (NSW)	Irrigation (long-term trigger value unless otherwise specified†)	Health	Aesthetic
pH (pH units)		6.5 - 8	6.5 – 8.5			6.5 - 8.5
Electrical Conductivity (µS/cm)		350	300	950†		
Total Dissolved Solids						600
Turbidity (NTU)		25	50			5
Dissolved Oxygen (% sat)		90 - 110	85 - 110			85
Sodium						180
Chloride				175†		250
Sulphate as SO_4						250
Total Aluminium	0.055			5		
Total Arsenic	0.024			0.1	0.01	
Total Barium					2	
Total Boron	0.37			0.5	4	
Total Cadmium	0.0002			0.01	0.002	
Total Chromium	0.001			0.1		
Total Copper	0.0014			0.2	2	1
Total Iron				0.2		0.3
Total Lead	0.0034			2	0.01	
Total Manganese	1.9			0.2	0.5	07.1
Total Mercury	0.0006			0.002	0.001	
Total Nickel	0.011			0.2		0.02
Total Selenium	0.011			0.02	0.01	
Total Zinc	0.008			2		3
Total Nitrogen		0.25	0.35	5		
Total Phosphorus		0.02	0.025	0.05		

† Trigger value for sensitive crops

The water quality objectives listed in Table 5 have been used as a basis for interpretation of the water quality data summarised in Section 2.5. Where multiple water quality objectives are specified for a parameter, the most conservative value has been adopted for comparison.

Wongawilli Colliery EPL 1087 specifies concentration limits of constituents discharged at LDP1 and LDP2 (refer Figure 4 for locations). The constituent concentration limits are specified in Table 6.

Table 6 Constituent Concentration Limits at LDP 1 and 2

Parameter	Concentration Limit	
	LDP1	LDP2
Biochemical Oxygen Demand (mg/L)	20	-
pH (pH units)	6.5 – 8.5	6.5 – 8.5
Oil and Grease (mg/L)	10	10
Total Suspended Solids [TSS] (mg/L)	30	50

2.5 WATER QUALITY MONITORING RESULTS

2.5.1 Lake Avon Catchment Surface Water Quality

Results of the WaterNSW water quality monitoring for sites on the Avon River and Flying Fox Ck No. 3 are summarised in Table 7. Results of the water quality monitoring for sites on the Avon River, Gallahers Creek and Bellbird Creek monitored by Wollongong Coal are summarised in Table 8 to Table 12 below. Where the value was below the laboratory limit of detection, the limit of detection has conservatively been adopted in the statistical analysis. The percentage of samples which exceeded the water quality objective are presented (% exceedances) and the exceeding statistic is shown in bold.

Table 7 WaterNSW Sites Water Quality Summary

Parameter (mg/L unless otherwise stated)	Water Quality Objective	Avon River – Summit Tank (E610)					Flying Fox Ck No. 3 (E604)				
		No. of Samples	Min	Median	Max	% Exceedances	No. of Samples	Min	Median	Max	% Exceedances
Field pH	6.5 – 8‡	134	**6.0**	7.0	**8.4**	9%	133	**6.2**	7.0	7.7	5%
Field EC (µS/cm)	350‡	135	45	106	174	0%	133	77	136	200	0%
Alkalinity (mg $CaCO_3$/L)	-	133	1	21	47	-	135	4	16	31	-
DO (% sat)	90 - 110%*	134	**61**	96	109	23%	133	**29**	96	110	27%
Dissolved Organic Carbon [DOC]	-	134	0.2	2.3	12.8	-	135	1.0	2.0	10.2	-
Sodium	180*	134	5	9	13	0%	135	10	13	28	0%
Chloride	250*	118	8	16	25	0%	119	13	26	32	0%
Sulphate as SO_4	250*	58	2	5	11	0%	59	2	4	8	0%
Turbidity (NTU)	5*	134	0	1	**19**	10%	133	0	1	**10**	5%
TSS	-	133	1	1	13	-	135	1	1	12	-
Total Aluminium	0.055†	134	<0.01	0.04	**0.28**	35%	135	<0.01	0.02	**0.38**	12%
Total Iron	0.3*	134	0.08	0.24	**0.66**	32%	135	0.02	0.06	**0.74**	4%
Total Manganese	0.1*	134	0.01	0.02	0.06	0%	135	<0.001	0.01	0.09	0%
Total Nitrogen	0.25‡	133	0.01	0.05	**0.34**	2%	135	0.06	0.20	**1.26**	15%
Total Phosphorus	0.02‡	133	<0.005	0.007	**0.04**	4%	135	<0.005	<0.005	**0.04**	2%

† ANZG (2018) default guideline value for aquatic ecosystems (95% level of species protection for slightly to moderately disturbed ecosystems); ‡ ANZECC & ARMCANZ (2000) default trigger value for Upland Rivers in NSW; * NHMRC (2018) aesthetic guideline value; ^ NHMRC (2018) health guideline value.

Table 8 Avon River Water Quality Summary – Upstream and Central

Parameter (mg/L unless otherwise stated)	Water Quality Objective	Avon River Upstream (AV1, AV2)					Avon River Central (AV3, AV4)				
		No. of Samples	Min	Median	Max	% Exceedances	No. of Samples	Min	Median	Max	% Exceedances
Field pH	6.5 – 8‡	24	**4.1**	**5.2**	6.9	88%	15	**4.4**	**5.4**	**5.9**	100%
Field EC (µS/cm)	350‡	24	55	70	249	0%	15	51	66	**1,179**	7%
DO	-	24	8	14	18	-	15	7	15	19	-
Total Dissolved Solids [TDS]	600*	16	22	54	89	0%	13	33	59	90	0%
Sodium	180*	16	9	10	14	0%	13	9	10	13	0%
Chloride	250*	16	16	19	27	0%	13	16	20	28	0%
Sulphate as SO_4	250*	16	1	2	9	0%	13	1	2	2	0%
Total Aluminium	0.055†	14	0.03	**0.06**	**0.1**	57%	11	0.03	**0.08**	**0.72**	82%
Total Arsenic	0.01^	14	<0.001	<0.001	<0.001	0%	11	<0.001	<0.001	<0.001	0%
Total Barium	2^	14	0.001	0.008	0.021	0%	11	0.001	0.004	0.026	0%
Total Cadmium	0.0002†	14	<0.0001	<0.0001	**0.001**	14%	11	<0.0001	<0.0001	**0.003**	27%
Total Chromium	0.001†	14	<0.001	<0.001	**0.003**	7%	11	<0.0001	<0.001	**0.005**	18%
Total Copper	0.0014†	14	<0.001	<0.001	**0.014**	21%	11	<0.001	<0.001	**0.027**	36%
Total Iron	0.3*	16	<0.05	<0.05	0.13	0%	13	<0.05	<0.05	**1.8**	8%
Total Lead	0.0034†	14	<0.001	<0.001	**0.013**	14%	11	<0.001	<0.001	**0.008**	27%
Total Lithium	-	14	<0.001	<0.001	0.002	-	11	<0.001	<0.001	0.002	-
Total Manganese	0.1*	14	0.014	0.021	0.041	0%	11	0.007	0.019	0.064	0%
Total Nickel	0.011†	14	<0.001	<0.001	0.007	0%	11	<0.001	<0.001	0.007	0%
Total Selenium	0.01^	14	<0.01	<0.01	<0.01	0%	11	<0.01	<0.01	<0.01	0%

† ANZG (2018) default guideline value for aquatic ecosystems (95% level of species protection for slightly to moderately disturbed ecosystems); ‡ ANZECC & ARMCANZ (2000) default trigger value for Upland Rivers in NSW; * NHMRC (2018) aesthetic guideline value; ^ NHMRC (2018) health guideline value.

Table 8 (Cont.) Avon River Water Quality Summary – Upstream and Central

Parameter (mg/L unless otherwise stated)	Water Quality Objective	Avon River Upstream (AV1, AV2)					Avon River Central (AV3, AV4)				
		No. of Samples	Min	Median	Max	% Exceedances	No. of Samples	Min	Median	Max	% Exceedances
Total Strontium	-	14	0.002	0.005	0.007	-	11	0.001	0.004	0.015	-
Total Zinc	0.008†	14	<0.005	0.008	**0.071**	36%	11	<0.005	**0.011**	**0.117**	55%
Total Nitrogen	0.25‡	16	0.04	**0.3**	**1**	56%	13	0.2	**0.3**	**9.8**	69%
Total Phosphorus	0.02‡	16	<0.01	<0.01	**0.14**	13%	13	<0.01	<0.01	**0.04**	8%

† ANZG (2018) default guideline value for aquatic ecosystems (95% level of species protection for slightly to moderately disturbed ecosystems); ‡ ANZECC & ARMCANZ (2000) default trigger value for Upland Rivers in NSW; * NHMRC (2018) aesthetic guideline value; ^ NHMRC (2018) health guideline value.

Table 9 Avon River Water Quality Summary – Downstream

Parameter (mg/L unless otherwise stated)	Water Quality Objective	Avon River Downstream (AV5, AV6, AV7 and AVT1)					Lake Avon (AVD1)				
		No. of Samples	Min	Median	Max	% Exceedances	No. of Samples	Min	Median	Max	% Exceedances
Field pH	6.5 – 8‡	50	**4.6**	**5.7**	**9.2**	82%	10	**5.1**	**6.0**	7.5	80%
Field EC (µS/cm)	350‡	50	43	73	**966**	2%	10	56	74	96	0%
DO	-	50	6	15	22	-	10	13	19	25	-
TDS	600*	36	10	50	96	0%	6	32	46	53	0%
Sodium	180*	36	7	10	13	0%	6	9	10	10	0%
Chloride	250*	35	12	21	28	0%	6	12	15	18	0%
Sulphate as SO_4	250*	35	1.0	2.0	4.0	0%	6	3.0	3.5	4.0	0%
Total Aluminium	0.055†	29	0.02	0.05	**0.12**	34%	6	0.01	0.01	0.05	0%
Total Arsenic	0.01^	32	<0.001	<0.001	<0.001	0%	6	<0.001	<0.001	<0.001	0%
Total Barium	2^	32	0.001	0.007	0.011	0%	6	0.003	0.008	0.014	0%
Total Cadmium	0.0002†	32	<0.0001	<0.0001	**0.001**	16%	6	<0.0001	<0.0001	**0.0003**	17%
Total Chromium	0.001†	32	<0.001	<0.001	**0.005**	3%	6	<0.001	<0.001	<0.001	0%
Total Copper	0.0014†	32	<0.001	<0.001	**0.01**	13%	6	<0.001	<0.001	<0.001	0%
Total Iron	0.3*	36	<0.05	0.07	**1.12**	11%	6	<0.05	<0.05	0.09	0%
Total Lead	0.0034†	32	<0.001	<0.001	**0.004**	6%	6	<0.001	<0.001	<0.001	0%
Total Lithium	-	32	<0.001	<0.001	0.002	-	6	<0.001	<0.001	<0.001	-
Total Manganese	0.1*	34	0.014	0.039	**0.237**	9%	6	0.009	0.019	0.058	0%
Total Nickel	0.011†	32	<0.001	<0.001	**0.022**	3%	6	<0.001	<0.001	<0.001	0%
Total Selenium	0.01^	32	<0.01	<0.01	<0.01	0%	6	<0.01	<0.01	<0.01	0%

† ANZG (2018) default guideline value for aquatic ecosystems (95% level of species protection for slightly to moderately disturbed ecosystems); ‡ ANZECC & ARMCANZ (2000) default trigger value for Upland Rivers in NSW; * NHMRC (2018) aesthetic guideline value; ^ NHMRC (2018) health guideline value.

Table 9 (Cont.) Avon River Water Quality Summary – Downstream

Parameter (mg/L unless otherwise stated)	Water Quality Objective	Avon River Downstream (AV5, AV6)					Lake Avon (AVD1)				
		No. of Samples	Min	Median	Max	% Exceedances	No. of Samples	Min	Median	Max	% Exceedances
Total Strontium	-	31	<0.001	0.005	0.01	-	6	0.008	0.016	0.018	-
Total Zinc	0.008†	32	<0.005	0.006	**0.281**	25%	6	<0.005	<0.005	**0.019**	33%
Total Nitrogen	0.25‡	36	0.1	0.2	**1.9**	42%	6	0.1	0.2	**0.4**	33%
Total Phosphorus	0.02‡	36	<0.01	<0.01	**0.14**	19%	6	<0.01	<0.01	<0.01	0%

† ANZG (2018) default guideline value for aquatic ecosystems (95% level of species protection for slightly to moderately disturbed ecosystems); ‡ ANZECC & ARMCANZ (2000) default trigger value for Upland Rivers in NSW; * NHMRC (2018) aesthetic guideline value; ^ NHMRC (2018) health guideline value.

Table 10 Gallahers Creek Water Quality Summary - Upstream

Parameter (mg/L unless otherwise stated)	Water Quality Objective	Gallahers Creek (GC4)					Gallahers Creek (GC5, GC6)				
		No. of Samples	Min	Median	Max	% Exceedances	No. of Samples	Min	Median	Max	% Exceedances
Field pH	6.5 – 8‡	9	**4.4**	**5.7**	**5.9**	100%	15	**3.9**	**5.0**	**6.0**	100%
Field EC (µS/cm)	350‡	9	76	101	**1,588**	11%	15	69	110	**2,224**	13%
DO	-	9	10	16	18	-	15	8	16	18	-
TDS	600*	7	52	61	87	0%	13	44	73	508	0%
Sodium	180*	7	12	14	15	0%	13	12	14	16	0%
Chloride	250*	7	22	25	33	0%	13	22	27	34	0%
Sulphate as SO_4	250*	7	1.0	2.0	2.0	0%	13	1.0	3.0	4.0	0%
Total Aluminium	0.055†	5	0.04	0.05	**0.09**	40%	10	0.04	**0.12**	**0.28**	90%
Total Arsenic	0.01^	6	<0.001	<0.001	<0.001	0%	11	<0.001	<0.001	<0.001	0%
Total Barium	2^	6	0.003	0.011	0.015	0%	11	0.004	0.012	0.019	0%
Total Cadmium	0.0002†	6	<0.0001	<0.0001	<0.0001	0%	11	<0.0001	<0.0001	**0.0013**	18%
Total Chromium	0.001†	6	<0.001	<0.001	<0.001	0%	11	<0.001	<0.001	**0.007**	9%
Total Copper	0.0014†	6	<0.001	<0.001	**0.002**	17%	11	<0.001	<0.001	**0.019**	18%
Total Iron	0.3*	7	<0.05	<0.05	<0.05	0%	13	<0.05	<0.05	<0.05	0%
Total Lead	0.0034†	6	<0.001	<0.001	**0.01**	17%	11	<0.001	<0.001	**0.01**	9%
Total Lithium	-	6	0.002	0.003	0.004	-	11	<0.001	0.003	0.004	-
Total Manganese	0.1*	6	0.024	0.04	0.063	0%	11	0.022	0.043	**0.118**	18%
Total Nickel	0.011†	6	<0.001	0.002	0.002	0%	11	<0.001	0.002	0.010	0%
Total Selenium	0.01^	6	<0.01	<0.01	<0.01	0%	11	<0.01	<0.01	<0.01	0%

† ANZG (2018) default guideline value for aquatic ecosystems (95% level of species protection for slightly to moderately disturbed ecosystems); ‡ ANZECC & ARMCANZ (2000) default trigger value for Upland Rivers in NSW; * NHMRC (2018) aesthetic guideline value; ^ NHMRC (2018) health guideline value.

Table 10 (Cont.) Gallahers Creek Water Quality Summary – Upstream

Parameter (mg/L unless otherwise stated)	Water Quality Objective	Gallahers Creek (GC4)					Gallahers Creek (GC5, GC6)				
		No. of Samples	Min	Median	Max	% Exceedances	No. of Samples	Min	Median	Max	% Exceedances
Total Strontium	-	6	0.004	0.009	0.012	-	11	0.004	0.008	0.013	-
Total Zinc	0.008†	6	<0.005	0.007	**0.016**	33%	11	<0.005	**0.01**	**0.108**	55%
Total Nitrogen	0.25‡	7	0.1	0.2	**0.5**	43%	13	0.1	0.2	**0.6**	23%
Total Phosphorus	0.02‡	7	<0.01	<0.01	**0.15**	29%	13	<0.01	0.02	**0.17**	38%

† ANZG (2018) default guideline value for aquatic ecosystems (95% level of species protection for slightly to moderately disturbed ecosystems); ‡ ANZECC & ARMCANZ (2000) default trigger value for Upland Rivers in NSW; * NHMRC (2018) aesthetic guideline value; ^ NHMRC (2018) health guideline value.

Table 11 Gallahers Creek Water Quality Summary - Downstream

Parameter (mg/L unless otherwise stated)	Water Quality Objective	Gallahers Creek (GC1)					Gallahers Creek (GC2, GC3)				
		No. of Samples	Min	Median	Max	% Exceedances	No. of Samples	Min	Median	Max	% Exceedances
Field pH	6.5 – 8‡	9	**4.6**	**5.1**	7.0	89%	20	**4.3**	**5.5**	**6.3**	100%
Field EC (µS/cm)	350‡	9	61	74	**455**	11%	20	52	76	**1,110**	10%
DO	-	9	7	16	19	-	20	8	16	23	-
TDS	600*	7	26	45	73	0%	15	22	40	101	0%
Sodium	180*	7	9	12	14	0%	15	8	12	14	0%
Chloride	250*	7	15	20	26	0%	15	13	21	27	0%
Sulphate as SO_4	250*	7	1.0	2.0	2.0	0%	15	1.0	2.0	3.0	0%
Total Aluminium	0.055†	5	0.03	0.05	**0.07**	40%	11	0.01	0.04	**0.12**	45%
Total Arsenic	0.01^	6	<0.001	<0.001	<0.001	0%	13	<0.001	<0.001	<0.001	0%
Total Barium	2^	6	0.001	0.003	0.008	0%	13	0.002	0.007	0.012	0%
Total Cadmium	0.0002†	6	<0.0001	<0.0001	**0.001**	17%	12	<0.0001	<0.0001	<0.0001	0%
Total Chromium	0.001†	6	<0.001	<0.001	<0.001	0%	12	<0.001	<0.001	<0.001	0%
Total Copper	0.0014†	6	<0.001	<0.001	<0.001	0%	13	<0.001	<0.001	<0.001	0%
Total Iron	0.3*	7	<0.05	<0.05	<0.05	0%	15	<0.05	<0.05	0.16	0%
Total Lead	0.0034†	6	<0.001	<0.001	0.002	0%	13	<0.001	<0.001	<0.001	0%
Total Lithium	-	6	<0.001	<0.001	<0.001	-	13	<0.001	<0.001	0.002	-
Total Manganese	0.1*	6	0.010	0.017	0.022	0%	13	0.011	0.018	0.026	0%
Total Nickel	0.011†	6	<0.001	<0.001	<0.001	0%	13	<0.001	<0.001	0.002	0%
Total Selenium	0.01^	6	<0.01	<0.01	<0.01	0%	12	<0.01	<0.01	<0.01	0%

† ANZG (2018) default guideline value for aquatic ecosystems (95% level of species protection for slightly to moderately disturbed ecosystems); ‡ ANZECC & ARMCANZ (2000) default trigger value for Upland Rivers in NSW; * NHMRC (2018) aesthetic guideline value; ^ NHMRC (2018) health guideline value.

Table 11 (Cont.) Gallahers Creek Water Quality Summary – Downstream

Parameter (mg/L unless otherwise stated)	Water Quality Objective	Gallahers Creek (GC1)					Gallahers Creek (GC2, GC3)				
		No. of Samples	Min	Median	Max	% Exceedances	No. of Samples	Min	Median	Max	% Exceedances
Total Strontium	-	6	0.001	0.003	0.004	-	13	0.002	0.004	0.011	-
Total Zinc	0.008†	6	<0.005	<0.005	**0.014**	17%	13	<0.005	0.006	**0.017**	8%
Total Nitrogen	0.25‡	7	0.1	0.2	**2.8**	43%	15	0.1	0.1	**0.9**	33%
Total Phosphorus	0.02‡	7	<0.01	<0.01	**0.07**	29%	15	<0.01	<0.01	**0.07**	27%

† ANZG (2018) default guideline value for aquatic ecosystems (95% level of species protection for slightly to moderately disturbed ecosystems); ‡ ANZECC & ARMCANZ (2000) default trigger value for Upland Rivers in NSW; * NHMRC (2018) aesthetic guideline value; ^ NHMRC (2018) health guideline value.

Table 12 Bellbird Creek Water Quality Summary

Parameter (mg/L unless otherwise stated)	Water Quality Objective	Bellbird Creek Upstream					Bellbird Creek Downstream				
		No. of Samples	Min	Median	Max	% Exceedances	No. of Samples	Min	Median	Max	% Exceedances
TDS	600*	20	34	50	72	0%	35	30	45	68	0%
Sodium	180*	20	6	10	13	0%	35	6	9	13	0%
Chloride	250*	20	12	19	24	0%	35	9	16	24	0%
Sulphate as SO_4	250*	20	1	1	6	0%	35	1	3	4	0%
Total Aluminium	0.055†	19	0.03	**0.30**	**0.36**	89%	31	0.01	**0.15**	**0.28**	84%
Total Arsenic	0.01^	20	0.001	0.001	0.01	0%	34	0.001	0.001	**0.03**	3%
Total Barium	2^	20	<0.001	0.002	0.01	0%	35	<0.001	0.002	0.01	0%
Total Copper	0.0014†	20	<0.001	<0.001	**0.002**	10%	34	<0.001	<0.001	**0.002**	3%
Total Iron	0.3*	20	<0.01	0.3	**1.3**	50%	35	<0.05	**0.4**	**3.1**	54%
Total Lead	0.0034†	20	<0.001	<0.001	<0.001	0%	34	<0.001	<0.001	<0.001	0%
Total Lithium	-	20	<0.001	<0.001	0.01	-	34	<0.001	<0.001	0.05	-
Total Manganese	0.1*	20	0.002	0.01	0.1	0%	35	0.006	0.02	0.1	0%
Total Nickel	0.011†	20	<0.001	<0.001	0.0	0%	34	<0.001	<0.001	0.0	0%
Total Strontium	-	20	<0.002	<0.003	0.02	-	35	<0.002	<0.004	0.03	-
Total Zinc	0.008†	20	0.005	**0.01**	**0.018**	55%	34	0.005	**0.01**	**0.018**	12%
Total Nitrogen	0.25‡	20	0.1	**0.4**	**3.8**	75%	35	0.1	0.1	**8.8**	20%
Total Phosphorus	0.02‡	20	<0.01	0.02	**0.5**	35%	34	<0.01	<0.01	**0.3**	29%

† ANZG (2018) default guideline value for aquatic ecosystems (95% level of species protection for slightly to moderately disturbed ecosystems); ‡ ANZECC & ARMCANZ (2000) default trigger value for Upland Rivers in NSW; * NHMRC (2018) aesthetic guideline value; ^ NHMRC (2018) health guideline value.

The data in Table 7 indicates that slightly acidic to slightly alkaline conditions have been recorded at the Avon River – Summit Tank (E610) monitoring site, with 9% of samples either lower or higher than the ANZECC & ARMCANZ (2000) lower and upper default trigger value for pH for upland rivers in NSW. The pH values recorded at Flying Fox Ck No. 3 (E604) indicate slightly acidic to near neutral conditions with 5% of samples recording lower values than the ANZECC & ARMCANZ (2000) lower default trigger value for pH for upland rivers in NSW.

The NHMRC (2018) aesthetic guideline value for turbidity was exceeded in 10% of the Avon River – Summit Tank (E610) samples and 5% of the Flying Fox Ck No. 3 (E604) samples, however the turbidity levels at both sites did not exceed the ANZECC & ARMCANZ (2000) default trigger value for upland rivers in NSW. Exceedances of the ANZG (2018) default guideline values for total aluminium were recorded in 35% of samples from the Avon River – Summit Tank (E610) and 12% of samples from Flying Fox Ck No. 3 (E604). Exceedances of the NHMRC (2018) aesthetic guideline value for total iron and the ANZECC & ARMCANZ (2000) default trigger value for total nitrogen and total phosphorus were also recorded at both sites.

The data in Table 8 and Table 9 show that the pH along the reach of the Avon River from monitoring site AV1 (upstream) to monitoring site AVD1 (upper Lake Avon) ranges widely from acidic to alkaline. The ANZECC & ARMCANZ (2000) default trigger value for pH was exceeded in 88% of samples recorded at the upstream monitoring sites (AV1, AV2), 100% of samples recorded at the central monitoring sites (AV3, AV4) and 82% of samples recorded at the downstream monitoring sites (AV5, AV6, AV7 and AVT1). At the Lake Avon (AVD1) monitoring site, 80% of recorded pH values were below the lower ANZECC & ARMCANZ (2000) default trigger value.

The pH of water in the Upper Nepean catchment has been found to be invariably below the ANZECC & ARMCANZ (2000) default trigger value of pH 6.5 (WaterNSW, 2018a). The low pH arises naturally due to the equilibration of waters with silicic acid derived from dissolution of silica and the leaching of small concentrations of low molecular weight organic acids from peats and other organic matter (Ecoengineers, 2007).

The EC values recorded at the Avon River and Lake Avon sites were generally less than the ANZECC & ARMCANZ (2000) default trigger value for upland rivers in NSW of 350 µS/cm except at the central Avon River sites (AV3, AV4) where the default trigger value was exceeded in 7% of samples and at the downstream Avon River sites (AV5, AV6, AV7 and AVT1) where the default trigger value was exceeded in 2% of samples.

At the upstream Avon River sites (AV1, AV2), the ANZG (2018) default guideline value for protection of aquatic ecosystems was exceeded for 57% of total aluminium concentrations, 14% of total cadmium concentrations, 7% of total chromium concentrations, 21% of total copper concentrations, 14% of total lead and 36% of total zinc concentrations. At the central Avon River sites (AV3, AV4), the ANZG (2018) default guideline value for protection of aquatic ecosystems was exceeded for 82% of total aluminium concentrations, 27% of total cadmium concentrations, 18% of total chromium concentrations, 36% of total copper concentrations, 27% of total lead concentrations and 55% of total zinc concentrations. At the downstream Avon River sites (AV5, AV6, AV7 and AVT1), the ANZG (2018) default guideline value for protection of aquatic ecosystems was exceeded for 34% of total aluminium concentrations, 16% of total cadmium concentrations, 3% of total chromium concentrations, 13% of total copper concentrations, 6% of total lead concentrations, 3% of total nickel concentrations and 25% of total zinc concentrations. At the upper Lake Avon (AVD1) site, only the ANZG (2018) default guideline value for protection of aquatic ecosystems for total cadmium and total zinc were exceeded (17% and 33% of samples respectively).

The NHMRC (2018) aesthetic guideline value for total iron was exceeded in 8% of samples from the Avon River central sites (AV3, AV4) and 11% of samples from the Avon River downstream sites

(AV5, AV6, AV7 and AVT1). Exceedances of the ANZECC & ARMCANZ (2000) default trigger value for total nitrogen and total phosphorus in upland rivers in NSW were also recorded at all Avon River sites and the Lake Avon (AVD1) site.

The data in Table 10 and Table 11 show that the pH along the reach of Gallahers Creek from monitoring site GC6 (upstream) to monitoring site GC1 (downstream) typically ranged from acidic to slightly acidic. The ANZECC & ARMCANZ (2000) lower default trigger value for pH for upland rivers in NSW was exceeded in 100% of samples from upstream Gallahers Creek sites (GC4, GC5, GC6), 100% of samples from downstream Gallahers Creek sites (GC2, GC3) and 89% of samples from GC1 (Gallahers Creek downstream).

The ANZECC & ARMCANZ (2000) default trigger value for EC in upland rivers in NSW was exceeded in 11% and 13% of samples from upstream Gallahers Creek sites (GC4 and GC5, GC6 respectively) and in 11% and 10% of samples from downstream Gallahers Creek sites (GC1 and GC2, GC3 respectively). Exceedances of the ANZECC & ARMCANZ (2000) default trigger value for total nitrogen and total phosphorus were also recorded at all sites on Gallahers Creek.

At the upstream Gallahers Creek site (GC4), the ANZG (2018) default guideline value for protection of aquatic ecosystems was exceeded for 40% of total aluminium concentrations, 17% of total copper concentrations, 17% of total lead and 33% of total zinc concentrations. At the upstream Gallahers Creek sites (GC5, GC6), the ANZG (2018) default guideline value for protection of aquatic ecosystems was exceeded for 90% of total aluminium concentrations, 18% of total cadmium concentrations, 9% of total chromium concentrations, 18% of total copper concentrations, 9% of total lead concentrations and 55% of total zinc concentrations.

At the downstream Gallahers Creek site (GC1), the ANZG (2018) default guideline value for protection of aquatic ecosystems was exceeded for 40% of total aluminium concentrations, 17% of total cadmium concentrations and 17% of total zinc concentrations. At the downstream Gallahers Creek sites (GC2, GC3), the ANZG (2018) default guideline value for protection of aquatic ecosystems was exceeded for 45% of total aluminium concentrations and 8% of total zinc concentrations.

The water quality records for Bellbird Creek upstream and downstream monitoring sites, summarised in Table 12, were consistent with the records for Avon River and Gallahers Creek with exceedances of the default guideline values recorded for total aluminium, total copper, total iron, total zinc, total nitrogen and total phosphorus. One exceedance of the ANZG (2018) default guideline value for total arsenic was recorded at the Bellbird Creek downstream site.

2.5.2 Wongawilli Colliery Water Quality

In accordance with EPL 1087, monitoring of the water quality of discharge to LDP1 is undertaken when water is discharged. According to the Wongawilli Colliery Annual Review reports, there has been no discharge via LDP1 since prior to 2011. Results of the water quality monitoring for the Mine Dam and LDP2 are presented in Table 13.

Where the value was below the laboratory limit of detection, the limit of detection has conservatively been adopted in the statistical analysis. The percentage of samples which exceeded the water quality objective are presented (% exceedances) and the exceeding statistic is shown in bold.

Table 13 Wongawilli Colliery Water Quality Summary

Parameter (mg/L unless otherwise stated)	Water Quality Objective	Mine Dam					LDP2[#]				
		No. of Samples	Min	Median	Max	% Exceedances	No. of Samples	Min	Median	Max	% Exceedances
Biological Oxygen Demand	-	15	2	4	7	-	4	2	-	3	-
pH	6.5 – 8.5[‡#]	27	7.3	**8.9**	**10**	100%	61	7.2	7.6	**8.6**	100%
Oil and grease	10[#]	27	1	5	9	-	61	5	5	**12**	-
TSS	50[‡#]	27	5	8	108	-	61	5	9	132	-
EC (µS/cm)	300[‡]	27	**570**	**1,070**	**1,820**	100%	61	**607**	**1,800**	**2,110**	100%
Turbidity (NTU)	50[‡]	24	1	7	40	0%	13	2	12	**357**	8%
Calcium	-	14	13	28	44	-	4	40	-	49	-
Chloride	175°	11	24	47	64	0%	5	24	42	44	0%
Sulphate as SO_4	-	1	49	-	49	-	1	118	-	118	-
Total Aluminium	0.055[†]	15	0.01	0.05	**0.49**	40%	4	0.03	-	**0.38**	75%
Total Arsenic	0.024[†]	15	0.00	0.00	0.01	0%	4	0.001	-	0.01	0%
Total Barium	-	15	0.31	0.54	0.86	-	4	0.12	-	1.65	-
Total Boron	0.37[†]	5	<0.033	0.05	0.05	0%	-	-	-	-	-
Total Copper	0.0014[†]	9	<0.001	<0.001	**0.02**	44%	3	<0.001	-	**0.02**	67%
Total Iron	0.2°	16	<0.05	0.20	**0.83**	50%	5	0.06	**0.38**	**1.93**	60%
Total Lead	0.0034[†]	15	<0.001	<0.001	<0.001	0%	4	<0.001	-	<0.001	0%
Total Lithium	-	5	0.06	0.07	0.08	-	-	-	-	-	-
Total Manganese	1.9[†]	16	0.01	0.06	0.56	0%	5	0.01	0.09	0.25	0%
Total Mercury	0.0006[†]	15	<0.0001	<0.0001	<0.0001	0%	4	<0.0001	-	<0.0001	0%
Total Nickel	0.011[†]	15	<0.001	0.002	0.01	0%	4	<0.001	-	0.003	0%
Total Strontium	-	10	0.7	1.0	1.2	-	4	0.5	-	1.7	-
Total Zinc	0.008[†]	15	<0.005	<0.005	<0.005	0%	4	0.01	-	**0.06**	75%

[†] ANZG (2018) default guideline value for aquatic ecosystems (95% level of species protection for slightly to moderately disturbed ecosystems); [‡] ANZECC & ARMCANZ (2000) default trigger value for Lowland Rivers in NSW; [#] EPL 1087 constituent limits for LDP2; ° ANZECC & ARMCANZ (2000) guideline value for irrigation.

The data in Table 13 indicates that the water quality of the Mine Dam and the discharge to LDP2 ranges from near neutral to alkaline pH conditions. There has been one exceedance of the EPL 1087 constituent limits for pH, turbidity and oil and grease at LDP2 during the period of monitoring. The exceedance was reported to the NSW Environment Protection Authority (EPA) and documented in the Annual Review report (Wollongong Coal, 2020).

The concentrations of total aluminium recorded in 40% of samples collected from the Mine Dam and 75% of samples collected from LDP2 exceeded the ANZG (2018) default guideline values for aquatic ecosystems. Total copper concentrations also exceeded the ANZG (2018) default guideline values for aquatic ecosystems in 44% of samples collected from the Mine Dam and 67% of samples collected from LDP2. The concentrations of total zinc recorded in 75% of samples collected from LDP2 exceeded the ANZG (2018) default guideline values for aquatic ecosystems. It should be noted that these constituents naturally exceed the ANZG (2018) default guideline values for aquatic ecosystems as evidenced by the water quality monitoring results for surface water sites in the Lake Avon catchment (refer Section 2.5.1).

The electrical conductivity values recorded in all samples collected from the Mine Dam and at LDP2 exceeded the ANZECC & ARMCANZ (2000) default trigger value for lowland rivers in NSW of 300 µS/cm. The EC values of some surface water systems in the vicinity of the Wongawilli Colliery have naturally exceeded the ANZECC & ARMCANZ (2000) default trigger value at times as evidenced by the water quality monitoring results for surface water sites in the Lake Avon catchment (refer Section 2.5.1).

3.0 SURFACE WATER MANAGEMENT SYSTEM

3.1 EXISTING OPERATIONAL WATER MANAGEMENT SYSTEM

The water management system for the Wongawilli Colliery is shown in Figure 7. The water management system has been designed such that runoff from undisturbed and disturbed areas are separated and managed independently. Performance measures and criteria have been developed for the Wongawilli Colliery and comprise the following (Wollongong Coal, 2019a):

1. Minimisation of the use of potable water the increased usage of recycled and on-site water;
2. Prevention of water contamination through the effective implementation and maintenance of containment systems;
3. Prevention of surface water discharges above discharge limits;
4. Effective erosion control for all activities; and
5. Effective operation of the site water management system.

The site water management system comprises discrete water systems as follows and illustrated in Figure 8:

- surface water runoff management;
- mine dewatering from underground workings;
- potable water supply; and
- wastewater management.

3.1.1 Surface Water Management

Management of surface water runoff at the Wongawilli Colliery surface facilities is undertaken as follows (Wollongong Coal, 2019a):

1. Disturbed areas of the Colliery which include existing mine benches, work areas and access tracks have surface drainage infrastructure to direct disturbed area runoff to the Colliery's water management system.
2. Undisturbed areas of the Colliery outside of the existing cleared mine benches, work areas and access tracks have surface water drainage infrastructure to direct undisturbed area runoff to local surface water systems and off-site.

Runoff from the escarpment upslope of the mine facilities is diverted around the Colliery operations by a system of diversion drains which connect with local watercourses. An internal drainage system captures and directs runoff that potentially contains coal fines and sediment (from the upper pit top area, decline conveyor and coal storage/loading bins) to a series of sedimentation ponds for coarse particles to settle out (Decline Dam, Decline Surcharge Dam, Elevator Pit, Stackout Pit, Rail Sedimentation Pond). The drainage infrastructure comprises open drains and concrete sub-surface pipes and pits which have been designed to reduce erosional impacts (Wollongong Coal, 2019a).

Runoff from the coal stockpile area (along with overflows from the above sedimentation ponds) passes through two sediment ponds (Primary Treatment Settlement Pond and Secondary Treatment Settlement Pond) before discharging to the Filter Lagoon. Runoff from the coal refuse station is conveyed to Pond C and pumped to the Filter Lagoon. Excess water stored in the Filter Lagoon discharges to Robins Creek via LDP4 in accordance with EPL 1087 licence conditions.

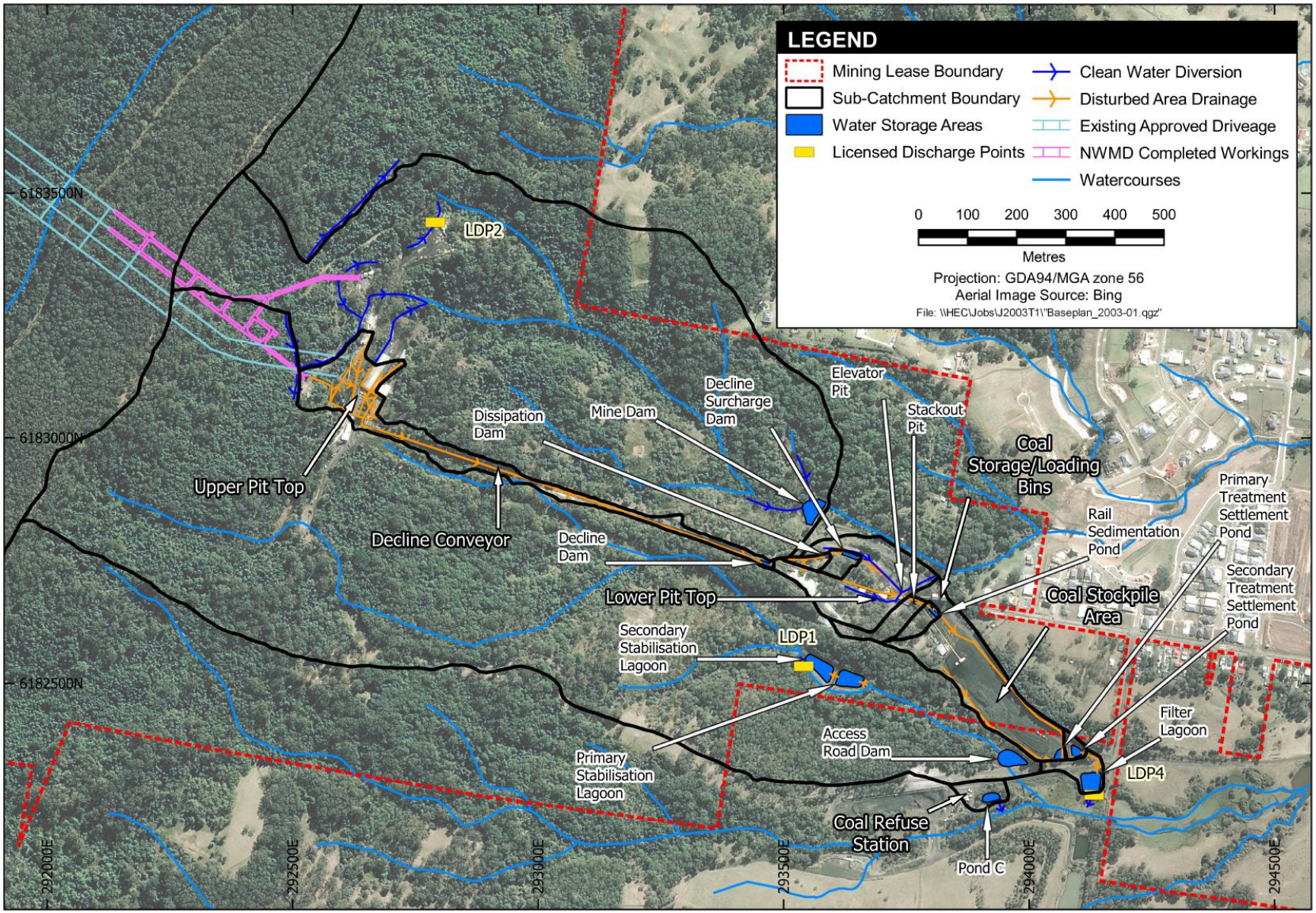

Figure 7 Wongawilli Colliery Water Management System

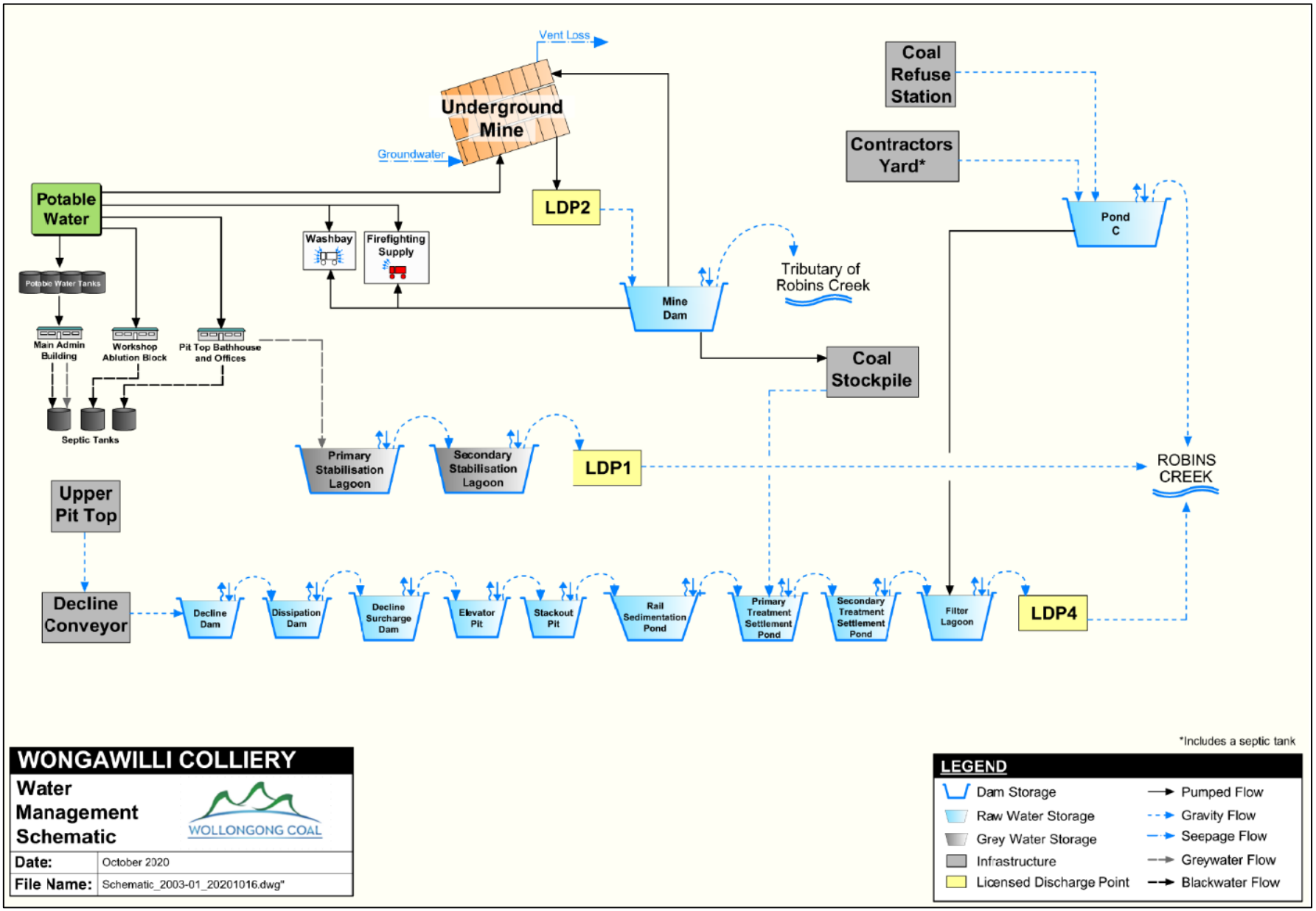

Figure 8 Wongawilli Colliery Conceptual Water Management System Schematic

Pond C and the series of sedimentation ponds from the decline conveyor to LDP4 were designed and are managed in accordance with guidelines in Landcom (2004) and DECC (2008) as follows (WRM, 2010):

- Type D or F sediment retention basin;
- sediment dams to be in place for more than three years;
- adequate settling zone capacity to capture runoff from a 90th percentile 5-day duration rainfall event (Department of Environment and Climate Change [DECC], 2008) of 59.8 mm (Albion Park 5-day rainfall depth in Table 6.3a of Landcom, 2004);
- a volumetric runoff coefficient of 0.68 (WRM, 2010);
- allowance for sediment storage zone capacity equal to 50% of the above calculated settling zone capacity; and
- sufficient pumping capacity to empty the dam within 5 days or rainfall.

Table 14 summarises the characteristics of the main water storages at the Wongawilli Colliery.

Table 14 Main Water Management System Storages

Water Management Structure	Sub Catchment Description	Cumulative Catchment Area (ha)	Estimated Storage Capacity (ML)
Mine Dam	Underground dewatering and undisturbed catchment	57.8	3.1
Decline Dam	Decline conveyor	4.3	0.4
Decline Surcharge Dam		4.7	0.6
Rail Sedimentation Pond	Disused bathhouse area, elevator pit and stackout pit	9.1	0.3
Primary Sedimentation Pond	Coal stockpile	13.1	0.6
Secondary Treatment Sedimentation Pond	Rail area	13.3	1.2
Filter Lagoon	Lagoon Area	13.9	5.8
Pond C	Coal refuse station	0.5	2.2

3.1.2 Mine Dewatering from Underground Workings

Groundwater dewatering, along with excess water sent to the underground for water supply purposes, is pumped to the surface and discharged into a concrete drainage channel at LDP2. The concrete drainage channel discharges to an unnamed tributary of Robins Creek which flows to the Mine Dam. Groundwater inflow to the NWMD area comprises a relatively small component of the total groundwater inflow dewatering from the underground workings and discharged to LDP2 (ERM, 2010).

Water is recycled back to the underground mine and extracted from the Mine Dam for coal stockpile dust suppression, firefighting purposes and vehicle washdown. An estimated 90 megalitres per year (ML/year) of water is extracted from the Mine Dam for use at the Wongawilli Colliery (WRM, 2010). Overflow from the Mine Dam discharges via a spillway to a tributary of Robins Creek.

As stated in Section 2.3.3, the EPL 1087 discharge limit at LDP2 is 10,000 kilolitres per day (kL/day). Figure 9 presents the daily recorded discharge rates to LDP2 from April 2015 to February 2020.

Over the period of record, the average discharge rate was 2,091 kL/day and the maximum discharge rate was 5,626 kL/day. The maximum annual discharge volume was 860 ML in 2017. The records indicate that there have been no exceedances of the EPL 1087 daily discharge limit at LDP2.

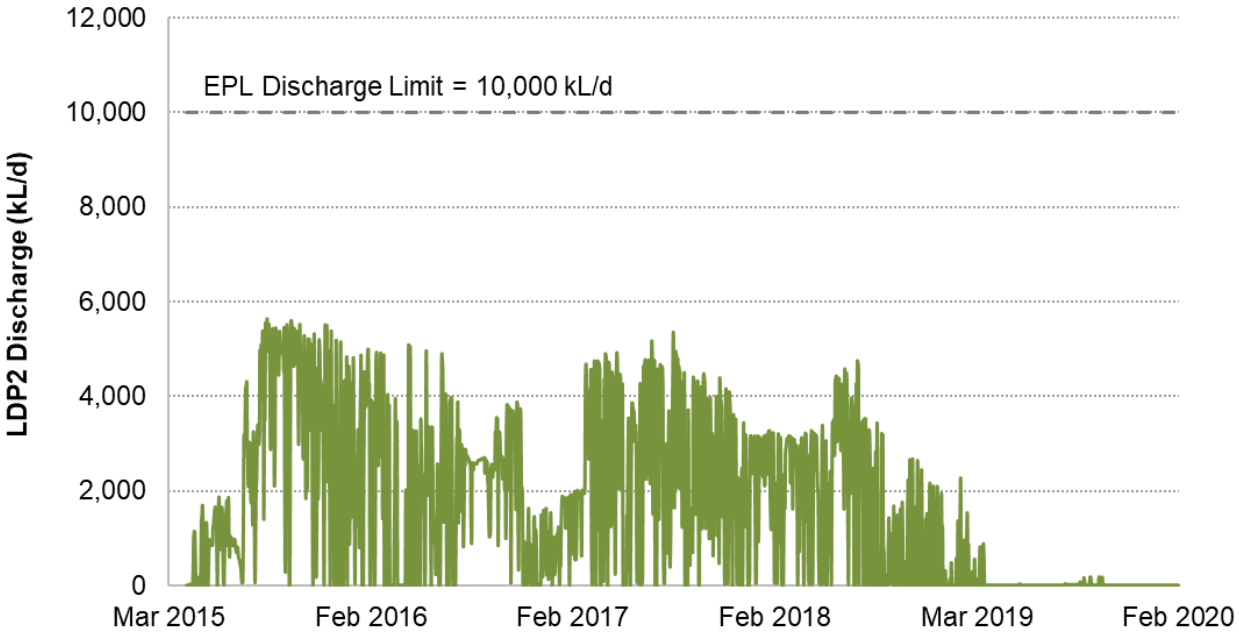

Figure 9 LDP2 Daily Discharge Rate

3.1.3 Potable Water Supply

Potable water is supplied via the Wollongong potable water supply reticulation system to the administration area and bathhouse. Additional potable water is supplied to meet mine demands as required when there is a shortfall of supply from the Mine Dam.

During operations, an estimated water demand of 235 ML/year is required for underground mine operations, coal stockpile dust suppression, firefighting purposes and vehicle washdown (pers. comm. Wollongong Coal, 2020). Excess water requirements which are not recycled back to the underground or supplied from the Mine Dam are sourced from the potable water supply.

3.1.4 Wastewater Management

Wastewater from the administration building and bathhouse is collected in tanks and pumped out fortnightly by a licensed waste contractor. Greywater from the administration building and bathhouse is pumped to the Primary Stabilisation Lagoon which overflows to the Secondary Stabilisation Lagoon before discharging to LDP1. The capacities of the Primary Stabilisation Lagoon and Secondary Stabilisation Lagoon 3.2 ML and 3.4 ML respectively (WRM, 2010).

3.2 PROPOSED OPERATIONAL WATER MANAGEMENT SYSTEM

The existing operational water management system is to be maintained for the proposed Modification, with few changes to surface infrastructure proposed. The coal handling and rail transport requirements will remain as per current requirements and waste rock associated with the NWMD workings will be stored underground within previous workings.

ROM coal is currently conveyed via the existing conveyor to either the coal storage bins or the Wongawilli Colliery lower pit top stockpile area. ROM coal is then directly loaded to trains from the coal storage bins or from stockpiles via a front end loader. The proposed Modification seeks to improve the coal conveyor network by constructing a new conveyor section approximately 60m in

length and undertaking minor upgrades of the existing conveyor network. All new and upgraded conveyor sections will be enclosed to reduce impacts as is consistent with existing infrastructure. No changes to surface water catchments or surface water management infrastructure will be required to facilitate the new and upgraded conveyor sections.

An estimated 150 employees may be required for the proposed Modification works. The estimated 150 workforce size is less than the 300 workforce size currently approved for the Wongawilli Colliery. It is therefore anticipated that the existing potable water supply reticulation system and wastewater management system will be sufficient to meet the demands of the expected workforce.

4.0 POTENTIAL SURFACE WATER IMPACTS

4.1 SUBSIDENCE EFFECTS

The assessment of potential subsidence effects associated with development of the NW Mains is documented in SCT (2020). SCT (2020) indicate that the proposed workings are not expected to cause any perceptible surface subsidence unless widespread pillar instability was to occur, of which the potential is assessed as negligible. As such, impacts to natural surface and built features are expected to be imperceptible. These findings are consistent with those documented in the 2010 EA.

4.2 GROUNDWATER EFFECTS

4.2.1 Groundwater Inflow and Mine Dewatering

SLR (2020) estimate a maximum annual total groundwater inflow associated with the Modification (for both the approved and proposed driveages) of 36.8 ML in 2024 and a maximum daily inflow rate of 1,600 kL/d occurring for a short period in late 2024 to early 2025. The historical site records show that a maximum of 860 ML was discharged to LDP2 in 2017 (refer Section 3.1.2). Based on a historical maximum discharge rate of 5,626 kL/day to LDP2 (refer Section 3.1.2) and the predicted maximum daily inflow rate of 1,600 kL/d for the approved and proposed NWMD (SLR, 2020), a maximum discharge rate to LDP2 of 7,226 kL/day may be required. This rate is below the current discharge limit of 10,000 kL/day at LDP2 and, as such, the discharge limits at LDP2 are not expected to be exceeded as a result of the proposed Modification.

4.2.2 Dewatered Groundwater Quality

The quality of groundwater inflow dewatered from the NWMD area and subsequently the quality of discharge to LDP2 is expected to be consistent with the quality of dewatering discharged at present (refer Section 2.5.2). As such, the water quality discharge limits at LDP2 are not expected to be exceeded as a result of the proposed Modification.

4.2.3 Baseflow Loss

The groundwater assessment undertaken for the Modification (SLR, 2020) identified that:

- negligible drawdown in the upper units of the alluvium / weathered zone or Hawkesbury Sandstone is predicted; and
- fracturing associated with the NWMD is not expected to extend into the Bulgo Sandstone and the overlying hydrostratigraphic units.

As such, there is expected to be negligible baseflow loss from surface water systems within the Project Area and negligible impacts to surface water systems or groundwater dependent ecosystems. These predictions are consistent with that of the 2010 EA.

4.3 SURFACE WATER EFFECTS

The 2010 EA concluded that, due to the lack of predicted subsidence associated with development of the NW Mains (Western Driveage), no adverse impacts to surface water systems with the Lake Avon catchment were expected including:

- no streamflow loss;
- no adverse effects on water quality in surface water systems or Lake Avon;
- no adverse changes in stream bed or bank stability;
- no adverse effect on stream pools; and
- no adverse effect on the ephemeral shallow soil groundwater system.

The 2010 EA identified that, although there will be some lateral depressurisation of the overburden above Gallahers Creek, the depressurization will not be notably transferred through the claystone to Lake Avon. As such, there will be no observable, adverse effect on the water storage capacity or water quality of Lake Avon (GeoTerra, 2010a). Additionally, there will be no loss of flow from surface water systems upstream of Lake Avon and no adverse effect on the ephemeral shallow soil groundwater system (GeoTerra, 2010b).

The outcomes of the groundwater assessment for the proposed Modification are in general accordance with the 2010 EA (SLR, 2020).

As the existing operational water management system is to be maintained for the proposed Modification, with minimal changes to surface infrastructure proposed, no impacts to the surface water systems or the water management system of the Wongawilli Colliery is expected to occur as a result of the NWMD.

4.4 NEUTRAL OR BENEFICIAL EFFECTS

Under the *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011*, all development in the Sydney drinking water catchment is required to demonstrate a neutral or beneficial effect on water quality. For the proposed Modification, this applies to any area within the catchment or discharging to the catchment of Lake Avon. The following definition and criteria for satisfying the neutral or beneficial 'test' are contained in WaterNSW (2015):

A neutral or beneficial effect on water quality is satisfied if the development:

(a) has no identifiable potential impact on water quality, or

(b) will contain any water quality impact on the development site and prevent it from reaching any watercourse, water-body or drainage depression on the site, or

(c) will transfer any water quality impact outside the site where it is treated and disposed of to standards approved by the consent authority.

In accordance with WaterNSW (2015), it is reasonable to assume that a development will have no identifiable potential impact on water quality if the development is unlikely to result in:

- *a concentration of flow of water;*
- *the impedance of flow of water;*
- *discharge of effluent, dust pollutants or stormwater; and*
- *other matters considered to result in a water quality impact, such as the potential for contamination.*

No surface development associated with the Modification is proposed to be undertaken in the Lake Avon catchment and negligible impact to surface water systems within the Lake Avon catchment are expected to occur as a result of the proposed Modification. As such, the Modification is expected to result in a neutral effect on water quality of surface water systems within the Lake Avon catchment.

5.0 MONITORING, MITIGATION AND MANAGEMENT

Water management at the Wongawilli Colliery is documented in the Surface Water Management Plan (SWMP) (Wollongong Coal, 2019a). Management of wastewater and greywater is documented in the Integrated Wastewater Management Plan (IWMMP) (Wollongong Coal, 2019b). The SWMP details the surface water monitoring program and Trigger Action Response Plans (TARPs) necessary to identify and respond to potential surface water impacts associated with the Wongawilli Colliery operations. The water monitoring program and TARPs detailed in the SWMP have been developed to ensure that the Wongawilli Colliery complies with the EPL 1087 LDP conditions.

It is recommended that the surface water quality monitoring program for the Lake Avon catchment be recommenced and continued for the duration of the Modification. For the Wongawilli Colliery surface water systems, it is recommended that water quality monitoring is undertaken in the tributary of Robins Creek downstream of the overflow point from the Mine Dam. It is recommended that field water quality monitoring is undertaken each month and/or following overflow events and that sampling and laboratory water quality analysis is undertaken at least at six monthly intervals. The water quality parameters to be monitored should comprise:

- Field analysis: pH, electrical conductivity (EC), dissolved oxygen (DO) and temperature.
- Laboratory analysis: total alkalinity, total dissolved solids, sulphate, total metals, total phosphorus and total nitrogen.

This will provide an improved understanding of the potential water quality impacts to Robins Creek associated with the Wongawilli Colliery.

In order to provide additional information to support the development of an operational water balance for the Wongawilli Colliery, it is recommended that metering of pumped volumes from key water storages is undertaken including transfer from the Mine Dam and Pond C.

The outcomes of the surface water monitoring program should continue to be reported in the Wongawilli Colliery Annual Review reports, in accordance with the SWMP (Wollongong Coal, 2019a).

6.0 REFERENCES

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