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WESTERN COAL SERVICES PROJECT

AIR QUALITY IMPACT AND GREENHOUSE GAS ASSESSMENT

Springvale Coal

Job No: **5299A**

29 July 2013

PROJECT TITLE:	AIR QUALITY IMPACT AND GREENHOUSE GAS ASSESSMENT
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PREPARED FOR:	Springvale Coal
APPROVED FOR RELEASE BY:	J. Barnett
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Pacific Environment Operations Pty ABN 86 127 101 642

BRISBANE
Level 1, 59 Melbourne Street, South Brisbane QLD 4101
PO Box 3306, South Brisbane QLD 4101
Ph: +61 7 3004 6400
Fax: +61 7 3844 5858

Unit 1, 22 Varley Street
Yeerongpilly, Qld 4105
Ph: +61 7 3004 6460

ADELAIDE
35 Edward Street, Norwood SA 5067
PO Box 3187, Norwood SA 5067
Ph: +61 8 8332 0960
Fax: +61 7 3844 5858

PERTH
Level 1, Suite 3
34 Queen Street, Perth WA 6000
Ph: +61 8 9481 4961
Fax: +61 7 3844 5858

SYDNEY
Suite 1, Level 1, 146 Arthur Street
North Sydney, NSW 2060
Ph: +61 2 9870 0900
Fax: +61 2 9870 0999

MELBOURNE
Suite 62, 63 Turner Street, Port Melbourne VIC 3207
PO Box 23293, Docklands VIC 8012
Ph: +61 3 9681 8551
Fax: +61 3 9646 3408

GLADSTONE
Suite 2, 36 Herbert Street, Gladstone QLD 4680
Ph: +61 7 4972 7313
Fax: +61 7 3844 5858

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1 INTRODUCTION

This report has been prepared by Pacific Environment for RPS Group on behalf of Centennial Coal. It forms an appendix to the Environmental Impact Statement (EIS) to support an application for Project Approval. The report assesses the likely air quality impacts of the proposed Western Coal Services Project, located near Lithgow in New South Wales (NSW).

The air quality assessment is based on the use of a computer-based dispersion model to predict ground-level dust concentrations and deposition levels in the vicinity of the Project. To assess the effect that the dust emissions would have on existing air quality, the dispersion model predictions have been compared to relevant air quality criteria.

The assessment follows the procedures outlined by the NSW Environmental Protection Authority (EPA) in their document titled "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (**EPA, 2005**) (hereafter referred to as the "Approved Methods"). The Approved Methods specify how assessments based on the use of air dispersion models should be completed. They include guidelines for the preparation of meteorological data, emissions data and relevant air quality criteria.

In summary, the report provides information on the following:

- A description of operations at the various sites, with a focus on describing those aspects that will affect air quality.
- Air quality criteria that need to be met to protect the air quality environment.
- Meteorological and climatic conditions in the area.
- A discussion on the existing air quality conditions in the area.
- The methods used to estimate dust emissions and the way in which dust emissions from the Project would disperse and fallout.
- The expected dispersion and dust fallout patterns due to emissions from the Project and a comparison between the predicted dust concentration and fallout levels and the relevant air quality criteria.
- A Greenhouse Gas (GHG) assessment.

2 LOCAL SETTING AND TOPOGRAPHY

The Project Application Area (the Project) incorporates operations at a number of different sites, but predominantly the Springvale Coal Services Site (SCSS), which is located adjacent to the Castlereagh Highway, approximately 16 kilometres (km) to the northwest of Lithgow and approximately 5 km from the township of Wallerawang, NSW. The Project Application Area (PAA) includes the SCSS as well as Angus Place Colliery, Springvale Mine, Kerosene Vale, private haul roads and overland conveyers.

Figure 2.1 shows the location of the PAA and surrounding areas. The proposed layout of the SCSS is shown in **Figure 2.2.** The nearest residences in Blackmans Flat, immediately adjacent to the eastern boundary of the SCSS, are shown **Figure 2.3**. Nine additional residences have also been identified and assessed for the scenario where all Angus Place coal is hauled to the Wallerawang Power Station. These five include two near Lidsdale Village (L1 and L2), five near the Springvale Pit Top (S1 – S5) and two near Angus Place off Wolgan Road (WR1 and WR2). These are shown in **Figure 2.4**.

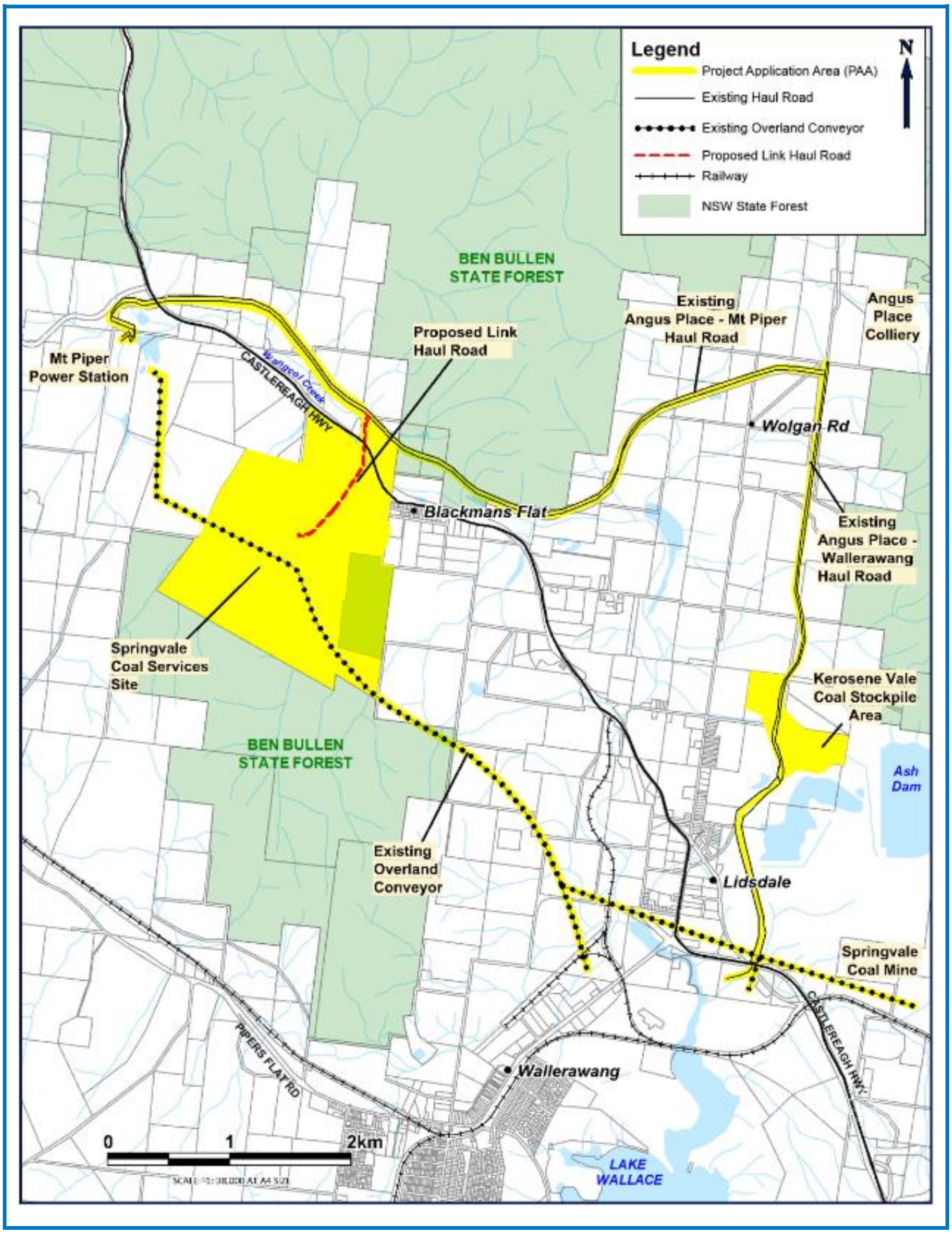


Figure 2.1: Project Application Area

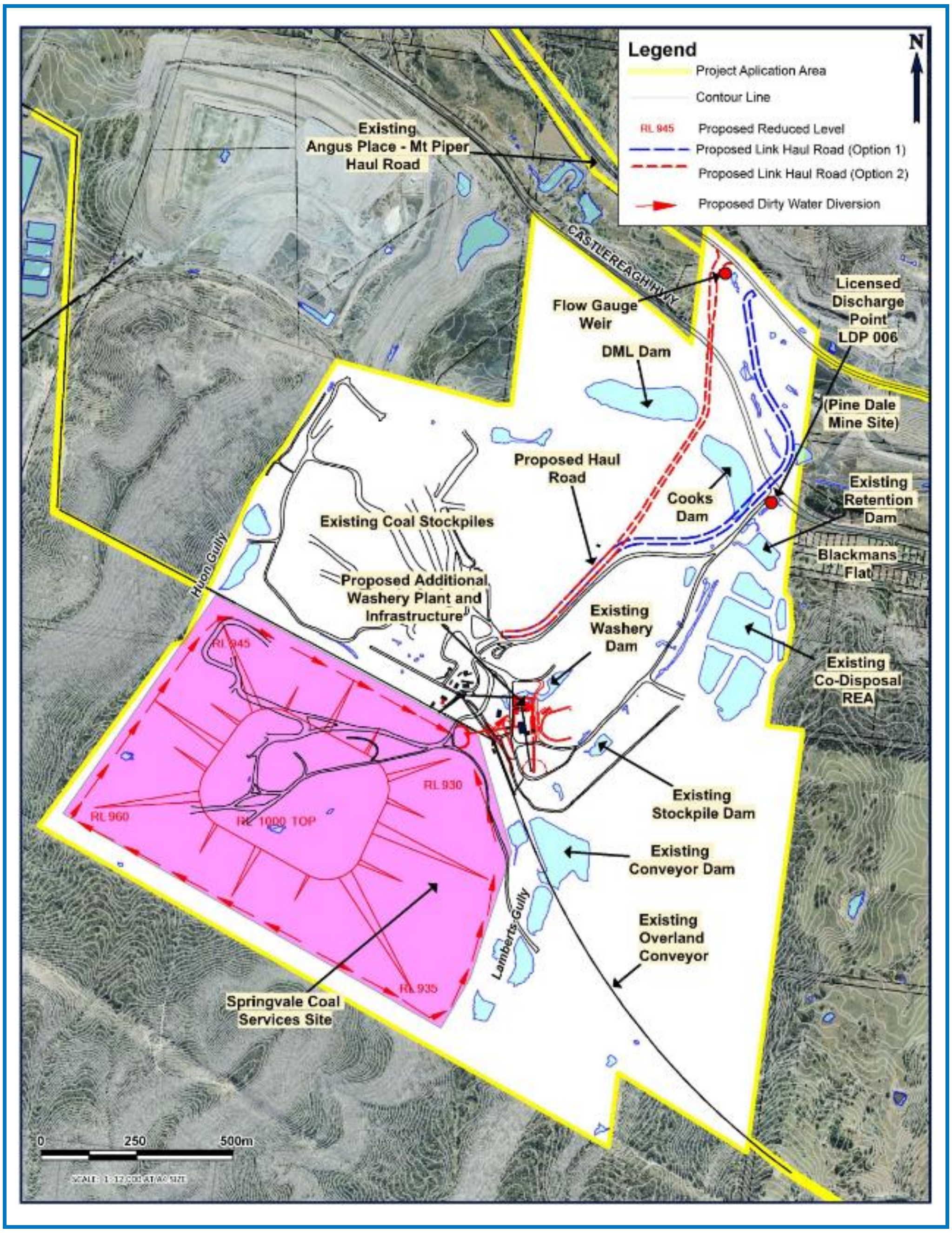


Figure 2.2: Springvale Coal Services Site

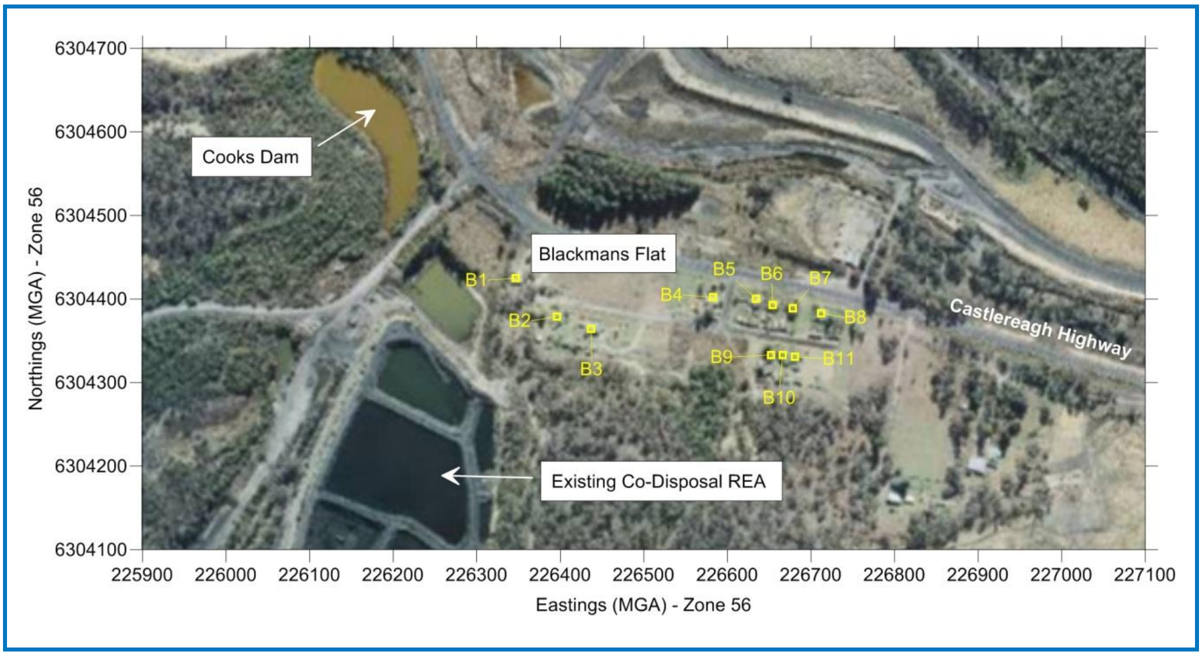


Figure 2.3: Blackmans Flat residential locations

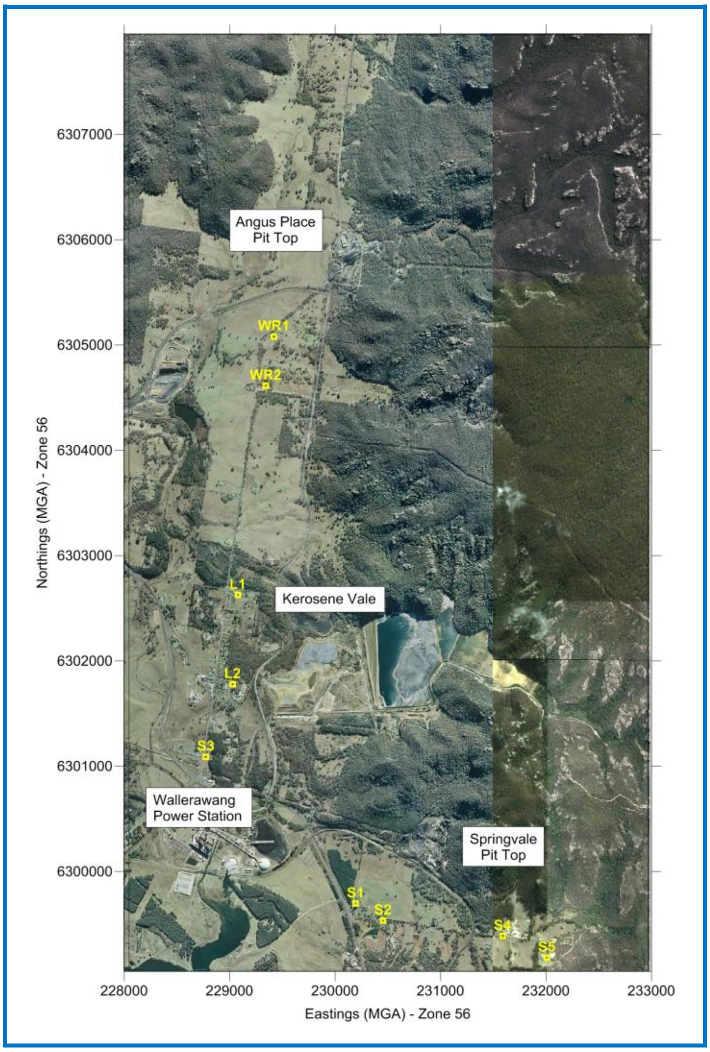


Figure 2.4: Lidsdale Village and Wolgan Road residential locations

Figure 2.5 shows the topography of the area. The Project is located on the western slopes of the Great Diving Range with several steep sandstone escarpments dividing the site topographically. The topography surrounding the Project typically consists of moderately undulating terrain and includes the Ben Bullen State Forest to the north.

Land use in the wider region includes other mining operations (e.g. Pine Dale Colliery, Neubeck Open Cut, Cullen Valley Mine and the Invincible Colliery) as well as agricultural and forestry activities.

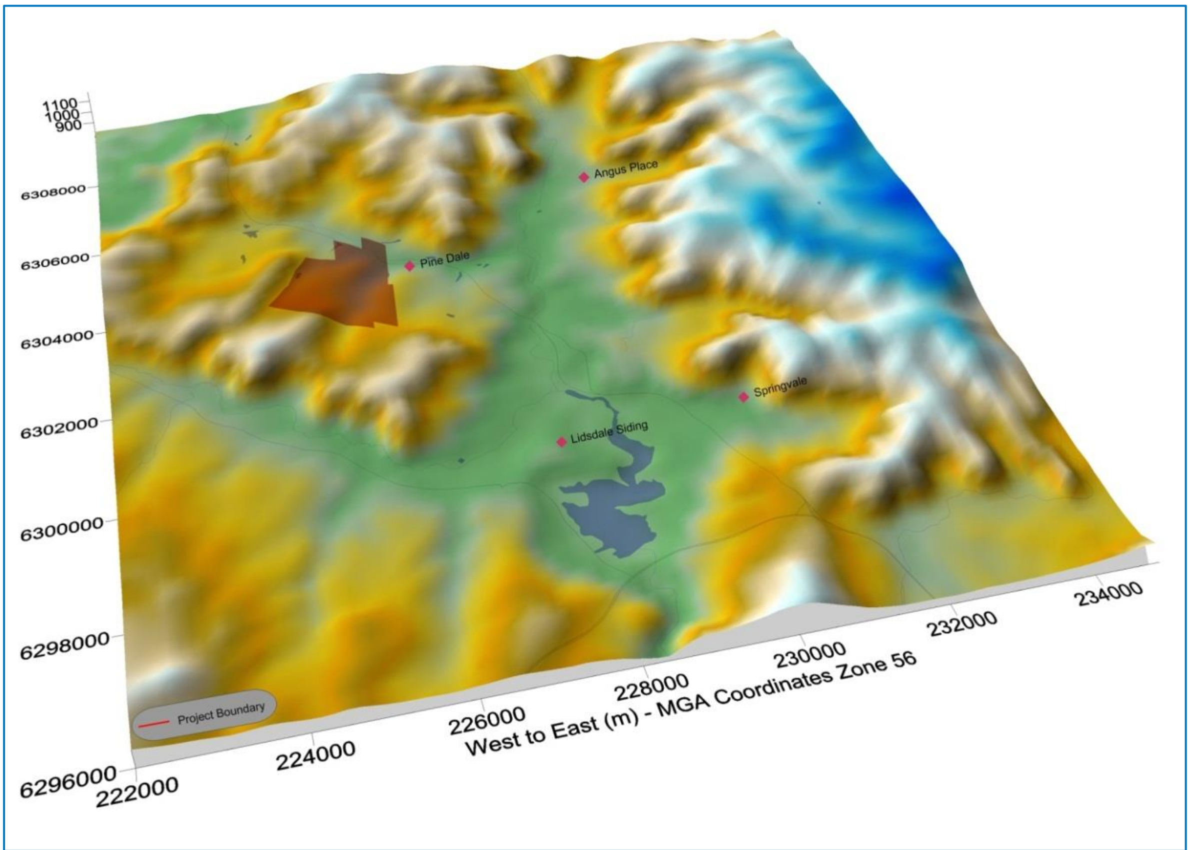


Figure 2.5: Pseudo 3-dimensional topographic representation of local terrain

3 THE PROJECT

This Project forms part of a long term strategy for Centennial's future operations in the Western Coalfield. The strategy centres on the transport and processing of coal from both Springvale Coal Mine and Angus Place Colliery, but also involves the potential for coal supplies from other nearby sources within the Mt Piper area.

It is understood that the SCSS Upgrade will involve:

- Upgrading the existing washery at the SCSS by constructing additional processing infrastructure adjacent to the existing facility which is capable of processing a combined total of 7 Million tonnes per annum (Mtpa).
- Making provision for sufficient reject disposal capacity for a 25 year life.
- Increasing the rate and utilisation of the return side of existing overland conveyor system to enable up to 6.3 Mtpa to be delivered to Lidsdale Siding.
- Construction of additional conveyors and transfer points and other coal handling requirements to cater for the upgraded washery facility.
- Construction of a private haul road linking the SCSS with the existing private haul road from Angus Place Colliery to Mount Piper Power Station. This private haul road will cross a section of the existing Pine Dale Mine operation and over the Castlereagh Highway.
- Integration of the existing approved transport and processing of coal at Springvale Colliery and Angus Place Colliery into the consent for Centennial Western Coal Services.
- Include the remaining rehabilitation, monitoring and reporting requirements associated with the Lamberts Gully Mine which occupies the SCSS.
- The continued use of all existing approved infrastructure, facilities and activities associated with the transport and processing of coal from each mine gate and the point of delivery to either power station and Lidsdale Siding including existing conveyors, private haul roads, services, access roads, car parking and buildings.
- The installation of additional pollution control infrastructure.

To this end, and to enable flexibility in the quantities and destinations of coal transported, we have identified two operating scenarios and these are listed below. Scenario 1 includes all operations at the SCSS including a full 6 Mtpa load on the new internal link road, while Scenario 2 represents a cumulative assessment consisting of operations at the SCSS, Angus Place, Springvale Colliery, Kerosene Vale and Neubeck Open Cut. Within each of these scenarios there will be another option which will assess each of the internal link road route options. A third option within Scenario 2 takes into account all coal from Angus Place being hauled to Wallerawang Power Station instead of Mt Piper Power Station. It should be noted that Scenario 2c is highly conservative since it is unlikely that Wallerawang Power Station can receive the full 4 Mtpa from Angus Place.

The scenarios and individual options are described below, and the two internal link road options are shown in **Figure 3.1**.

- **Scenario 1a**: SCSS operations only with a maximum of 6 Mtpa of material being hauled on the new internal link road (Route 1). This 6 Mtpa comprises the total 4 Mtpa from Angus Place Coal Mine, 1 Mtpa of coal from Neubecks Coal Mine and 1 Mtpa of rejects being hauled off-site.
- **Scenario 1b**: Same as Scenario 1a but using internal link road Route 2.
- **Scenario 2a**: Cumulative modelling including operations at the SCSS, Angus Place, Springvale, operations and haulage from Neubecks, and Angus Place (4 Mtpa from Angus Place going to Mt Piper Power Station (MPPS)).
- **Scenario 2b**: Same as Scenario 2a but using internal link road Route 2.
- **Scenario 2c**: Same as Scenario 2b but hauling Angus Place coal to Wallerawang Power Station instead of MPPS.

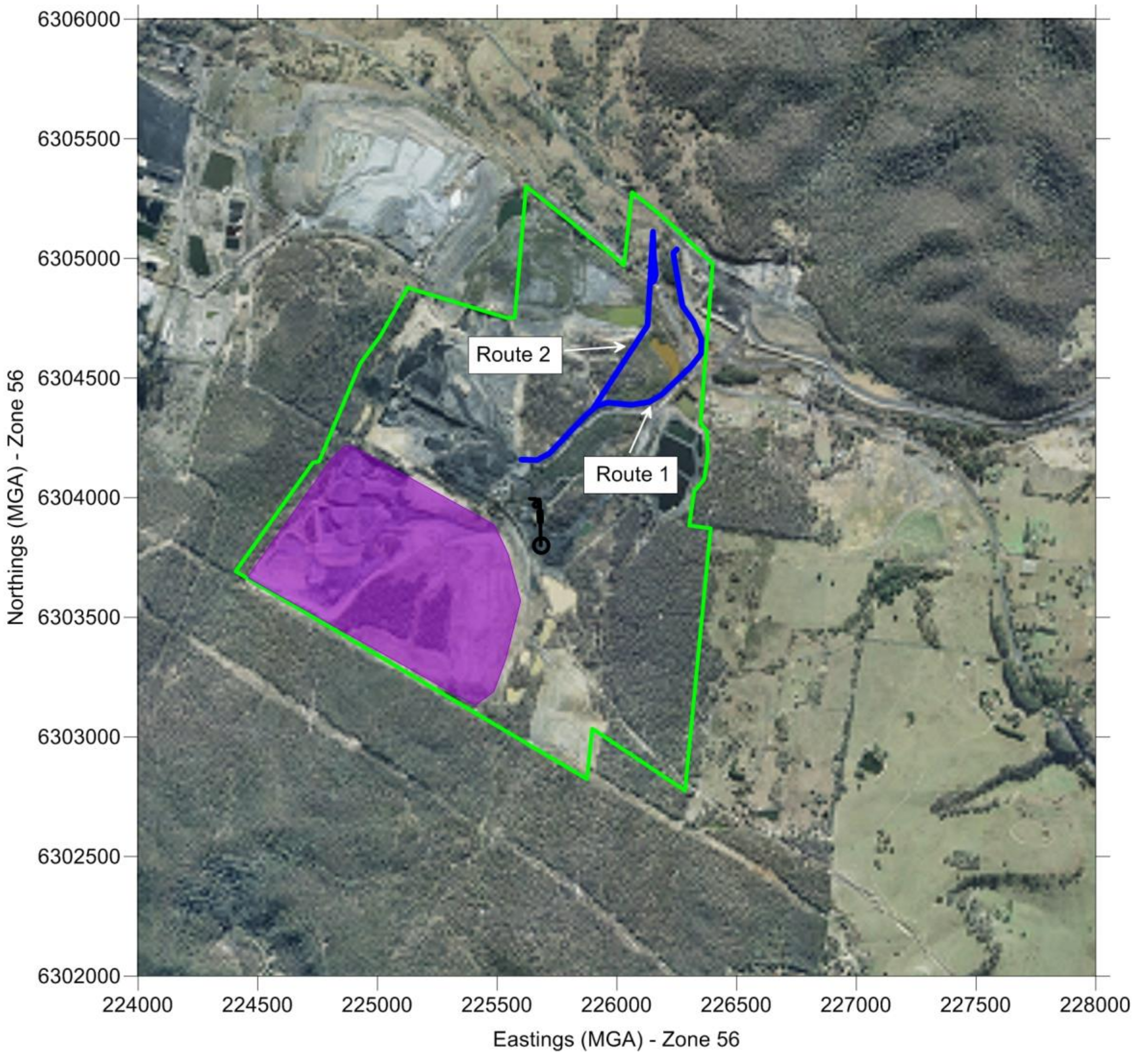


Figure 3.1: Internal Link Road Options

4 LEGISLATIVE SETTING

4.1 Particulate Matter and Health

The key air quality issue for mining is the emission of dust and particulate matter (PM). Mining generates PM from numerous activities including handling of coal, hauling by heavy vehicles and wind erosion from stockpiles and exposed surfaces. PM is formed when particulate becomes entrained in the atmosphere by the turbulent action of wind, by the mechanical disturbance of materials, or through the release of particulate-rich gaseous emissions from combustion sources.

Suspended PM can be defined by its size, chemical composition and source. Particle size is an important factor influencing its dispersion and transport in the atmosphere and its potential effects on human health. Typically, the size of suspended particles ranges from approximately 0.005 to 100 micrometers (µm) and is often described by the aerodynamic diameter of the particle.

The particulate size ranges are commonly described as:

- TSP – Total Suspended Particulate matter refers to all suspended particles in the air In practice, the upper size range is typically 30 µm – 50 µm.
- PM_{10} –refers to all particles with equivalent aerodynamic diameters of less than 10 µm, that is, all particles that behave aerodynamically in the same way as spherical particles with a unit density.
- $PM_{2.5}$ – refers to all particles with equivalent aerodynamic diameters of less than 2.5 µm diameter (a subset of PM_{10}). Often referred to as the fine particles.
- $PM_{2.5-10}$ – defined as the difference between PM_{10} and $PM_{2.5}$ mass concentrations. Often referred to as coarse particles.

Both natural and anthropogenic processes contribute to the atmospheric load of PM. Coarse particles ($PM_{2.5-10}$) are derived primarily from mechanical processes resulting in the suspension of dust, soil, or other crustal[a] materials from roads, farming, mining, dust storms, and so forth. Coarse particles also include sea salts, pollen, mould, spores, and other plant parts.

Fine particles or $PM_{2.5}$ are derived primarily from combustion processes, such as vehicle emissions, wood burning, coal burning for power generation, and natural processes, such as bush fires. Fine particles also consist of transformation products, including sulphate and nitrate particles, and secondary organic aerosol from volatile organic compound emissions. Mining dust is likely to be composed of predominantly coarse particulate matter (and larger).

There have been a number of extensive reviews of the health effects of particulates over the past several years. Particles have been associated with a range of acute and chronic adverse health effects, including increased daily hospital admissions and emergency room visits for respiratory and cardiovascular symptoms, and decreased lung function.

The effects of PM on human health are primarily determined by:

- The physical and chemical nature of the particles.
- The physics of deposition and distribution in the respiratory tract.
- The physiological events that occur in response to the presence of the particle.

The size of particles determine their behaviour in the respiratory system, including how far the particles are able to penetrate, where they deposit, and how effective the body's clearance mechanisms are in removing them. Additionally, particle size is an important parameter in determining the residence time and spatial distribution of particles in ambient air, key considerations in assessing exposure. It is generally thought that the smaller PM are of greater health concern as these particles can penetrate deep into the respiratory tract.

[a] Crustal dust refers to dust generated from materials derived from the earth's crust.

This is demonstrated in **Figure 4.1** which shows the relative deposition by particle size within various regions of the respiratory tract.

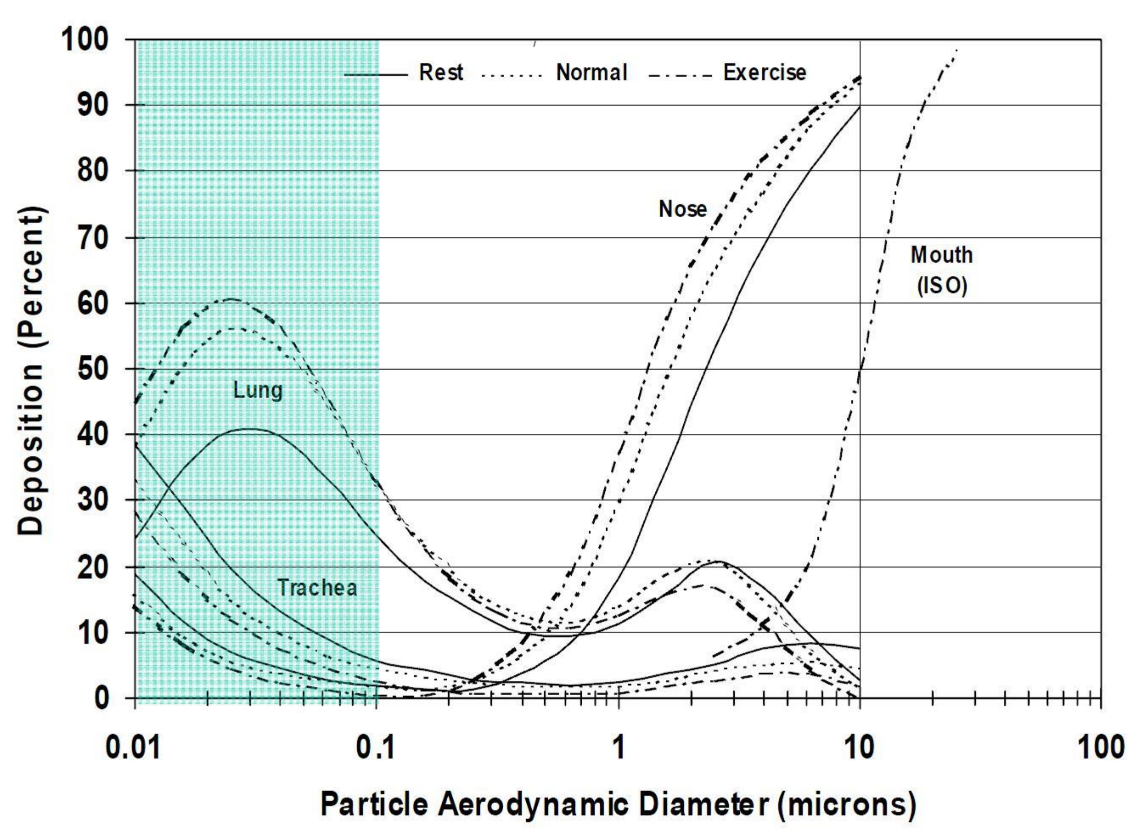


Figure 4.1: Particle Deposition within the Respiratory Track (*Source: Phalen et al, 1991*)

4.2 EPA Criteria

The NSW EPA "*Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW*" (Approved Methods) specifies air quality assessment criteria relevant for assessing impacts from air pollution (**EPA, 2005**). The air quality goals relate to the total dust burden in the air and not just the dust from the proposed modification. In other words, consideration of background dust levels needs to be made when using these goals to assess potential impacts. These criteria are health-based (that is, they are set at levels to protect against health effects) and are consistent with the *National Environment Protection Measure for Ambient Air Quality* (referred to as the Ambient Air-NEPM) (**NEPC, 1998a**). However, the EPA's criteria include averaging periods, which are not included in the Ambient Air-NEPM, and also references other measures of air quality, namely dust deposition and TSP.

In May 2003, the National Environment Protection Council (NEPC) released a variation to the Ambient Air National Environment Protection Measure (Air-NEPM) (**NEPC, 2003**) to include advisory reporting standards for particulate matter with an equivalent aerodynamic diameter of 2.5 µm or less ($PM_{2.5}$). The purpose of the variation was to gather sufficient data nationally to facilitate the review of the Ambient Air-NEPM, which is currently underway. The variation includes a protocol setting out monitoring and reporting requirements for $PM_{2.5}$ particles. It is noted that the Ambient Air-NEPM $PM_{2.5}$ advisory reporting standards are not impact assessment criteria. A comparison of $PM_{2.5}$ predictions to these advisory reporting standards is included in **Section 8**.

Table 4.1 summarises the air quality goals for pollutants that are relevant to this study.

Table 4.1: EPA Air Quality Standards/Goals for Particulate Matter Concentrations

Pollutant	Standard	Averaging Period	Source
TSP	90 µg/m³	Annual	NSW DEC (2005) (assessment criteria)
PM_{10}	50 µg/m³	24-Hour	NSW DEC (2005) (assessment criteria)
	30 µg/m³	Annual	NSW DEC (2005) (assessment criteria)
	50 µg/m³	24-Hour	NEPM (allows five exceedances per year)
$PM_{2.5}$	8 µg/m³	Annual	NEPM advisory reporting standard
	25 µg/m³	24-Hour	NEPM advisory reporting standard

Notes: µg/m³ – micrograms per cubic metre.

In addition to health impacts, airborne dust also has the potential to cause nuisance effects by depositing on surfaces, including vegetation. Larger particles do not tend to remain suspended in the atmosphere for long periods of time and will fallout relatively close to source. Dust fallout is assessed for nuisance or amenity impacts, rather than health impacts.

Table 4.2 shows the total and the maximum acceptable increase in dust deposition over the existing dust levels from an amenity perspective. These criteria for dust fallout levels are set to protect against nuisance impacts (**EPA, 2005**).

Table 4.2: EPA Criteria for Dust (Insoluble Solids) Fallout

Pollutant	Averaging period	Maximum increase in deposited dust level	Maximum total deposited dust level (cumulative)
Deposited dust	Annual	2 g/m²/month	4 g/m²/month

Notes: g/m²/month – grams per square metre per month.

5 EXISTING ENVIRONMENT

5.1 Dispersion Meteorology

5.1.1 CALMET

CALMET is a meteorological pre-processor that includes a wind field generator containing objective analysis and parameterised treatments of slope flows, terrain effects and terrain blocking effects. The pre-processor produces fields of wind components, air temperature, relative humidity, mixing height and other micro-meteorological variables to produce the three-dimensional meteorological fields that are utilised in the CALPUFF dispersion model (i.e. the CALPUFF dispersion model requires meteorological data in three dimensions). CALMET uses the meteorological inputs in combination with land use and geophysical information for the modelling domain to predict gridded meteorological fields for the region.

CALMET was initially run for a coarse outer grid domain of 65 km x 65 km, centred near the Project site, with a 1.3 km grid resolution. This coarse outer grid was used as input to the finer resolution inner grid domain of 15 km x 26 km with a 0.2 km grid resolution, also centred over the Project site. The rationale for modelling an outer meteorological domain was to capture significant regional features, for example the Grampians, and to allow cloud data from the Bureau of Meteorology (BoM) monitoring sites to be incorporated. The inner grid modelling was used to create a fine resolution three-dimensional meteorological field for the area around the Project site. Observed hourly data from the Pine Dale Automatic Weather Station (AWS), Lidsdale AWS, Springvale AWS, BoM Bathurst Airport AWS and BoM Mount Boyce AWS were used as input for CALMET. Cloud cover and cloud heights were sourced from observations at BoM Mount Boyce and Bathurst AWS. Upper air data were also extracted from The Air Pollution Model (TAPM).

5.1.2 CALMET Generated Wind Data

Figure 5.1 shows the annual and seasonal windroses extracted for a point at the approximate location of the Pine Dale AWS, while **Figure 5.2** shows the windroses compiled from the Pine Dale AWS data itself.

The CALMET annual wind rose displays very similar characteristics to the measured wind speeds at Pine Dale with moderate to strong wind speeds dominating from the northwest. The average wind speed at Pine Dale AWS was measured to be 1.8 m/s in 2010, with calm conditions (wind speeds less than 0.5 m/s) occurring 27.5% of the time. The CALMET generated data showed the same average wind speed and percentage of calm conditions as the measured data at Pine Dale.

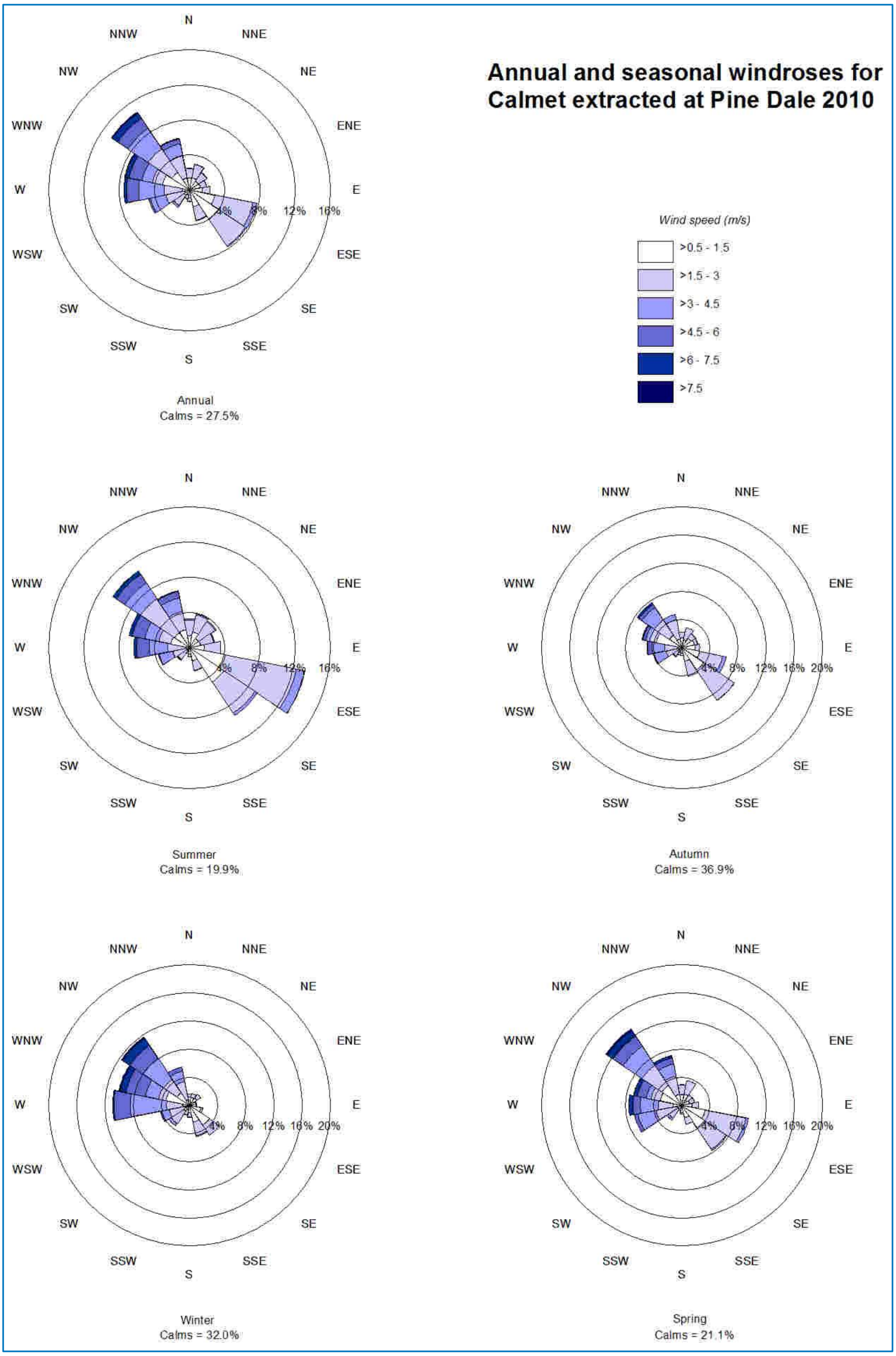


Figure 5.1: Windroses for CALMET extracted at Pine Dale 2010

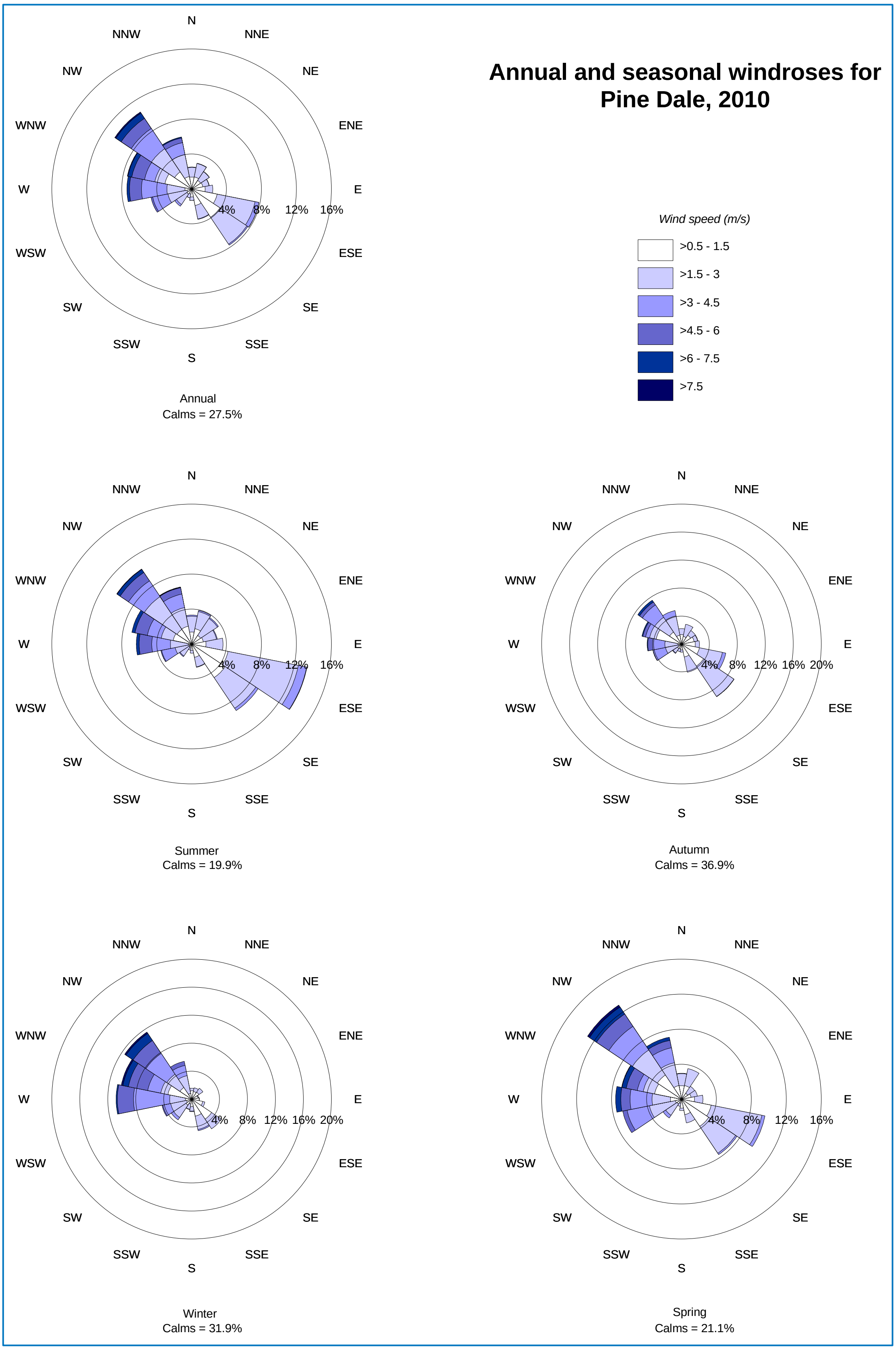


Figure 5.2: Windroses for Pine Dale (AWS) 2010

The frequency distribution of hourly averaged wind speed values for CALMET extracted at Pine Dale 2010 is shown in **Figure 5.3**. Light wind speeds (up to 2 m/s) occur approximately 63.6% of the time. Strong winds (greater than 6 m/s) occur approximately 2% of the time.

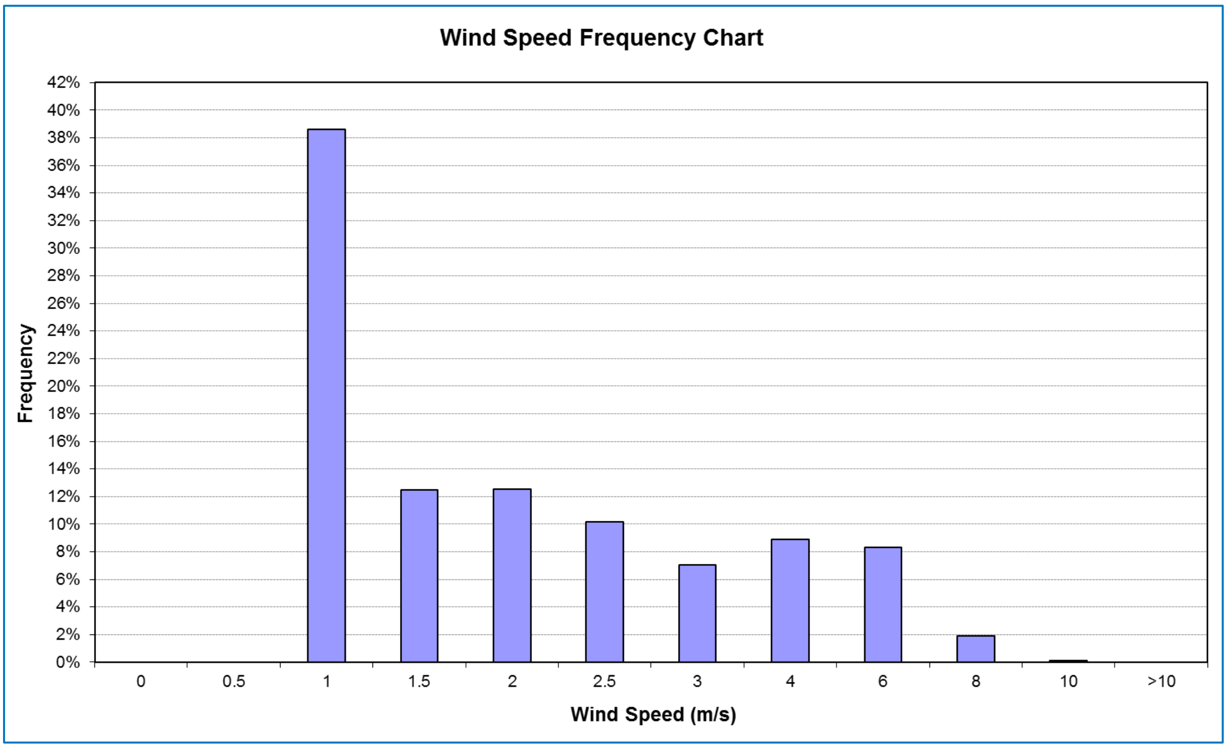


Figure 5.3: Wind speed distribution for CALMET extracted at Pine Dale 2010

5.1.3 Stability Class

An important aspect of emissions dispersion is the level of turbulence in the atmosphere near the ground. Turbulence acts to dilute or diffuse a plume by increasing the cross-sectional area of the plume due to random motion. As turbulence increases, the rate of plume dilution or diffusion increases. Weak turbulence limits diffusion and is a critical factor in causing high plume concentrations downwind of a source. Turbulence is related to the vertical temperature gradient, the condition of which determines what is known as stability, or thermal stability. For traditional dispersion modelling using Gaussian plume models, categories of atmospheric stability are used in conjunction with other meteorological data to describe the dispersion conditions in the atmosphere.

The best known stability classification is the Pasquill-Gifford (P-G) scheme, which denotes stability classes from A to F. Class A is described as highly unstable and occurs in association with strong surface heating and light winds, leading to intense convective turbulence and much enhanced plume dilution. At the other extreme, class F denotes very stable conditions associated with strong temperature inversions and light winds, such as those that commonly occur under clear skies at night and in the early morning. Under these conditions plumes can remain relatively undiluted for considerable distances downwind. Intermediate stability classes grade from moderately unstable (B class), through neutral (D class) to slightly stable (E class). Whilst classes A and F are closely associated with clear skies, class D is linked to windy and/or cloudy weather, and short periods around sunset and sunrise when surface heating or cooling is small.

The CALMET-generated meteorological data can be used to estimate stability class for the site and the frequency distribution of estimated stability classes is presented in **Figure 5.4**. The data show a high proportion of neutral conditions (class D).

It is noted that a turbulence based scheme within CALPUFF was used in the modelling and the P-G stability class frequency is shown for information only. The use of turbulence based dispersion coefficients is recommended (**TRC, 2010**) for the same reasons that the US EPA has replaced P-G-based dispersion with a turbulence-based approach in their regulatory model (AERMOD) and is in accordance with best science practice and model evaluation studies.

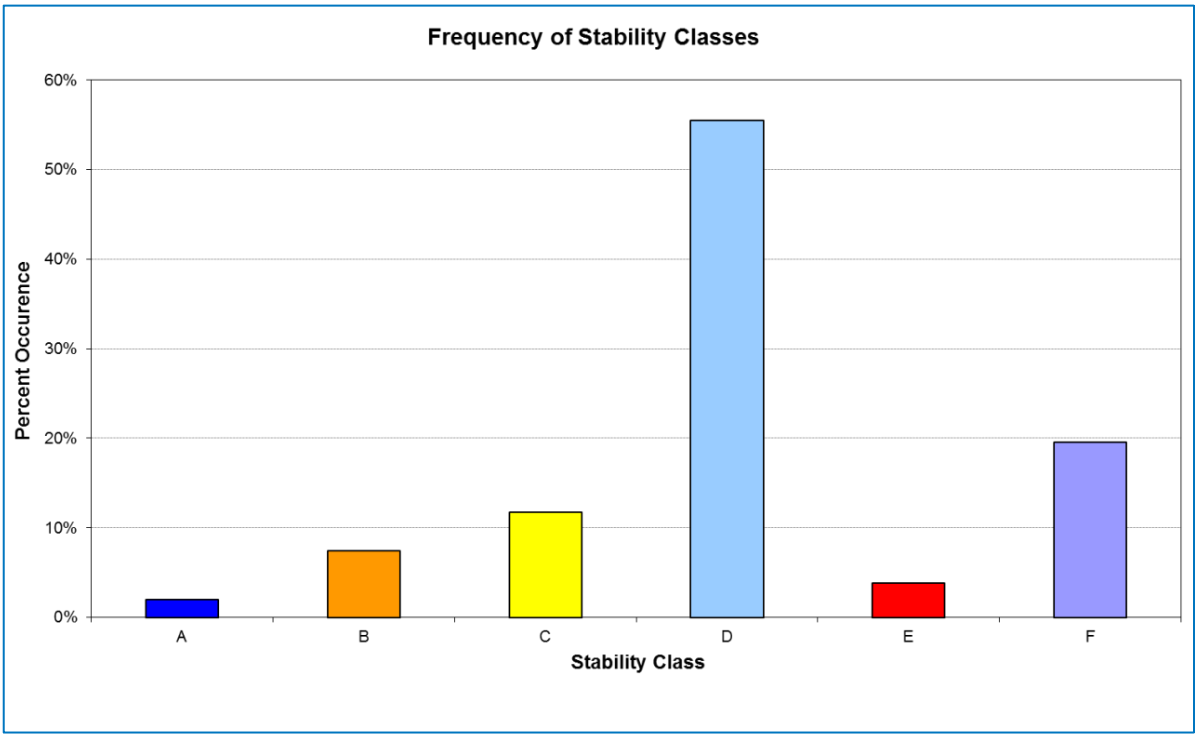


Figure 5.4: Stability class distribution for extracted data at Pine Dale 2010

5.1.4 Mixing Height

Mixing height is defined as the height above ground of a temperature inversion or statically stable layer of air capping the atmospheric boundary layer.

It is an important parameter within air pollution meteorology as vertical diffusion or mixing of a plume is generally considered to be limited by the mixing height, as the air above this layer tends to be stable, with restricted vertical motion.

It is often associated with, or measured by, a sharp increase of temperature with height, a sharp decrease of water-vapour, a sharp decrease in turbulence intensity and a sharp decrease in pollutant concentration. Mixing height is variable in space and time, and typically increases during fair-weather daytime over land from tens to hundreds of metres around sunrise up to 1-3 km in the mid-afternoon, depending on the location, season and day-to-day weather conditions.

Mixing heights show diurnal variation and can change rapidly after sunrise and at sunset. Diurnal variations in the minimum, maximum and average mixing depths, based on the CALMET-generated meteorological data for the site, are shown in **Figure 5.5**. As expected, mixing heights begin to grow following sunrise with the onset of vertical convective mixing with maximum heights reached in mid to late afternoon. The median, highest and lowest mixing heights for each hour are represented by the horizontal lines. The vertical bars represent the lower quartile and upper quartile of mixing heights.

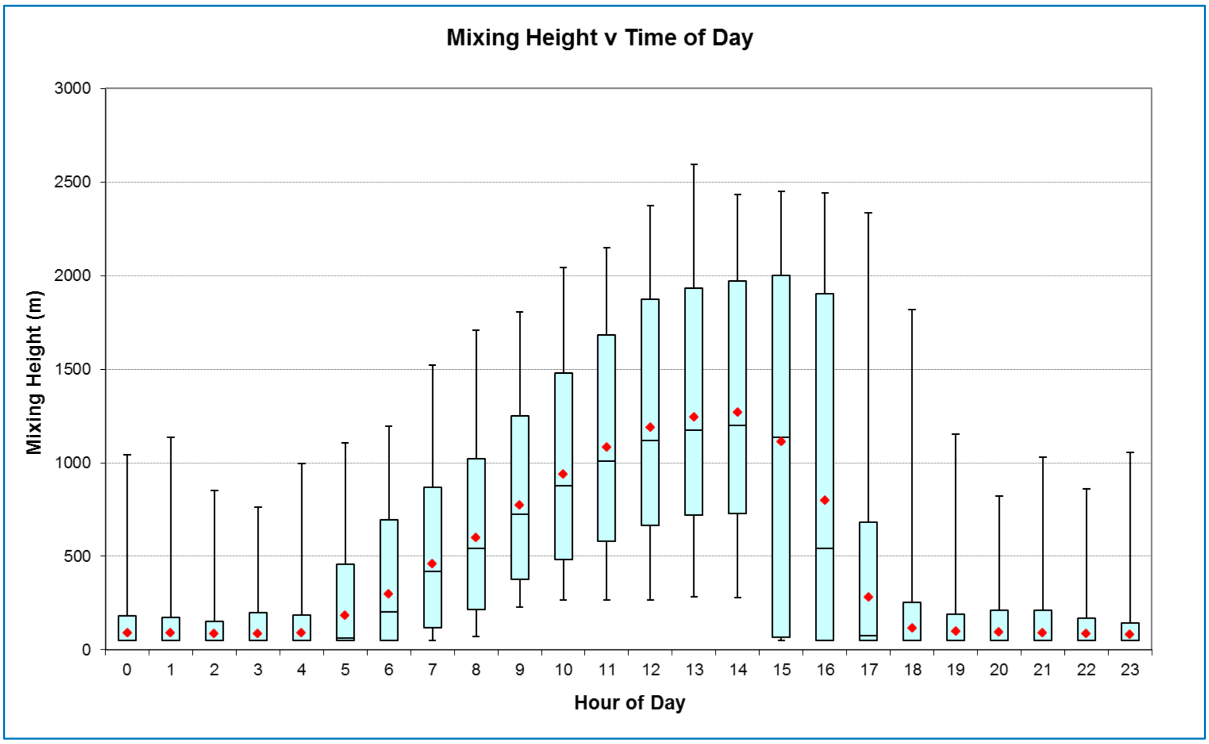


Figure 5.5: Average Daily Diurnal Variation in Mixing Layer Depth

5.2 Local Climatic Conditions

The BoM collects climatic information in the vicinity of the study area. A range of climatic information collected from Lithgow (Braidwood St) (located approximately 16 km from the Project) are presented in **Table 5.1** (**BoM, 2012**). Temperature and humidity data consist of monthly averages of 9 am and 3 pm readings. Also presented are monthly averages of maximum and minimum temperatures. Rainfall data consist of mean monthly rainfall and the average number of rain days per month.

The annual average maximum and minimum temperatures experienced at Lithgow are 18.2°C and 6.4°C respectively. On average January is the hottest month, with an average maximum temperature of 25.5°C. July is the coldest month, with average minimum temperature of 0.7°C.

The annual average relative humidity reading collected at 9 am from the Lithgow site is 70% and at 3 pm the annual average is 58%. The month with the highest relative humidity on average is June with a 9 am average of 82%. The month with the lowest relative humidity is December with a 3 pm average of 50%.

Rainfall data collected at Lithgow shows that January is the wettest month, with an average rainfall of 94.3 mm over 8.3 rain days. The average annual rainfall is 858.5 mm with an average of 95.8 rain days.

Table 5.1: Climate Information for Lithgow (Braidwood St)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
9 am Mean Dry-bulb and Wet-bulb Temperatures (°C)[1] and Relative Humidity (%)													
Dry-bulb	18.7	17.8	15.8	12.4	8.5	5.6	4.7	6.4	10.0	13.5	15.7	18.1	12.3
Humidity	64	70	73	76	81	82	79	73	64	60	60	61	70
3 pm Mean Dry-bulb and Wet-bulb Temperatures (°C)[1] and Relative Humidity (%)													
Dry-bulb	23.9	22.9	20.8	17.4	13.3	10.0	9.3	10.8	13.7	17.0	19.7	22.7	16.8
Humidity	54	58	60	59	66	67	66	56	54	51	53	50	58
Mean Maximum Temperature (°C)[1]													
Mean	25.5	24.7	22.4	18.4	14.3	11.1	10.4	12.0	15.4	18.7	21.5	24.5	18.2
Mean Minimum Temperature (°C)[1]													
Mean	11.9	12.1	10.1	6.7	3.9	1.8	0.7	1.3	3.4	6.0	8.1	10.4	6.4
Rainfall (mm)[2]													
Mean	94.3	83.8	83.9	62.7	63.0	67.6	67.6	63.4	58.9	67.7	70.0	76.1	858.5
Raindays (Number)													
Mean	8.3	7.6	8.4	7.0	7.6	8.8	8.4	8.3	7.9	8.2	7.7	7.6	95.8

Source: BOM (2012)

[1] °C = degrees Celsius

[2] mm = millimetres

Climate averages for Station: 063224; Commenced: 1889, Last record: 2006; Latitude: 33.49 °S; Longitude: 150.15 °E.

5.3 Existing Air Quality

5.3.1 Introduction

Air quality standards and criteria refer to pollutant levels that include the contribution from specific projects and existing sources of dust. To assess impacts against all the relevant air quality standards and criteria (see **Section 4**) it is necessary to have information or estimates on existing dust concentration and deposition levels in the area in which the Project is likely to contribute. It is important to note that the existing air quality levels (that is, background levels) will be influenced by the existing mining operations in the area, including the current SCSS.

The current monitoring network consists of High Volume Air Samplers (HVAS) and dust deposition gauges. HVAS measure both PM_{10} and TSP on a 6-day cycle to coincide with monitoring carried out by the NSW EPA. Deposition gauges measure the amount of deposited insoluble solids on a monthly basis to determine an annual average which can then be compared to air quality criteria. The following three mines include a combination of both HVAS and deposition gauges.

- Angus Place – One HVAS and eight dust deposition gauges.
- Pine Dale – One HVAS and three dust deposition gauges.
- Springvale – One HVAS Five dust deposition gauges.
- Lidsdale Siding – Five dust deposition gauges.

Figure 5.6 shows the location of all HVAS and dust deposition gauges in the study area.

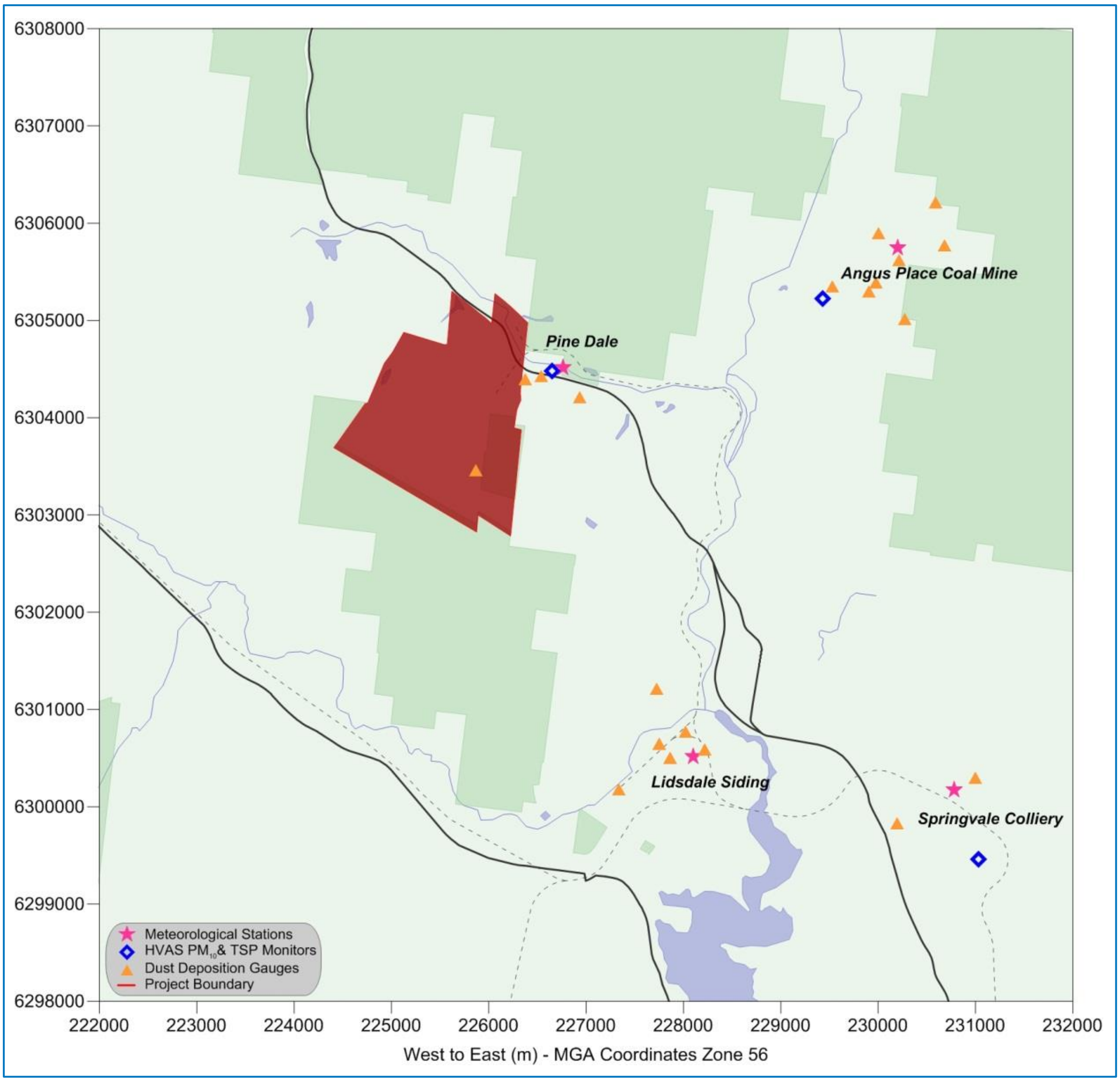


Figure 5.6: Monitoring locations

5.3.2 PM_{10} Concentrations

Table 5.2 presents the annual average PM_{10} concentrations as measured at the Angus Place and Pine Dale monitoring sites. Annual average PM_{10} concentrations at the two sites are below the EPA assessment criterion of 30 µg/m³.

Table 5.2: Annual average PM_{10} (µg/m³) concentrations for each monitoring site

Year	Location		
	Angus Place	Pine Dale	Springvale
2007	-	15	-
2008	-	13	-
2009	6	14	-
2010	7	10	7.7
2011	4	11	8.2
2012	4	11	8.9

5.3.3 Total Suspended Particulate Concentrations

Table 5.3 presents the annual average TSP concentrations as measured at the Angus Place and Pine Dale monitoring sites. Annual average TSP concentrations at the two sites are below the EPA assessment criterion of 90 µg/m³ and will include emissions from the current SCSS operations.

Table 5.3: Annual average TSP (µg/m³) concentrations for each monitoring site

Year	Location		
	Angus Place	Pine Dale	Springvale
2007	-	38	-
2008	-	36	-
2009	17	35	-
2010	16	27	18
2011	21	20	18
2012	13	24	24

5.3.4 Dust Deposition

Table 5.4 presents the annual average dust deposition levels as measured at the Angus Place, Pine Dale and Springvale monitoring sites. Annual average dust deposition levels at the three sites are below the EPA assessment criterion of 4 g/m²/month.

Table 5.4: Annual average dust deposition levels for each monitoring site (all gauges)

Year	Angus Place	Pine Dale	Springvale
2003	-	-	1.6
2004	-	-	1.5
2005	-	-	1.2
2006	1.5	0.9	1.4
2007	1.5	0.9	1.1
2008	1.0	1.4	1.4
2009	2.6	0.9	1.1
2010	1.2	0.6	1.4
2011	3.0	0.6	1.6
2012	1.0	0.7	1.4

5.3.5 Estimating Background Levels

For the purposes of establishing annual background levels at Blackmans Flat (those nearest to the SCSS), the maximum values at Pine Dale and Angus Place were taken into account. Adding monitored PM_{10} concentrations at Pine Dale to predictions at Blackmans Flat residences, will be overly conservative and unrealistic because the dominant source of PM_{10} concentrations at that location will be the existing operations in the area including, the SCSS, haulage from Angus Place and the Neubeck Open Cut, as well as more distant sources which have been included in the cumulative modelling scenarios. The monitoring data at Angus Place are likely to be more indicative of what the contributions may be from non-modelled sources and therefore more representative of background levels. The highest annual average PM_{10} value for Angus Place was measured to be 7 µg/m³. To remain conservative, an intermediate value of approximately 10 µg/m³ is used to represent the background PM_{10} concentrations (those due to non-modelled sources). Similarly, a value of 27 µg/m³ has been used to represent existing TSP concentrations and a value of 1.4 g/m²/month was chosen to represent background dust deposition levels in the area.

Estimating the annual average background value for $PM_{2.5}$ is more difficult as there are no direct measurements in the immediate area. Data from a number of NSW EPA sites with co-located PM_{10} and $PM_{2.5}$ measurements in 2011 were analysed for annual average and these values plotted in **Figure 5.7**, showing a relationship between the two particle size groups. The annual average PM_{10} concentration for Bathurst in 2011 (at the NSW EPA TEOM site) was 11.0 µg/m³. Even though this is outside the range of the data shown in **Figure 5.7**, it would be reasonable to extrapolate. Applying the same regression function to the Bathurst data gives an estimated annual average $PM_{2.5}$ concentration of approximately 4.0 µg/m³. This value has been used to represent the annual average $PM_{2.5}$ background for this assessment.

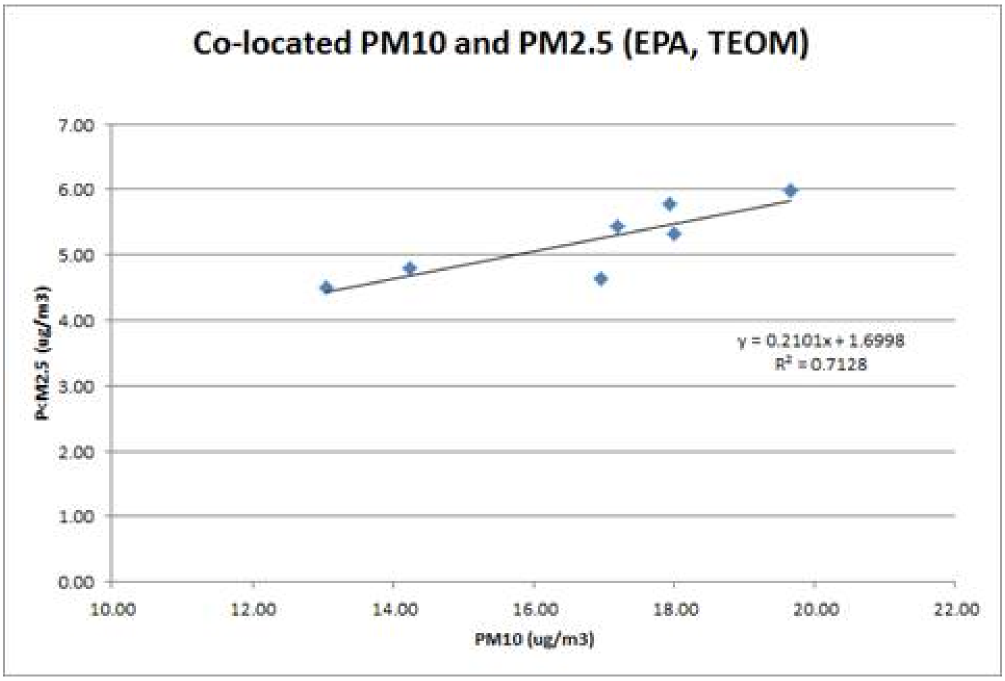


Figure 5.7: Annual average $PM_{2.5}$ and PM_{10} data from co-located TEOMs in 2011

In summary, conservative estimates of background dust levels are estimated to be as follows.

- 27 µg/m³ for annual average TSP
- 10 µg/m³ for annual average PM_{10}
- 4 µg/m³ for annual average $PM_{2.5}$
- 1.4 g/m²/month for annual average dust deposition

In addition to the consideration of annual averages, the EPA guidelines require an assessment against 24-hour PM_{10} concentrations. The approach for the assessment of 24-hour cumulative PM_{10} is different from that for annual averages and will be discussed in detail in **Section 8**.

6 APPROACH TO ASSESSMENT

The assessment has generally followed the EPA's Approved Methods (**EPA, 2005**). The approved methods specify how assessments based on the use of air dispersion models should be completed. They include guidelines for the preparation of meteorological data to be used in dispersion models and the relevant air quality criteria for assessing the significance of predicted concentration and deposition rates from a proposal.

The approach taken in this assessment generally follows the guidelines. The only deviation relates to the use of the ISCMOD. ISCMOD has been specially developed from the US EPA's ISCST3 model to give improved performance in the prediction of short-term PM_{10} concentrations. It has been accepted for use in NSW by the EPA for a number of years for recently completed mining and quarry assessments, including large Hunter Valley mines. It should also be noted that an initial analysis of existing emissions from the SCSS operations carried out using ISCMOD, showed similarities with existing monitoring data for annual PM_{10} concentrations.

ISCMOD has been derived from the ISCST3[b] model by applying changes to the horizontal and vertical dispersion curves following recommendations made by the American Meteorological Society (AMS) Expert Panel on Dispersion Curves (**Hanna et al., 1977**) (see **Holmes Air Sciences, 2007**). ISCST3 is fully described in the user manual and the accompanying technical description (**US EPA, 1995**). The modelling has been based on the use of three particle-size categories (0 to 2.5 µm - referred to as $PM_{2.5}$, 2.5 to 10 µm - referred to as CM (coarse matter) and 10 to 30 µm - referred to as the Rest). Emission rates of TSP have been calculated using emission factors derived from **US EPA (1985)** and **SPCC (1983)** work.

The distribution of particles has been derived from measurements in the **SPCC (1986)** study. The distribution of particles in each particle size range is as follows:

- $PM_{2.5}$ (FP) is 4.7% of the TSP
- $PM_{2.5-10}$ (CM) is 34.4% of TSP
- PM_{10-30} (Rest) is 60.9% of TSP

Modelling was done using three source groups. Each group corresponded to a particle size category. Each source in the group was assumed to emit at the full TSP emission rate and to deposit from the plume in accordance with the deposition rate appropriate for particles with an aerodynamic diameter equal to the geometric mean of the limits of the particle size range, except for the $PM_{2.5}$ group, which was assumed to have a particle size of 1 µm.

The predicted concentration in the output files for each group were then combined according to the weightings in the dot points above to determine the concentration of $PM_{2.5}$, PM_{10} and TSP. For example, using the naming convention of the source groups listed above, TSP = FP + CM + Rest, PM_{10} = FP + CM and $PM_{2.5}$ = FP.

The ISC models also have the capacity to take into account dust emissions that vary in time, or with meteorological conditions. This has proved particularly useful for simulating emissions on mining or quarry operations where wind speed is an important factor in determining the rate at which dust is generated.

For the current study, the operations were represented by a series of volume sources located according to the location of activities for the two modelled scenarios (see **Figure 6.1**). Estimates of emissions for each source were developed on an hourly time step taking into account the activities that would take place at that location. Thus, for each source, for each hour, an emission rate was determined which depended upon the level of activity and the wind speed. It is important to do this in the ISC models to ensure that long-term average emission rates are not combined with worst-case dispersion conditions, which are associated with light winds. Light winds at the SCSS would correspond with periods of low dust generation (because wind erosion and other wind-dependent emissions rates will be low) and also correspond with periods of poor dispersion. If these measures are not taken then the model has the potential to significantly overstate impacts.

[b] In subsequent text, when referring to the operation of the ISCMOD or ISCST3 model, where the structure of the models is identical, the acronym ISC will be used.

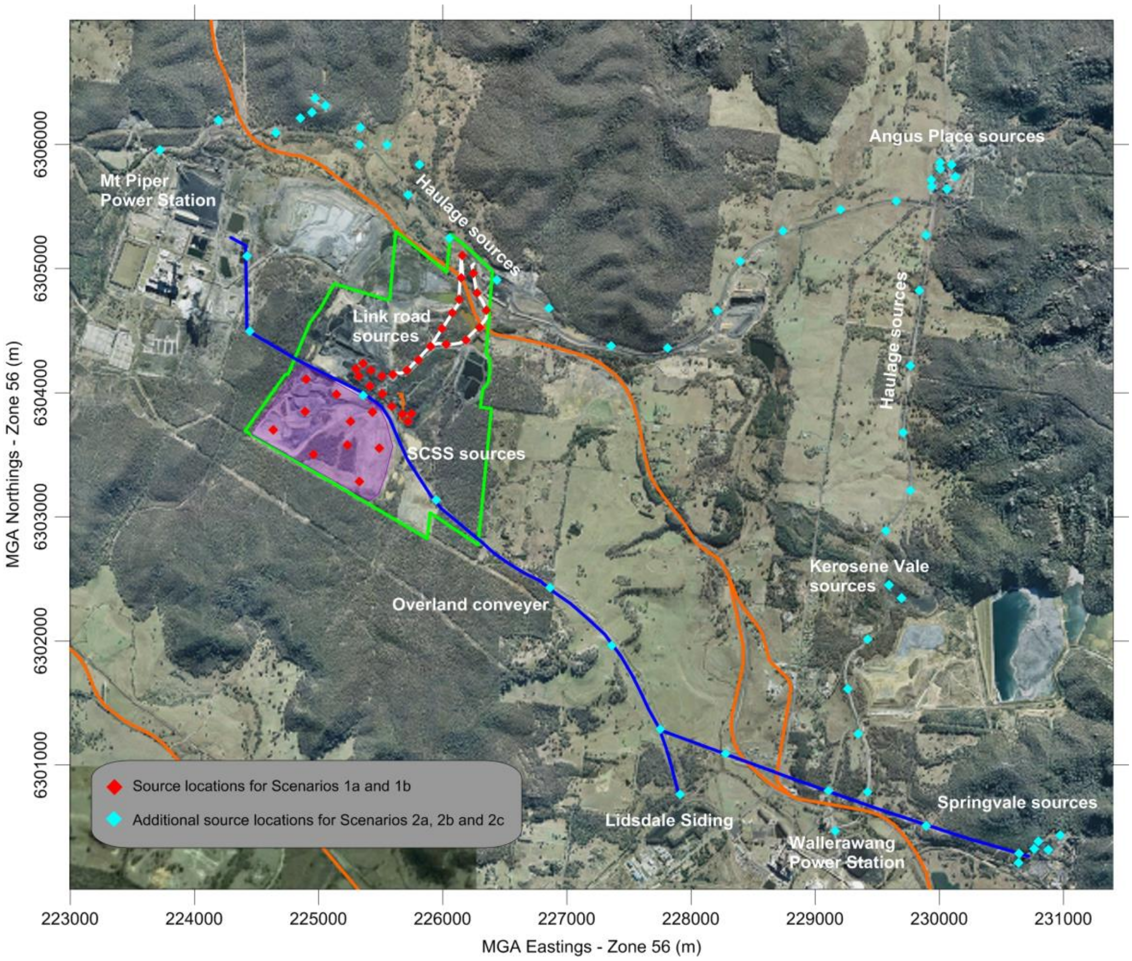


Figure 6.1: Modelling source locations

In order to assess the cumulative impacts of the mine, estimates of background levels have been made using the air quality monitoring data discussed in **Section 5.3**.

7 EMISSION ESTIMATES OF PARTICULATE MATTER

This section discusses the calculation of the particulate emissions applied in the assessment. Emissions have been calculated for loading and transport operations, as well as wind erosion sources at the Springvale and Angus Place Collieries, and operations at the SCSS.

The operation of the Project has been analysed and estimates of dust emissions for the key dust generating activities have been made for each of the Scenarios listed below. Emission factors developed both locally and by the US EPA, have been applied to estimate the amount of dust produced by each activity.

- **Scenario 1a**: SCSS operations only, with a maximum of 6 Mtpa of total material being hauled on the new internal link road (Route 1).
- **Scenario 1b**: Same as Scenario 1a but using internal link road Route 2.
- **Scenario 2a**: Cumulative assessment including operations at the SCSS, Angus Place, Springvale, operations and haulage at Neubecks, and haulage of 4 Mt of coal from Angus Place to Mt Piper Power Station (MPPS).
- **Scenario 2b**: Same as Scenario 2a but using internal link road Route 2.
- **Scenario 2c**: Same as Scenario 2b but hauling all Angus Place coal to Wallerawang Power Station instead of MPPS.

The operational and transport plans for the Project have been analysed and detailed emissions inventories have been prepared for these key operating scenarios. These modelled scenarios were chosen to represent the worst-case for each of the various options Centennial Coal wish to use for their transport of varying quantities of coal.

Table 7.1 presents the emission estimates for each scenario modelled.

Table 7.1: Estimated annual TSP emissions for the Project (kg/y)

ACTIVITY	Scenario 1a	Scenario 1b	Scenario 2a	Scenario 2b	Scenario 2c
SCSS					
Unloading conveyer from Springvale (ROM)	848	848	848	848	848
Unloading coal from trucks from Angus Place	135,107	135,107	135,107	135,107	135,107
Unloading coal from trucks from Neubecks	33,777	33,777	33,777	33,777	33,777
FEL loading ROM to washery	1,319	1,319	1,319	1,319	1,319
Dozers on product coal stockpiles	32,790	32,790	32,790	32,790	32,790
Wind erosion on product coal stockpiles	3,154	3,154	3,154	3,154	3,154
Hauling rejects to emplacement area	48,398	48,398	48,398	48,398	48,398
Dozers on emplacement area	1,969	1,969	1,969	1,969	1,969
Trucks dumping on emplacement area	92	92	92	92	92
Hauling coal from Angus Place on new link road	30,704	29,567	-	-	-
Hauling rejects off site on new link road	12,446	11,985	12,446	11,985	12,446
Hauling coal from Neubecks on new link road	12,446	11,985	12,446	11,985	12,446
Springvale					
Wind erosion on ROM stockpiles	-	-	4,205	4,205	4,205
Wind erosion on other exposed areas	-	-	2,453	2,453	2,453
Dozers on coal stockpiles	-	-	43,720	43,720	43,720
Angus Place					
Loading ROM to stockpile (via conveyer)	-	-	754	754	754
Loading ROM to truck through chute	-	-	754	754	754
Wind erosion on ROM Stockpiles	-	-	1,051	1,051	1,051
Wind erosion on other exposed areas	-	-	1,051	1,051	1,051
Dozers on Angus Place stockpile	-	-	70,191	70,191	70,191
Kerosene Vale					
Unloading ROM at Kerosene Vale stockpile	-	-	16,843	16,843	16,843
Re-loading ROM at Kerosene Vale stockpile	-	-	16,843	16,843	16,843
Dozer on stockpile	-	-	14,973	14,973	14,973
Wind erosion on stockpile	-	-	5,256	5,256	5,256
Neubecks					
Hauling Coal on sealed road to SCSS intersection with new link road	-	-	18,439	18,439	18,439
Hauling reject on sealed road from SCSS intersection with new link road	-	-	18,439	18,439	18,439
Operations due to operations (1 Mtpa of ROM, 4 Mbcm of overburden removal, transport and wind erosion)	-	-	181,952	181,952	181,952
Angus Place					
Hauling ROM coal on sealed road to MPPS	-	-	170,474	170,474	-
Hauling ROM coal on sealed road to WPS	-	-	-	-	118,226
Overland Conveyors					
MPPS to Lidsdale Siding	-	-	70	70	70
From Springvale pit top	-	-	30	30	30
Total	**313,049**	**310,990**	**849,845**	**848,923**	**797,596**

8 ASSESSMENT OF IMPACTS

8.1 Assessment Criteria

The air quality criteria used for identifying which properties are likely to experience air quality impacts are those specified in the Approved Methods. These have been applied in the assessment process following the practices used in contemporary approvals for mining projects in NSW.

The criteria are:

- 50 µg/m^3 for 24-hour average PM_{10} for the Project and other sources (excluding natural events).
- 30 µg/m^3 for annual average PM_{10} due to the Project and other sources.
- 90 µg/m^3 for annual average TSP concentrations due to the Project alone and other sources.
- 2 g/m^2/month for annual average dust deposition (insoluble solids) due to the Project considered alone.
- 4 g/m^2/month for annual average predicted cumulative deposition (insoluble solids) due to the Project and other sources.

Dust concentrations due to SCSS and other operations have been presented as isopleth diagrams in the following sections. Summary tables are also presented showing the predicted $PM_{2.5}$, PM_{10}, TSP and dust deposition impacts, together with the estimated background levels.

While there is no current air quality criteria for $PM_{2.5}$ in NSW, the results have been compared to the NEPM advisory standard.

8.2 Annual Predictions

8.2.1 Scenarios 1a and 1b – Springvale Coal Services Site only

Table 8.2 presents the incremental modelling results for Scenarios 1a and 1b, at each of the nearest residential properties at Blackmans Flat shown in **Figure 2.3**. The cumulative predictions are shown in **Table 8.2** which include the estimated background concentrations (as listed in **Section 5.3.5**).

Table 8.2 shows that the predicted annual average $PM_{2.5}$ concentrations due to emissions from the SCSS are well below the NEPM reporting standard of 8 µg/m^3. The cumulative predictions are shown in which include the estimated background concentrations (as listed in **Section 5.3.5**).

As can be seen in **Table 8.2**, there are no predicted exceedances of the annual criteria for $PM_{2.5}$, PM_{10}, TSP or deposition at Blackmans Flat. The highest concentrations are estimated to occur at Residence B1 in both cases. These scenarios incorporate the maximum 6 Mtpa being transported along the new internal link road for the entire year and which is a significant overestimate of what is likely to occur in practice. There may be occasions when this link road will run at maximum capacity, but this will not occur for the entire year. Even at this maximum capacity, there are no predicted exceedances.

The predictions for the wider area are shown in contour plots in **Figure 8.1** to **Figure 8.6**. These contour plots show predictions for the SCSS operations only and do not include the background estimates listed in **Section 5.3.5** or noted in **Table 8.2**.

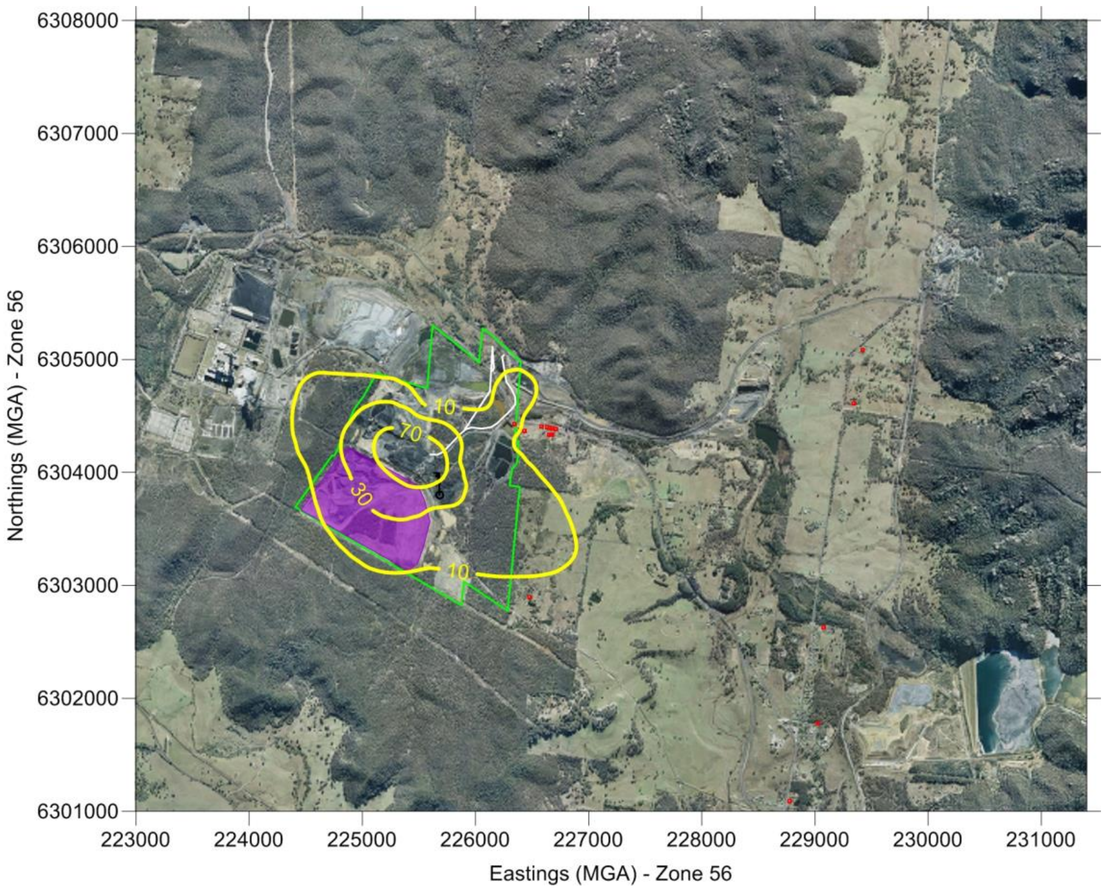
It is clear that the western haul road option (Scenario 1b) would be the preferred option in terms of air quality at Blackmans Flat.

Table 8.1: Predicted annual averages for the SCSS only – Scenarios 1a and 1b

Residence ID	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	Deposition (g/m²/month)
Scenario 1a				
B1	1.7	13.5	25.4	1.6
B2	1.4	10.7	18.8	1.1
B3	1.3	9.7	16.2	0.9
B4	1.0	7.3	11.4	0.6
B5	0.9	6.6	10.0	0.5
B6	0.9	6.4	9.5	0.5
B7	0.8	6.1	9.0	0.5
B8	0.8	5.8	8.4	0.4
B9	0.9	6.6	9.6	0.5
B10	0.9	6.5	9.3	0.5
B11	0.9	6.3	9.0	0.5
Scenario 1b				
B1	0.8	6.4	10.9	0.6
B2	0.8	6.2	10.1	0.6
B3	0.8	6.0	9.5	0.5
B4	0.7	5.0	7.5	0.4
B5	0.6	4.7	7.0	0.4
B6	0.6	4.7	6.8	0.4
B7	0.6	4.6	6.6	0.3
B8	0.6	4.4	6.4	0.3
B9	0.7	5.0	7.1	0.4
B10	0.7	4.9	7.0	0.4
B11	0.7	4.9	6.9	0.3

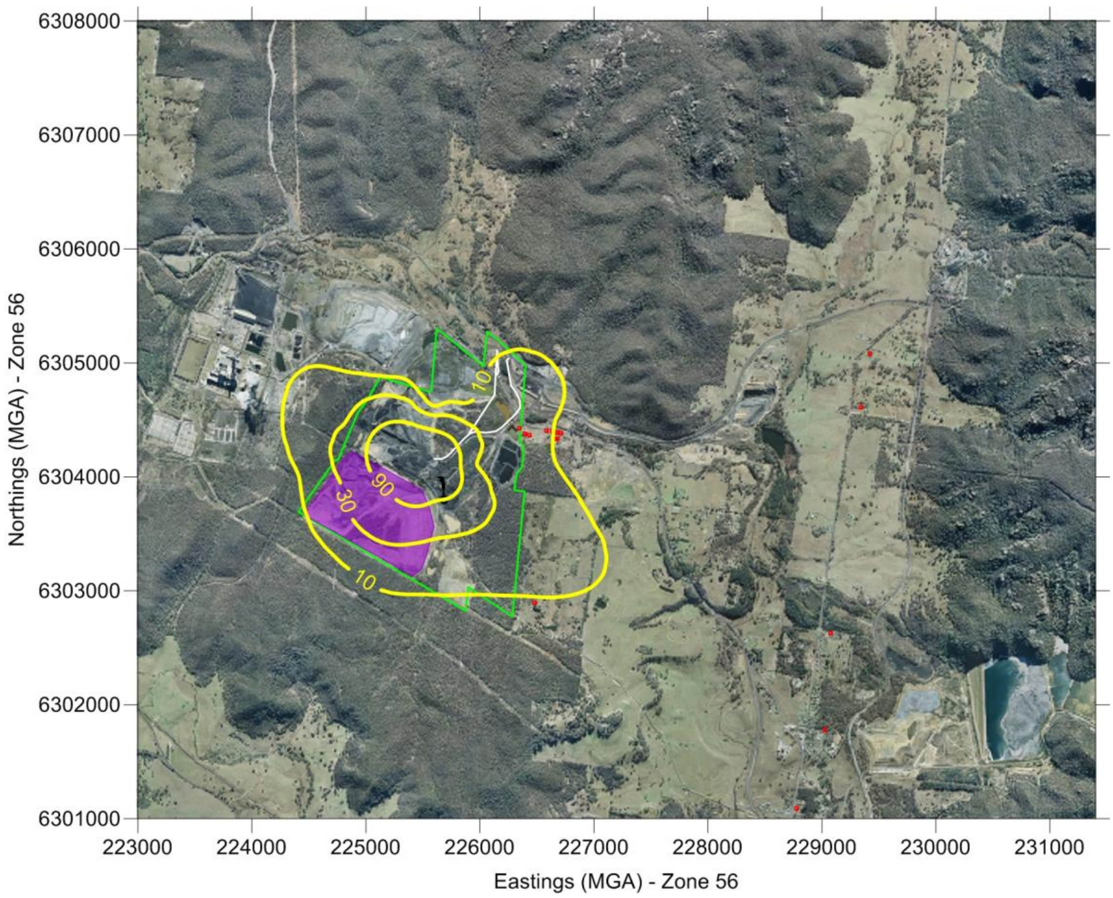
Table 8.2: Estimated cumulative values for Scenarios 1a and 1b

Residence ID	Annual $PM_{2.5}$ (µg/m³)	Annual PM_{10} (µg/m³)	Annual TSP (µg/m³)	Dust deposition (g/m²/month)
Criteria ⇨	***8***	***30***	***90***	***4***
Background ⇨	*4*	*10*	*27*	*1.4*
Scenario 1a				
B1	5.7	23.5	52.4	3.0
B2	5.4	20.7	45.8	2.5
B3	5.3	19.7	43.2	2.3
B4	5.0	17.3	38.4	2.0
B5	4.9	16.6	37.0	1.9
B6	4.9	16.4	36.5	1.9
B7	4.8	16.1	36.0	1.9
B8	4.8	15.8	35.4	1.8
B9	4.9	16.6	36.6	1.9
B10	4.9	16.5	36.3	1.9
B11	4.9	16.3	36.0	1.9
Scenario 1b				
B1	4.8	16.4	37.9	2.0
B2	4.8	16.2	37.1	2.0
B3	4.8	16.0	36.5	1.9
B4	4.7	15.0	34.5	1.8
B5	4.6	14.7	34.0	1.8
B6	4.6	14.7	33.8	1.8
B7	4.6	14.6	33.6	1.7
B8	4.6	14.4	33.4	1.7
B9	4.7	15.0	34.1	1.8
B10	4.7	14.9	34.0	1.8
B11	4.7	14.9	33.9	1.7



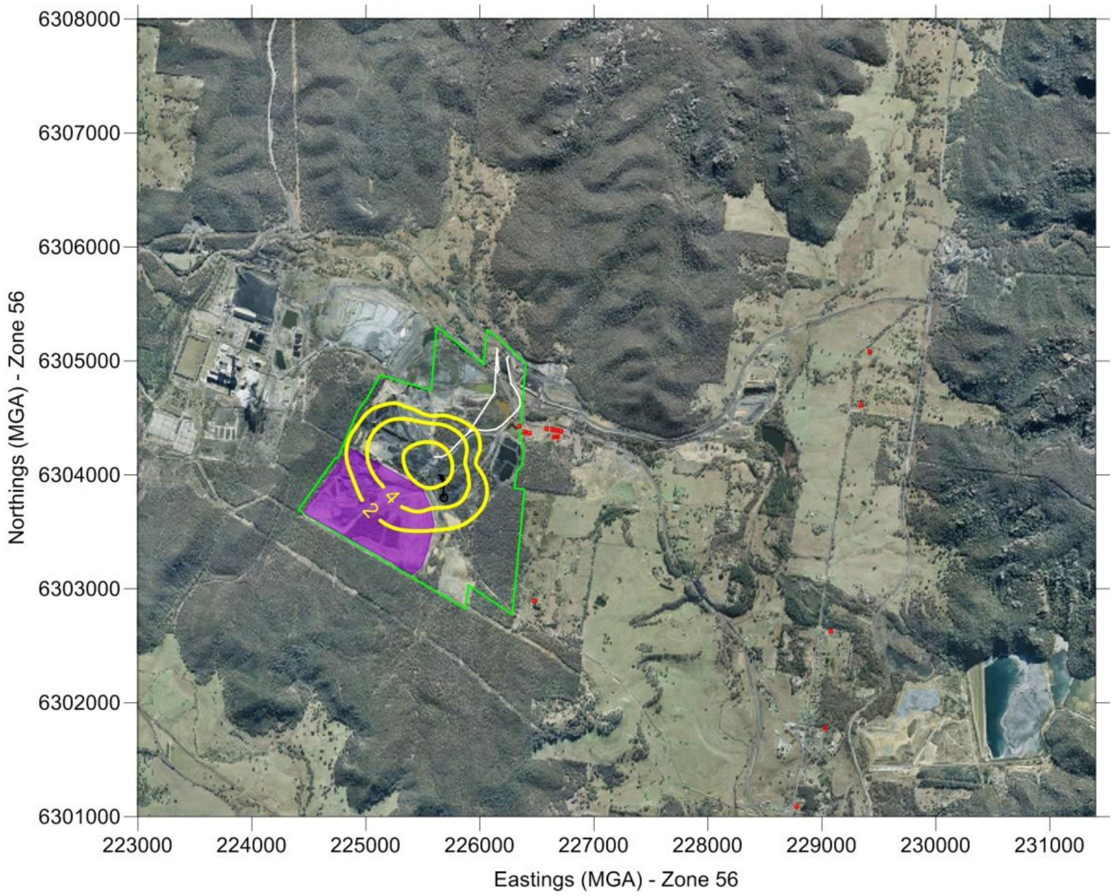
Species: PM10	Location: SCSS	Scenario 1a: SCSS only	Percentile: N/A	Averaging Time: Annual
Model Used: ISCMOD	**Units:** µg/m³	**Guideline:** N/A	**Met Data:** 2010	**Plot:** J. Barnett

Figure 8.1: Predicted annual average PM_{10} concentrations due to emissions from SCSS operations only, using internal link Route 1



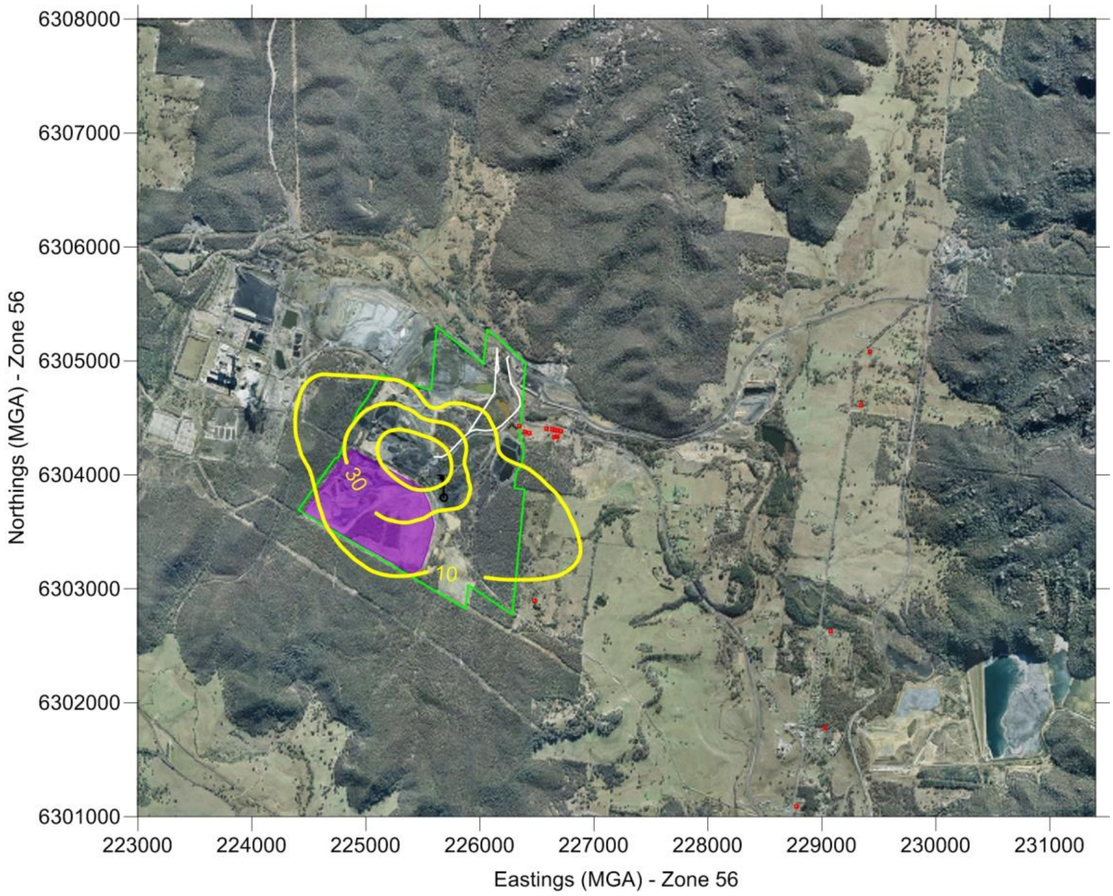
Species: TSP	**Location:** SCSS	**Scenario 1a:** SCSS only	**Percentile:** N/A	**Averaging Time:** Annual
Model Used: ISCMOD	**Units:** µg/m³	**Guideline:** N/A	**Met Data:** 2010	**Plot:** J. Barnett

Figure 8.2: Predicted annual average TSP concentrations due to emissions from SCSS operations only, internal link Route 1



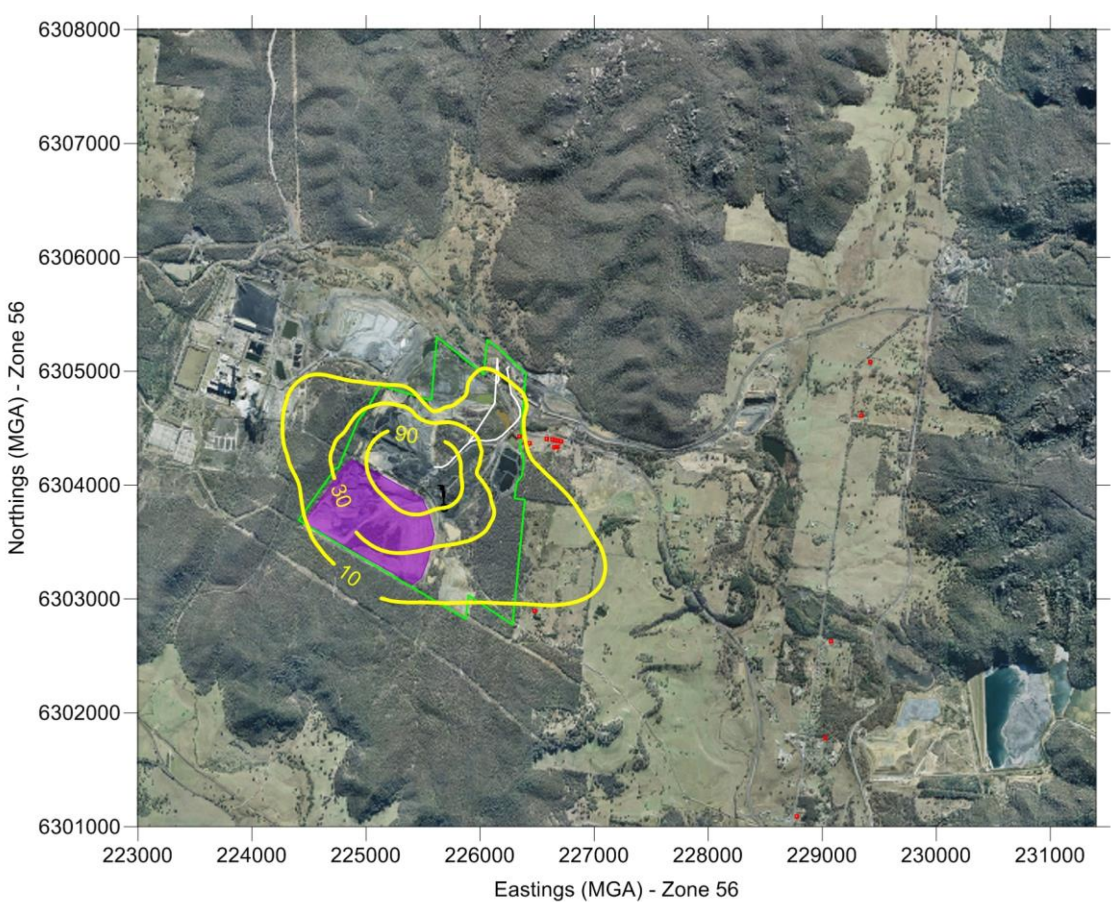
Species: Deposition	**Location:** SCSS	**Scenario 1a:** SCSS only	**Percentile:** N/A	**Averaging Time:** Annual
Model Used: ISCMOD	**Units:** g/m²/month	**Guideline:** 2 g/m²/month	**Met Data:** 2010	**Plot:** J. Barnett

Figure 8.3: Predicted annual average dust deposition levels due to emissions from the SCSS operations only, using internal link Route 1



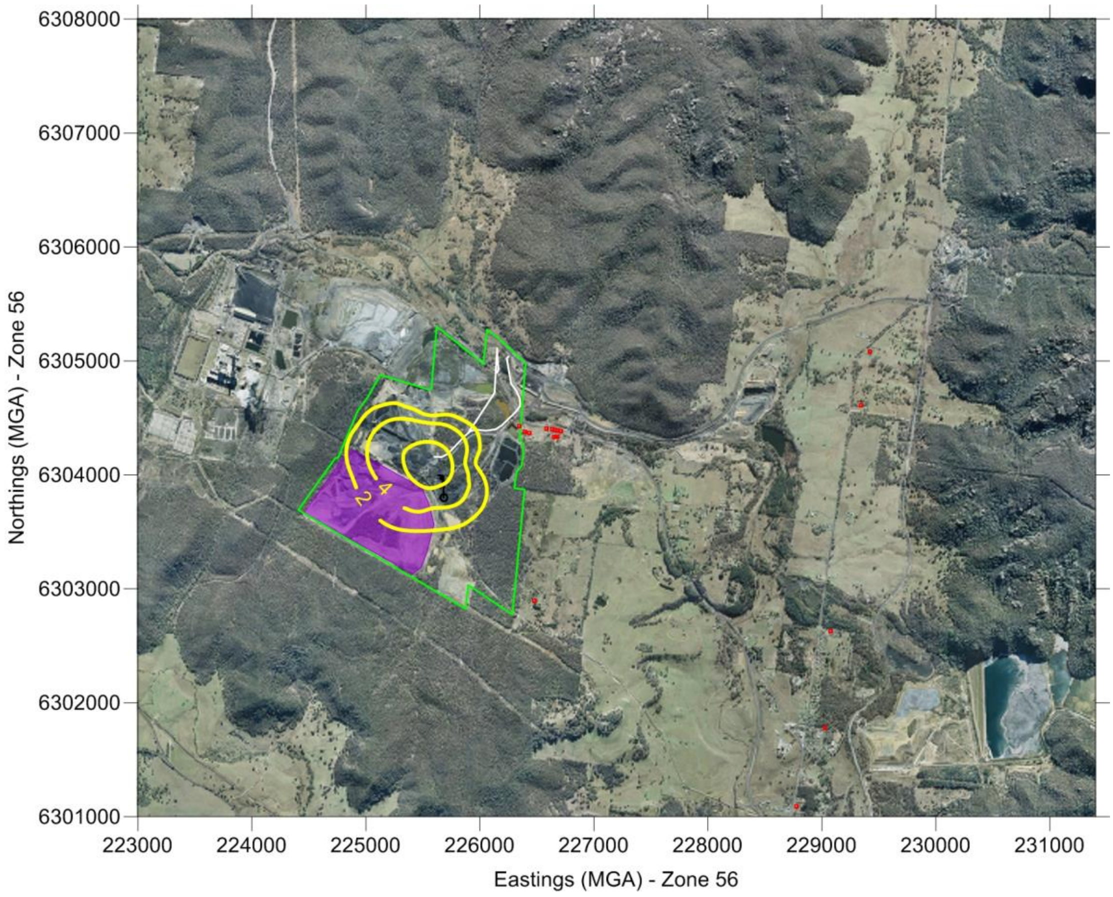
Species: PM10	**Location:** SCSS	**Scenario 1b:** SCSS only	**Percentile:** N/A	**Averaging Time:** Annual
Model Used: ISCMOD	**Units:** µg/m³	**Guideline:** N/A	**Met Data:** 2010	**Plot:** J. Barnett

Figure 8.4: Predicted annual average PM_{10} concentrations due to emissions from SCSS operations only, using internal link Route 2



Species: TSP	**Location:** SCSS	**Scenario 1b:** SCSS only	**Percentile:** N/A	**Averaging Time:** Annual
Model Used: ISCMOD	**Units:** µg/m³	**Guideline:** N/A	**Met Data:** 2010	**Plot:** J. Barnett

Figure 8.5: Predicted annual average TSP concentrations due to emissions from SCSS operations only, internal link Route 2



Species: Deposition	Location: SCSS	Scenario 1b: SCSS only	Percentile: N/A	Averaging Time: Annual
Model Used: ISCMOD	**Units:** g/m²/month	**Guideline:** 2 g/m²/month	**Met Data:** 2010	**Plot:** J. Barnett

Figure 8.6: Predicted annual average dust deposition levels due to emissions from the SCSS operations only, using internal link Route 2

8.2.2 Scenarios 2a, 2b and 2c – All Operations

Table 8.3 and **Table 8.4** present the modelling results for Scenarios 2a, 2b and 2c, at each of the nearest residential properties at Blackmans Flat (**Figure 2.3**), Lidsdale Village and Wolgan Road (**Figure 2.4**). This scenario involves the total 4 Mtpa from Angus Place being directed to the Mt Piper Power Station (Scenarios 2a and 2b) of Wallerawang Power Station (Scenario 2c) and therefore not using the new internal link road. The internal link road (Route 2) is still used for the transfer of rejects off site and for incoming coal from Neubecks.

It can be seen that by removing a significant load from the internal haul route (compare Scenarios 2a and 2b), the concentrations at some of the Blackmans Flat residences are reduced. Levels at the residences further along the highway to the east are slightly higher, but still remain below their respective goals.

The results also show that the levels at Blackmans Flat are also slightly further reduced when the Angus Place coal is hauled to Wallerawang rather than Mt Piper Power Station (compare Scenarios 2b and 2c). Levels at the Lidsdale Village residences are higher for this option, but still remain below their respective goals.

Levels at the Wolgan Road residences are predicted to be slightly lower for this option. Given that these residences are near both the Wallerawang and Mt Piper haul roads, they would be expected to be similar. The slightly higher levels at these locations for Scenario 2a and 2b, are likely to be a result of the predominant northwesterlies (as shown in **Figure 5.1** and **Figure 5.2**) blowing from the Mt Piper Haul Road towards Wolgan Road.

It should also be noted that the predicted annual average PM_{10} concentrations at Residence L1 remain relatively unchanged between each of the three Scenarios 2a, 2b and 2c. This is not unexpected given its close proximity to Kerosene Vale. The results indicate that the dominant dust sources for that location are operations at Kerosene Vale and that traffic on the Wallerawang haul road has little impact on predicted ground level concentrations there. Levels at L1 are still predicted to remain below their respective air quality goals, even when including highly conservative background values.

Predictions for the wider area are shown in contour plots in **Figure 8.7** to **Figure 8.15**.

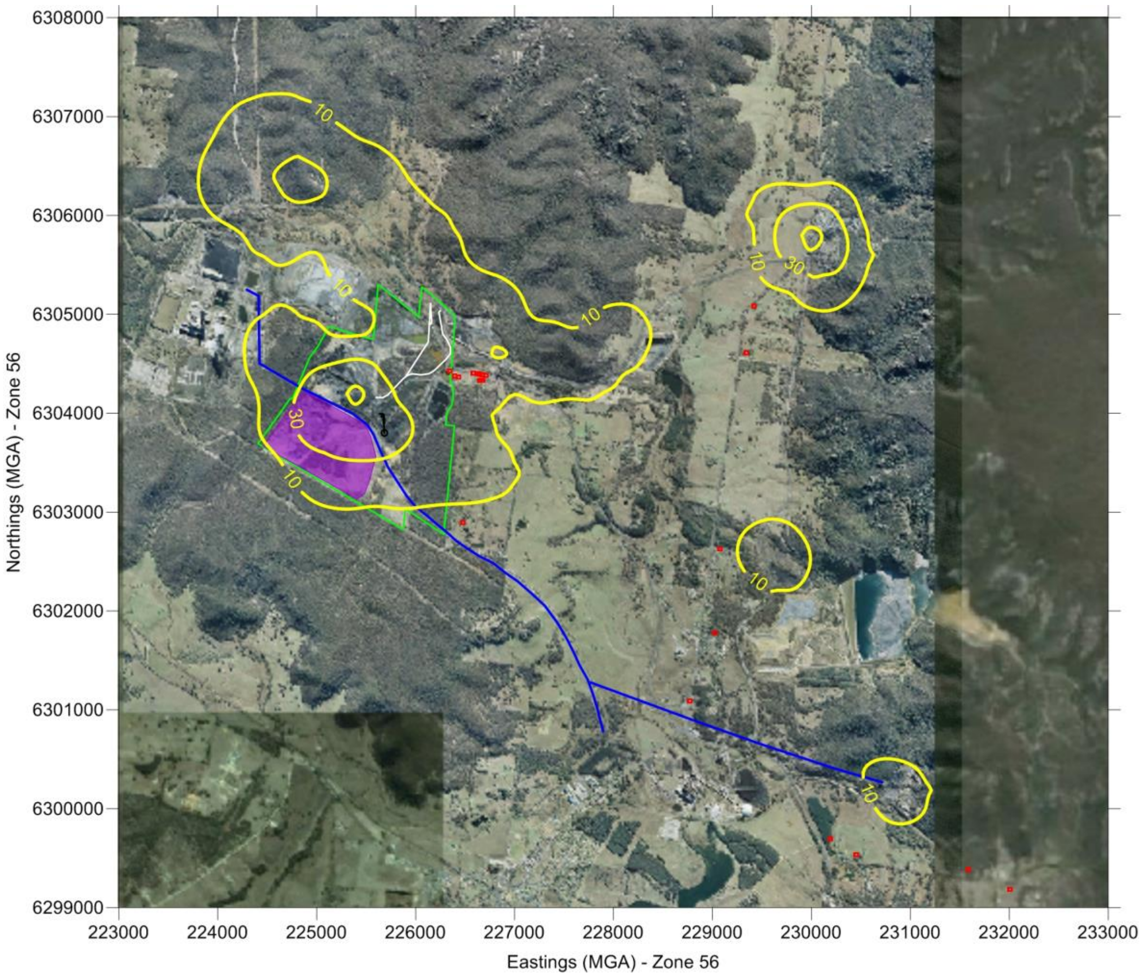
The term 'All Operations' in these results include all operations at the SCSS, Angus Place, Kerosene Vale, Springvale Colliery, Neubeck Open Cut, the overland conveyors and haulage. Other operations in the area such as Mt Piper and Wallerawang power stations and associated ash disposal, Western Matrix reject project, Lidsdale Siding and other coal mining operations are accounted for in the non-modelled background values discussed in **Section 5.3.5**.

Table 8.3: Predicted annual averages for all operations – Scenarios 2a, 2b and 2c

Residence ID	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	Deposition (g/m²/month)
		Scenario 2a		
B1	1.5	11.4	18.6	1.0
B2	1.4	10.2	15.5	0.8
B3	1.3	9.7	14.4	0.7
B4	1.2	9.1	13.0	0.6
B5	1.2	9.0	12.7	0.6
B6	1.2	9.0	12.6	0.6
B7	1.2	8.9	12.5	0.6
B8	1.2	8.9	12.4	0.6
B9	1.2	9.0	12.2	0.6
B10	1.2	8.9	12.1	0.6
B11	1.2	8.9	12.1	0.5
L1	1.1	7.7	9.1	0.2
L2	0.8	5.4	5.9	0.1
S1	0.4	2.9	3.2	0.1
S2	0.5	3.3	3.6	0.1
S3	0.5	3.6	3.9	0.1
S4	0.5	3.4	3.8	0.1
S5	0.5	3.1	3.3	0.1
WR1	0.9	6.8	8.4	0.3
WR2	0.9	6.0	6.8	0.2
		Scenario 2b		
B1	1.1	8.3	12.2	0.6
B2	1.1	8.1	11.7	0.6
B3	1.1	8.1	11.5	0.6
B4	1.1	8.1	11.3	0.5
B5	1.1	8.2	11.4	0.5
B6	1.1	8.2	11.4	0.5
B7	1.1	8.2	11.4	0.5
B8	1.1	8.3	11.5	0.5
B9	1.1	8.3	11.1	0.5
B10	1.1	8.2	11.1	0.5
B11	1.1	8.3	11.1	0.5
L1	1.1	7.7	9.1	0.2
L2	0.8	5.4	5.9	0.1
S1	0.4	2.9	3.2	0.1
S2	0.5	3.2	3.6	0.1
S3	0.5	3.6	3.9	0.1
S4	0.5	3.4	3.8	0.1
S5	0.5	3.1	3.3	0.1
WR1	0.9	6.8	8.4	0.3
WR2	0.9	6.0	6.8	0.2
		Scenario 2c		
B1	0.9	6.5	9.8	0.5
B2	0.9	6.5	9.5	0.5
B3	0.9	6.4	9.2	0.5
B4	0.8	5.9	8.1	0.4
B5	0.8	5.8	7.8	0.4
B6	0.8	5.7	7.7	0.4
B7	0.8	5.7	7.6	0.4
B8	0.8	5.6	7.4	0.4
B9	0.8	6.0	7.9	0.4
B10	0.8	5.9	7.8	0.4
B11	0.8	5.9	7.7	0.4
L1	1.1	7.7	9.4	0.3
L2	1.1	8.0	10.6	0.3
S1	0.5	3.4	3.9	0.1
S2	0.5	3.7	4.1	0.1
S3	0.7	4.7	5.5	0.1
S4	0.6	3.8	4.2	0.1
S5	0.5	3.3	3.6	0.1
WR1	0.6	4.4	5.6	0.2
WR2	0.6	4.4	5.3	0.1

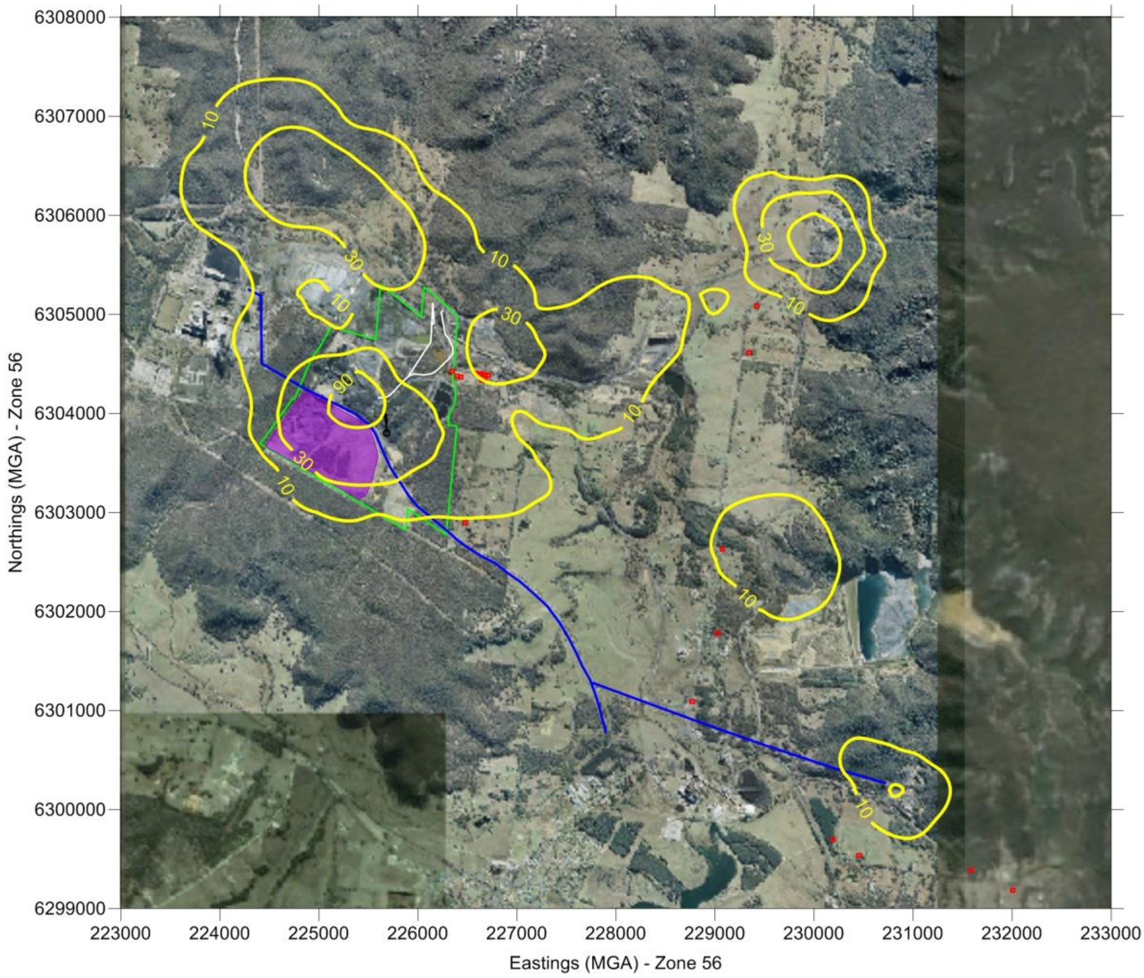
Table 8.4: Estimated cumulative values for Scenarios 2a, 2b and 2c

Residence ID	Annual $PM_{2.5}$ (µg/m³)	Annual PM_{10} (µg/m³)	Annual TSP (µg/m³)	Dust deposition (g/m²/month)
Criteria ⇨	***8***	***30***	***90***	***4***
Background ⇨	*4*	*10*	*27*	*1.4*
Scenario 2a				
B1	5.5	21.4	45.6	2.4
B2	5.4	20.2	42.5	2.2
B3	5.3	19.7	41.4	2.1
B4	5.2	19.1	40.0	2.0
B5	5.2	19.0	39.7	2.0
B6	5.2	19.0	39.6	2.0
B7	5.2	18.9	39.5	2.0
B8	5.2	18.9	39.4	2.0
B9	5.2	19.0	39.2	2.0
B10	5.2	18.9	39.1	2.0
B11	5.2	18.9	39.1	1.9
L1	5.1	17.7	36.1	1.6
L2	4.8	15.4	32.9	1.5
S1	4.4	12.9	30.2	1.5
S2	4.5	13.3	30.6	1.5
S3	4.5	13.6	30.9	1.5
S4	4.5	13.4	30.8	1.5
S5	4.5	13.1	30.3	1.5
WR1	4.9	16.8	35.4	1.7
WR2	4.9	16.0	33.8	1.6
Scenario 2b				
B1	5.1	18.3	39.2	2.0
B2	5.1	18.1	38.7	2.0
B3	5.1	18.1	38.5	2.0
B4	5.1	18.1	38.3	1.9
B5	5.1	18.2	38.4	1.9
B6	5.1	18.2	38.4	1.9
B7	5.1	18.2	38.4	1.9
B8	5.1	18.3	38.5	1.9
B9	5.1	18.3	38.1	1.9
B10	5.1	18.2	38.1	1.9
B11	5.1	18.3	38.1	1.9
L1	5.1	17.7	36.1	1.6
L2	4.8	15.4	32.9	1.5
S1	4.4	12.9	30.2	1.5
S2	4.5	13.2	30.6	1.5
S3	4.5	13.6	30.9	1.5
S4	4.5	13.4	30.8	1.5
S5	4.5	13.1	30.3	1.5
WR1	4.9	16.8	35.4	1.7
WR2	4.9	16.0	33.8	1.6
Scenario 2c				
B1	4.9	16.5	36.8	1.9
B2	4.9	16.5	36.5	1.9
B3	4.9	16.4	36.2	1.9
B4	4.8	15.9	35.1	1.8
B5	4.8	15.8	34.8	1.8
B6	4.8	15.7	34.7	1.8
B7	4.8	15.7	34.6	1.8
B8	4.8	15.6	34.4	1.8
B9	4.8	16.0	34.9	1.8
B10	4.8	15.9	34.8	1.8
B11	4.8	15.9	34.7	1.8
L1	5.1	17.7	36.4	1.7
L2	5.1	18.0	37.6	1.7
S1	4.5	13.4	30.9	1.5
S2	4.5	13.7	31.1	1.5
S3	4.7	14.7	32.5	1.5
S4	4.6	13.8	31.2	1.5
S5	4.5	13.3	30.6	1.5
WR1	4.6	14.4	32.6	1.6
WR2	4.6	14.4	32.3	1.5



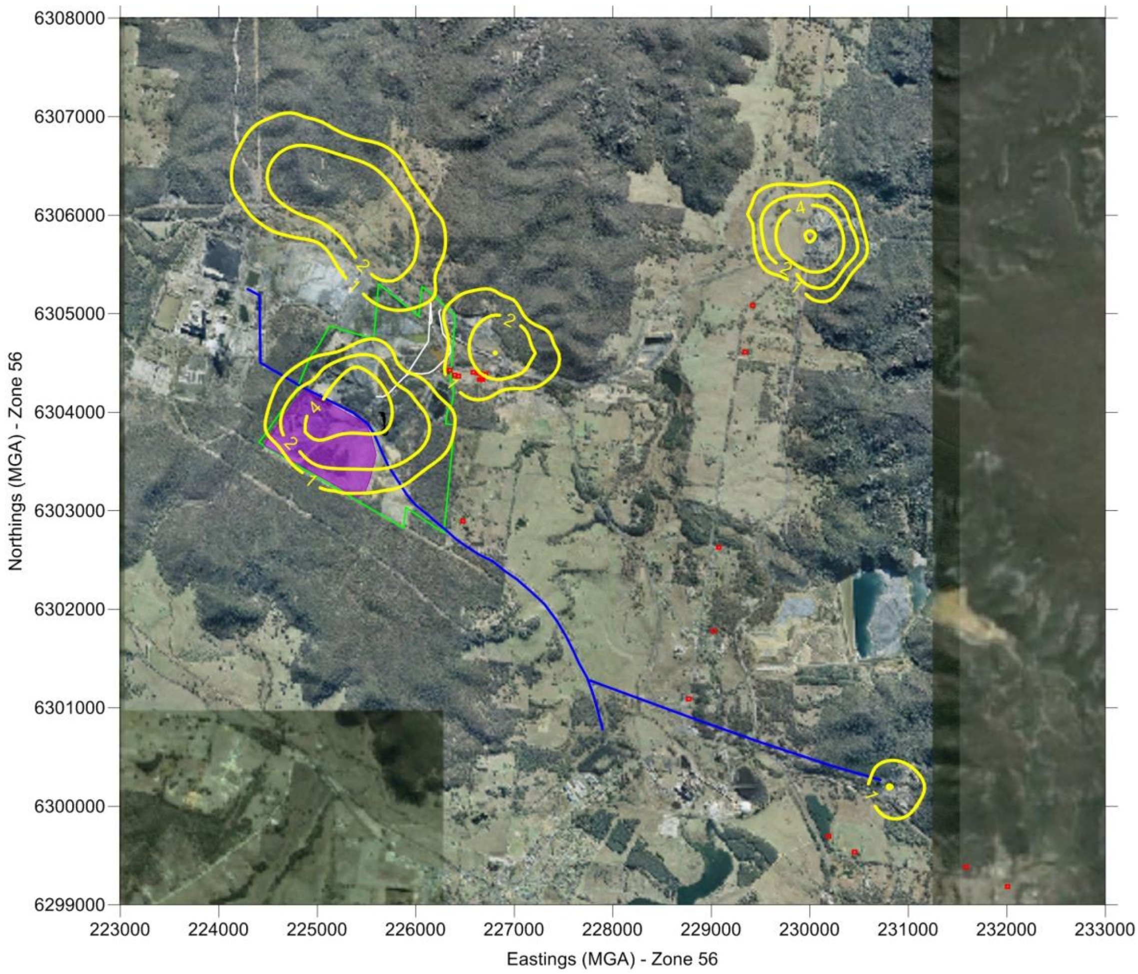
Species: PM10	**Location:** SCSS	**Scenario 2a:** SCSS and other operations	**Percentile:** N/A	**Averaging Time:** Annual
Model Used: ISCMOD	**Units:** µg/m³	**Guideline:** 30	**Met Data:** 2010	**Plot:** J. Barnett

Figure 8.7: Predicted annual average PM_{10} concentrations due to emissions from SCSS and other operations using internal link Route 1 – all Angus Place coal hauled to Mt Piper Power Station



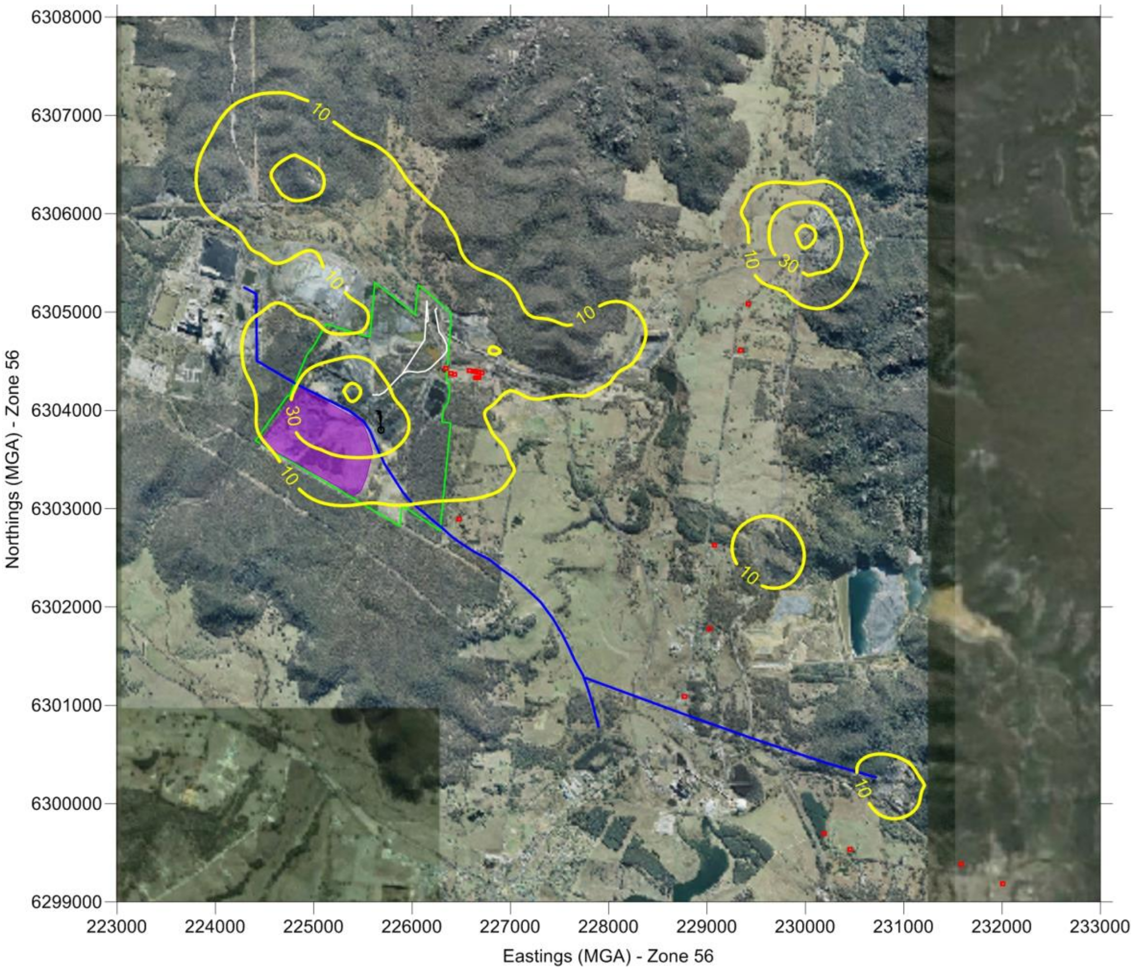
Species: TSP	**Location:** SCSS	**Scenario 2a:** SCSS and other operations	**Percentile:** N/A	**Averaging Time:** Annual
Model Used: ISCMOD	**Units:** µg/m³	**Guideline:** 90	**Met Data:** 2010	**Plot:** J. Barnett

Figure 8.8: Predicted annual average TSP concentrations due to emissions from SCSS and other operations using internal link Route 1 – all Angus Place coal hauled to Mt Piper Power Station



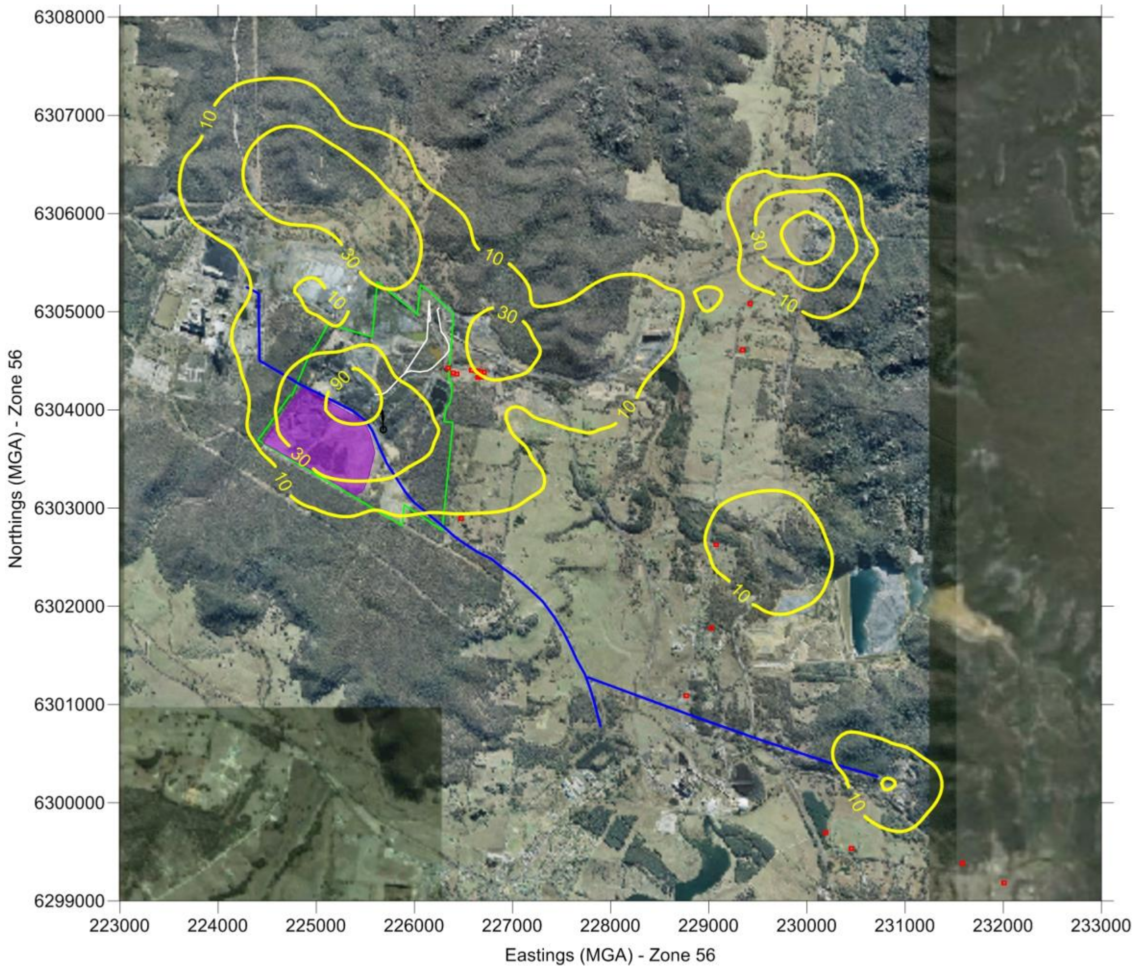
Species: Deposition	Location: SCSS	Scenario 2a: SCSS and other operations	Percentile: N/A	Averaging Time: Annual
Model Used: ISCMOD	**Units:** g/m²/month	**Guideline:** 4	**Met Data:** 2010	**Plot:** J. Barnett

Figure 8.9: Predicted annual average dust deposition levels due to emissions from the SCSS and other operations using internal link Route 1 – all Angus Place coal hauled to Mt Piper Power Station



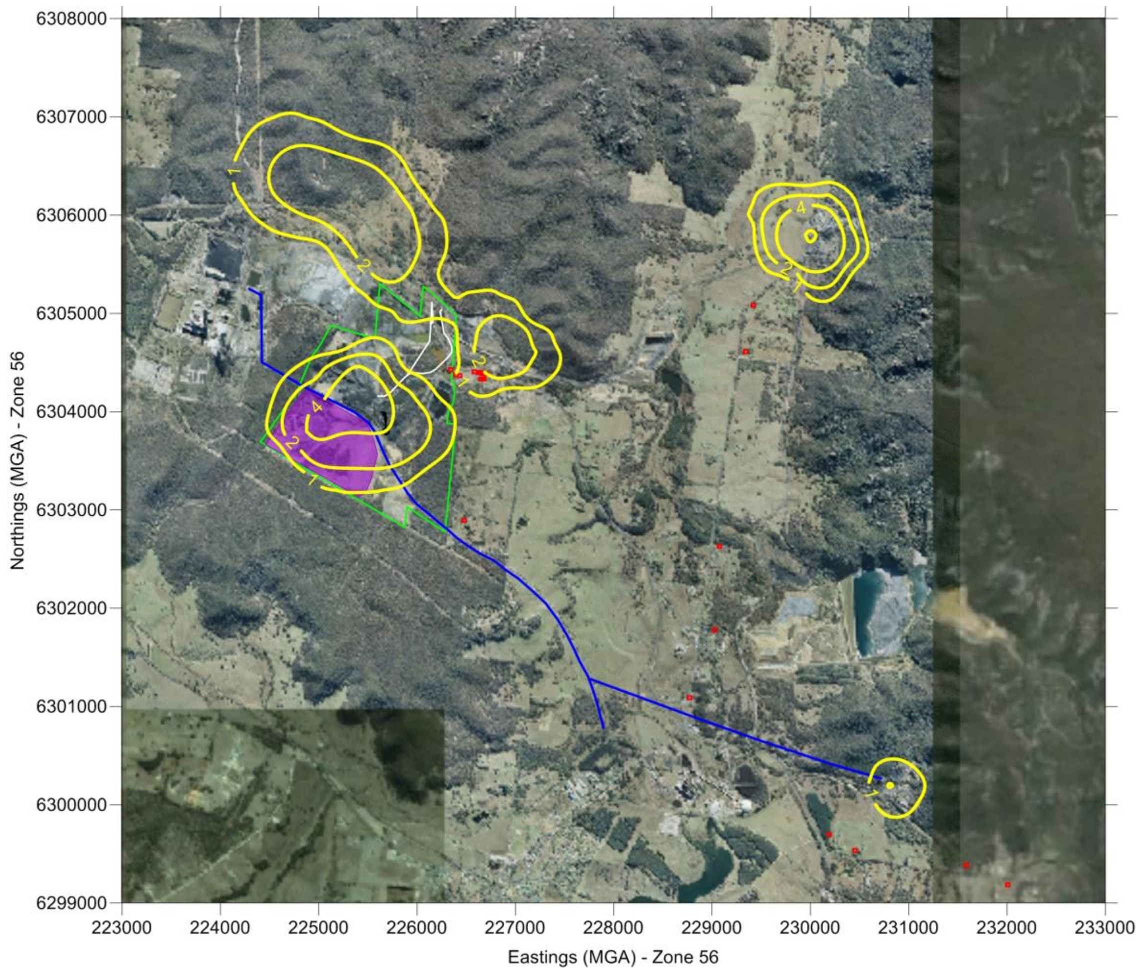
Species: PM$_{10}$	Location: SCSS	Scenario 2b: SCSS and other operations	Percentile: N/A	Averaging Time: Annual
Model Used: ISCMOD	**Units:** µg/m³	**Guideline:** 30	**Met Data:** 2010	**Plot:** J. Barnett

Figure 8.10: Predicted annual average PM$_{10}$ concentrations due to emissions from SCSS and other operations using internal link Route 2 – all Angus Place coal hauled to Mt Piper Power Station



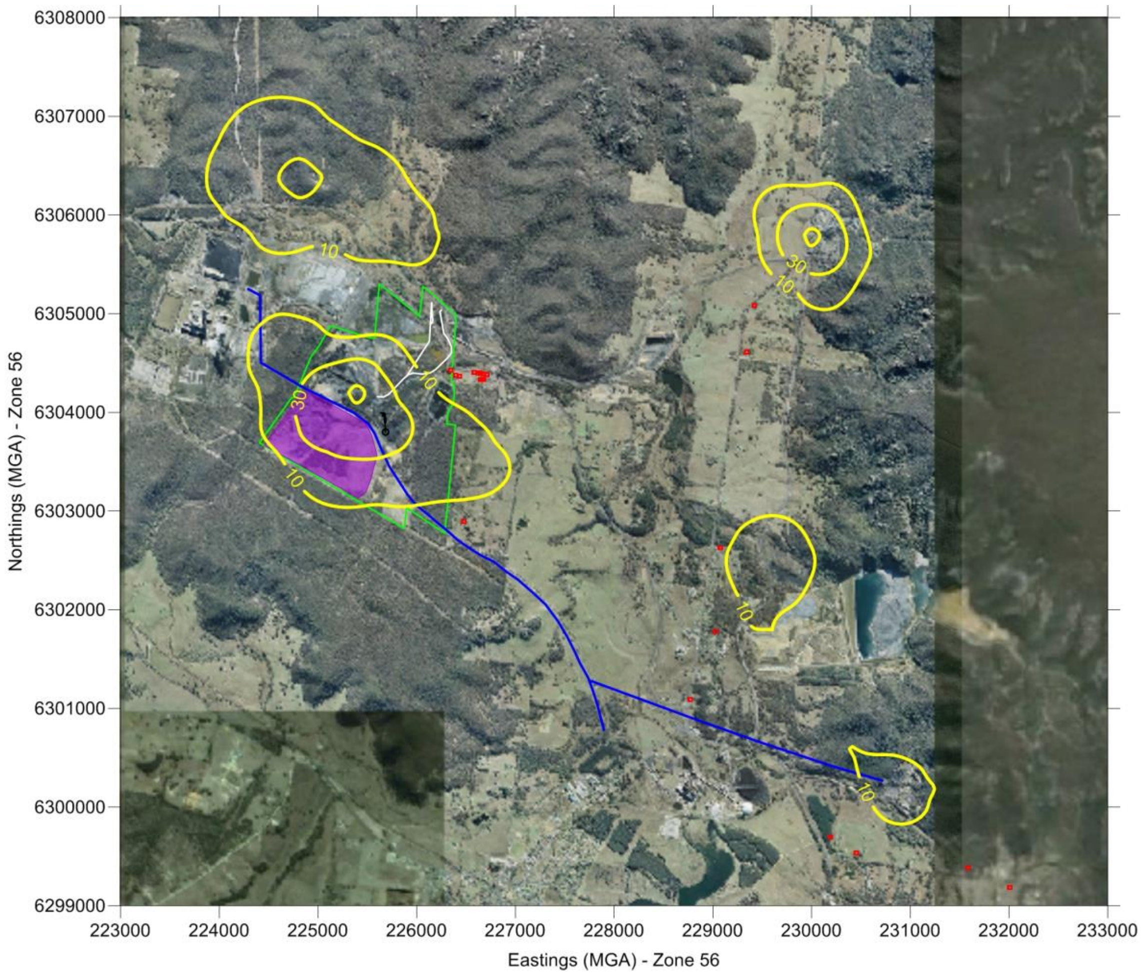
Species: TSP	**Location:** SCSS	**Scenario 2b:** SCSS and other operations	**Percentile:** N/A	**Averaging Time:** Annual
Model Used: ISCMOD	**Units:** µg/m³	**Guideline:** 90	**Met Data:** 2010	**Plot:** J. Barnett

Figure 8.11: Predicted annual average TSP concentrations due to emissions from SCSS and other operations using internal link Route 2 – all Angus Place coal hauled to Mt Piper Power Station



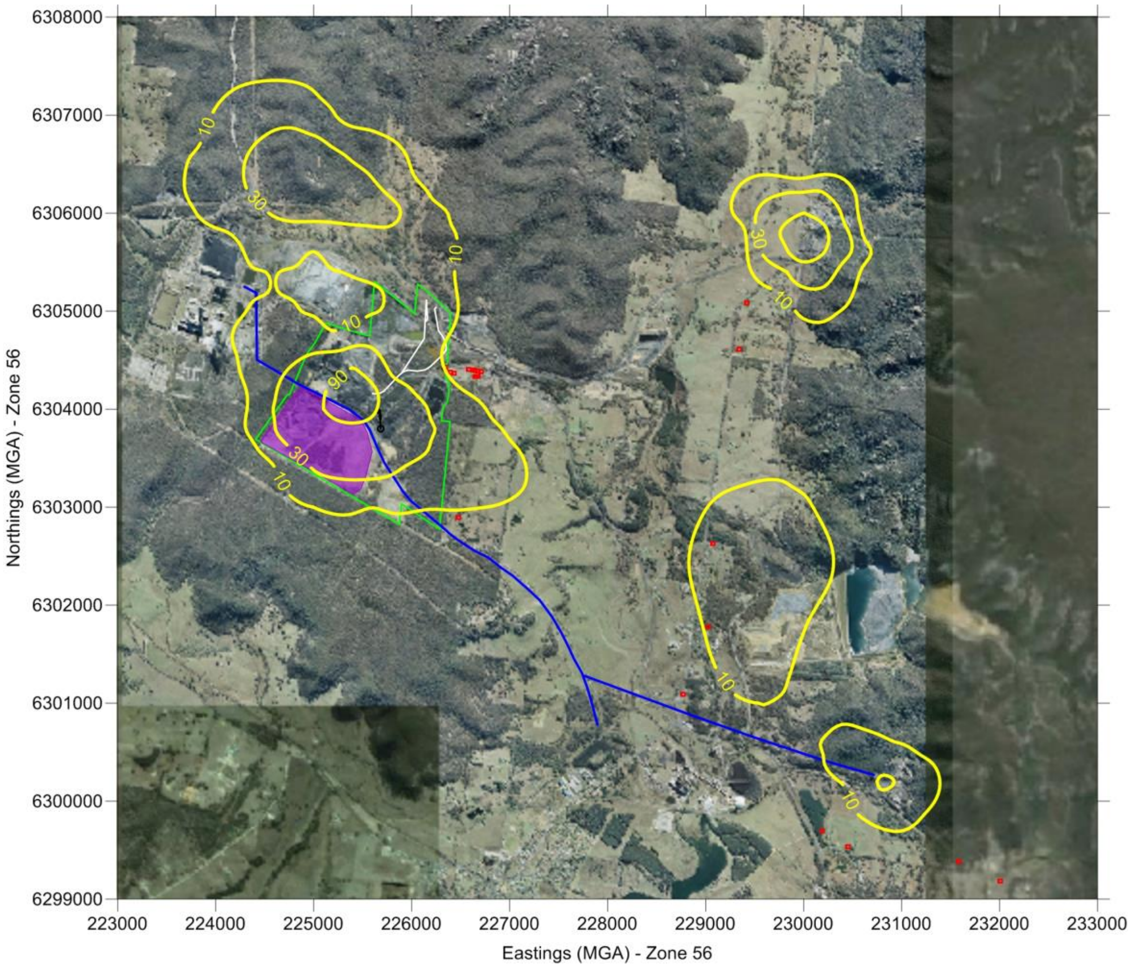
Species: Deposition	**Location:** SCSS	**Scenario 2b:** SCSS and other operations	**Percentile:** N/A	**Averaging Time:** Annual
Model Used: ISCMOD	**Units:** g/m²/month	**Guideline:** 4	**Met Data:** 2010	**Plot:** J. Barnett

Figure 8.12: Predicted annual average dust deposition levels due to emissions from the SCSS and other operations using internal link Route 2 – all Angus Place coal hauled to Mt Piper Power Station



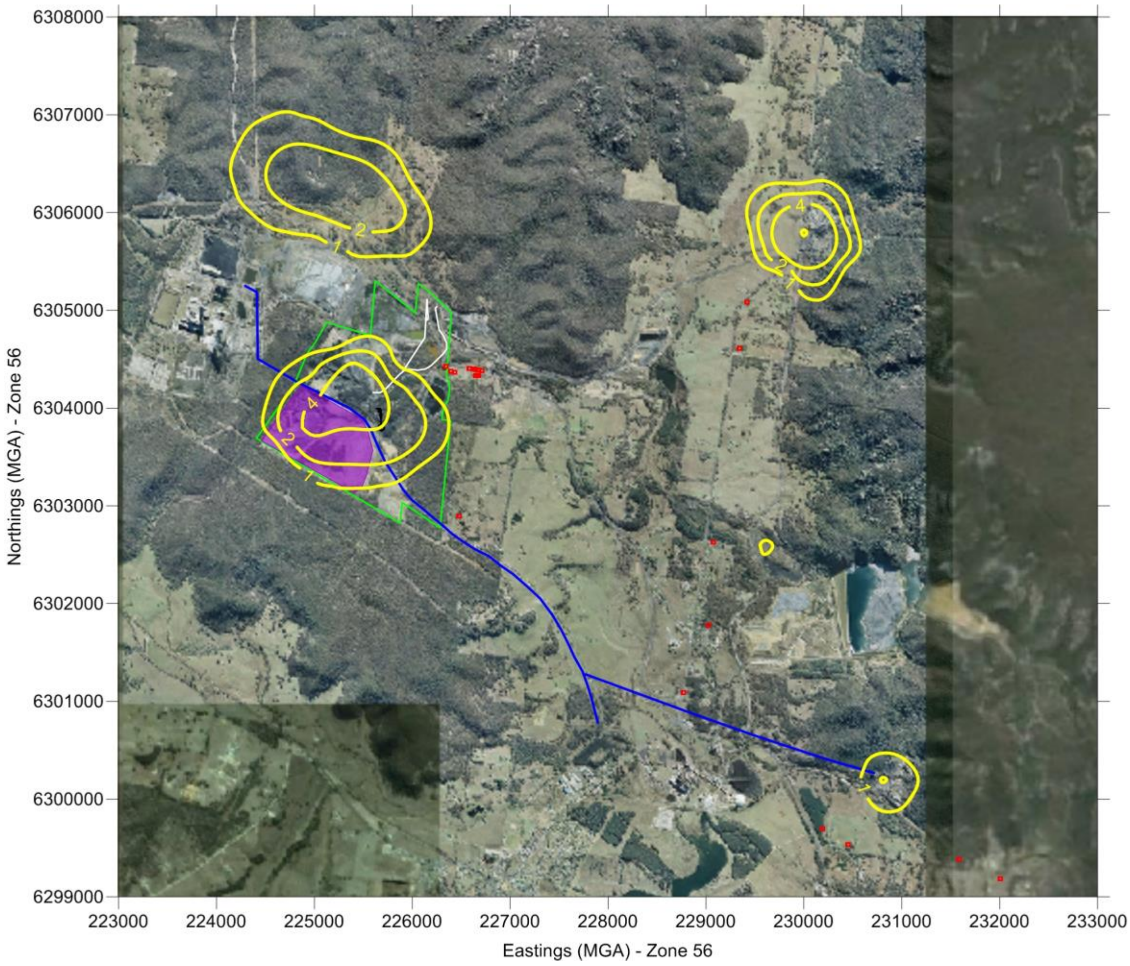
Species: PM10	Location: SCSS	Scenario 2c: SCSS and other operations	Percentile: N/A	Averaging Time: Annual
Model Used: ISCMOD	**Units:** µg/m³	**Guideline:** 30	**Met Data:** 2010	**Plot:** J. Barnett

Figure 8.13: Predicted annual average PM_{10} concentrations due to emissions from SCSS and other operations using internal link Route 2 – all Angus Place coal hauled to Wallerawang Power Station



Species: TSP	Location: SCSS	Scenario 2c: SCSS and other operations	Percentile: N/A	Averaging Time: Annual
Model Used: ISCMOD	**Units:** µg/m³	**Guideline:** 90	**Met Data:** 2010	**Plot:** J. Barnett

Figure 8.14: Predicted annual average TSP concentrations due to emissions from SCSS and other operations using internal link Route 2 – all Angus Place coal hauled to Wallerawang Power Station



Species: Deposition	Location: SCSS	Scenario 2c: SCSS and other operations	Percentile: N/A	Averaging Time: Annual
Model Used: ISCMOD	**Units:** g/m²/month	**Guideline:** 4	**Met Data:** 2010	**Plot:** J. Barnett

Figure 8.15: Predicted annual average dust deposition levels due to emissions from the SCSS and other operations using internal link Route 2 – all Angus Place coal hauled to Wallerawang Power Station

8.3 24-hour Average Concentrations

Predictions of maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations have been made for each of the nearest representative receptors. The results are listed in **Table 8.5**. It can be seen that the only two residences predicted to exceed the PM_{10} 50 µg/m³ criterion are WR1 and WR2. These exceed for both haul road scenarios, but the magnitude of the exceedances are lower for the Wallerawang haul road option (Scenario 2c). It should be noted however, that these predictions are highly conservative as it is unlikely that the full 4 Mt will be hauled along either roadway to the exclusion of the other. Rather, the load would be shared between the two haul routes.

Table 8.5: Predicted maximum 24-hour average $PM_{2.5}$ and PM_{10} concentrations (µg/m³)

Residence ID	Scenario 1a	Scenario 1b	Scenario 2a	Scenario 2b	Scenario 2c
			PM_{10} (µg/m³)		
B1	34.8	21.6	30.2	24.2	20.0
B2	30.7	21.4	26.8	22.8	20.2
B3	28.8	20.9	25.9	22.4	19.8
B4	23.1	17.6	32.0	30.7	16.9
B5	21.6	16.8	39.8	38.7	16.5
B6	21.2	16.7	42.5	41.5	16.5
B7	20.7	16.5	44.7	43.8	16.5
B8	20.3	16.3	45.0	44.2	16.4
B9	23.3	18.7	41.2	40.4	18.0
B10	22.9	18.4	41.6	40.8	17.9
B11	22.6	18.3	41.5	40.7	17.8
L1	14.2	14.0	23.2	23.1	29.0
L2	13.6	13.5	22.7	22.7	31.0
S1	5.7	5.6	40.6	40.6	41.1
S2	5.5	5.4	47.0	46.9	47.4
S3	8.8	8.7	19.0	19.0	28.6
S4	5.7	5.6	13.0	13.0	13.6
S5	5.5	5.5	11.4	11.4	11.9
WR1	4.6	4.6	**92.6**	**92.6**	**63.6**
WR2	6.4	6.2	**72.4**	**72.4**	**64.8**
			$PM_{2.5}$ (µg/m³)		
B1	4.4	2.7	3.9	3.2	2.5
B2	3.9	2.7	3.4	2.9	2.6
B3	3.7	2.7	3.3	2.9	2.5
B4	2.9	2.2	4.2	4.0	2.2
B5	2.7	2.1	5.2	5.1	2.2
B6	2.7	2.1	5.6	5.5	2.2
B7	2.6	2.1	5.9	5.8	2.2
B8	2.6	2.1	5.9	5.8	2.1
B9	2.9	2.4	5.5	5.4	2.4
B10	2.9	2.3	5.5	5.4	2.3
B11	2.8	2.3	5.5	5.4	2.3
L1	2.0	1.9	3.8	3.8	6.1
L2	1.9	1.9	3.8	3.8	5.3
S1	0.9	0.9	6.3	6.3	6.3
S2	0.8	0.8	7.3	7.3	7.4
S3	1.2	1.2	3.6	3.6	5.7
S4	0.9	0.9	1.9	1.9	2.0
S5	0.9	0.9	1.7	1.7	1.8
WR1	0.6	0.6	14.3	14.3	10.2
WR2	0.9	0.9	12.8	12.8	11.6

Further analysis was carried out on the two Wolgan Road residences to determine how often the 50 µg/m³ level was exceeded on an annual basis. **Figure 8.16** shows a time series of the 24-hour average PM_{10} predictions at WR1 and WR2. Levels above 50 µg/m³ are only predicted to occur on two occasions in the year. On these two days winds were predominantly in the direction from either the Mt Piper haul road or the Angus Place surface facilities towards the residences. Given that these worst case scenarios result in a small number of predicted exceedances, these should be able to be managed effectively. For the majority of the year, the levels at these residences are predicted to be below 10 µg/m³.

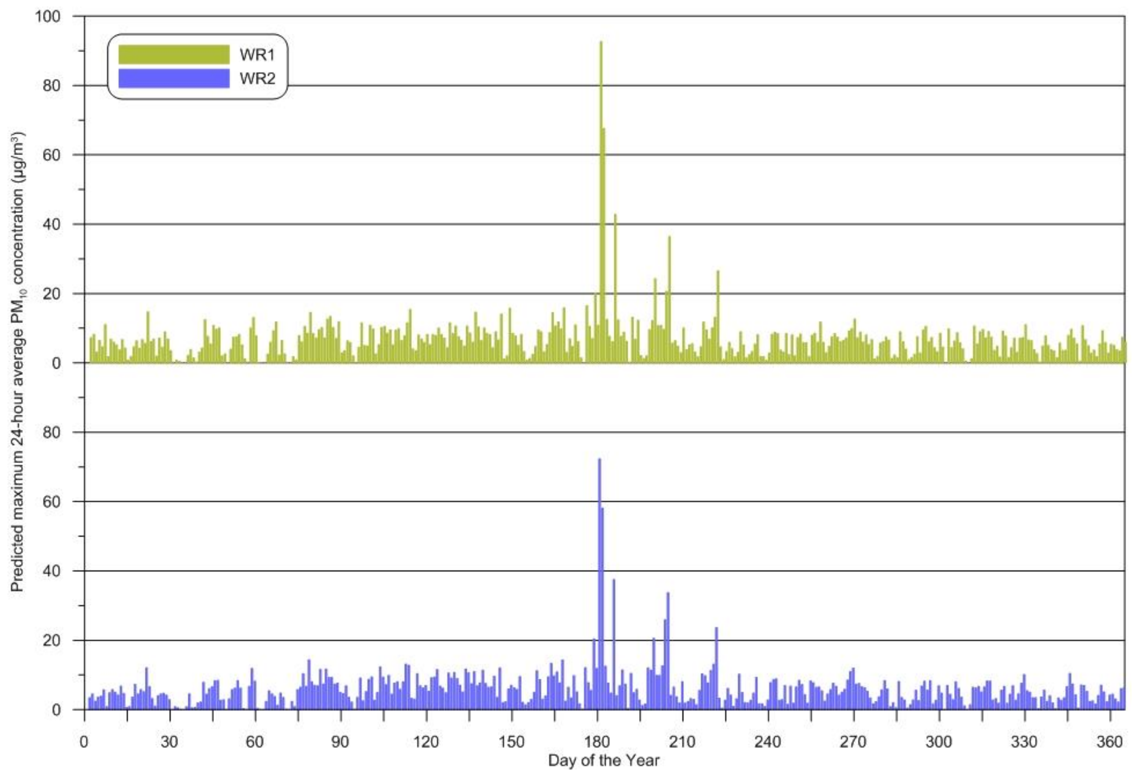


Figure 8.16: Time series of predicted 24-hour average PM_{10} concentrations at WR1 and WR2

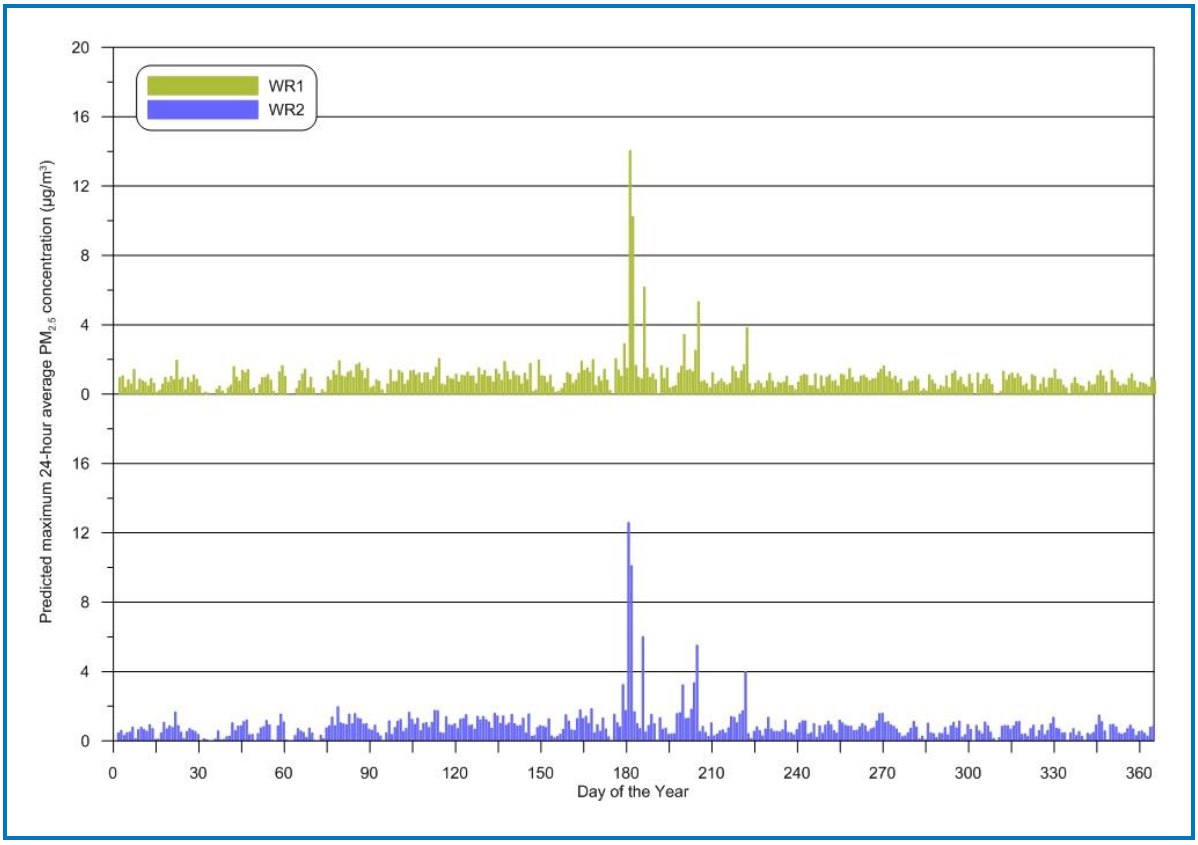


Figure 8.17: Time series of predicted 24-hour average $PM_{2.5}$ concentrations at WR1 and WR2

8.4 Cumulative 24-hour PM_{10} Concentrations

8.4.1 Introduction

It is difficult to accurately predict cumulative 24-hour average PM_{10} concentration using dispersion modelling due to the difficulties in resolving (on a day to day basis) the varying intensity, duration and precise locations of activities at mine sites, weather conditions at the time of the activity, or a combination of activities.

Difficulties in predicting cumulative 24-hour average impacts are compounded by the day to day variability in ambient dust levels and the spatial and temporal variation in any other anthropogenic activity, for example, agricultural activity, or uncontrolled event such as bushfires, and so on, and including mining in the future. Experience shows that in many cases the worst-case 24-hour average PM_{10} concentrations are strongly influenced by other sources in an area, such as bushfires and dust storms, which are essentially unpredictable.

Due to the difficulties outlined above, cumulative air quality impacts have been evaluated using a statistical approach (Monte Carlo Simulation). This approach has been provided to achieve the objectives of a Level 2 Assessment (see Section 11.2 of [**EPA, 2005**]).

Four locations have been selected to provide an indication of worst case cumulative 24-hour PM_{10} concentrations. Two of these are in Blackmans Flat and two are on Wolgan Road near Angus Place.

- Residence B2 (closest private residence to the SCSS eastern boundary and highest 24-hour average predictions for a private residence for Scenario 1).
- Residence B8 (highest predicted PM_{10} 24-hour concentration for Scenario 2 at Blackman's Flat).
- Residence WR1 and WR2 (locations of predicted exceedances of the 24-hour average 50 µg/m^3 criterion for Scenario 2).

8.4.2 Monte Carlo Simulation

The Monte Carlo Simulation is a statistical approach that combines the frequency distribution of one data set (in this case, background 24-hour average PM_{10} concentrations) with the frequency distribution of another data set (modelled impacts at a given receptor). This is achieved by repeatedly randomly sampling and combining values within the two data sets to create a third, 'cumulative' data set and associated frequency distribution.

Receptors (residence numbers) B2, B8, WR1 and WR2 were chosen to represent the most affected private residences. PM_{10} data from the Angus Place HVAS monitor was used to represent possible background values in the area. Individual 24-hour average predictions for the proposed modification are added to a random value from the above data sets. This process is repeated many thousands of times yielding the 'cumulative' data set, which is then presented as a frequency distribution.

The process assumes that a randomly selected background value would have a chance equal to that of any other background value from the data set of occurring on the given 'modelled day'. Over sufficient repetitions, this yields a good statistical estimate of the combined and independent effects of varying background and Project contributions to total PM_{10}.

To generate greater confidence in the statistical robustness of the results, the Monte Carlo Simulation was repeated 250,000 times for each of the two receptors. In other words, the same 1-year set of predicted (modelled) 24-hour average PM_{10} concentrations were added to 250,000 variations of the randomly selected background concentrations (a different random background concentration is selected each time).

The results of this analysis are presented graphically in **Figure 8.18**. The plot shows the statistically estimated number of days that 24-hour average PM_{10} concentrations might exceed a certain concentration and also compares the cumulative probability with the measured background. From this analysis the 50 µg/m³ criterion is estimated to be exceeded at Blackmans Flat for 1 day (or less) per year, or less than 0.3% of the time.

Residences at Wolgan Road are predicted to exceed 50 µg/m³ on approximately 3 days per year, or less than 0.9% of the year. Model predictions for these two residences indicated two exceedances of 50 µg/m³ without additional background included (**Figure 8.16**). The Monte Carlo analysis shows that there is therefore only likely to be one additional exceedance when background is added.

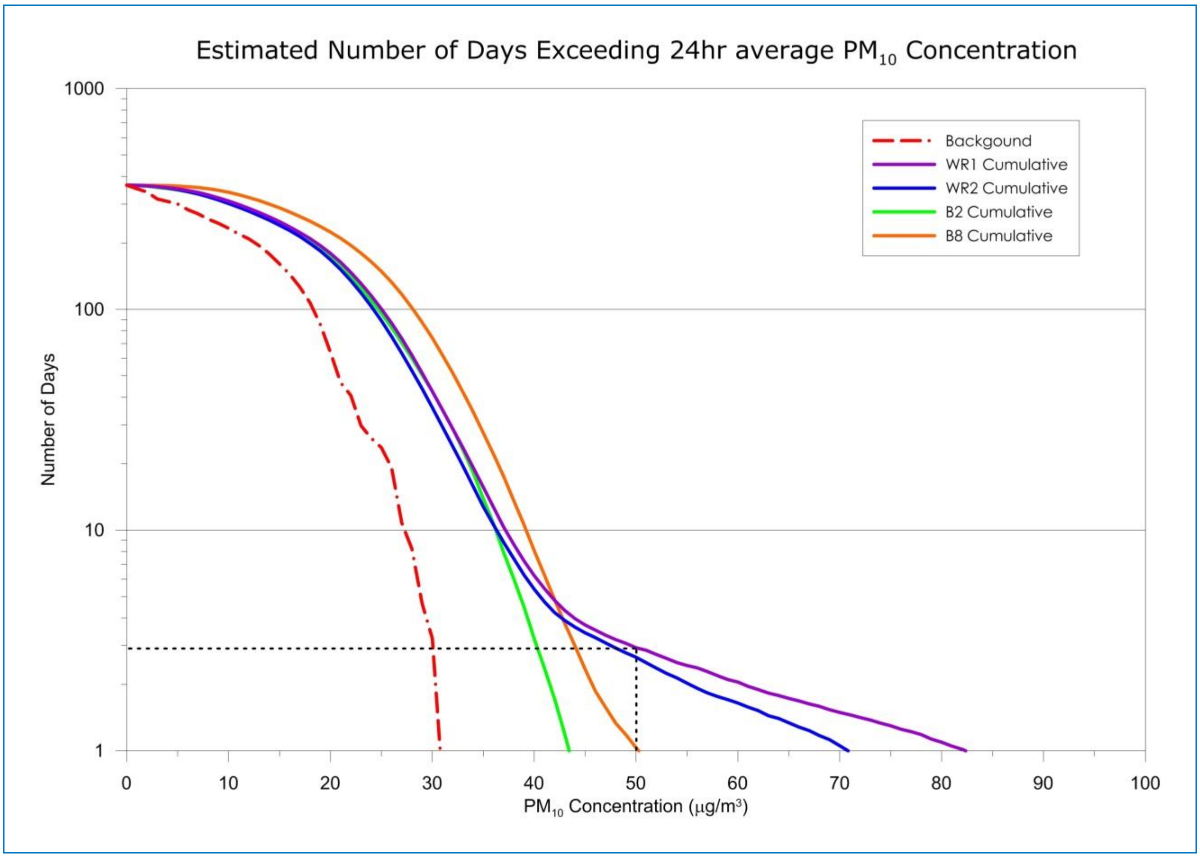


Figure 8.18: Statistical estimate of number of days exceeding 24-hr PM_{10} average concentrations following Monte Carlo simulation

8.5 Other Neighbouring Operations

The background levels for the assessment of cumulative impacts associated with the Project have been developed based on monitoring data, and therefore these background levels are inclusive of dust generated by existing industrial operations.

Projects that have recently been approved by the NSW Department of Planning and Infrastructure (DP&I) and proposed projects, are not included in the adopted background levels. A description of recently approved or proposed projects in the vicinity of the Project is provided below.

8.5.1 Pine Dale Coal Mine – Yarraboldy Extension

The Pine Dale Coal Mine (Yarraboldy Extension) is an extension of open cut mining adjacent to the existing Pine Dale coal mine facilities and lies northeast of the SCSS boundary. This extension would include the extraction of approximately 350,000 tonnes of ROM coal per year for three years, including six months at the end of coal extraction to finalise rehabilitation on-site. This project was approved in February 2011 and is therefore estimated to be completed by 2014.

Whilst it is recognised that the two projects will operate simultaneously for a short time, it is unlikely that the Yarraboldy Extension would materially contribute to short-term cumulative impacts at Blackmans Flat when considered together with the SCSS operations. This is largely due to the fact that the two operations lie in different directions from Blackmans Flat and winds will not simultaneously carry emissions from both Yarraboldy and SCSS towards those receptors.

It should also be noted that the maximum predicted 24-hour PM_{10} concentration at the worst affected receptor due to operations at Yarraboldy was 8.6 µg/m^3 (**Heggies, 2010**). This level combined with SCSS maximum predictions could cause an exceedance of the 24-hour PM_{10} criterion for Scenario 2. However, as discussed above, it is unlikely that these maximum predictions would occur in the same 24-hour period.

8.5.2 Pine Dale Coal Mine – Stage 2 Extension

A potentially more significant extension of the Pine Dale Coal Mine is currently proposed immediately to the north of the SCSS Project area. An application was made in March 2011 for Director-General's Requirements to extend coal mining and processing operations at the Pine Dale Coal Mine on the northern side of the Castlereagh Highway.

This proposal is for open cut mining of up to 2 Mt per year as well as the construction and operation of a crushing and screening plant and rail load-out area. The total area of the Stage 2 Extension will cover approximately 210 ha and progress from south to north.

While this proposed extension is significantly larger in size and production than the approved Yarraboldy extension, the cumulative issues will be similar. That is, there may not be a significant short-term PM_{10} impact due to both the position of the operations relative to Blackmans Flat, and the prevailing wind directions.

As was shown in **Figure 5.2**, the winds at Pine Dale are predominantly along a northwest/southeast axis. Neither of these wind directions would carry dust emissions from both the SCSS and Pine Dale simultaneously. It is possible that there could be some long-term (annual) criterion exceedances due to the close proximity of these operations and receptors, but the magnitude of these impacts cannot be determined without further operational details of the Pine Dale Stage 2 Extension. Due to prevailing wind directions however, it is likely that these annual cumulative impacts would not be significant.

It should also be noted that the proposed extension is to progress from the south to the north, and is not expected to reach the maximum 2 Mt per year production rate until Year 5 of the project. By this time the open cut operations will be further removed from the Blackmans Flat area.

Notwithstanding this, it is important that dust management plans are constantly reviewed and updated where necessary to ensure that emissions are minimised as much as possible.

8.5.3 Other Operations

There are other operations in the region of the PAA such as Cullen Valley Mine and Invincible Colliery (more than 7km north), and further north such as Airly and Charbon, but these are further afield and would not materially contribute to ground level concentrations at Blackmans Flat. Recent modelling undertaken for the Coalpac Consolidation Project has shown that predicted annual average PM_{10} concentrations resulting from their operations would be less than 1 µg/m^3 at Blackmans Flat.

9 MITIGATION MEASURES

The Project has the potential to generate dust. It is therefore necessary to take reasonable and feasible measures to prevent or minimise dust impacts at sensitive receptors.

The term "best practice" is frequently used in pollution control and pollution management. However, what constitutes "best practice" is difficult to define in practical situations. Environment Australia published a series of booklets in the 1990's to assist the mining industry with incorporating best practice environmental management through all phases of mineral production from exploration through construction and eventual closure. In the booklet for Dust Control (**Environment Australia, 1998**) they defined "best practice" as follows:

"Best Practice can be defined as the most practical and effective methodology that is currently in use or otherwise available. Best practice dust management can be achieved by appropriate planning in the case of new or expanding mining operations, and by identifying and controlling dust sources during the active phases of all mining operations."

This document has since been updated by the Department of Energy, Resources and Tourism (DERT) who have published the handbook *Leading Practice Sustainable Development Program for the Mining Industry* (**DERT, 2009**). This new handbook introduces the term "leading practice", in which:

"*...considers the latest and most appropriate technology applied in order to seek better financial, social and environmental outcomes for present stakeholders and future generations.*"

The implementation of a predictive, real-time dust management system is considered best and leading practice and would apply leading technology to achieve the best possible outcomes currently available.

Other procedures proposed for the management of dust emissions from the Project have been considered against those determined to be leading practice in the **DERT (2009)** handbook.

Specific measures should be made as to how the proposed mitigation measures align with best practice, as outlined in the NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining, 2010, prepared for OEH by Katestone Environmental (**Donnelly et al, 2011**). **Table 9.1** provides an overview of the best practice air quality mitigation measures relevant to the Project.

In 2011 and 2012, the EPA updated Environment Protection Licences (EPLs) for a number of NSW coal mines, requiring that investigations be made into further dust control measures that could potentially be applied at each site. This initiative, known as the 'Dust Stop: Pollution Reduction Program (PRP)' involved analysing and ranking current dust generating activities, then determining if any further reasonable and feasible measures could be adopted to further reduce emissions at the source. This determination is based on both practical and financial implications of each control measure.

The Springvale Coal Services PRP, submitted in September 2012, indicated a number of measures that may potentially be applied at the site (**Centennial Coal, 2012**). **Table 9.1** provides a summary of these measures and the status of investigation and implementation. The current mitigation measures are listed below and have been incorporated into the modelling. They include:

- Enclosure of the existing and proposed washery
- Enclosure of conveyor transfer points
- Loading of coal rejects from an enclosed bin
- Coal reclaim from stockpiles via underground reclaim tunnel
- Three quarter enclosed conveyors
- Stockpile water sprays which are wind activated
- New haul road link to be fully sealed

- Regular use of water carts on unsealed roads trafficked by heavy vehicles. This will include the surface of the proposed REA and these controls have been included in the modelling.

It was concluded that Springvale Coal Services would initially perform the relevant analysis required to determine the Dust Extinction Moisture (DEM) levels of ROM and product coal. Wind tunnel testing will also be undertaken to determine the wind speeds required to initiate wind erosion more accurately than using generic emission factors. This would help to target any additional mitigation strategies.

Table 9.1: Overview of Best Practice Emission Reduction Measures Described in Katestone (2011)

Air Quality Emission Source	Emission Reduction Measure	Used for the Project?	Comments	Effectiveness of reduction in Emissions Inventory
Haul Trucks travelling on Unpaved Roads (this activity is limited to haulage of rejects to the emplacement areas)	Use of water carts to control emissions	No	No watering of the internal access routes on unpaved roads has been assumed.	Level 2 watering could achieve a reduction of at least 75% of annual emissions. However given the low usage of internal unpaved roads, the net benefit would be negligible. The proposed private haul road link will be sealed.
	Control of the speed of trucks	Yes	Speed controlled to approximately 40 kilometres per hour (kph).	Emission factor based on amount of material moved, so no reduction to the emissions inventory, however there would be a marginal reduction in practice.
	Largest practical truck size	Yes	Based on the amount of material being moved and the limitations on physical dimensions of vehicles used, Centennial has given the largest economic and practical size haul trucks for assessment.	Emission factor partially based on size of truck. A smaller sized truck will give a higher estimate of TSP emissions per year for hauling activities.
Wind Erosion of Exposed Materials and Stockpiles	Use of water carts to control emissions	Yes	Water carts used on exposed areas.	50%
ROM Coal Handling	Water application	Yes	Water sprays used at the ROM hopper	50%
	Minimisation of drop heights	No	Coal is delivered by conveyer and dropped from an elevated conveyer gantry	Emission factor does not consider drop height, so no reduction to the emissions inventory, however there would be a material reduction in practice.
ROM Coal Stockpile	Water application	Yes	Dust suppression sprays are installed on the conveyor gantry.	N/A
	Enclosure of ROM coal stockpile	No	This is not considered to be practical by Centennial.	Dozers infrequently push coal outside the area of the stockpile sprays. This will be rectified with the new upgrade facility which includes a separate truck dump station and conveyor system leading to the ROM coal stockpile.

Air Quality Emission Source	Emission Reduction Measure	Used for the Project?	Comments	Effectiveness of reduction in Emissions Inventory
Bulldozing	Watering of trafficked areas	No	Currently no watering of material where dozers operate outside the spray area beneath the conveyor gantry.	Under further investigation and based on the results of the DEM testing, further controls may be implemented.
	Minimisation of travel speed and distance travelled.	No	Centennial would undertake an education campaign with contracted dozer operators to ensure appropriate speeds and routes are used.	Emission factor based on hours used, so no reduction to the emissions inventory, however there would be a marginal reduction in practice.

10 GREENHOUSE GAS ASSESSMENT

10.1 Introduction

Greenhouse Gas (GHG) emissions have been estimated based on the methods outlined in the following documents:

- The World Resources Institute/World Business Council for Sustainable Development (WRI/WBCSD) Greenhouse Gas Protocol *The Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard Revised Edition* (**WRI/WBCSD, 2004**).
- National Greenhouse and Energy Reporting (Measurement) Determination 2008 (**DCCEE, 2008**).
- The Commonwealth Department of Climate Change and Energy Efficiency (DCCEE) *National Greenhouse Accounts* (NGA) *Factors 2012* (**DCCEE, 2012**).

The GHG Protocol establishes an international standard for accounting and reporting of GHG emissions. The GHG Protocol has been adopted by the International Standard Organisation, endorsed by GHG initiatives (such as the Carbon Disclosure Project) and is compatible with existing GHG trading schemes.

Three 'scopes' of emissions (scope 1, scope 2 and scope 3) are defined for GHG accounting and reporting purposes, as described below. This terminology has been adopted in Australian GHG reporting and measurement methods and has been employed in this assessment. The 'scope' of an emission is relative to the reporting entity. Indirect scope 2 and scope 3 emissions will be reportable as direct scope 1 emissions from another facility.

1) Scope 1: Direct Greenhouse Gas Emissions

Direct GHG emissions are defined as those emissions that occur from sources that are owned or controlled by the reporting entity. Direct GHG emissions are those emissions that are principally the result of the following types of activities undertaken by an entity:

- Generation of electricity, heat or steam. These emissions result from combustion of fuels in stationary sources.
- Physical or chemical processing. Most of these emissions result from manufacture or processing of chemicals and materials (e.g. the manufacture of cement, aluminium, etc.).
- Transportation of materials, products, waste and employees. These emissions result from the combustion of fuels in entity owned/controlled mobile combustion sources (e.g. trucks, trains, ships, aeroplanes, buses and cars).
- Fugitive emissions. These emissions result from intentional or unintentional releases (e.g. equipment leaks from joints, seals, packing, and gaskets; CH_4 emissions from coal mines and venting); hydroflurocarbon emissions during the use of refrigeration and air conditioning equipment; and CH_4 leakages from gas transport.

2) Scope 2: Energy Product Use Indirect Greenhouse Gas Emissions

Scope 2 emissions are a category of indirect emissions that account for GHG emissions from the generation of purchased energy products (principally, electricity, steam/heat and reduction materials used for smelting) by the entity.

Scope 2 in relation to coal mines typically covers purchased electricity, defined as electricity that is purchased or otherwise brought into the organisational boundary of the entity.

3) Scope 3: Other Indirect Greenhouse Gas Emissions

Scope 3 emissions are defined as those emissions that are a consequence of the activities of an entity, but which arise from sources not owned or controlled by that entity. Some examples of scope 3 activities provided in the GHG Protocol are extraction and production of purchased materials, transportation of purchased fuels, and use of sold products and services.

In the case of the Project, scope 3 emissions will include emissions associated with the extraction, processing and transport of fuels used on-site and the transportation and combustion of product coal. The GHG Protocol provides that reporting scope 3 emissions is optional. If an organisation believes that scope 3 emissions are a significant component of the total emissions inventory, these can be reported along with scope 1 and scope 2. However, the GHG Protocol notes that reporting scope 3 emissions can result in double counting of emissions and can also make comparisons between organisations and/or products difficult because reporting is voluntary. Double counting needs to be avoided when compiling national (country) inventories under the Kyoto Protocol. The GHG Protocol also recognises that compliance regimes are more likely to focus on the "point of release" of emissions (i.e. direct emissions) and/or indirect emissions from the purchase of electricity.

10.2 Greenhouse Gas Emission Estimates

Inventories of GHG emissions can be calculated using published emission factors. Different gases have different greenhouse warming effects (referred to as global warming potentials) and emission factors take into account the global warming potentials of the gases created during combustion. The estimated emissions are referred to in terms of CO_2 equivalent (CO_2-e) emissions by applying the relevant global warming potential. The GHG assessment has been conducted using the NGA Factors, published by the **DCCEE (2012)**.

Project-related GHG sources included in the assessment are as follows:

- Emissions from combustion of fuel by on-site vehicles used to transport staff and materials associated with operations and to handle and manage coal stockpile (s) – Scope 1.
- Emissions from the use of Liquefied Petroleum Gas (LPG), and oils and greases – Scope 1.
- Electricity use – Scope 2 and 3.
- Emissions from the use and combustion of the product coal – Scope 3.
- Indirect emissions associated with the extraction, production and transport of fuels – Scope 3.
- Indirect emissions from the combustion of the coal produced by the site – Scope 3.

Emissions from the shipping of product coal are not included in this assessment due to the uncertainties in emission estimates, including uncertainty in future export destinations and limited data on emission factors and/or fuel consumption for ocean going vessels.

Activity data have been obtained from the Proponent for the period between July 2011 and forecast to the end of June 2016. It has been assumed that the start project year corresponds with the 2013/2014 data provided in the GHG spreadsheet. The data provided extends to 2015/2016 only and it is therefore assumed that activity data in future years is the same as 2015/2016. It is noted that the mine is likely to wind down in operations towards the end its 25 year mine life. Comparisons have been made between GHG emissions estimated for an existing year (July 2011 to June 2012) and Project years into the future. This year is referred to as the 'base-case' year and recorded data for this year has been provided by the client. The GHG emissions estimated for the base-case year are presented in each subsequent section and is summarised in **Section 10.3**. It is noted that the total estimated emissions in each of the subsequent sections do not include emissions from the base-case year and are shown for comparison only.

10.2.1 On-site Fuel Consumption

10.2.1.1 Diesel

Greenhouse gas emissions from diesel consumption were estimated using the following equation:

$$E_{CO_2-e} = \frac{Q \times EF}{1000}$$

where:

E_{CO2-e}	=	Emissions of GHG from diesel combustion	(t CO_2-e)
Q	=	Estimated quantity of diesel	(GJ)[1]
EF	=	Emission factor (Scope 1 or Scope 3) for diesel combustion	(kg CO_2-e/GJ)[2]

[1] GJ = giga joules

[2] kg CO_2-e/GJ = kilograms of carbon dioxide equivalents per gigajoule

The amount of diesel consumed in L per year was provided by Centennial Coal. The quantity of diesel consumed in GJ is calculated using an energy content factor for diesel of 38.6 gigajoules per kilolitre (GJ/kL). The Scope 1 emission factors are 69.5 kg CO_2-e/GJ for fuel used for stationary energy purposes and 69.9 kg CO_2-e/GJ for fuel used for transport energy purposes. The Scope 3 emission factor is 5.3 kg CO_2-e/GJ and accounts for indirect emissions from the extraction, production and transport of the fuel.

The estimated annual and Project total GHG emissions from diesel usage are presented in **Table 10.1**.

Table 10.1: Estimated CO_2-e (tonnes) for Diesel Consumption

Year	Diesel (kL)		Emissions (t CO_2-e)		
	Transport	Stationary	Scope 1	Scope 3	Total
Base-case year	1,200	477	4,506	343	4,850
1	1,200	606	4,855	370	5,224
2	1,200	606	4,855	370	5,224
3	1,200	606	4,855	370	5,224
4	1,200	606	4,855	370	5,224
5	1,200	606	4,855	370	5,224
6	1,200	606	4,855	370	5,224
7	1,200	606	4,855	370	5,224
8	1,200	606	4,855	370	5,224
9	1,200	606	4,855	370	5,224
10	1,200	606	4,855	370	5,224
11	1,200	606	4,855	370	5,224
12	1,200	606	4,855	370	5,224
13	1,200	606	4,855	370	5,224
14	1,200	606	4,855	370	5,224
15	1,200	606	4,855	370	5,224
16	1,200	606	4,855	370	5,224
17	1,200	606	4,855	370	5,224
18	1,200	606	4,855	370	5,224
19	1,200	606	4,855	370	5,224
20	1,200	606	4,855	370	5,224
21	1,200	606	4,855	370	5,224
22	1,200	606	4,855	370	5,224
23	1,200	606	4,855	370	5,224
24	1,200	606	4,855	370	5,224
25	1,200	606	4,855	370	5,224
Total	**30,000**	**15,154**	**121,367**	**9,238**	**130,605**

10.2.1.2 LPG

Greenhouse gas emissions from LPG consumption were estimated using the following equation:

$$E_{CO_2-e} = \frac{Q \times EF}{1000}$$

where:

E_{CO2-e}	=	Emissions of GHG from LPG combustion	(t CO_2-e)
Q	=	Estimated quantity of LPG	(GJ)[1]
EF	=	Emission factor (Scope 1 or Scope 3) for diesel combustion	(kg CO_2-e/GJ)[2]

[1] GJ = giga joules

[2] kg CO_2-e/GJ = kilograms of carbon dioxide equivalents per gigajoule

The amount of LPG consumed in kg per year was provided by Centennial Coal. The quantity of diesel consumed in GJ is calculated using an energy content factor for diesel of 25.7 gigajoules per kilolitre (GJ/kL). The Scope 1 emission factor is 59.9 kg CO_2-e/GJ.

The estimated annual and Project total GHG emissions from LPG usage are presented in **Table 10.2.**

Table 10.2: Estimated CO_2-e (tonnes) for LPG Consumption

Year	LPG (kL)	Scope 1 Emissions (t CO_2-e)
1	94	145
2	94	145
3	94	145
4	94	145
5	94	145
6	94	145
7	94	145
8	94	145
9	94	145
10	94	145
11	94	145
12	94	145
13	94	145
14	94	145
15	94	145
16	94	145
17	94	145
18	94	145
19	94	145
20	94	145
21	94	145
22	94	145
23	94	145
24	94	145
25	94	145
Total	**2,352**	**3,621**

10.2.1.3 Employee travel

Greenhouse gas emissions from gasoline consumption from staff travel were estimated using the following equation:

$$E_{CO_2-e} = \frac{Q \times EF}{1000}$$

where:

$E_{CO2\text{-}e}$ = Emissions of GHG from gasoline combustion ($t\ CO_2$-e)

Q = Estimated quantity of gasoline (GJ)[1]

EF = Emission factor (Scope 1 or Scope 3) for gasoline combustion (kg CO_2-e/GJ)[2]

[1] GJ = giga joules

[2] kg CO^2-e/GJ = kilograms of carbon dioxide equivalents per gigajoule

The amount of gasoline consumed in L per year was provided by Centennial Coal. The quantity of gasoline consumed in GJ is calculated using an energy content factor for diesel of 34.2 gigajoules per kilolitre (GJ/kL). The Scope 1 emission factor is 69.6 kg CO_2-e/GJ and the Scope 3 emission factor is 5.3 kg CO_2-e/GJ.

The estimated annual and Project total GHG emissions from gasoline usage are presented in **Table 10.3**.

Table 10.3: Estimated CO_2-e (tonnes) for Gasoline Consumption

Year	Gasoline (kL)	Emissions (t CO_2-e)		
		Scope 1	Scope 3	Total
Base-case year	43	102	7.8	110
1	50	119	9.1	128
2	50	119	9.1	128
3	50	119	9.1	128
4	50	119	9.1	128
5	50	119	9.1	128
6	50	119	9.1	128
7	50	119	9.1	128
8	50	119	9.1	128
9	50	119	9.1	128
10	50	119	9.1	128
11	50	119	9.1	128
12	50	119	9.1	128
13	50	119	9.1	128
14	50	119	9.1	128
15	50	119	9.1	128
16	50	119	9.1	128
17	50	119	9.1	128
18	50	119	9.1	128
19	50	119	9.1	128
20	50	119	9.1	128
21	50	119	9.1	128
22	50	119	9.1	128
23	50	119	9.1	128
24	50	119	9.1	128
25	50	119	9.1	128
Total	**1,293**	**2,975**	**227**	**3,202**

10.2.2 Fugitive emissions from oils and greases

Greenhouse gas emissions from diesel consumption were estimated using the following equation:

$$E_{pogCO2} = Q_{pog} \times EC_{pogCO2} \times \frac{(EF_{pogCO2ec})}{1000}$$

where:

E_{pogCO2} = CO_2e-T of emissions of carbon dioxide from combustion of petroleum based oils/greases

Q_{pog} = Volume of oil or grease measured in kilolitres

EC_{pogCO2} = Energy content factor

$EF_{pogCO2ec}$ = Emission factor (kg CO_2-e/GJ)[2]

The amount of oils and greases consumed in kL per year was provided by Centennial Coal. The quantity of oils and greases consumed in GJ is calculated using an energy content factor for petroleum based oils and greases of 38.6 gigajoules per kilolitre (GJ/kL). The Scope 1 emission factor is 69.5 and 27.9 kg CO_2-e/GJ respectively.

The estimated annual and Project total GHG emissions from oil and grease usage are presented in **Table 10.4**.

Table 10.4: Estimated CO_2-e (tonnes) for Oil and Grease Consumption

Year	Oil (kL)	Grease (kL)	Total emissions (t CO_2-e)
Base- case year	241	3	263
1	186	4	205
2	186	4	205
3	186	4	205
4	186	4	205
5	186	4	205
6	186	4	205
7	186	4	205
8	186	4	205
9	186	4	205
10	186	4	205
11	186	4	205
12	186	4	205
13	186	4	205
14	186	4	205
15	186	4	205
16	186	4	205
17	186	4	205
18	186	4	205
19	186	4	205
20	186	4	205
21	186	4	205
22	186	4	205
23	186	4	205
24	186	4	205
25	186	4	205
Total	**4,661**	**92**	**5,119**

10.2.3 Electricity

Greenhouse gas emissions from electricity usage were estimated using the following equation:

$$E_{CO_2-e} = \frac{Q \times EF}{1000}$$

where:

E_{CO2-e}	=	Emissions of greenhouse gases from electricity usage	(tCO_2-e/annum)
Q	=	Estimated electricity usage	(kWh/annum)[1]
EF	=	Emission factor (Scope 2 or Scope 3) for electricity usage	($kgCO_2$-e/kWh)[2]

[1] kWh/annum = kilowatt hours per annum
[2] $kgCO_2$-e/kWh = kilograms of carbon dioxide equivalents per kilowatt hour

The amount of electricity consumed in kWh per year was provided by Centennial Coal. The Scope 2 and Scope 3 emission factors are 0.88 and 0.18 kg CO_2-e/kWh respectively.

The estimated annual and Project total GHG emissions from electricity usage are presented in **Table 10.5**.

Table 10.5: Estimated CO_2-e (tonnes) for Electricity

Year	Electricity (kWhr)	Emissions (t CO_2-e)		
		Scope 2	Scope 3	Total
Base- case year	15,063,269	13,256	2,711	15,967
1	14,244,700	12,535	2,564	15,099
2	14,244,700	12,535	2,564	15,099
3	14,244,700	12,535	2,564	15,099
4	14,244,700	12,535	2,564	15,099
5	14,244,700	12,535	2,564	15,099
6	14,244,700	12,535	2,564	15,099
7	14,244,700	12,535	2,564	15,099
8	14,244,700	12,535	2,564	15,099
9	14,244,700	12,535	2,564	15,099
10	14,244,700	12,535	2,564	15,099
11	14,244,700	12,535	2,564	15,099
12	14,244,700	12,535	2,564	15,099
13	14,244,700	12,535	2,564	15,099
14	14,244,700	12,535	2,564	15,099
15	14,244,700	12,535	2,564	15,099
16	14,244,700	12,535	2,564	15,099
17	14,244,700	12,535	2,564	15,099
18	14,244,700	12,535	2,564	15,099
19	14,244,700	12,535	2,564	15,099
20	14,244,700	12,535	2,564	15,099
21	14,244,700	12,535	2,564	15,099
22	14,244,700	12,535	2,564	15,099
23	14,244,700	12,535	2,564	15,099
24	14,244,700	12,535	2,564	15,099
25	14,244,700	12,535	2,564	15,099
Total	**356,117,490**	**313,383**	**64,101**	**377,485**

10.2.4 Other Scope 3 Emissions

It is noted that Scope 3 emissions are emissions from sources not owned or controlled by Centennial Coal, and therefore optional for reporting purposes. Measures to minimise or reduce these emissions cannot be made by Centennial and these emissions are shown here for completeness.

10.2.4.1 Coal Transportation

The Scope 3 emissions associated with product coal transportation have been estimated based on 6.3 Mt/annum product coal being transported from the Lidsdale Siding for export by rail. This is the maximum amount of product coal that will be transported in any given year and therefore it is conservative to assume his amount for each year of the mine's operations. Emissions associated with product coal transportation have been estimated based on an emission factor for loaded trains of 12.3 grams per net tonne per kilometre (**QR Network Access, 2002**).

Emission factors were not available for unloaded trains so the factor for loaded trains is conservatively applied for the return trip. The return rail trip from the Project to Port Kembla is estimated to be 285.68 km.

The total estimated GHG emissions from rail transport of product coal are provided in **Table 10.6** below.

Table 10.6: Estimated CO_2-e (tonnes) for Rail Transportation

Year	Product Coal (tpa)	Scope 3 Emissions (t CO_2-e)
Base-case year	1,948,864	6,848
1	6,300,000	22,137
2	6,300,000	22,137
3	6,300,000	22,137
4	6,300,000	22,137
5	6,300,000	22,137
6	6,300,000	22,137
7	6,300,000	22,137
8	6,300,000	22,137
9	6,300,000	22,137
10	6,300,000	22,137
11	6,300,000	22,137
12	6,300,000	22,137
13	6,300,000	22,137
14	6,300,000	22,137
15	6,300,000	22,137
16	6,300,000	22,137
17	6,300,000	22,137
18	6,300,000	22,137
19	6,300,000	22,137
20	6,300,000	22,137
21	6,300,000	22,137
22	6,300,000	22,137
23	6,300,000	22,137
24	6,300,000	22,137
25	6,300,000	22,137
Total	**157,500,000**	**553,434**

10.2.4.2 Burning Product Coal

Based on data provided by the Centennial Coal, all coal will be sold as thermal coal. The Scope 3 emissions associated with the combustion of product coal were estimated using the following equation:

$$E_{CO_2-e} = \frac{Q \times EC \times EF}{1000}$$

Where:

$E_{CO2\text{-}e}$	=	Emissions of GHG from coal combustion	(t CO_2-e)
Q	=	Quantity of product coal burnt	(GJ)
EC	=	Energy Content Factor for black / coking coal	(GJ/t)[1]
EF	=	Emission factor for thermal coal combustion	(kg CO_2-e/GJ)

[1] GJ/t = gigajoules per tonne

The quantity of thermal coal burnt in Mtpa is converted to GJ using an energy content factor for black coal of 27 GJ/t and a Scope 3 emission factor of 88.4 CO_2 e/GJ.

The emissions associated with the use of the product coal are presented in **Table 10.7** below.

Table 10.7: Estimated CO_2-e (tonnes) for Energy Production

Year	Product Coal (tpa)	Scope 3 Emissions (t CO_2-e)
Base- case year	1,948,864	4,653,128
1	8,500,000	20,294,685
2	9,500,000	22,682,295
3	9,500,000	22,682,295
4	9,500,000	22,682,295
5	9,500,000	22,682,295
6	9,500,000	22,682,295
7	9,500,000	22,682,295
8	9,500,000	22,682,295
9	9,500,000	22,682,295
10	9,500,000	22,682,295
11	9,500,000	22,682,295
12	9,500,000	22,682,295
13	9,500,000	22,682,295
14	9,500,000	22,682,295
15	9,500,000	22,682,295
16	9,500,000	22,682,295
17	9,500,000	22,682,295
18	9,500,000	22,682,295
19	9,500,000	22,682,295
20	9,500,000	22,682,295
21	9,500,000	22,682,295
22	9,500,000	22,682,295
23	9,500,000	22,682,295
24	9,500,000	22,682,295
25	9,500,000	22,682,295
Total	**238,448,864**	**564,669,765**

10.3 Summary of GHG Emissions

A summary of the total GHG emissions associated with the Project are presented in **Table 10.8**. The emissions from the burning of product coal will be much larger than those associated with the extraction and processing of the coal. As stated in **Section 10.2.4**, these are indirect emissions (Scope 3) from sources not owned or controlled by Centennial Coal, and therefore optional for reporting purposes. Measures to minimise or reduce these emissions cannot be made by Centennial and these emissions are shown here for completeness.

The Project's contribution to projected climate change, and the associated impacts, would be in proportion with its contribution to global GHG emissions. Average annual Scope 1 emissions from the Project (0.005 million tonnes [Mt] CO_2-e) would represent approximately 0.001% of Australia's commitment under the Kyoto Protocol (591.5 Mt CO_2-e) and a very small portion of global greenhouse emissions, given that Australia contributed approximately 1.5% of global GHG emissions in 2005 (**Commonwealth of Australia, 2011**).

As described in **Section 10.2**, GHG emissions estimates have been provided for a base-case year of July 2011 to June 2012 to provide a comparison to future Project years. **Table 10.8** presents the total estimated GHG emissions for the base-case year. GHG estimates for all scopes are lower than projected years and is to be expected considering the proposed increased processing capacity.

Table 10.8: Summary of Estimated CO_2-e (tonnes) – All Scopes

Year	Scope 1 Emissions (t CO_2-e)					Scope 2 Emissions (t CO_2-e)	Scope 3 Emissions (t CO_2-e)					
	Diesel	Oils & Greases	LPG	Staff Transport	*Total*	Electricity	Diesel	Staff Transport	Electricity	Energy Production	Rail	*Total*
Base-case year	4,506	263	99	102	*4,970*	13,256	343	8	2,711	4,653,128	6,848	*4,663,031*
1	4,855	205	145	119	*5,324*	12,535	370	9	2,564	20,294,685	22,137	*20,319,756*
2	4,855	205	145	119	*5,323*	12,535	370	9	2,564	22,682,295	22,137	*22,707,366*
3	4,855	205	145	119	*5,323*	12,535	370	9	2,564	22,682,295	22,137	*22,707,366*
4	4,855	205	145	119	*5,323*	12,535	370	9	2,564	22,682,295	22,137	*22,707,366*
5	4,855	205	145	119	*5,323*	12,535	370	9	2,564	22,682,295	22,137	*22,707,366*
6	4,855	205	145	119	*5,323*	12,535	370	9	2,564	22,682,295	22,137	*22,707,366*
7	4,855	205	145	119	*5,323*	12,535	370	9	2,564	22,682,295	22,137	*22,707,366*
8	4,855	205	145	119	*5,323*	12,535	370	9	2,564	22,682,295	22,137	*22,707,366*
9	4,855	205	145	119	*5,323*	12,535	370	9	2,564	22,682,295	22,137	*22,707,366*
10	4,855	205	145	119	*5,323*	12,535	370	9	2,564	22,682,295	22,137	*22,707,366*
11	4,855	205	145	119	*5,323*	12,535	370	9	2,564	22,682,295	22,137	*22,707,366*
12	4,855	205	145	119	*5,323*	12,535	370	9	2,564	22,682,295	22,137	*22,707,366*
13	4,855	205	145	119	*5,323*	12,535	370	9	2,564	22,682,295	22,137	*22,707,366*
14	4,855	205	145	119	*5,323*	12,535	370	9	2,564	22,682,295	22,137	*22,707,366*
15	4,855	205	145	119	*5,323*	12,535	370	9	2,564	22,682,295	22,137	*22,707,366*
16	4,855	205	145	119	*5,323*	12,535	370	9	2,564	22,682,295	22,137	*22,707,366*
17	4,855	205	145	119	*5,323*	12,535	370	9	2,564	22,682,295	22,137	*22,707,366*
18	4,855	205	145	119	*5,323*	12,535	370	9	2,564	22,682,295	22,137	*22,707,366*
19	4,855	205	145	119	*5,323*	12,535	370	9	2,564	22,682,295	22,137	*22,707,366*
20	4,855	205	145	119	*5,323*	12,535	370	9	2,564	22,682,295	22,137	*22,707,366*
21	4,855	205	145	119	*5,323*	12,535	370	9	2,564	22,682,295	22,137	*22,707,366*
22	4,855	205	145	119	*5,323*	12,535	370	9	2,564	22,682,295	22,137	*22,707,366*
23	4,855	205	145	119	*5,323*	12,535	370	9	2,564	22,682,295	22,137	*22,707,366*
24	4,855	205	145	119	*5,323*	12,535	370	9	2,564	22,682,295	22,137	*22,707,366*
25	4,855	205	145	119	*5,323*	12,535	370	9	2,564	22,682,295	22,137	*22,707,366*
Total	**121,367**	**5,119**	**3,621**	**2,975**	**133,082**	**313,383**	**9,238**	**227**	**64,101**	**564,669,765**	**553,434**	**565,296,537**

10.4 Impact on the Environment

According to the Intergovernmental Panel of Climate Change's (IPCC) Fourth Assessment Report, global surface temperature has increased 0.74 ± 0.18°C during the 100 years ending 2005 (**IPCC, 2007a**). The IPCC has determined *"most of the observed increase in globally averaged temperatures since the mid-twentieth century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations"*. "Very likely" is defined by the IPCC as greater than 90% probability of occurrence (**IPCC, 2007b**).

Climate change projections specific to Australia have been determined by the CSIRO, based on the following global emissions scenarios predicted by the IPCC (**CSIRO, 2007**):

- A1F1 (high emissions scenario) – assumes very rapid economic growth, a global population that peaks in mid-century and technological change that is fossil fuel intensive.
- A1B (mid emissions scenario) – assumes the same economic and population growth as A1F1, with a balance between fossil and non-fossil fuel intensive technological changes.
- B1 (low emissions scenario) – assumes the same economic and population growth as A1F1, with a rapid change towards clean and resource efficient technologies.

For the global emissions scenarios described above, the projected changes in annual temperature relative to 1990 levels for Australian cities for 2030 and 2070 are presented in **Table 10.9** as determined by the **CSIRO (2007)**. The towns/cities presented in **Table 10.9** are those closest to the Project for which results are available.

Table 10.9: Projected Changes in Annual Temperature (relative to 1990)

Location	2030 - A1B (mid-range emissions scenario)	2070 - B1 (low emissions scenario)	2070 - A1F1 (high emissions scenario)
	Temperature (°C)		
Brisbane	0.7 - 1.4	1.1 - 2.3	2.1 - 4.4
Dubbo	0.7 - 1.5	1.2 - 2.5	2.2 - 4.8
St George (Queensland)	0.7 - 1.6	1.2 - 2.7	2.4 - 5.2
Sydney	0.6 - 1.3	1.1 - 2.2	2.1 - 4.3

Notes: Range of values represents the 10th and 90th percentile results.
For 2030, only A1B results are shown as there is little variation in projected results for the global emission scenarios A1B, B1 and A1F1 (**CSIRO, 2007**).

Source: **CSIRO (2007)** *Climate Change in Australia – Technical Report 2007*, Commonwealth Scientific and Industrial Research Organisation.

The CSIRO also details projected changes to other meteorological parameters (for example rainfall, potential evaporation, wind speed, relative humidity and solar radiation) and the predicted changes to the prevalence of extreme weather events (for example droughts, bush fires and cyclones).

The potential social and economic impacts of climate change to Australia are detailed in the Garnaut Climate Change Review (**Garnaut, 2008**), which draws on IPCC assessment work and the CSIRO climate projections. The Garnaut review details the negative and positive impacts associated with predicted climate change with respect to:

- Agricultural productivity.
- Water supply infrastructure.
- Urban water supplies.
- Buildings in coastal settlements.
- Temperature related deaths.
- Ecosystems and biodiversity.
- Geopolitical stability and the Asia-Pacific region.

A comparison of predicted annual GHG emissions from the Project with global, Australian and NSW emissions inventories are presented in **Table 10.10**.

Table 10.10: Comparison of Greenhouse Gas Emissions

Geographic coverage	Source coverage	Timescale	Emission Mt CO_2-e	Reference
Project	Scope 1 only	Average annual	0.005	This report.
Global	Consumption of fossil fuels	Total since industrialisation 1750 - 1994	865,000	IPCC (2007a). Figure 7.3 converted from Carbon unit basis to CO_2 basis. Error is stated greater than ±20%.
Global	CO_2-e emissions	2005	35,000	Based on Australia representing 1.5% of global emissions (Commonwealth of Australia, 2011). Australian National Greenhouse Gas Inventory (2005) taken from http://www.ageis.greenhouse.gov.au/
Global	CO_2-e emission increase 2004 to 2005	2005	733	IPCC (2007a). From tabulated data presented in Table 7.1 on the basis of an additional 733 Mt/a. Data converted from Carbon unit basis to CO_2 basis.
Australia	1990 Base	1990	547.7	Taken from the National Greenhouse Gas Inventory (2009) http://www.ageis.greenhouse.gov.au/
Australia	Kyoto target	Average annual 2008 - 2012	591.5	Based on 1990 net emissions multiplied by 108% Australia's Kyoto emissions target.
Australia	Total	2009	564.5	Taken from the National Greenhouse Gas Inventory (2009) http://www.ageis.greenhouse.gov.au/
NSW	Total	2009	160.5	Taken from the National Greenhouse Gas Inventory (2009) http://www.ageis.greenhouse.gov.au/

The commitment from the Australian Government to reduce GHG emissions is achieved through the introduction of the Australian Government's carbon pricing mechanisms. From 1 July 2012, this a fixed price on GHG emissions was introduced, with no cap on Australia's GHG emissions, or emissions from individual facilities (**Commonwealth of Australia, 2011**).

From 1 July 2015 an emissions trading scheme is proposed to be implemented. As such, Australia's GHG emissions, inclusive of emissions associated with the Project, would be capped at a level specified by the Australian Government. Under the emissions trading scheme, there will specifically be no limit on the level of GHG emissions from individual facilities, with the incentive for facilities to reduce their GHG emissions driven by the carbon pricing mechanism **(Commonwealth of Australia, 2011)**.

10.5 Greenhouse Gas Management

Centennial Coal will commit to implementing a number of reasonable and feasible measures to minimise GHG emissions from the Project. Recommended measures are described below:

- Maximising energy efficiency as a key consideration in the development of the mine plan. For example, significant savings of GHG emissions (through increased energy efficiency) can be achieved by mine planning decisions which minimise haul distances for ROM coal and waste rock transport, and therefore fuel use.
- Centennial Coal would prepare a Greenhouse Gas management plan. The plan will include standards to minimise energy usage and GHG emissions from the Project's operations. The plan will include objectives, commitments, procedures and responsibilities for:
    - Assisting in researching and promoting low emission coal technologies.
    - Improving energy use and efficiency.
    - Consideration of the use of alternative fuels where economically and practically feasible.
    - Review of mining practices to minimise double handling of materials and ensuring that coal and overburden haulage is undertaken using the most efficient routes.
    - Ongoing scheduled and preventative maintenance to ensure that diesel and electrically powered plants operate efficiently.
    - Develop targets for greenhouse gas emissions and energy use and monitor and report against these.
    - Implementation of a detailed energy monitoring programme. This would include monitoring the electricity and diesel usage on-site to identify the main sources of greenhouse gas emissions and apply appropriate reduction mechanisms where possible.
    - Regular maintenance of diesel powered equipment to ensure operation at peak efficiency.
    - Conduct baseline study of energy use.
    - Assess lighting plant efficiency.

The effectiveness of these reasonable and feasible measures to reduce GHG emissions (and energy consumption) will be monitored, as Centennial Coal will annually estimate GHG emissions and energy consumption in accordance with National Greenhouse and Energy Reporting and Energy Efficiency Operations requirements.

11 CONCLUSIONS

This assessment has investigated the potential air quality impacts of the upgrade of the Centennial Springvale Coal Services Site (SCSS) and associated operations in the Project Application Area (PAA) with respect to air quality and greenhouse gas emissions.

Dispersion modelling has been used to predict off-site dust concentration and dust deposition levels due to the dust generating activities that would occur as a result of the Project. Emissions inventories were developed for two scenarios, each with two internal haul road options. The dispersion conditions for the area were characterised based on regional and local meteorological data and the dispersion model ISCMOD was used to predict the maximum 24-hour $PM_{2.5}$ and PM_{10}, annual average $PM_{2.5}$, PM_{10} and TSP and annual average dust deposition.

Detailed modelling was conducted to assess whether the Project would adversely impact any privately owned residences located within the vicinity of the PAA. The assessment included predictions of air quality impacts from the Project in isolation as well as the potential cumulative impacts of other sources. The modelling indicates that the nearest sensitive receptors at Blackmans Flat are unlikely to experience dust concentrations above the EPA's air quality assessment criteria. There are a number of potential dust mitigation measures that could be implemented to further reduce emissions and these have been identified in the report.

Generally, the predictions presented in this report incorporate a level of conservatism due to worst case assumptions and the nature of dispersion modelling. As a result, it is expected that actual ground level concentrations would be lower than those predicted in the model during normal operation of the Project. Notwithstanding this, it is proposed that the worst case impacts would be managed on a day to day basis.

A Greenhouse Gas (GHG) assessment for the project indicates that average annual direct emissions from the Project (0.005 Mt CO_2-e) would represent approximately 0.001% of Australia's commitment under the Kyoto Protocol (591.5 Mt CO_2-e) and a very small portion of global greenhouse emissions. GHG emissions for a base-case year were estimated and compared to proposed Project years. GHG estimates for all scopes were lower than those in projected years and are expected, considering the proposed increased processing capacity. Centennial Coal will commit to a range of GHG mitigation measures including the completion of a Greenhouse Gas Management Plan which will include objectives for improving energy use and efficiency, develop targets for GHG emissions and energy use and conduct a baseline study of energy use.

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