APPENDIX

F

Air Quality Impact Assessment

AIR QUALITY IMPACT ASSESSMENT

MAULES CREEK COAL PROJECT

Hansen Bailey

Job No: 3768

11 July 2011

A PEL Company

PROJECT TITLE:	**MAULES CREEK COAL PROJECT**
JOB NUMBER:	**3768**
PREPARED FOR:	Nathan Cooper
	HANSEN BAILEY
PREPARED BY:	Justine Beaney
QA PROCEDURES CHECKED BY:	Ronan Kellaghan
APPROVED FOR RELEASE BY:	Aleks Todoroski
DISCLAIMER & COPYRIGHT:	This report is subject to the copyright statement located at www.paeholmes.com © Queensland Environment Pty Ltd trading as PAEHolmes ABN 86 127 101 642

DOCUMENT CONTROL

VERSION	**DATE**	**PREPARED BY**	**REVIEWED BY**
FINAL	11.02.2011	Justine Beaney	Ronan Kellaghan
FINAL V1	25.05.2011	Ronan Kellaghan	Ronan Kellaghan
FINAL V2	23.06.2011	Ronan Kellaghan	Ronan Kellaghan
FINAL V3	7.07.2011	Ronan Kellaghan	Ronan Kellaghan
FINAL V3	11.07.2011	Ronan Kellaghan	Ronan Kellaghan

Queensland Environment Pty Ltd trading as
PAEHolmes ABN 86 127 101 642

SYDNEY:
Suite 203, Level 2, Building D, 240 Beecroft Road
Epping NSW 2121
Ph: +61 2 9870 0900
Fax: +61 2 9870 0999

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

Email: info@paeholmes.com

Website: www.paeholmes.com

ES1 EXECUTIVE SUMMARY

Overview

PAEHolmes was commissioned by Hansen Bailey on behalf of Aston Resources Pty Limited to undertake an air quality impact assessment for the Maules Creek Coal Project (the Project), a proposed open-cut coal mine on the northwest slopes and plains of NSW. The Project is proposed to continue for at least 21 years, commencing in 2012 and will consist of contemporary mining methods and practices to enable the maximum and efficient extraction of coal reserves. For the purposes of assessing air quality, mining during the years 5, 10, 15 and 21 of the Project has been assessed.

Existing Environment

The Project is located on the northwest slopes and plains of NSW, approximately 18 km northwest of Boggabri. Land-use in the local area is dominated by agricultural operations and open cut mining, with rural residential holdings mainly located to the north and west of the Project Boundary.

A weather station has been installed at the site to characterise the dispersion characteristics of the area, however a full year of meteorological data was not yet available for dispersion modelling. There are two other weather stations located to the south of the Project Boundary, owned and operated by Boggabri Coal Mine and Tarrawonga Coal Mine. These data, along with the available Maules Creek data, have been used to generate a site representative meteorological dataset for Maules Creek, generated using a diagnostic meteorological modelling system known as CALMET. The annual winds predicted by CALMET correlate well with the windroses presented for Maules Creek, based on the available data collected to date.

The Maules Creek air quality monitoring network commenced operation in August and October 2010, and data collected to date are presented in this report. Longer term monitoring data have been collected at Boggabri Coal Mine and Tarrawonga Coal Mine and are also used to provide an indication of background dust levels for the area.

Emissions, Dispersion Modelling and Assessment Approach

The dispersion model known as ISCMOD was used to predict the impact of dust emissions from the operation of the Project. Dust emissions arise from a number of activities associated with open-cut mining and emissions have been estimated using detailed operational information provided by the Proponent and emission factor equations published by the US EPA and NPI.

Cumulative impacts from other operations, including the Boggabri Coal Mine and Tarrawonga Coal Mine were also assessed.

Impact Assessment

The modelling indicates there are a number of residences that are predicted to experience maximum 24-hour average PM_{10} concentrations above the NSW Office of Environment and Heritage (OEH) [a] criterion of 50 µg/m^3, based on the impacts from the Project alone. Cumulative impacts were also assessed, however the analysis indicates that the residences most likely to experience cumulative 24-hour PM_{10} impacts are those that are already predicted to be impacted from the Project alone.

[a] The NSW EPA exists as a legal entity operated within the Office of Environment and Heritage (OEH) which came into existence in April 2011. OEH was previously part of the Department of Environment, Climate Change and Water (DECCW). The DECCW was also recently known as the Department of Environment and Climate Change (DECC), and prior to that the Department of Environment and Conservation (DEC). The terms NSW EPA, OEH, DECCW, DECC and DEC are interchangeable in this report.

There are no private or mine-owned residences predicted to experience annual average PM_{10} concentrations above the DECCW goal of 30 μg/m^3 for the operation of the Project alone. However when the contributions from other mining activities are added, along with a background for all other sources, a number of residences are predicted to be impacted.

No privately owned or mine-owned residences are predicted to exceed the DECCW assessment criterion for TSP or Dust Deposition.

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 during normal operation of the Project. Nothwithstanding, it is proposed that the worst case impacts would be managed on a day to day basis using a network of real-time monitoring stations, which will enable mine personnel to repond to high dust levels prior to reaching critical levels and modify activities or increase controls as required.

Greenhouse Gas Emissions

The potential greenhouse gas emissions that are likely to occur as a result of the operation of the Project have been estimated. On average, Scope 1 emissions from the Project would increase emissions by 0.04% of the 1990 baseline Australian levels, which represents minor impacts.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

Aston Coal 2 Pty Limited (Aston), a subsidiary of Aston Resources Limited (Aston Resources) is seeking a contemporary Project Approval for the Maules Creek Coal Project, a proposed open-cut coal mine on the northwest slopes and plains of New South Wales (NSW) (hereafter referred to as the Project).

PAEHolmes was commissioned by Hansen Bailey on behalf of Aston Resources to undertake an air quality impact assessment for the Project. The purpose of the assessment is to form part of an Environmental Assessment (EA) being prepared by Hansen Bailey to support an application for a contemporary Project Approval under Part 3A of the Environmental Planning and Assessment Act 1979 (EP&A Act).

1.1 Background

In June 1990, Kembla Coal & Coke was granted Development Consent approval (DA 85/1819) for a period of 21 years as described in the *Maules Creek Coal Project Environmental Impact Statement* (Maules Creek EIS) (**KCC, 1989**) which included:

- The development of a coal mine within the Leard State Forest utilising open cut mining and underground mining methods at an average production rate of 9 Million tonnes per annum (Mtpa) product coal;
- The extraction of coal down to the Braymont coal seam via open cut mining methods and the extraction of coal commencing in the Braymont coal seam down to the Lower Northam coal seam via underground mining methods;
- Construction of mining infrastructure, including a rail loop and associated rail spur, Coal Handling and Preparation Plant (CHPP), mine administration and bathhouse facilities, workshop, communications and powerlines and water reticulation; and
- Employment of up to 683 employees during peak production periods.

DA 85/1819 was physically commenced in 1995 with the construction of the Development Dam; however no open cut mining has been conducted at the site to date. DA 85/1819 has no sunset clause and remains as a valid planning approval.

The purpose of this report is to assess the potential air quality impacts from the Project in accordance with the Director-General's Environmental Assessment Requirements which were received on 6 December 2010. The DGRs for Air Quality are:

- "a quantitative assessment of the potential air quality impacts from the project".

The assessment follows the procedures outlined in the Department of Environment and Climate Change and Water's (DECCW) *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (**NSW DEC, 2005**) (referred to hereafter as the *Approved Methods*).

The United States Environmental Protection Agency's (US EPA) Industrial Source Complex – Short Term Version 3 (ISCST3, later modified to ISCMOD) computer based dispersion model has been used to predict dust concentration and deposition levels due to the Project alone and the cumulative impacts of surrounding mines and other sources. The emissions inventories have been used with local and simulated meteorological data to predict the maximum 24-hour PM_{10}, annual average PM_{10}, annual average TSP and annual average dust deposition for four stages of the Project's mining operations.

1.2 Scope of work

This report provides information on the following:

- Local setting and Project description;
- Relevant air quality goals;
- Meteorological and climatic conditions in the area;
- A discussion of the current air quality conditions in the area;
- The methods used to estimate dust emissions from the Project;
- The predicted dust concentration and deposition due to emissions from the Project and cumulative impacts from other sources;
- A comparison of the proposed impacts at sensitive residences with the relevant impact assessment criteria outlined in the *Approved Methods*;
- An outline of the proposed mitigation measures and air quality monitoring; and
- Quantification and reporting of greenhouse gas (GHG) emissions from the Project.

2 LOCAL SETTING

The Project is located on the northwest slopes and plains of NSW, approximately 18 km northwest of Boggabri. Further afield are the regional centres of Narrabri and Gunnedah, approximately 35 km and 55 km from the Project, respectively.

Land-use in the local area is dominated by agricultural operations and open cut mining, with rural residential holdings mainly located to the north and west of the Project Boundary. The regional setting of the Project is shown in **Figure 2.1**. Significant features within the area include the Mt Kaputar National Park to the northeast of the Project Boundary and the Namoi River to the southwest.

There are a number of isolated rural residences associated with the surrounding farms within the vicinity of the Project Boundary, as well as the Maules Creek Public School (residence Id 67) located to the north of the Project Boundary. **Figure 2.2** shows the location of sensitive residences. **Appendix A** provides information on property ownership and residence coordinates.

The surrounding terrain is gently undulating in the north with steeper slopes emerging near ridgelines towards the central portion of the Project Boundary. Much of the higher ground and steeper slopes retain moderately dense woodland cover which form part of the National Parks and State Forests found within the region. To the south of the Project Boundary is the Gunnedah basin, with an altitude of 250 m above sea level. **Figure 2.3** shows a pseudo 3-dimensional representation of the terrain in the area of the mine and surrounds.

Figure 2.1: Regional setting

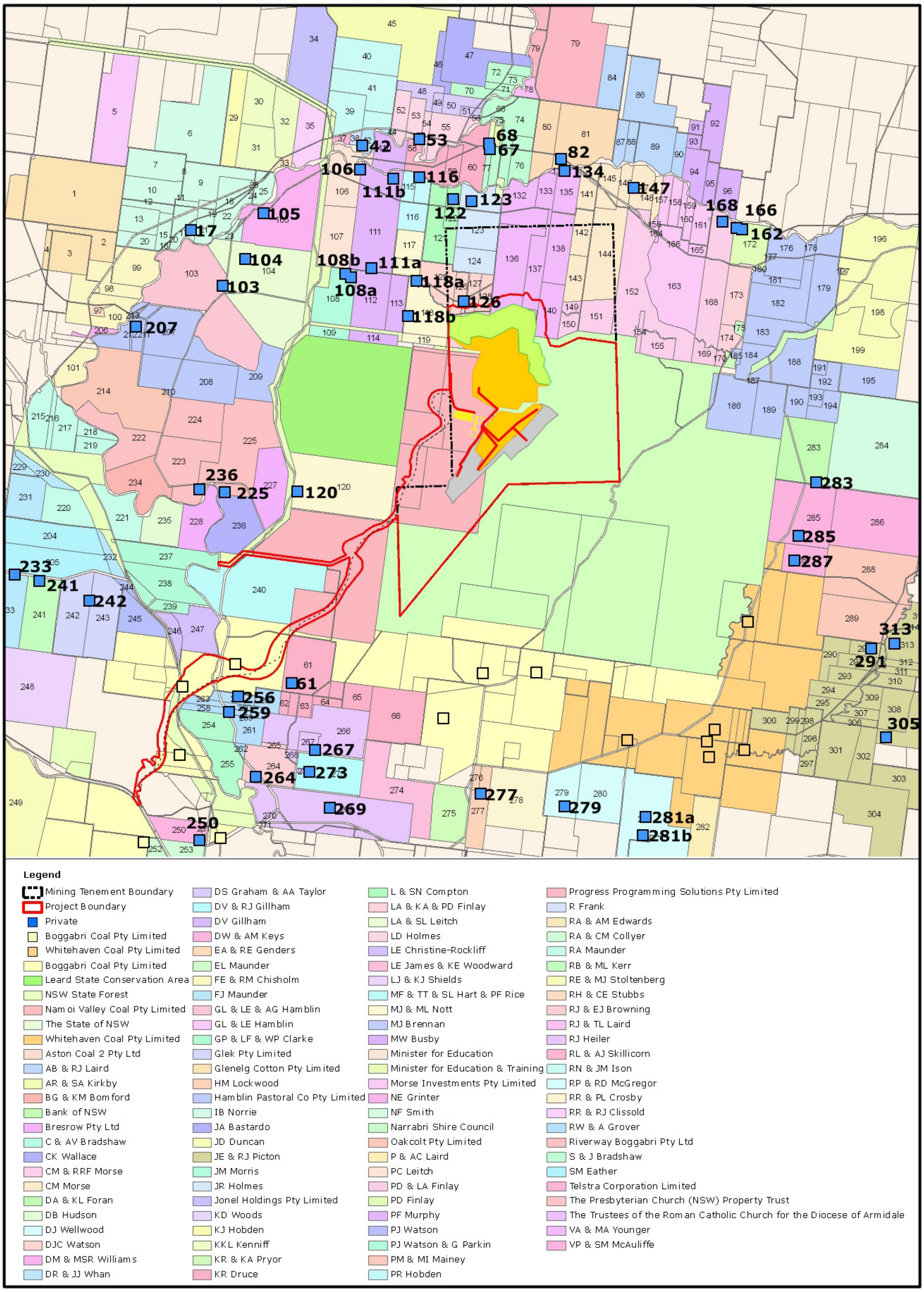


Figure 2.2: Location of private and mine owned residences in the vicinity of the Project

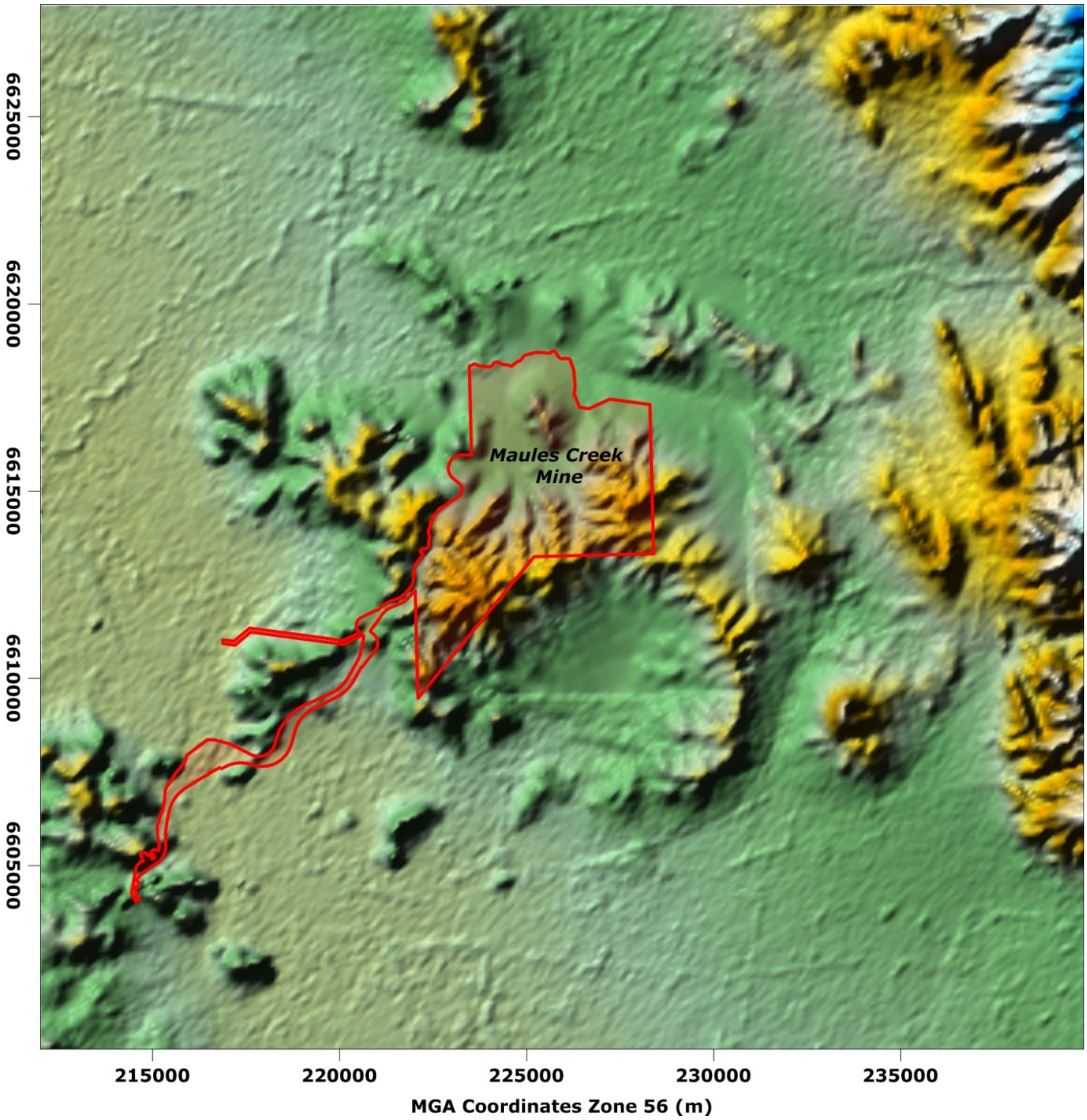


Figure 2.3: Pseudo 3-dimensional plot of the surrounding terrain

3 PROJECT DESCRIPTION

The Project would be generally consistent with the development as approved in the original Development Consent with contemporary mining methods and practices to be implemented enabling the maximum and efficient extraction of coal reserves.

The Project is proposed to continue for at least 21 years, commencing in 2012 and will consist of:

- The construction and operation of an open cut mining operation extracting up to 13 Mtpa Run of Mine (ROM) coal to the Templemore Seam;
- Open cut mining fleet including excavator / shovels and fleet of haul trucks, dozers, graders and water carts utilising up to 470 permanent employees;
- The construction and operation of a CHPP with a throughput capacity of 13 Mtpa ROM coal;
- The construction and operation of a Tailings Drying Area;
- The construction and operation of a rail spur, rail loop, associated load out facility and connection to the Werris Creek to Mungindi Railway Line;
- The construction and operation of a Mine Access Road;
- The construction and operation of administration, workshop and related facilities;
- The construction and operation of water management infrastructure including a water pipeline, pumping station and associated infrastructure for access to water from the Namoi River; and
- The installation of supporting power and communications infrastructure.
- The construction and operation of explosive magazine and explosives storage areas.

For the purposes of this assessment, mine plans for Years 5, 10, 15 and 21 of the Project have been provided. The mine plans as modelled for each stage are presented in **Figure 3.1**.

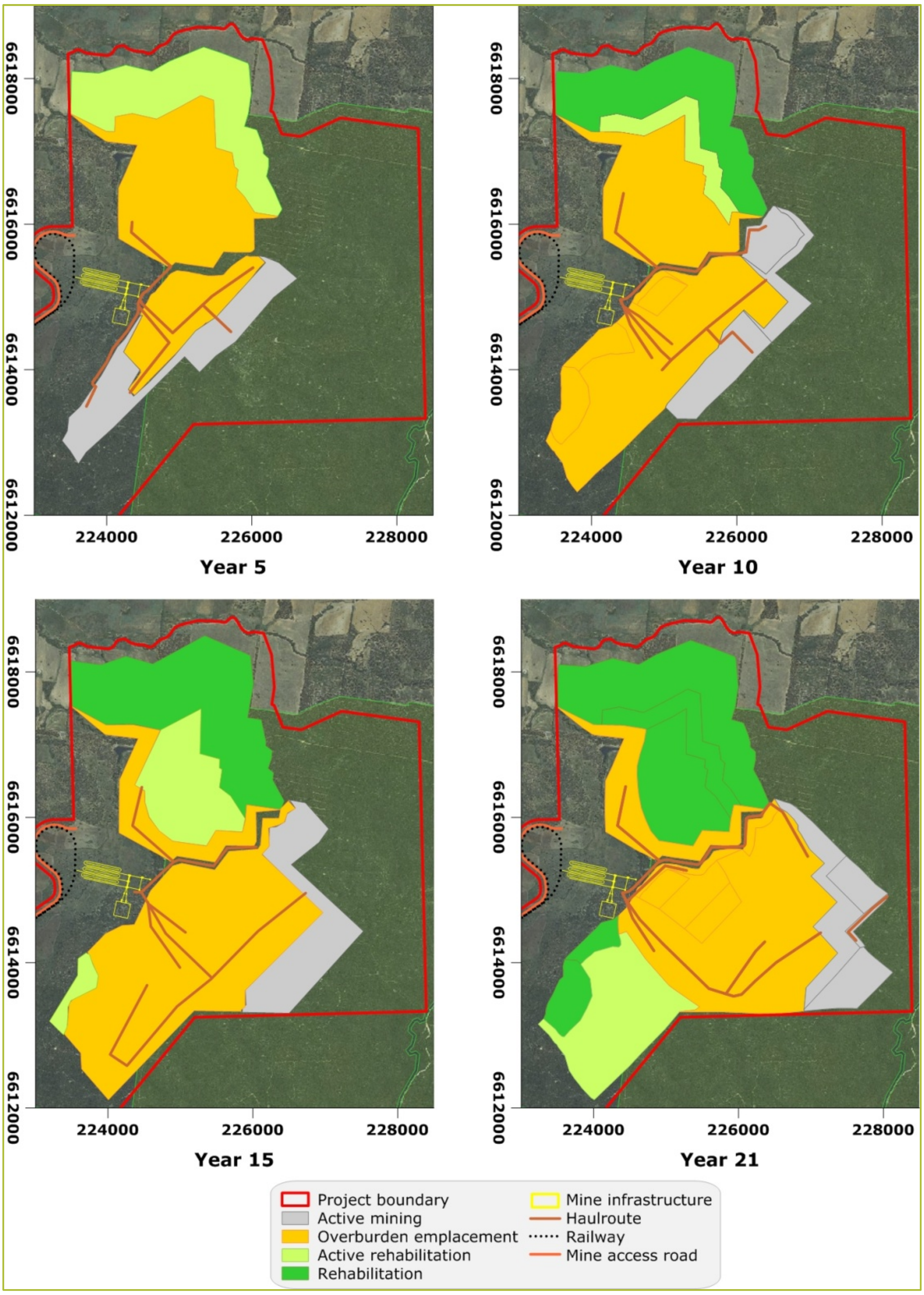


Figure 3.1: Mine plans

A summary of the projected ROM coal extracted and overburden removed over the life of the Project is shown in **Table 3.1** with the years chosen for assessment highlighted in bold.

Table 3.1: ROM coal extracted and overburden removed over the life of the Project

Year of operations	ROM extraction (Mtpa)	Overburden removed (Mbcm)
Year 1	3.8	22.2
Year 2	6.3	53.6
Year 3	11.7	73.6
Year 4	11.7	74.3
Year 5	**12.4**	**74.3**
Year 6	11.3	74.3
Year 7	11.3	74.3
Year 8	13.0	74.3
Year 9	13.0	74.2
Year 10	**12.7**	**74.3**
Year 11	12.3	74.3
Year 12	12.0	74.3
Year 13	12.4	74.3
Year 14	13.0	74.3
Year 15	**11.2**	**74.3**
Year 16	11.5	74.3
Year 17	12.6	74.3
Year 18	13.0	85.4
Year 19	12.2	85.7
Year 20	12.0	85.2
Year 21	**13.0**	**85.4**

4 AIR QUALITY ASSESSMENT CRITERIA

4.1 Introduction

Extraction of coal using open cut mining methods requires the clearing of land and excavation of overburden material to recover the coal by heavy earthmoving equipment. These operations generate fugitive dust emissions in the form of particulate matter described as total suspended particulate matter (TSP)[b], particulate matter with an equivalent aerodynamic diameter of 10 μm or less (PM_{10})[c] and particles with an equivalent aerodynamic diameter of 2.5 μm and less ($PM_{2.5}$). In addition, combustion engines from vehicles release emissions through vehicle exhausts including carbon monoxide (CO), minor quantities of sulphur dioxide (SO_2) and nitrogen dioxide (NO_2).

The low sulphur content of Australian diesel, in combination with the fact that mining equipment is widely dispersed over mine sites, is such that the sulphur dioxide (SO_2) goals would not be exceeded, even in mining operations that use large quantities of diesel. For this reason, no detailed study is required to demonstrate that emissions of SO_2 from the Project would not significantly affect ambient SO_2 concentrations. Similarly, NO_x and CO emissions from the mining activities are too small and too widely dispersed to require a detailed modelling assessment. For this reason these pollutants are not considered further in this report.

Other emissions to air from the Project include greenhouse gases (GHG) such as fugitive methane from exposed coal, carbon dioxide from the combustion of fuel in mining equipment, blasting and indirect GHG emissions from the purchase of electricity for use on-site. GHG emissions are discussed in **Section 12**.

The following sections provide information on the air quality criteria used to assess the impact of dust and particulate emissions.

The assessment criteria provide benchmarks, which if met, are intended to protect the community against the adverse effects of air pollutants. These criteria are generally considered to reflect current Australian community standards for the protection of health and protection against nuisance effects. To assist in interpreting the significance of predicted concentration and deposition levels some background discussion on the potential harmful effects is also provided.

4.2 Particulate Matter

Particulate matter has the capacity to affect health and to cause nuisance effects and is categorised by size and/or by chemical composition. The potential for harmful effects depends on both.

Existing evidence suggests that health effects from exposure to airborne particulate matter are predominantly related to the respiratory and cardiovascular systems. The human respiratory system has in-built defensive systems that prevent larger particles from reaching the more sensitive parts of the respiratory system. Particles larger than 10 μm, while not able to affect health, can soil materials and generally degrade aesthetic elements of the environment. For this reason air quality goals make reference to measures of the total mass of all particles suspended in the air, this is referred to as TSP. In practice particles larger than 30 to 50 μm

[b] TSP refers to all particles suspended in the air. In practice, the upper size range is typically 30 to 50 μm.
[c] PM_{10} refers to all particles with the 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.

settle out of the atmosphere too quickly to be regarded as air pollutants. The upper size range for TSP is usually taken to be 30 μm. TSP includes PM_{10}.

Just as PM_{10} particles are a sub-component of TSP, $PM_{2.5}$ particles are also a sub-component of PM_{10} and therefore a sub-component of TSP. $PM_{2.5}$ are fine particles with aerodynamic diameters of 2.5 μm or less which may penetrate beyond the larynx and into the thoracic respiratory tract. There is evidence that particles in this size range are more harmful than the coarser component of PM_{10}, namely the 2.5 to 10 μm fraction. The health effects of particulate matter are further compounded by the chemical nature of the particles and by the possibility of synergistic effects with other air pollutants.

The health-based assessment criteria used by DECCW have, to a large extent, been developed by reference to epidemiological studies undertaken in urban areas with large populations where the primary pollutants are the products of combustion. This means that, in contrast to dust of crustal[d] origin, the particulate matter from urban areas would be composed of smaller particles and would generally contain acidic and carcinogenic substances that are associated with combustion. The indication therefore is that particulate matter of crustal origin, such as dust from mining, may be less harmful to health as it contains a smaller fraction of fine particulate matter, (e.g. $PM_{2.5}$ and PM_1) and also relatively less matter containing acidic and carcinogenic substances.

Both long term and short term exposure to particulate matter are important and, as such, short-term (24-hour) and long term (annual mean) guidelines are needed to protect health.

Mining emissions will also include particles from diesel exhausts in activities where diesel powered equipment is used. Thus mining generates particles in all the above size categories, namely $PM_{2.5}$, PM_{10} and TSP. However, the great majority of the particles from mining operations are due to the abrasion, crushing of rock and coal and general disturbance of dusty material. As such most of the emissions will be larger than 2.5 μm. This is in contrast to particles found in bushfire smoke, or in the atmosphere in urban areas, where many of the particles are the result of combustion processes. A study of the distribution of particle sizes near (10 to 200 m) mining dust sources was undertaken on behalf of the State Pollution Control Commission (SPCC – now EPA) in 1986. The average of approximately 120 samples showed that $PM_{2.5}$ comprised 4.7% of the TSP, and PM_{10} comprised 39.1% of the TSP in the samples (**SPCC, 1986**). Thus, although emissions of $PM_{2.5}$ do occur from mining the percentages of the emissions in this size range are small and in practice the concentrations of $PM_{2.5}$ in the vicinity of mining dust sources are likely to be low compared with internationally recognised goals.

The US EPA also suggests ratios of $PM_{2.5}$ to PM_{10} from various emissions sources for use in emissions estimation. The ratios for various activities that may take place at a mine (unpaved roads, aggregate handling and wind erosion) are in the range of 0.1 to 0.15 (i.e. 10% to 15% of PM_{10} is $PM_{2.5}$). While mining does generate fine particulate, it appears that the bulk of fine particles in the atmosphere are typically derived from other sources, such as combustion sources.

4.2.1 DECCW Criteria

In the *Approved Methods*, the DECCW specifies air quality assessment criteria relevant for assessing impacts from air pollution (**NSW DEC, 2005**). **Table 4.1** summarises the air quality

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

goals for concentrations of particulate matter that are relevant to this study. The air quality goals for TSP and PM_{10} relate to the total dust burden in the air and not just the dust from the Project. In other words, consideration of background dust levels needs to be made when using these goals to assess potential impacts. This is discussed further in **Section 7.3.1**.

These criteria are consistent with the *National Environment Protection Measures for Ambient Air Quality* (referred to as the Ambient Air-NEPM (see **NEPC, 1998**)). However, the NSW DECCW's criteria include averaging periods, which are not included in the Ambient Air-NEPMs, and also references to other measures of air quality, namely dust deposition and total suspended particulate matter.

Table 4.1: DECCW air quality standards / goals for particulate matter concentrations

Pollutant	Averaging period	Standard / Goal	Agency
Total suspended particulate matter (TSP)	Annual mean	90 $\mu g/m^3$	NHMRC
Particulate matter with an equivalent aerodynamic diameter less than 10 μm (PM10)	24-hour maximum	50 $\mu g/m^3$	NSW DECCW impact assessment criteria; NEPM reporting goal, allows five exceedances per year for bushfires and dust storms;
	Annual mean	30 $\mu g/m^3$	NSW DECCW impact assessment criteria;

Notes: $\mu g/m^3$ – micrograms per cubic metre, μm – micrometre;

In addition to potential health impacts, airborne dust also has the potential to cause nuisance effects by depositing on surfaces. **Table 4.2** shows 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 (**NSW DEC, 2005**).

Table 4.2: DECCW criteria for dust (insoluble solids) fallout

Pollutant	Averaging period	Maximum increase in deposited dust level	Maximum total deposited dust level
Deposited dust	Annual	2 g/m^2/month	4 g/m^2/month

4.2.2 $PM_{2.5}$

In May 2003, NEPC released a variation to the NEPM (**NEPC, 2003**) to include advisory reporting standards for $PM_{2.5}$. The purpose of the variation was to gather sufficient data nationally to facilitate the review of the Air Quality NEPM which is currently underway. The variation includes a protocol setting out monitoring and reporting requirements for particles as $PM_{2.5}$.

The advisory reporting standards for $PM_{2.5}$ are a maximum 24-hour average of 25 $\mu g/m^3$ and an annual average of 8 $\mu g/m^3$. The NEPM $PM_{2.5}$ advisory reporting standards are not impact assessment criteria and should not be applied as such. While predictions have been made as to the likely contribution that emissions from the Project would make to ambient $PM_{2.5}$ concentrations, these predictions have not been used to assess impacts against the proposed advisory standard.

5 EXISTING ENVIRONMENT

This section provides a description of the meteorological and air quality monitoring programs operated by Aston and provides a review of other publicly available information. The main objective of the review is to establish existing air quality conditions and to identify the best source of meteorological data to be used in the assessment.

The locations of the meteorological and air quality monitoring stations for the Project and other sites are shown in **Figure 5.1** and described further in the following sections.

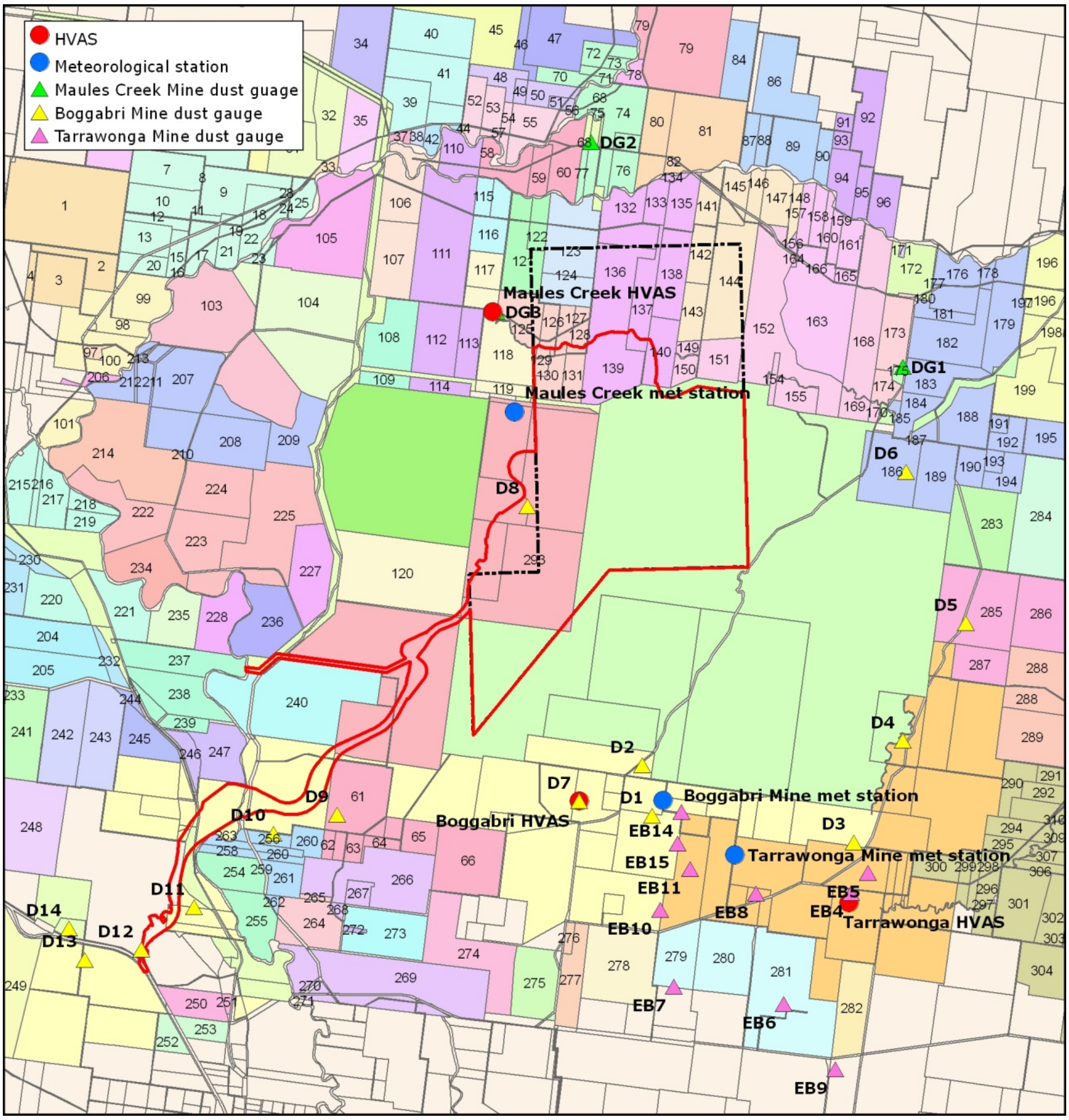


Figure 5.1: Location of meteorological and air quality monitoring sites in the vicinity of the Project

5.1 Dispersion Meteorology

The Gaussian dispersion model used for this assessment requires information about the dispersion characteristics of the area. In particular, data are required on temperature, wind speed, wind direction, atmospheric stability class and mixing height.

5.1.1 Wind speed and wind direction

The DECCW have listed requirements for meteorological data that are used for air dispersion modelling in their *Approved Methods*. The requirements are as follows:

- Data must span at least one year;
- Data must be at least 90% complete; and
- Data must be representative of the area in which emissions are modelled.

A modified version of the US EPA computer-based dispersion model ISCST3 (ISCMOD discussed later) has been used in this study to assess the dispersion of particulate matter and meteorological data are required as input to the model.

An automatic weather station (AWS) was installed in the vicinity of the Project Boundary on 14 May 2010. The Maules Creek AWS records 10-minute averages of wind speed, wind direction, temperature (at 2m and 10m), solar radiation and rainfall.

The location of the Maules Creek AWS is shown in **Figure 5.1**. The siting of the Maules Creek AWS posed a number of challenges due to a large portion of the available land being densely forested, the significantly undulating terrain, the location of the proposed infrastructure and restrictions in accessing land. However, the installation and siting is in accordance with "*AS/NZS 3580.9.6:2003: Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – PM_{10} high volume sampler with size selective inlet – Gravimetric method*".

A windrose for the available measured data is presented in **Figure 5.2**. For the duration of the collection period the prevailing wind directions are from the southeast and west-northwest and, to a lesser extent, the west and south-southeast. Almost no winds originate from the north to north-northwest.

Although the Maules Creek Weather Station has achieved 100% data collection since it was installed, at the time of writing this report, a full year of meteorological data was not yet available for the Maules Creek AWS and as such this data cannot be used for dispersion modelling.

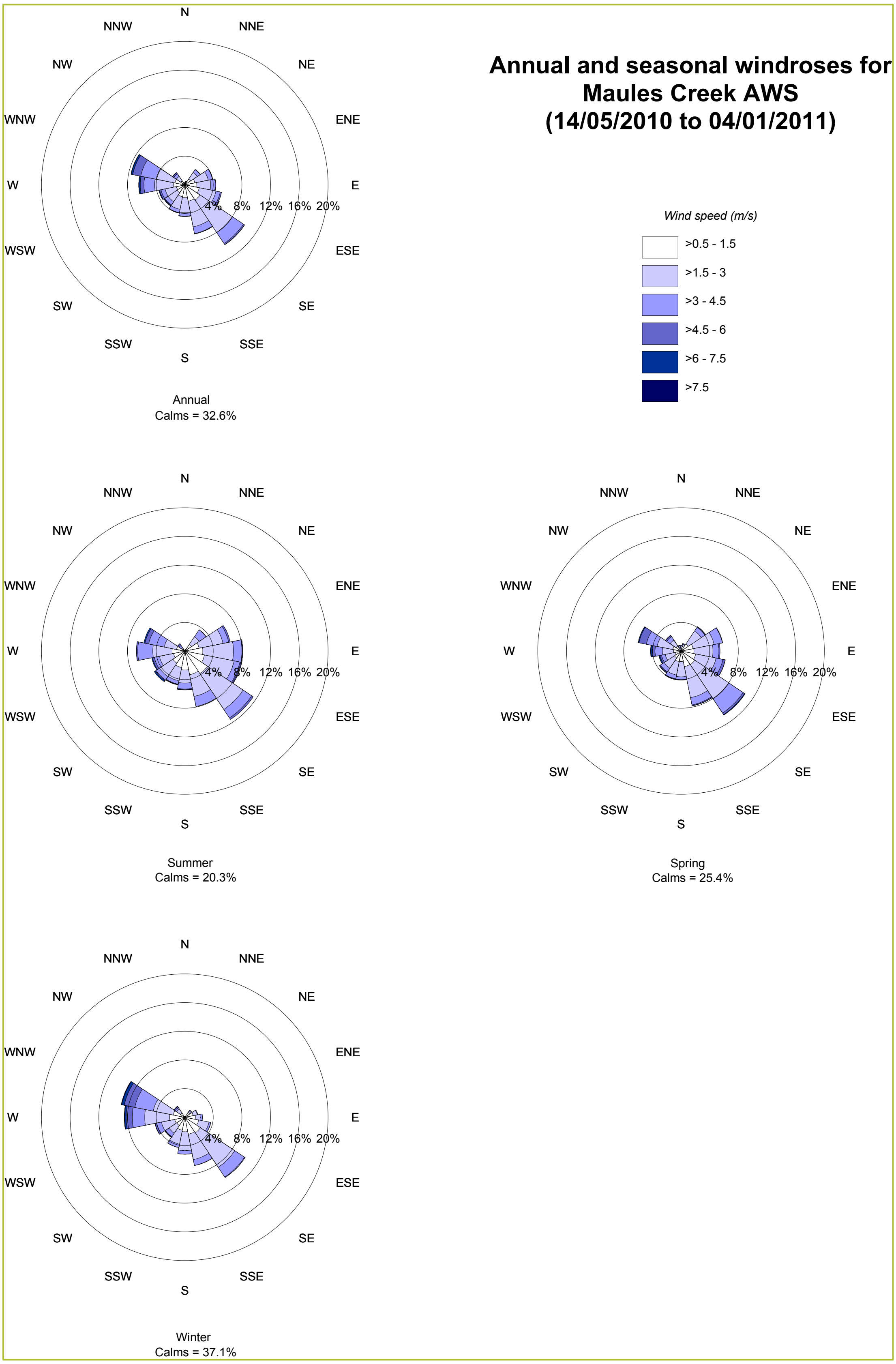


Figure 5.2: Annual and seasonal windrose for Maules Creek AWS

There are two other automatic weather stations located to the south of the Project and these are owned and operated by Boggabri Coal Mine and Tarrawonga Coal Mine (see **Figure 5.1** for the location). The data collected at the Boggabri Coal Mine AWS did not on its own meet the DECCW's requirements 90% capture requirements suitable to conduct modelling. The measurements made by the Tarrawonga Coal Mine AWS are discontinuous with information on wind speed and wind direction missing for intermittent periods throughout the dataset.

Table 5.1 provides a summary of the available meteorological data from the Maules Creek AWS, Boggabri Coal Mine AWS and Tarrawonga Coal Mine AWS.

Table 5.1: Summary of Available Meteorological Monitoring Data for 2009 / 2010

AWS	Available data	Time span	Notes
Maules Creek	14/05/2010 – 04/01/2011	7 months	
Boggabri Coal Mine	01/07/2010 – 17/01/2011	6 months	
Tarrawonga Coal Mine	01/01/2010 – 31/12/2010	12 months	Wind speed and wind direction discontinuous (29.9% missing)
Narrabri Airport	01/08/2009 – 15/04/2010	12 months	

The closest Bureau of Meteorology (BoM) station is located at Narrabri Airport (Station Number 054038), approximately 37 km to the northwest of the Project Boundary. This distance is too great to be representative of conditions within the Project Boundary.

Annual windroses are compared for the Boggabri Coal Mine AWS, Tarrawonga Coal Mine AWS and the Narrabri BoM AWS, and presented in **Figure 5.3**.

For the Boggabri Coal Mine AWS and Tarrawonga Coal Mine AWS, a full year of data was not available concurrently and seasonal attributes that characterise the wind pattern at each location may not have been captured. However, the windroses provide an indication of the variation in prevailing wind conditions in the region.

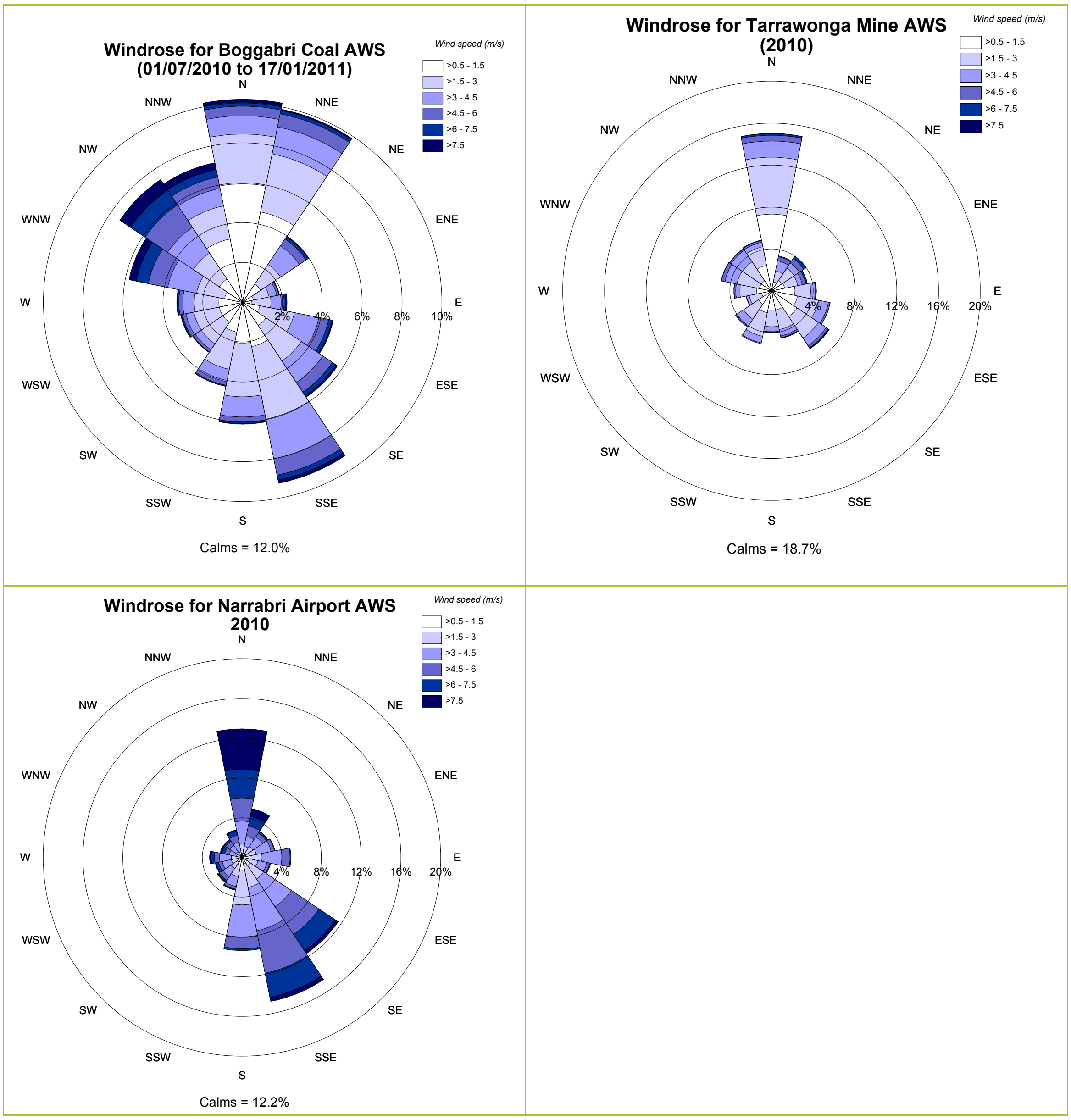


Figure 5.3: Annual Boggabri Coal Mine AWS, Tarrawonga Coal Mine AWS and the Narrabri Airport AWS

Each of the windroses presents a distinctly different wind distribution pattern to the available data from Maules Creek. It is difficult to draw definitive conclusions from these data as a result of the differing time periods and data. However, the influence of local terrain features in generating channelling effects and drainage flows in the area is apparent. The Maules Creek AWS data does not display the dominant northerly component that is prevalent in the Boggabri Coal Mine AWS and Tarraonwga Mine AWS data which suggests that the terrain feature between the Project Boundary and Boggabri Coal Mine results in drainage flow at the Boggabri Coal Mine which is not prevalent at Maules Creek and the terrain is steering and channelling in different ways at the two sites. This is an important consideration when assessing the cumulative impacts from the contemporaneous operations at both sites.

In the absence of a complete meteorological dataset for the Project and the varying nature of the wind conditions measured at the Boggabri and Tarrawonga AWS's, it was determined that the best approach for this assessment was to generate a site representative meteorological dataset for Maules Creek using a diagnostic meteorological modelling system known as CALMET. CALMET uses available measured surface input data from multiple weather stations, upper air and cloud data in combination with geophysical data (land use, terrain) to predict the meteorology for a region or local area. CALMET can treat slope flows, terrain effects and terrain blocking effects to generate three-dimensional meteorological fields suitable for dispersion modelling. A detailed description of CALMET and the relevant inputs used to generate this meteorological file has been provided in **Appendix B**.

The annual and seasonal windroses for a meteorological dataset extracted from CALMET at the location of the Maules Creek AWS for the period of 1 January 2010 to 31 December 2010 are presented in **Figure 5.4**.

The annual winds predicted by CALMET correlate reasonably well with the windroses presented for Maules Creek, based on the available data collected to date (**Figure 5.2**). The CALMET generated windroses show that on an annual basis the prevailing wind directions are from the southeast and south-southeast which is reflected in the measured data at the Maules Creek AWS.

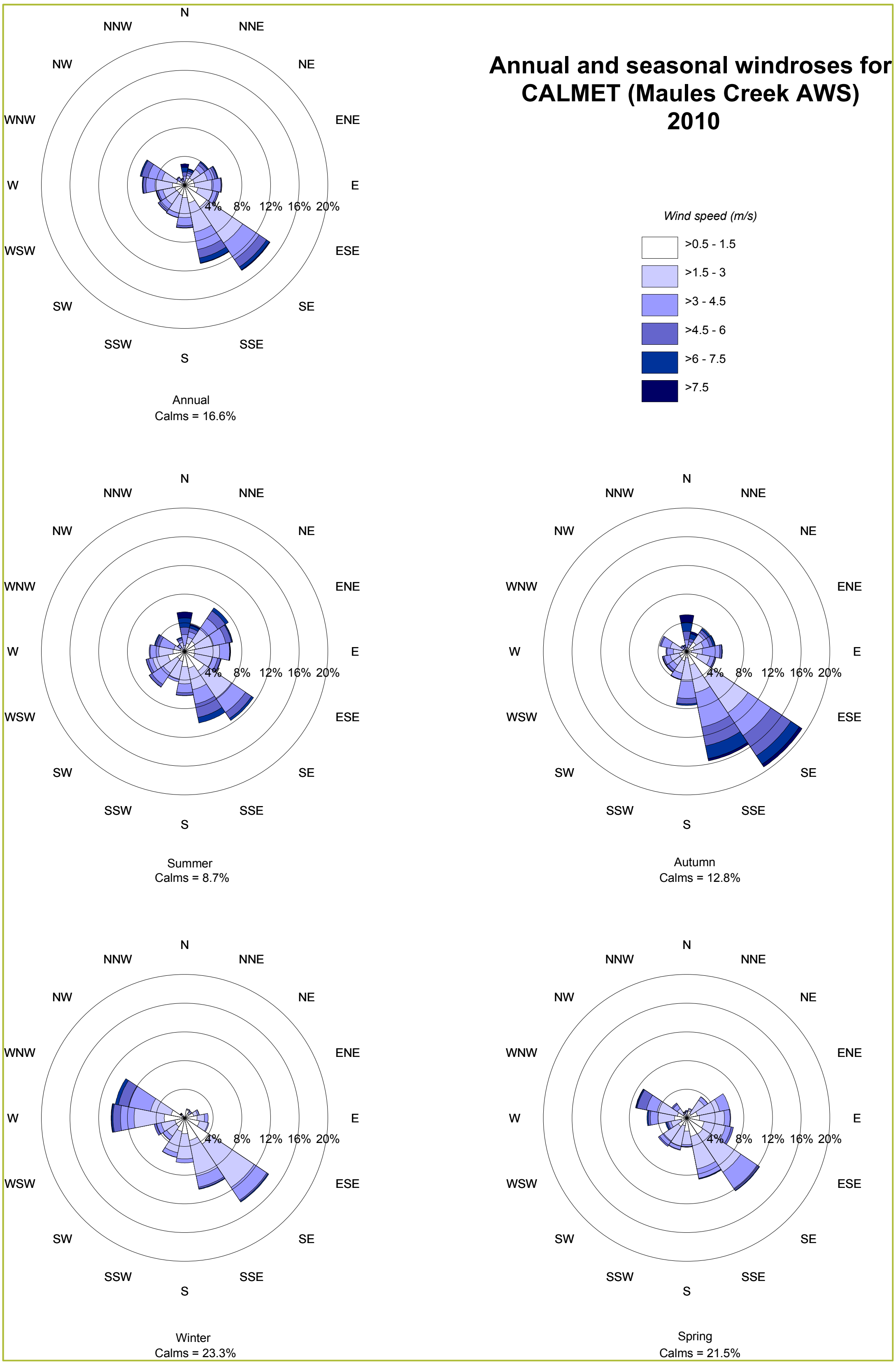


Figure 5.4: CALMET windroses at Maules Creek AWS (2010)

5.1.2 Mixing Height and Stability Class

Stability class is used by dispersion models to determine the rate at which the plume grows by the process of turbulent mixing. Each stability class is associated with a dispersion curve, which is used by the model to calculate the plume dimensions and dust concentration at points downwind of the source. In the model used here, the Pasquill-Gifford dispersion curves have been used.

The Pasquill-Gifford scheme classifies the atmosphere into six (sometimes seven) classes A to F (or G in the extended scheme);

- Class A occurs in the day with light winds and strong solar radiation with strong convection; dispersion is rapid;
- Class D, also known as "neutral conditions", occurs with moderate to strong winds and/or overcast skies, again dispersion is rapid;
- Class F (and G) occurs under light winds with clear skies at night. These conditions are conducive to the formation of ground-based inversions and as such, dispersion is slow; and
- Classes B and C are intermediate between A and D, and E is intermediate between D and F.

Table 5.2 shows the frequency of occurrence of the different stability categories calculated by CALMET. The most common stability class in the area was determined to be F recording 41.0%. This would suggest that the dispersion conditions are such that dust emissions disperse slowly for a significant proportion of the time. Joint wind speed, wind direction and stability class frequency tables are presented in **Appendix C**.

Table 5.2: Frequency of Occurrence of Stability Classes for CALMET (2010)

Stability Class	Frequency of Occurrence
A	4.7
B	20.1
C	16.6
D	11.2
E	6.4
F	41.0
Total	100

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 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 and 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 variation in the minimum, maximum and average mixing depths, based on the CALMET-generated meteorological data for the site, is shown below. 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.

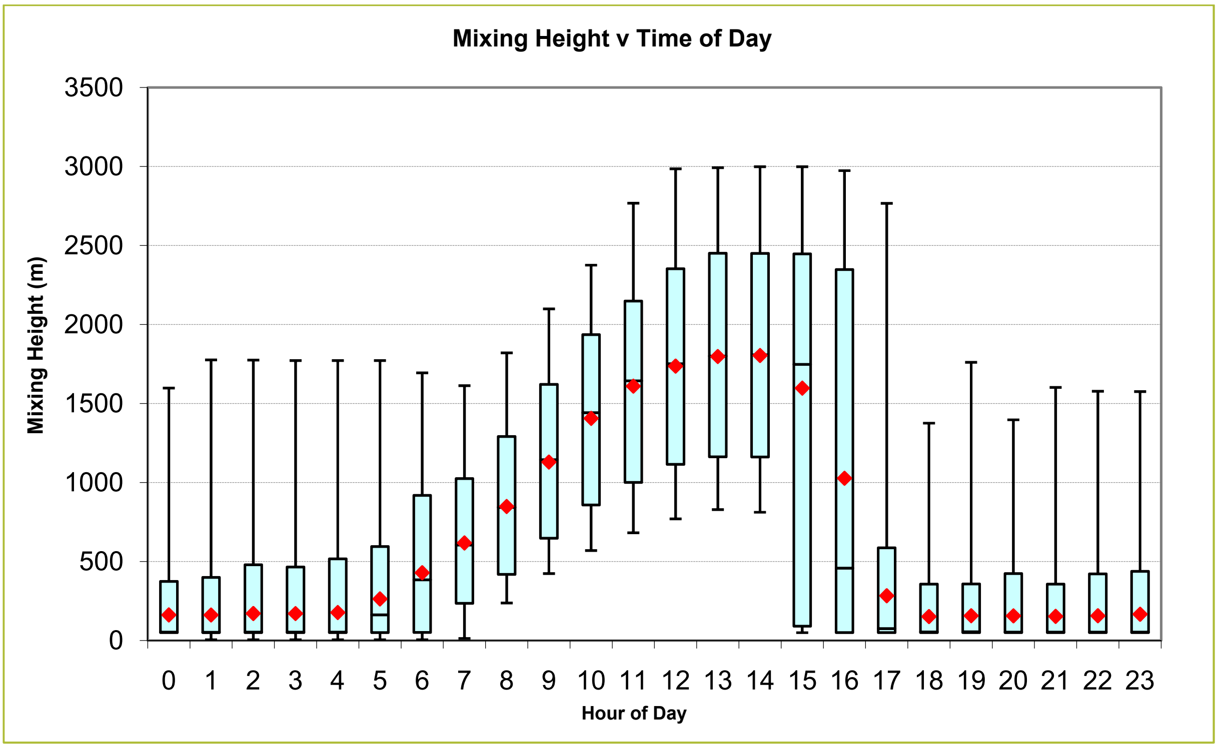


Figure 5.5: Mixing Height by Hour of the Day (generated by CALMET)

5.2 Climate Data

The BOM collects climatic information from the monitoring station located at Gunnedah Pool (Station Number 055023) approximately 50 km to the south-southeast of the Project. These data provide information on the long-term average values of climatic elements such as temperature, humidity, rainfall, the number of raindays per year etc.

Table 5.3 presents temperature, humidity and rainfall data collected at Gunnedah between 1876 and 2010 (**Bureau of Meteorology, 2010**). Temperature and humidity data consist of monthly averages of 9am and 3pm readings. Also presented are monthly averages of maximum and minimum temperatures. Rainfall data consist of mean and median monthly rainfall and the average number of raindays per month.

The annual average maximum and minimum temperatures experienced at Gunnedah are 26.0°C and 10.9°C, respectively. On average, January is the hottest month with an average maximum temperature of 34.0°C. July is the coldest month, with average minimum temperature of 3.0°C.

The annual average humidity reading observed at 9 am at Gunnedah is 67 percent, and at 3 pm the annual average is 46 percent. The month with the highest humidity on average is June with a 9 am average of 79 percent, and the lowest is November and December with a 3 pm average of 40 percent.

Rainfall data collected at Gunnedah shows that January is the wettest month, with an average rainfall of 71.3 mm over 6.5 days. The average annual rainfall is 615.5 mm with an average of 72.0 raindays.

Table 5.3: Climate Information for Gunnedah Pool Monitoring Station

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
9 am Mean Dry-bulb and Wet-bulb Temperatures (°C) and Relative Humidity (%)													
Dry-bulb	25.0	23.8	22.1	18.3	13.3	9.8	8.8	10.9	15.0	19.1	22.1	24.4	17.7
Wet-bulb	19.7	19.3	17.7	14.6	11.1	8.2	7.1	8.4	11.7	14.6	16.8	18.8	14.0
Humidity	61	65	65	67	73	79	77	71	65	61	59	58	67
3 pm Mean Dry-bulb and Wet-bulb Temperatures (°C) and Relative Humidity (%)													
Dry-bulb	31.2	30.3	28.7	24.9	20.0	16.7	15.8	17.7	21.3	24.5	27.7	30.2	24.1
Wet-bulb	21.6	21.4	20.0	17.3	14.3	12.0	11.0	11.9	14.3	16.4	18.3	20.2	16.6
Humidity	43	45	44	46	51	55	53	48	44	43	40	40	46
Mean Maximum Temperature (°C)													
Mean	34.0	32.9	30.7	26.4	21.3	17.6	16.9	18.9	22.8	26.7	30.3	33.0	26.0
Mean Minimum Temperature (°C)													
Mean	18.3	18.1	15.8	11.4	7.1	4.3	3.0	4.2	7.0	10.7	14.1	16.8	10.9
Rainfall (mm)													
Mean	71.3	66.5	48.1	37.7	42.4	43.9	42.7	41.3	39.9	55.4	60.9	68.6	618.5
Raindays (Number)													
Mean	6.5	6.1	4.7	4.3	5.1	6.3	6.3	6.2	5.8	6.9	6.8	7.0	72.0

[a] Bureau of Meteorology, 2010

5.3 Existing Air Quality

5.3.1 Introduction

Air quality standards and goals refer to pollutant levels that include the contribution from specific projects and existing sources. To fully assess impacts against all the relevant air quality standards and goals 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 to these levels. It is important to note that the existing air quality conditions (that is, background conditions) will be influenced to some degree by existing mining operations in the vicinity of the Project.

At the time of writing, only limited data were available from the Maules Creek air quality monitoring network, which commenced operation in August and October 2010. A network of three dust deposition gauges was installed in August 2010 and a High Volume Air Sampler (HVAS) commenced monitoring in October 2010. The available monitoring data from these sites provides a snapshot of the existing baseline environment for the area around Maules Creek, however, is not reflective of the seasonal variation in particulate matter that would be seen in longer term datasets. Air quality monitoring data have been collected by the neighbouring mines for a longer period and has been used to establish the existing air quality baseline for the area.

The location of the air quality monitoring network for the Project, along with the neighbouring Boggabri Coal Mine and Tarrawonga Coal Mine are shown in **Figure 5.1** and the monitoring results are discussed below.

5.3.2 PM_{10}

The determination of the 24-hour average PM_{10} concentration is conducted using a HVAS run on a one day in six cycle. At the time of writing, only 3 months of HVAS monitoring data were available for the Maules Creek monitoring site. These data are presented in **Table 5.4**.

Table 5.4: Maules Creek HVAS PM_{10} Monitoring to date

HVAS Run Date	PM_{10} Concentration ($\mu g/m^3$)
4/10/2011	7
10/10/2011	8
16/10/2011	4
22/10/2011	10
28/10/2011	27
4/11/2010	11
10/11/2010	9
16/11/2010	3
22/11/2010	22
4/12/2010	7
10/12/2010	8
16/12/2010	11
21/12/2010	8
27/12/2010	4
Average	**9**

Longer term monitoring data have been collected by the neighbouring HVAS at Boggabri Coal Mine and Tarrawonga Coal Mine, which includes all emission sources from the current mining operations in the area along with other localised activities. Sources of particulate matter in the area would include mining activities, traffic on unsealed roads, local building and construction activities, farming, animal grazing and to a lesser extent traffic from the other local roads and other sources such a wood-burning fires.

Three years of monitoring data are presented in **Figure 5.6**, displaying 24-hour average and rolling annual average PM_{10} concentrations. The full data set for the HVAS measurements collected by Boggabri Coal Mine and Tarrawonga Coal Mine are also presented in **Appendix D**.

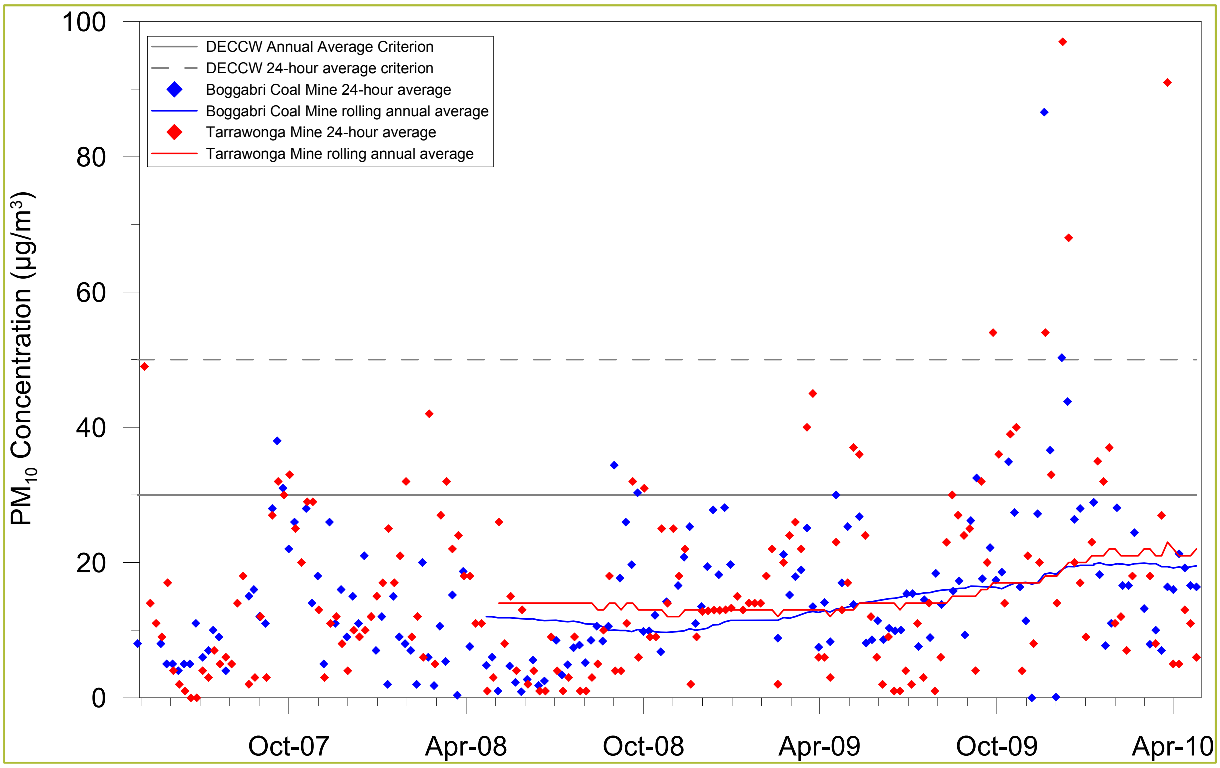


Figure 5.6: PM_{10} monitoring results for the Boggabri Coal Mine HVAS and Tarrawonga Coal Mine HVAS – µg/m³

From **Figure 5.6** it can be seen that there have been several occasions where the 24-hour average PM_{10} concentration has been recorded at a level that is above the DECCW's criterion of 50 µg/m³.

The monitoring data collected at the Tarrawonga Coal Mine HVAS indicates that there have been five elevated recordings above the DECCW goal during the monitoring period, with four occurring between September and December 2009, a period in which a number of dust storms and strong winds were experienced across NSW. The maximum 24-hour average PM_{10} concentration recorded was 97 µg/m³ on the 8th December 2009, a day when most of NSW experienced strong winds and elevated dust levels.

The elevated levels recorded at the Boggabri Coal Mine HVAS coincide roughly with those days in which elevated levels were also recorded at the Tarrawonga Coal Mine HVAS and are thus likely indicative of regional scale events rather that a direct contribution from either mine's operations.

Although the data indicates fewer than the five exceedances per year, it should be noted that the monitoring is not continuous and so it is not possible to conclude that the existing area complies with the PM_{10} Air-NEPM standard. However the fact that the exceedances are attributable to periods of severe wind suggests that generally, air quality is satisfactory.

Also shown in **Figure 5.6** is the rolling annual average for the Boggabri Coal Mine and Tarrawonga Coal Mine HVAS monitors. In spring 2008 the rolling annual average PM_{10} concentrations at the Tarrawonga Coal Mine HVAS were as low as 12 µg/m³ and have steadily increased and been as high as 23 µg/m³ in Autumn 2010. At the Boggabri Coal Mine HVAS the rolling annual average PM_{10} concentration was 10 µg/m³ in spring 2008 and increased to 20 µg/m³ in early 2010. Overall, the PM_{10} concentrations decreased significantly in June 2008 and began to increase again in spring 2009. The increasing trend in rolling annual average PM_{10} concentration may be as a result of the generally dryer conditions experienced across NSW during 2009 and are not necessarily as a result of intensification in mining activity. 2009 was the warmest year on record for the state of NSW and annual average rainfall for the state was low at 484 mm.

This is lower than that recorded in 2008 (519 mm), 2007 (543 mm), although higher than in 2006 (349 mm) and on a par with 2005 (494 mm). The similar pattern seen at both sites suggest an influence external to mining activities given that the Tarrawonga Coal mine HVAS is located in a prevailing downwind direction from both mining operations whereas the Boggabri Coal Mine HVAS is not in a direction prevailing downwind direction from either operation.

A summary of the annual average PM_{10} concentrations is shown in **Table 5.5**. All measurements were below the DECCW's criterion of 30 µg/m^3.

Table 5.5: PM_{10} monitoring results from Boggabri Coal Mine HVAS and Tarrawonga Coal Mine HVAS- µg/m^3

HVAS	2007 [a]	2008	2009	2010 [b]
Boggabri Coal Mine	14	11	19	17
Tarrawonga Coal Mine	13	13	21	20

[a] *Data available from May 2007*
[b] *Data available to April 2010*

There are no TSP data collected, however, experience with monitoring in other mining areas in the state indicates that where mining activities are a significant source of the particulate matter, then on an annual basis, approximately 39% of the TSP will be in the form PM_{10}. This would suggest that the annual average TSP concentrations are in the range 28 µg/m^3 to 54 µg/m^3. These concentrations are less than DECCW's annual average 90 µg/m^3 assessment criterion for TSP.

5.3.3 Dust Deposition

Aston currently measures dust deposition levels at three sites within the vicinity of the Project Boundary. The location of these dust gauges is shown in **Figure 5.1**. Dust deposition gauges use a simple device consisting of a funnel and bottle to estimate the rate at which dust settles onto the surface over a period of one month. The measured dust fallout includes the effects of all existing sources of particulate matter including the existing mining operations.

The Maules Creek dust gauges were installed in September 2010 and only one month of data was available at the time of writing. The results are presented in **Table 5.5**.

Table 5.6: Maules Creek Dust Deposition (insoluble solids) Results – g/m^2/month

Dust Gauge	MC01	MC02	MC03	MC04
September 2010	0.8	0.8	3.5	
November 2010	1.5	1.2	5.8	
December 2010	0.6	<0.1	6.9[a]	0.8

[a] *Field notes: Funnel not put in jar properly*

Historical data for dust deposition levels was collected for the original Maules Creek EIS (**KCC, 1989**) are also available from 1982 to 1986. The average deposition level for each of the dust gauges is presented in **Table 5.7**, providing an indication of background dust deposition levels pre-mining in the area.

Table 5.7: Average dust deposition levels for the Maules Creek EIS dust gauges - $g/m^2/month$

1982	1983	1984	1985	1986
2.1	2.8	1.4	1.8	1.3

It can be seen from both sets of data collected at the Maules Creek site (**Table 5.5** and **Table 5.6**) that the dust deposition levels are generally low and well below the DECCW's criteria of 4 $g/m^2/month$. It is noted that the dust deposition level at DG3 during September 2010 is 3.5 $g/m^2/month$, however, in the absence of longer term monitoring for comparison, conclusions cannot be drawn on whether this is an isolated event at this particular location.

Neighbouring mines at Boggabri and Tarrawonga have collected dust deposition for a number of years. The locations of the Boggabri Coal Mine and Tarrawonga Coal Mine dust gauges are also shown in **Figure 5.1**.

The data collected from these dust gauges has been obtained from the Tarrawonga AEMR 2009 (**Tarrawonga, 2009**). A summary of the dust deposition data collected from the gauges between 2005 and 2010 are summarised in **Table 5.8**. Measured levels above the 4 $g/m^2/month$ criteria are shown in bold.

As expected, the data show that those dust gauges located in close proximity to and within the prevailing wind direction of Tarrawonga Coal Mine (i.e. EB14 and EB15) experience higher deposition levels that exceed the DECCW criteria. At increased distance from each mine, dust levels are lower and more representative of private residences.

Table 5.8: Tarrawong Coal Mine dust deposition data (insoluble solids)– $g/m^2/month$[a]

Dust Gauge	2005	2006	2007	2008	2009	2010
EB-4	1.4	1.4	1.7	2.0	2.4	2.7
EB-5	**5.8**	2.1	2.2	2.3	2.8	3.6
EB-6	1.3	1.4	1.3	1.3	1.6	1.6
EB-7	0.8	0.9	1.4	1.2	1.4	1.4
EB-8	1.3	1.1	1.1	2.5	1.8	2.0
EB-9	1.2	1.0	1.5	1.0	1.5	1.0
EB-10	-	-	1.0	2.9	1.6	1.4
EB-11	-	-	1.4	1.4	0.9	2.2
EB-14	-	-	-	2.7	2.7	**5.0**
EB-15	-	-	-	2.7	**6.3**	**5.6**

[a] *All contaminated results have been removed from the annual averages*

Dust deposition is also monitored in the vicinity of Boggabri Coal Mine at 15 locations. Data collected from the gauges between 2005 and 2008 are summarised in **Table 5.9** (**PAEHolmes, 2010**).

The data indicate that deposition levels are generally low and within the DECCW's annual average assessment criteria of 4 $g/m^2/month$ for insoluble solids.

Table 5.9: Boggabri Coal Mine dust deposition data (insoluble solids) ($g/m^2/month$)[(a)]

Dust gauge	2005 average	2006 average	2007 average	2008 average	2009 average (to July)
D1	0.7	0.9	1.8	2.1	1.4
D2	0.7	1.5	2.0	2.1	1.6
D3	2.1	1.6	2.9	1.8	2.9
D4	2.2	1.5	2.3	1.6	1.8
D5	1.4	1.3	1.7	1.4	1.3
D6	1.5	1.0	1.7	1.6	1.4
D7	0.8	1.2	1.5	1.2	0.9
D8	1.1	1.1	1.3	1.2	0.9
D9	1.1	1.3	1.0	1.3	1.8
D10	1.1	0.8	1.1	1.1	0.7
D11	1.5	1.2	1.0	1.4	1.1
D12	1.1	1.6	1.9	1.7	1.6
D13	1.5	1.8	2.2	2.4	1.7
D14	0.9	0.9	1.6	1.7	4.0
D15	-	-	-	1.1	1.2

(a) Excluding contaminated data

6 ASSESSMENT METHODOLOGY

The DECCW's *Approved Methods* specify how assessments based on the use of air dispersion models should be undertaken. They include guidelines for the preparation of meteorological data to be used in dispersion models, the way in which emissions should be estimated and the relevant air quality criteria for assessing the significance of predicted concentration and deposition rates from the Project. The approach taken in this assessment follows as close as possible to the approaches suggested by the *Approved Methods*.

This section is provided so that technical reviewers can appreciate how the modelling of different particle size categories was carried out.

The model used was a modified version of the US EPA ISCST3 model (ISCMOD). ISCST3 is fully described in the user manual and the accompanying technical description (**US EPA, 1995a** and **US EPA, 1995b**). It is important to note that ISCMOD was selected as the appropriate dispersion model for the Project to enable comparisons with the neighbouring Boggabri Coal Mine, which was also assessed using ISCMOD. Different meteorological datasets have been used to account for varying conditions either side of the ridge line. It is noted that impacts from the neighbouring mines could also be assessed with a non-steady state model such as CALPUFF, and some preliminary screening analysis has been performed to compare the difference between using these two models to predict dust impacts. While an extensive investigation was not conducted, preliminary screening modelling results showed that the annual average predictions by the two models are comparable.

It is also noted that ISCMOD has been extensively verified and calibrated for use in assessing dust impacts from coal mines and as such is an appropriate model for this assessment. Also, the emission factors used in this assessment have been derived for coal mines based on verification studies which used Gaussian type models such as ISCMOD in the back calculations.

The ISCST3 model can overestimate short-term (24-hour) PM_{10} concentrations (see for example **Holmes Air Sciences, 2002a**). To overcome this difficulty it has been modified to create ISCMOD. ISCMOD is identical to ISC except that the horizontal plume spreading dispersion curves have been modified to adopt the recommendations of the American Meteorological Society's (AMS) expert panel on dispersion curves (**Hanna, 1977**) and the suggestions made by **Arya (1999)**. The suggested changes were recommended because, as the AMS panel notes, the original horizontal dispersion curves relate to an averaging time of three minutes and they recommend that these be adjusted to the one hour curves required by ISC. The change involves increasing the horizontal plume widths by a factor of 1.82 $(60 \text{ minutes} / 3 \text{ minute})^{0.2}$. The modifications improve the performance of the model in predicting 24-hour concentrations and make almost no difference to the annual average predictions.

A similar adjustment has been applied to account for the local surface roughness being different at Australian sites compared with the sites where the original curves were developed. The sites have been taken to have a surface roughness of 0.3 m compared with 0.03 m for the original curves. The adjustment leads to an increase in the horizontal and vertical curves by a factor of $(0.3 \text{ m} / 0.03 \text{ m})^{0.2}$, namely 1.6.

The modelling has been based on the use of three particle-size categories (0 to 2.5 µm - referred to as FP (fine particulate), 2.5 to 10 µm - referred to as CM (coarse matter) and 10 to 30 µm - referred to as Rest). Emission rates of TSP have been calculated using emission factors developed both within NSW and by the US EPA (see **Appendix E**).

The distribution of particles has been derived from measurements published by the SPCC **(SPCC, 1986)**. 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; and
- PM_{10-30} (Rest) is 60.9% of TSP.

Modelling was performed using three ISC source groups with each group corresponding 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 three plot output files for each group were then combined according to the weightings in the dot points above to determine the concentration of PM_{10} and TSP.

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 model 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 a mine site would correspond with periods of low dust generation because wind erosion and other wind dependent emissions rates will be low. Light winds also correspond with periods of poor dispersion. If these measures are not taken into account, the model has the potential to significantly overstate impacts.

For the Project, the operations were represented by a series of volume sources situated according to the location of activities for the modelled scenarios (see **Figure 6.1**). Source identification tables are presented in **Appendix E**.

Pit retention was considered an important factor to include in the dispersion modelling given the height difference between the local ground level and the pit floor. For the purposes of the dispersion modelling the calculation determines the fraction of dust emitted in the pit which will escape the pit. The relationship used is dependent on the gravitational settling velocity of the particles and wind speed and is given by the equation below (**US EPA, 1995**).

$$\varepsilon = \frac{1}{\left(1 + \frac{v_g}{\alpha U_r}\right)} \quad \textbf{(Equation 1)}$$

where:

ε = escape fraction for the particle size category

V_g = gravitational settling velocity (m/s)

U_r = approach wind speed at 10 m (m/s)

α = proportionality constant in the relationship between flux from the pit and the product of U_r and concentration in the pit

To model the effect of pit retention the emissions of sources within the mine pit have therefore been reduced to account for the fact that much of the coarser dust remains trapped in the mining area. Both the surrounding topography and local terrain of the proposed mine development has been incorporated into the modelling of the Project.

All activities have been modelled for 24 hours per day, with the exception of blasting which is limited in the modelling between the hours of 7am and 6pm. **Appendix E** provides a summary of dust emissions, hours of emission and allocation of sources for each activity.

Dust concentrations and deposition rates have been predicted for Year 5, Year 10, Year 15 and Year 21 of the life of the mine. The chosen years for modelling correspond to years of maximum ROM or overburden moved and / or minimum separation distance from sensitive residence locations.

The modelling was performed using the meteorological data discussed in **Section 5.1** and the dust emission estimates from **Section** 7. As an example, an ISCMOD input file is provided in **Appendix F**.

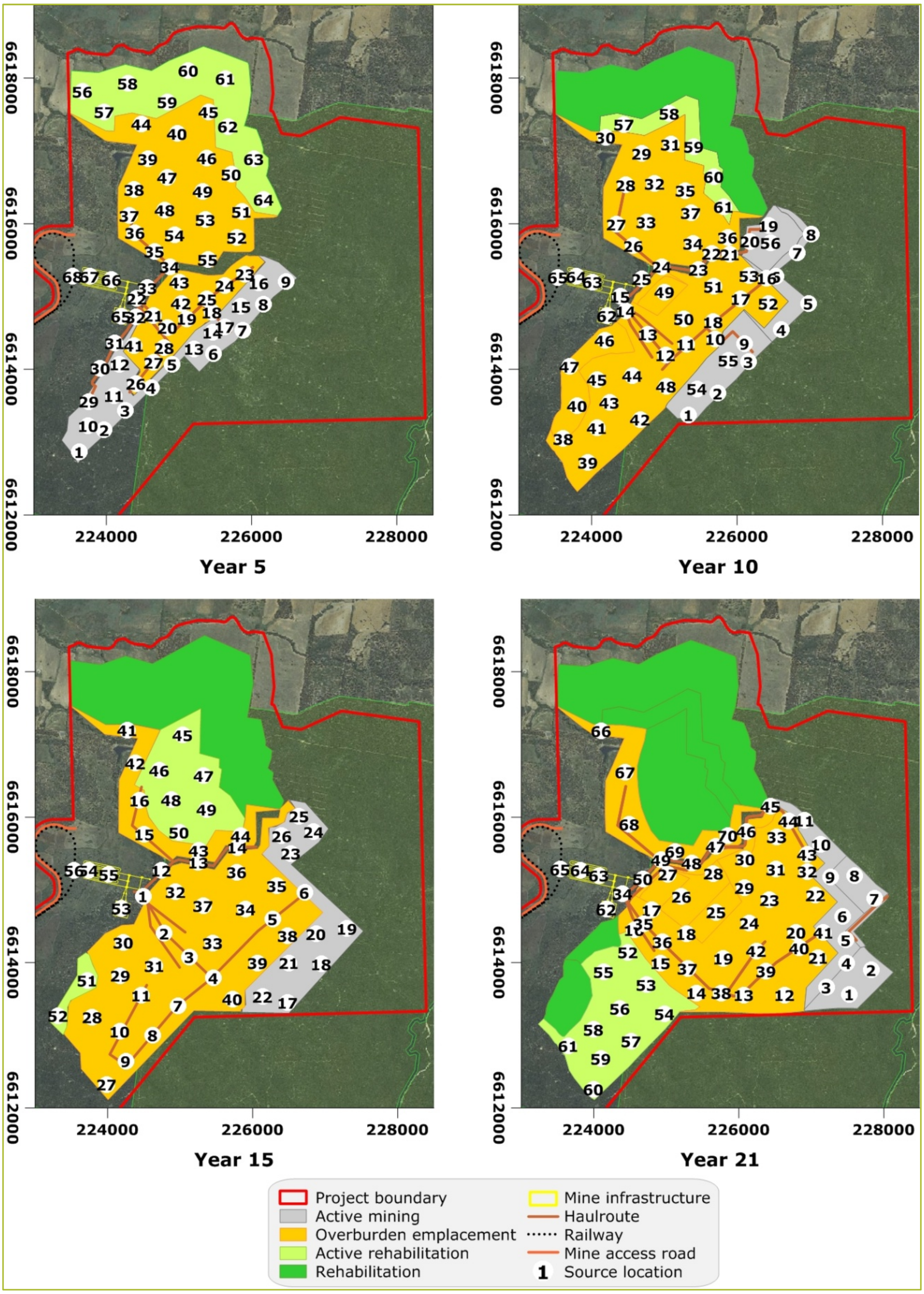


Figure 6.1: Source locations for each stage of the Project

7 ESTIMATED EMISSIONS OF PARTICULATE MATTER

Emissions from the proposed open-cut mining operations for the Project have been estimated, as well as emissions from other approved mining operations (or those pending approval), including Boggabri and Tarrawonga coal mines.

7.1 Estimated Emissions from the Project

Particulate emissions arise from a number of activities associated with open-cut mining. These emissions have been estimated using detailed operational information provided by the Proponent.

Emissions have been estimated using emission factor equations published in AP-42 (**US EPA, 1985** and updates from the US EPA website) and from studies undertaken by the coal industry in the Hunter Valley and published in a report prepared for the National Energy Research and Development and Demonstration Council (**NERDDC, 1988**). The emission factors applied are considered to be the most reliable for determining dust generation rates from coal mining operations in NSW.

The detailed calculations are presented in **Appendix E**, which provides information on the equations used, the basic assumptions about material properties (e.g. moisture content, silt content etc), information on the way in which equipment would be used to undertake different mining operations and the quantities of materials that would be handled in each operation.

Preliminary modelling indicated that of all the potential dust sources on-site, emissions from the hauling of overburden and ROM contributes more than any other source group to short-term PM_{10} impacts at the closest residential residences. Typically, modelling assessments for mine sites apply a haul road control level of 75% (representing control via > Level 2 watering). For the modelling scenario presented in this report, an additional level of control on hauling (85% control) has been applied to the emission estimates, a commitment made by the Proponent to ensure off-site impacts are controlled to the maximum extent achievable.

The 85% control is expected to be achieved by increasing the application rate of water and or through the use of chemical dust suppressants. As shown in **Figure 7.1**, 85% control can be achieved through the application of water, provided the moisture content of the surface material is between 6% and 7%.

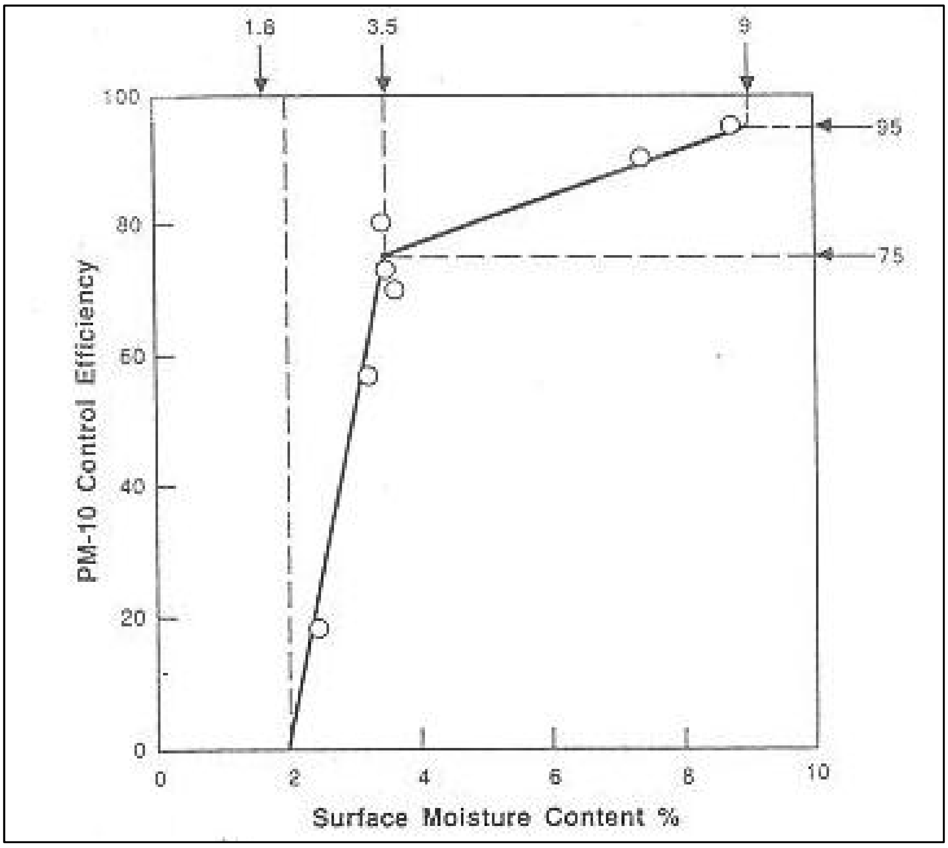


Figure 7.1: Watering control effectiveness for unpaved roads (Buonicore and Davis, 1992)

There are no known validation studies of the use of chemical suppressants completed in Australia, other than a study completed in 1984 by the NSW Coal Association, Pacific Chemical Industries (suppliers of the chemical suppressant "Pacwet") and the State Pollution Control Commission (SPCC, now NSW DECCW) which investigated the efficiency of chemical treatment in reducing dust emissions from unsealed roads at a mine site in the Hunter Valley (**Ferrari and Pender, c.1986**).

The study measured dust levels at distances of 15 m, 25 m and 50 m from a haul road that were untreated, watered and treated with "Pacwet" under temperature ranges of 4 ^{o}C to 21^{o}C, relative humidity of between 29% and 98% and wind speeds between calm and 11 m/s. The study concluded that regardless of the control applied, dust levels originating from the road decrease rapidly with distance and that it was clear that both water and "Pacwet" were very effective in controlling dust.

The US EPA Air Pollution Control Technology (APTC) Centre independently verifies commercial-ready technologies and has verified the performance of five products for the control of dust from unpaved roads. As shown in **Table 7.1**, the majority of the verified products showed control efficiencies for PM_{10} in excess of the 85% assumed in the dispersion modelling completed for the proposed operations.

On this basis, the additional control of 85% is expected to be achievable through additional watering and / or use of chemical suppressants.

Table 7.1: Average PM_{10} control efficiencies of dust suppressants as verified by US EPA

Product	Average PM_{10} control efficiency (%)	Source:
EK35	84-90%	EPA/600/R-05/128, 2006
EnviroKleen	87-98%	EPA/600/R-05/134, 2006
DustGard	88-90%	EPA/600/R-05/127, 2006
PetroTac	73-98%	EPA/600/R-05/135, 2006
TechSuppress	46-76%	EPA/600/R-05/129, 2006

The modelling assessment examines Year 5, Year 10, Year 15 and Year 21 of the life of the mine. These years have been selected as they represent the worst case scenario for the life of the Mine, including when other mining operations are considered.

For each stage of the mine shown in **Figure 3.1**, a corresponding emissions inventory has been developed. The information used for developing the inventories has been based on the operational description and mine plan drawings and used to determine haul road distances and routes, stockpile and pit areas, activity operating hours, truck sizes and other details that are necessary to estimate dust emissions. **Table 7.2** summarises the quantities of TSP estimated to be released by each activity of the Project.

The activities presented in **Table 7.2** are representative of the activities that would take place for each year of the Project. The only exception to this is Year 1, 2 and 3, when a Front End Loader (FEL) would be used for loading product coal to trains. After Year 3, the rail load out system will be utilised for the remaining years of the life of the Project. The difference in dust emissions generated from a FEL loading trains when compared to the rail loadout system is insignificant relative to the total estimated dust emissions for the Project and does not warrant a distinct modelling scenario for these years. Further, the amount of coal and overburden moved during Years 1 and 3 is significantly lower than the modelled years.

Table 7.2: Estimated TSP emissions each stage of the Project (kg TSP/year)

Activity	Year 5	Year 10	Year 15	Year 21
Topsoil Removal- Scraper clearing and stripping	35,424	35,424	35,424	35,424
OB - Drilling	28,044	27,998	27,727	32,177
OB - Blasting	131,788	131,477	130,022	150,957
OB - D10 Dozers removing OB	283,831	283,831	283,831	283,831
OB - Excavator loading OB to haul truck	237,546	237,546	237,527	273,100
OB - Hauling to OOP Dump	2,041,414	464,833	-	-
OB - Hauling to Inpit Dump	335,575	2,578,955	2,982,647	2,857,788
OB - Emplacing at OOP Dump	173,409	40,383	-	-
OB - Emplacing at Inpit dump	64,137	197,163	237,527	273,100
OB - D10 Dozers on OB in OOP Dump	51,799	7,096	-	-
OB - D10 Dozers on OB in Inpit Dump	19,159	58,895	70,958	70,958
OB - D10 Dozers on OB working on rehabilitation	8,368	8,368	8,368	8,368
CL - D11 Dozers ripping/pushing/clean-up	220,958	220,958	220,958	220,958
CL - Loading ROM coal to trucks with excavator	514,942	527,401	463,033	539,859
CL - Hauling open pit coal to ROM hopper	195,789	288,758	359,147	410,526
CL - Unloading ROM to hopper	514,942	527,401	463,033	539,859
CL - Sizer	124,000	127,000	111,500	130,000
CL - Transfer 55% to Processing Circuit (CHPP)	1,154	1,182	1,038	1,210
CL - Transfer 45% to Bypass Circuit	944	967	849	990
CL - Unloading to product stockpile (from bypass)	944	967	849	990
CL - Unloading to product stockpile (from CHPP)	776	794	697	813
CL- Cat 854 Dozers at Product stockpiles	49,624	49,624	49,624	49,624
CL - Loading product coal to trains	1,489	1,525	1,339	1,561
CL - Loading Trucks with Coarse Rejects	81	79	69	80
CL - Hauling rejects from Rejects Bin to dump	12,082	12,035	13,974	14,703
CL - Unloading Coarse Rejects	81	79	69	80
WE - OOP OB dump area	699,153	549,567	72,042	80,452
WE - Inpit OB dump area	285,716	933,886	1,263,963	1,138,239
WE - Open pit	420,410	417,467	422,617	409,372
WE - Product stockpiles	26,280	26,280	26,280	26,280
Grading roads	104,383	104,383	104,383	104,383
Total	**6,584,245**	**7,862,321**	**7,589,496**	**7,655,684**
Tarrawonga – Total Emissions	828,600			
Boggabri Continuation – Total Emissions	7,218,763	7,512,014	7,395,716	7,395,716

It is noted that the total emissions for the Project are similar to the total emissions for Boggabri Coal Continuation, despite significantly less ROM coal production rates at Boggabri Coal Mine. This is mainly due to the differences in assumptions used to estimate emissions from hauling (the largest emission source).

Maules Creek is proposing to use larger haul trucks than Boggabri (therefore less trips required) and is committed to additional controls for hauling (85%), compared to 75% at Boggabri.

7.2 Estimated Emissions from Neighbouring Mines

The Gunnedah Basin is a region rich in coal deposits that has only been mined to any significant extent for the past decade. While coal deposits were identified some time ago (i.e. the original Maules Creek EIS was conducted in 1989) the high market price for coal has led to a number of other proposed coal mines and proposed extensions of already existing mining operations. The following mines have been identified in the vicinity of the Project:

- Boggabri Coal Mine;
- Tarrawonga Coal Mine; and
- Goonbri Project (exploration lease status only).

Figure 7.2 shows the mining lease boundaries for these mines. There are other mines and Projects that exist or are proposed within the wider region, however these are considered to be sufficient distance from the Project Boundary to warrant assessment on a cumulative basis.

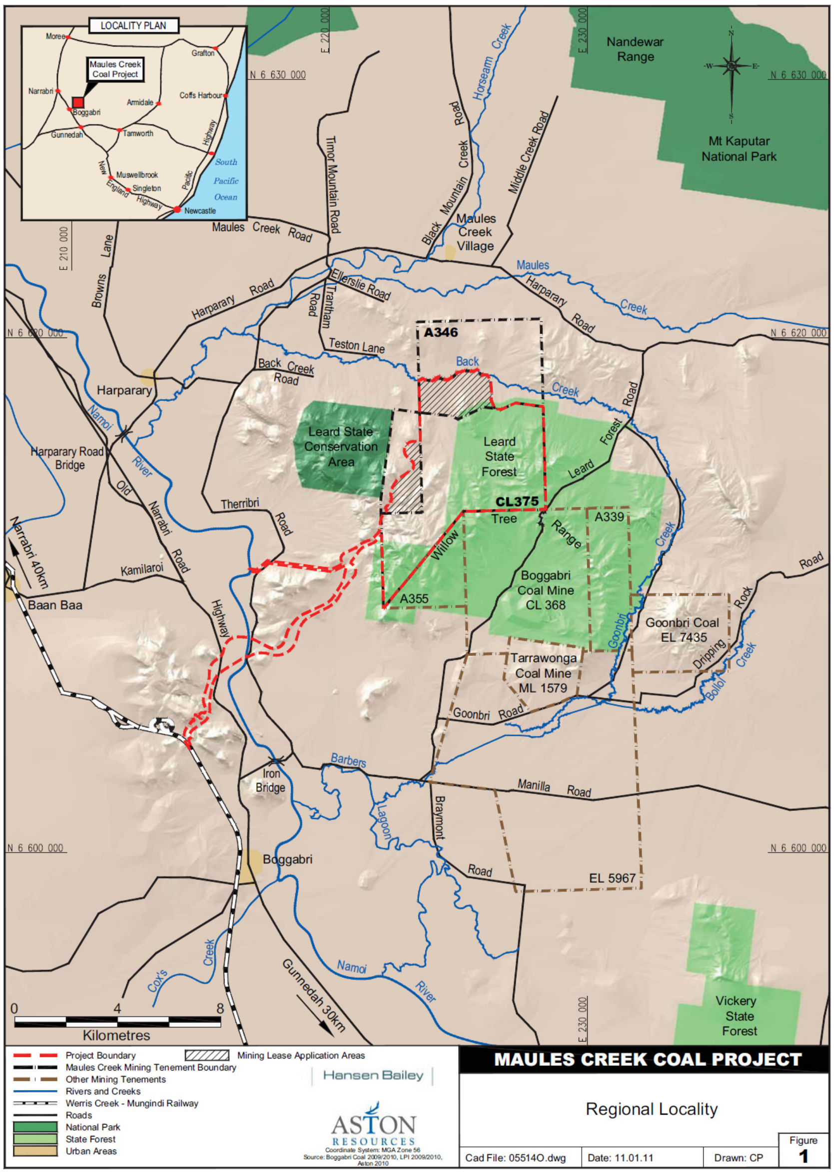


Figure 7.2: Neighbouring mine operations

At the time of writing, it is understood that the above mines are in the process of seeking approval for the development, modification, expansion and/or continuation of coal mine operations (except Goonbri Mine). The following provides a brief description of the proposed projects. It is important to note that the information presented below is not yet publicly available and may be subject to change from the time of writing this report.

7.2.1 Boggabri Coal Continuation

Boggabri Coal Mine has recently submitted an EA to the NSW Department of Planning (DoP) for the continuation and expansion of the current mining operations for another 21 years (Boggabri Coal Continuation). The continuation of mining would extract up to 7 Mtpa of ROM coal which would progress the operations to the northwest of the current operations, towards the Maules Creek Project Boundary.

Boggabri Coal Mine is also seeking approval for modifications to the existing site infrastructure including, construction of a CHPP and a 17 km rail spur which would connect existing rail lines and enable the transport of product coal directly from the mine, rather than using the existing haul roads.

The potential air quality impacts from the Boggabri Coal Continuation have been included in the cumulative assessment for annual average impacts from the Project (refer **Section 7.3**). The estimated emissions from the Boggabri Coal Continuation for each modelled year are presented in **Table 7.2**.

7.2.2 Tarrawonga Modification

The adjacent Tarrawonga Coal Mine recently submitted an application to the DoP which was supported by an EA and associated Air Quality Impact Assessment (AQIA), dated April 2010 (**Heggies, 2010**).

Tarrawonga Coal Mine has approval to increase the total amount of coal removed from the mine to 16.4 Mt, whilst maintaining the currently approved extraction rate of 2.0 Mtpa. There will be an additional 34.8 million bank cubic meters (bcm) of waste rock that would need to be removed and emplaced with a subsequent increase in height of the overburden emplacement and topsoil stockpiles.

In addition, the open cut disturbance area will be increased by 38 ha (160 ha to 198 ha) and would extend out further to the east of the existing northern emplacement. A more detailed description of the proposed modification to Tarrawonga Coal Mine is provided in the EA (**Resource Strategies, 2010** and the AQIA (**Heggies, 2010**). Tarrawonga Coal Mine currently has approval to extract coal from within their mining lease for eight to ten years.

The potential air quality impacts from the Tarrawonga Modification have been included in the cumulative assessment for the Project (refer **Section 7.3**). The estimated emissions from Tarrawonga Modification are presented in **Table 7.2** for Year 5 only, as mining would cease under current approvals at this stage.

7.2.3 Tarrawonga Extension

In addition to the Tarrawonga Modification there is the possibility of a further expansion of the Tarrawonga Coal Mine, which would most likely be via a new project approval. At the time of writing no approvals have been issued and no public documents describing the project are available. Therefore the extent of the operations (and hence the potential impacts on air quality) are not known and can only be addressed qualitatively.

7.2.4 Goonbri Project

The Goonbri Project is located to the southeast of the Project Boundary. Project Approval for the Goonbri Project may be sought at some time in the future. It is unknown at this time if this will be an open cut or underground coal mining operation. At the time of writing there have been no approvals granted for this project and no public documents describing the project are available. All that is known about this project is the existence of Exploration Licence 7435 held under the *Mining Act 1992*, and some media statements. Therefore the extent of the operations, and hence the specific potential impacts on air quality, are not known and can only be addressed qualitatively.

7.3 Cumulative Assessment Methodology

A common approach to cumulative air quality impact assessment is to use existing monitoring data for the area to characterise the existing (background) air quality environment (which includes existing industry) and to add dispersion modelling predictions for new projects to this background for an assessment of total impacts.

This approach, however, relies on good quality and long-term site specific (or at least site representative) monitoring data. This is not always available and when it is, the monitoring data can only provide an indication of background air quality for existing operations. It does not take into account, for example, any proposed future projects or modifications, such as the Boggabri Coal Continuation and Tarrawonga Modification.

The approach therefore is to include the operations of the Boggabri Coal Continuation and the Tarrawonga Modification in the modelling of long term annual average cumulative impacts and derive a background level for the contribution of other non-mining sources.

The cumulative assessment methodology for 24-hour PM_{10} impacts is presented in **Section 8.1.1**.

The cumulative contributions from Boggabri Coal have been determined using information presented in the Air Quality Impact Assessment (**PAEHolmes, 2010**). Detailed information including emission estimates and source locations were included in the modelling assessment.

A more generalised modelling approach was used for the Tarrawonga Modification, as detailed source and emissions information was not presented in the AQIA (**Heggies, 2010**). Sources have been considered in three classes covering all dust emission sources for which there are emission factor equations for open cut mines. These classes are as follows:

1. Wind erosion sources where emissions vary with the hourly average wind speed according to the cube of the wind speed;
2. Loading and dumping operations where emissions vary with wind speed raised to the power of 1.3; and
3. All other sources where emissions are assumed to be independent of wind speed.

For each of the surrounding mines, the proportions of emissions in each of these categories have been assumed to be:

- 0.73 for emissions independent of wind speed;
- 0.14 for emissions that depend on wind speed (such as loading and dumping); and
- 0.13 for wind erosion sources.

These factors are based on a detailed analysis of mine dust inventories undertaken as part of the Mount Arthur North EIS (**URS, 2000**) and these factors have been applied to subsequent air quality impact assessments for coal mines. The Mount Arthur North project is located in the Hunter Valley, however, it is expected that particle distributions in the Hunter Valley would provide a relatively high approximation for the Gunnedah Basin and therefore incorporate a degree of conservatism when applied to this Project.

The Tarrawonga Modification has been treated as a series of seven volume sources located at the apparent points of major emissions as estimated from the known locations of the pits and/or major dust sources on the mine or facility. The total dust emissions from the Tarrawonga Modification are estimated to be 828,600 kg TSP per year (**Heggies, 2010**).

The Tarrawonga Modification would coincide with approximately Year 5 of modelling for the Project, before the end of the mining lease for the Tarrawonga Coal Mine. Emissions from the Tarrawonga Modification are only therefore included for Year 5 modelling.

7.3.1 Estimated Emissions from Other Sources

In addition to those sources identified in **Section 7.1** and **Section 7.2**, contributions from other local sources such as dust from vehicles using private unsealed access roads, stock movements and exposed ground will contribute to $PM_{2.5}$, PM_{10}, TSP concentrations and dust deposition.

Estimating the background allowance for non-mining sources is difficult in the absence of monitoring data for the area before any mining commenced. As discussed in **Section 5.3** there is no long term monitoring data that has been collected on behalf of the Proponent available.

However, work undertaken in the Boggabri Continuation EA (**PAEHolmes 2010**) compares the modelling of the currently operating Boggabri Coal Mine with the monitoring data from the Boggabri Coal Mine air quality monitoring network. The difference between the modelled predictions and the monitoring data suggests that the annual average PM_{10} contributed by non mining sources is 12 $\mu g/m^3$, annual average TSP from non mining sources is 35 $\mu g/m^3$ and annual average deposited dust from non mining sources is 0.5 g/m^2/month.

Estimating the contribution from non mining sources (i.e. remaining background) for 24-hour average PM_{10} is more challenging. Background PM_{10} concentrations can vary substantially on a day to day basis and on some days the background will already be above the relevant air quality goals (typically during bushfires or dust storms). Without continuous 24-hour PM_{10} monitoring data for the area (pre-mining) it is difficult to accurately quantify this variation. Even when historical continuous 24-hour PM_{10} monitoring data is available, this does not necessarily reflect the daily variation for future years, this is especially important when considering that the modelling for the Project is projecting impacts that may occur up to 21 years into the mine life.

An alternative approach to cumulative 24-hour PM_{10} assessment is to analyse the probability that predicted 24-hour modelling results from the project would coincide with a background 24-hour PM_{10} concentration high enough to result in additional exceedances of the 24-hour PM_{10} impact assessment criteria. This analysis is presented in **Section 8**.

8 ASSESSMENT OF IMPACTS

Dispersion model simulations have been made for Year 5, Year 10, Year 15 and Year 21 of mining operations. This section provides an interpretation of the predicted dust concentrations (PM_{10} and TSP) and dust deposition produced by these simulations.

Contour plots of dust concentrations and deposition levels show the areas of land that are affected by dust at different levels. It is important to note that the isopleth figures are presented to provide a visual representation of the predicted impacts. To produce the isopleths it is necessary to make interpolations, and as a result the isopleths will not always match exactly with predicted impacts at any specific location.

The actual predicted impacts at nearby private residences are presented in tabular form, with those that are predicted to experience levels above the NSW DECCW's impact assessment criteria highlighted in bold.

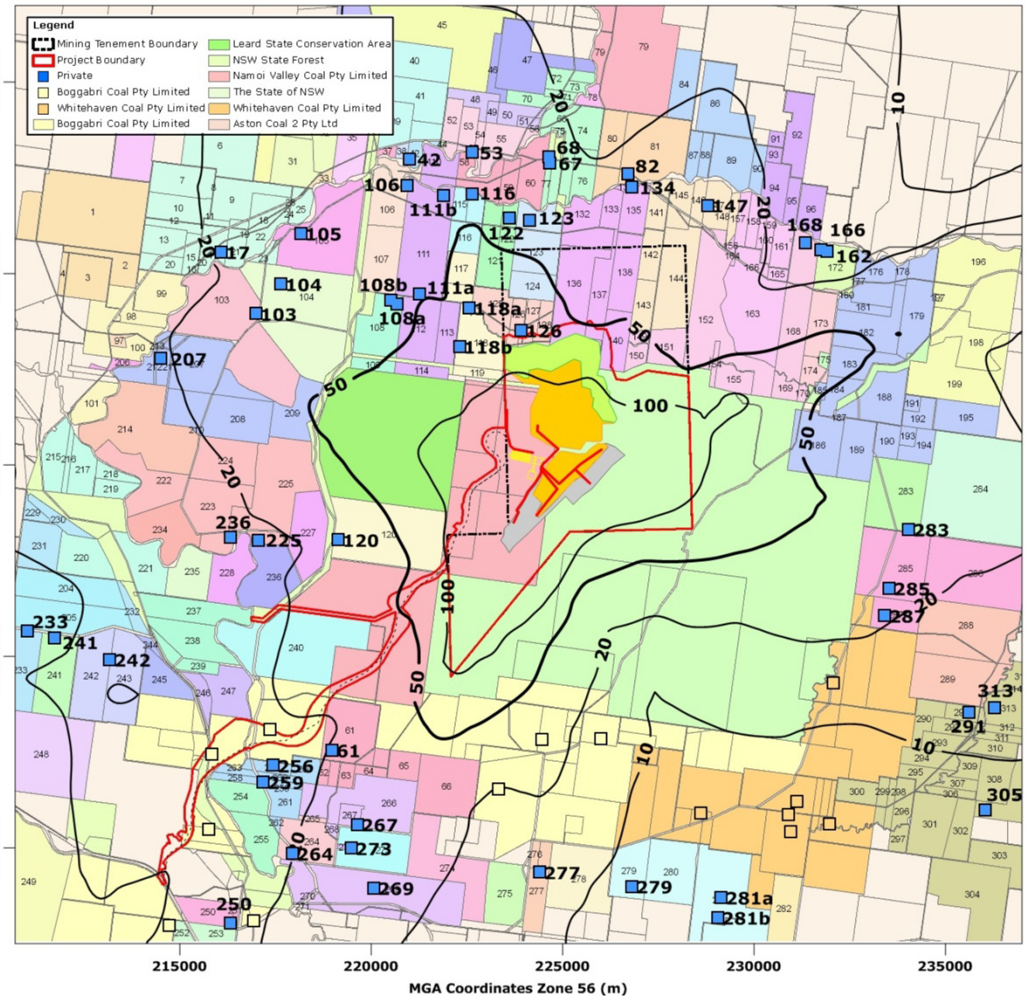
Contours have been presented for the predicted impact of the Project in isolation for short-term 24-hour impacts. Additional information on the potential cumulative impact from surrounding mines and other non-mining sources of dust is also considered and provided in **Section 8.1.1**.

For long-term impacts, contours are presented for both the impact of the Project in isolation and the cumulative impact of surrounding mines and other non mining sources of dust based on the methodology presented in **Section 7.3**.

8.1 Short-term (24-hour) PM_{10} Impacts

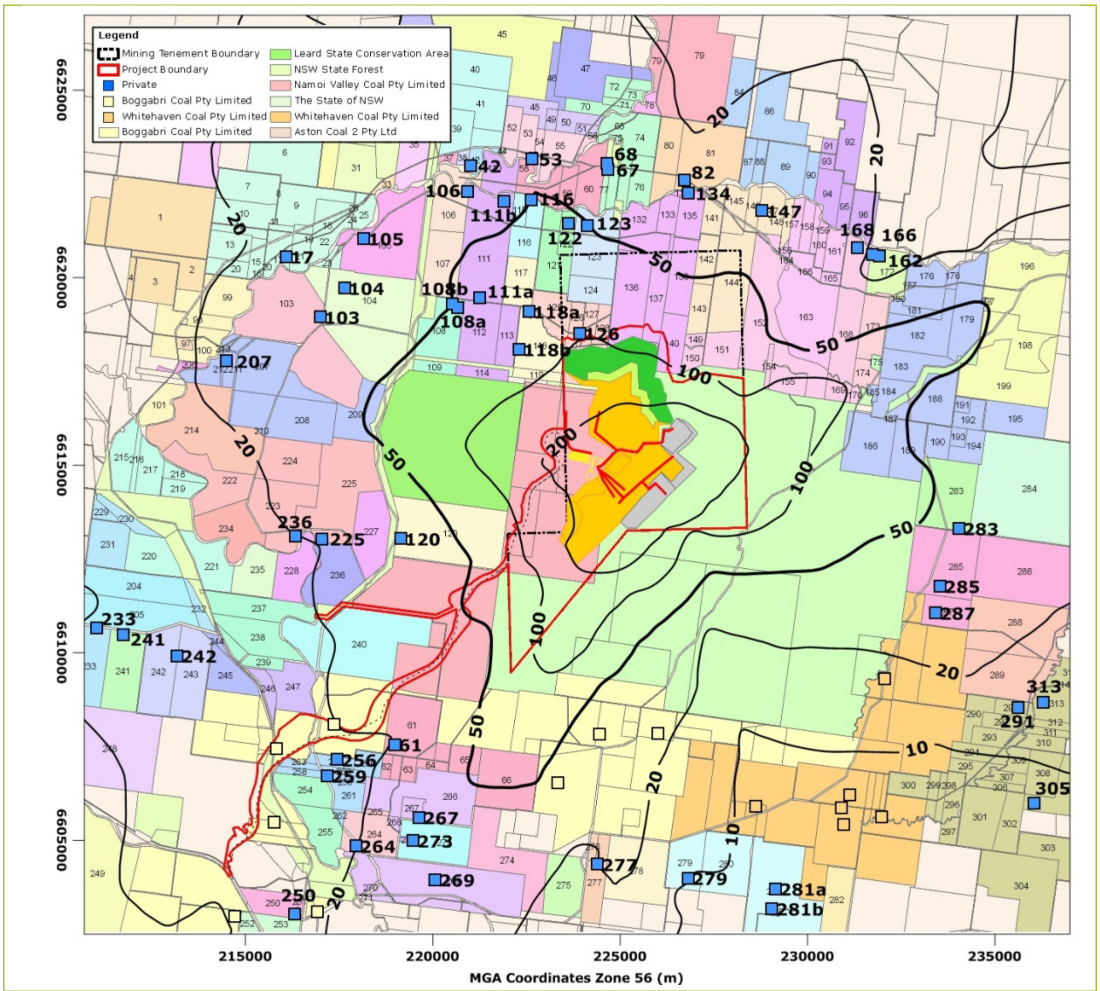
Figure 8.1 through **Figure 8.4** present contour plots for the predicted maximum 24-hour PM_{10} concentrations for the Project alone. The DECCW criterion of 50 µg/m^3 is highlighted in bold.

The 24-hour PM_{10} contours presented in **Figure 8.1** through **Figure 8.4** do not represent a single worst case day but rather represent the potential worst case 24-hour PM_{10} concentration that can potentially be reached based on the conditions modelled across the entire modelling year. The shape of the contour is a feature of the dispersion characteristics of the area and as discussed in **Section 5.1** a full year of meteorological data was not available for the Maules Creek site.



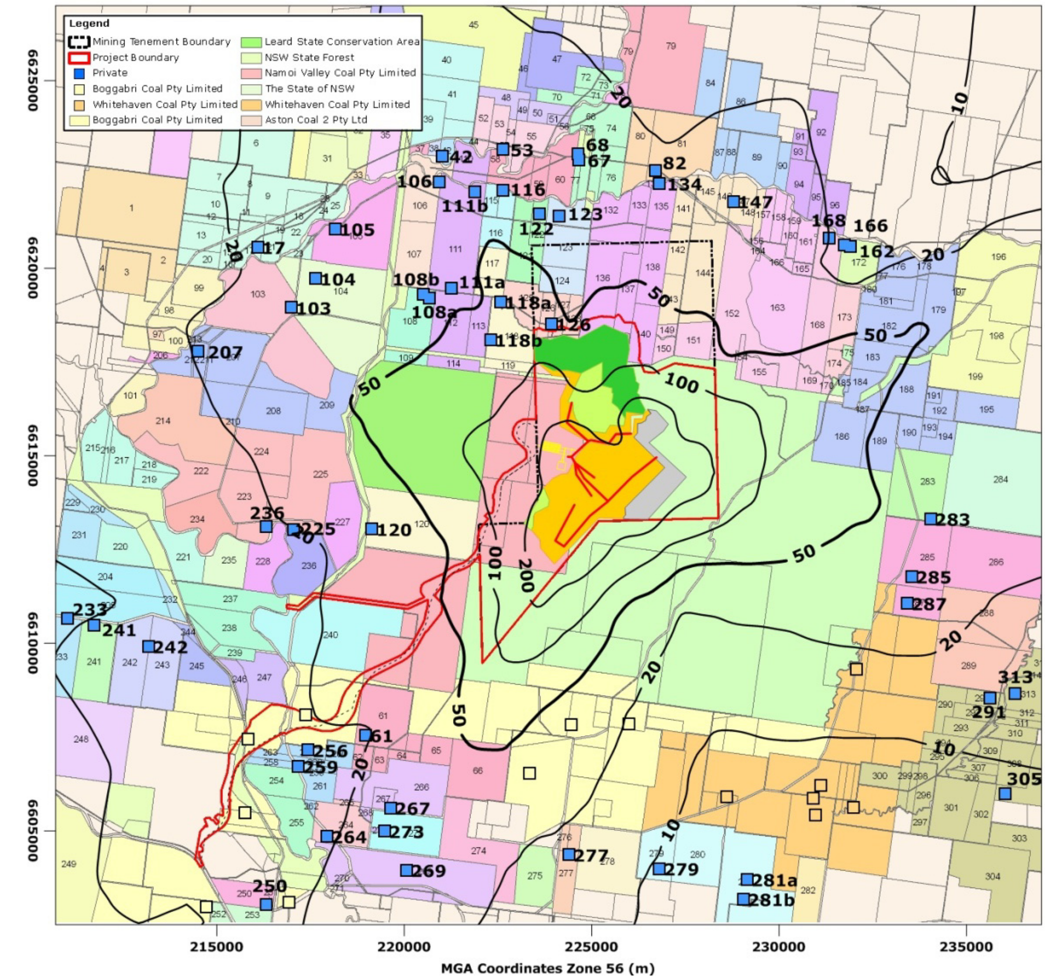
Species:	Location:	Scenario:	Percentile:	Averaging Time:
PM_{10}	Maules Creek	Year 5	Maximum	24 hour
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
ISCMOD	µg/m^3	50	CALMET	J. Beaney

Figure 8.1: Model predictions for maximum 24-hour average PM_{10} concentrations: Year 5 - Project in isolation



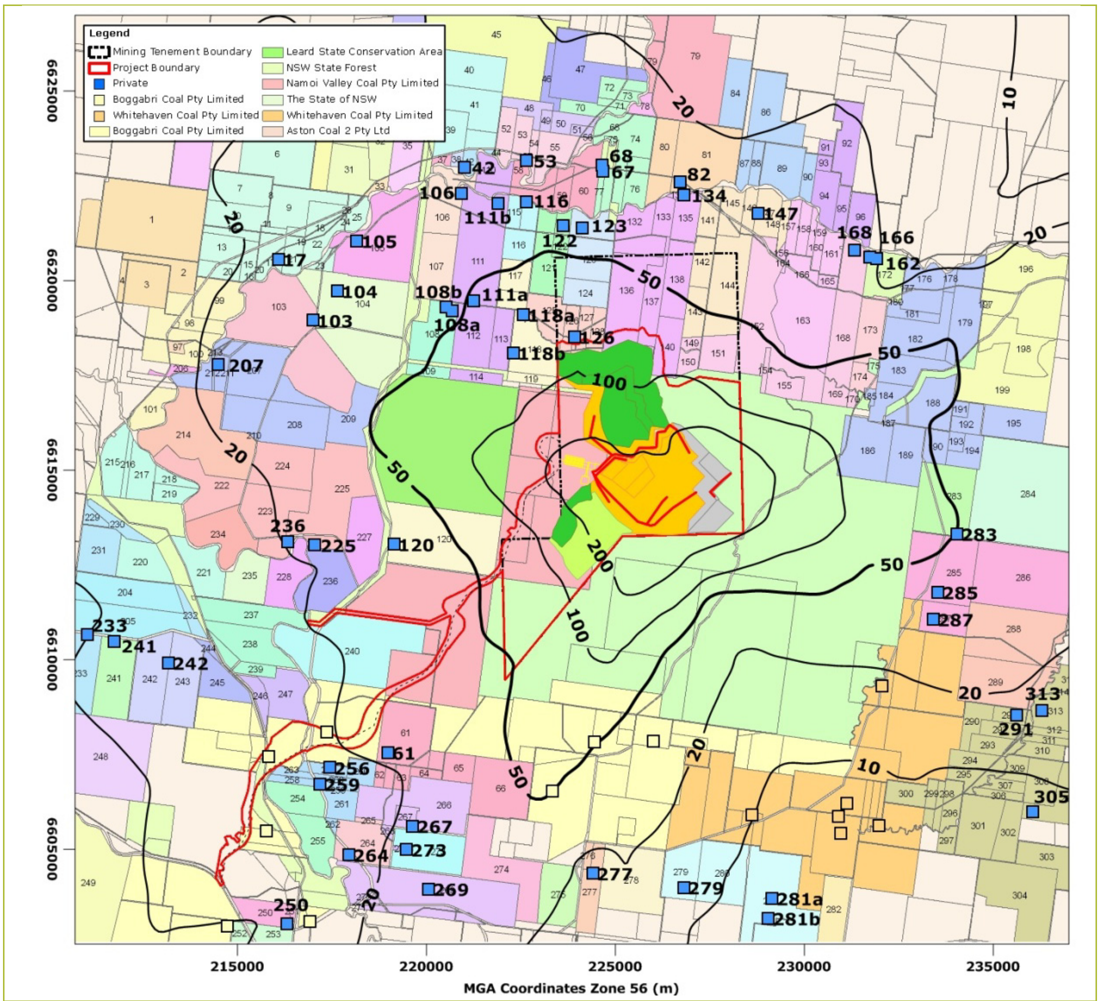
Species: PM10	**Location:** Maules Creek	**Scenario:** Year 10	**Percentile:** Maximum	**Averaging Time:** 24 hour
Model Used: ISCMOD	**Units:** µg/m³	**Guideline:** 50	**Met Data:** CALMET	**Plot:** J. Beaney

Figure 8.2: Model predictions for maximum 24-hour average PM_{10} concentrations: Year 10 - Project in isolation



Species: PM$_{10}$	Location: Maules Creek	Scenario: Year 15	Percentile: Maximum	Averaging Time: 24 hour
Model Used: ISCMOD	**Units:** µg/m^3	**Guideline:** 50	**Met Data:** CALMET	**Plot:** J. Beaney

Figure 8.3: Model predictions for maximum 24-hour average PM$_{10}$ concentrations: Year 15 - Project in isolation



Species:	**Location:**	**Scenario:**	**Percentile:**	**Averaging Time:**
PM_{10}	Maules Creek	Year 21	Maximum	24 hour
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
ISCMOD	$\mu g/m^3$	50	CALMET	J. Beaney

Figure 8.4: Model predictions for maximum 24-hour average PM_{10} concentrations: Year 21 - Project in isolation

A summary of the predicted impacts at each of the individual residences is provided in **Table 8.1**. Those residences that are predicted to experience maximum 24-hour average PM_{10} concentrations above the DECCW criterion of 50 µg/m^3 have been highlighted in bold.

In summary, the following residences are predicted to experience an exceedance of the 24-hour PM_{10} assessment criteria, due to emissions from the Project alone:

- Year 5 – 3 privately owned residences (118a, 118b, 126);
- Year 10 – 6 privately owned residences (108a, 111a, 116, 118a, 118b, 118c, 122 and 126);
- Year 15 – 3 privately owned residences (118a, 118b, 126); and
- Year 21 - 4 privately owned residences (111a, 118a, 118b, 126).

Table 8.1. Maximum predicted 24-hour average PM_{10} concentrations (μg/m^3)

Residence ID	Year 5	Year 10	Year 15	Year 21
17	21	23	22	23
42	32	28	31	27
53	31	46	31	37
61	21	19	19	21
67	27	36	29	31
82	24	22	21	29
103	23	30	23	28
104	27	30	28	30
105	27	33	26	30
106	30	33	30	34
108a	44	**51**	43	46
108b	42	49	41	45
111a	50	**60**	44	**52**
111b	44	42	40	37
116	41	**52**	37	41
118a	**54**	**69**	**59**	**58**
118b	**68**	**80**	**62**	**70**
120	26	32	27	31
122	36	**55**	35	44
123	37	47	35	45
126	**70**	**97**	**58**	**77**
134	26	25	23	30
147	27	35	29	26
162	14	16	16	20
166	13	18	17	21
168	13	23	20	24
207	19	22	21	21
225	16	20	20	23
233	9	10	9	10
236	16	20	17	20
241	10	12	10	10
242	11	14	13	13
250	23	30	23	28
256	14	17	17	18
259	13	16	16	17
264	19	20	18	16
267	35	34	30	22
269	31	35	32	33
273	34	35	32	24
277	18	20	19	17
279	9	10	9	13
281a	4	7	6	8
281b	4	6	6	8
283	33	42	41	50
285	22	29	25	34
287	20	27	24	31
291	14	16	15	18
305	6	8	8	8
313	13	17	15	18

Further analysis was conducted for each residence that is predicted to experience maximum 24-hour average PM_{10} concentrations above the DECCW criteria by identifying the number of days that this is likely to occur.

Table 8.2 summarises the number of days predicted to exceed the 24-hour average PM_{10} concentration at each residence.

Table 8.2: Number of days per year the 24-hour average PM_{10} concentration is predicted to be > 50 µg/m³

Residence ID	Year 5	Year 10	Year 15	Year 21
108a	n/a	1	n/a	n/a
111a	n/a	3	n/a	1
116	n/a	1	n/a	n/a
118a	1	**7**	1	3
118b	**6**	**18**	2	**12**
122	n/a	1	n/a	n/a
126	1	**18**	2	7

It can be seen from **Table 8.2** that there are three residences that are predicted to experience maximum 24-hour average PM_{10} concentrations for more than five days during the year modelled. The predicted impacts during Year 10 of mining operations indicate that this is the worst case year for impacts to air quality, based on the highest number of elevated 24-hour PM_{10} concentrations.

8.1.1 Cumulative 24-hour Average PM_{10} concentrations

It is difficult to predict with any accuracy the cumulative 24-hour PM_{10} concentrations 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 neighbouring mine sites. More accurate operation assumptions can be on an annual average basis and as such provide more accurate predictions.

The difficulties for 24-hour impacts are compounded by the day to day variability in ambient levels and the spatial and temporal variation in any other anthropogenic activity, including mining in the future. Experience shows that the worst-case 24-hour PM_{10} concentrations are strongly influenced by other sources in the area, such as bushfires and dust storms, which are essentially unpredictable. The variability in 24-hour average PM_{10} concentrations can be clearly seen in the data collected at the two HVAS monitors located in the vicinity of Boggabri Coal Mine and Tarrawonga Coal Mine (see **Figure 5.6**).

The DECCW's (2005) "*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*" describes two methods for assessing cumulative air quality impacts (see Section 11.2 of the Approved Methods). The level 1 assessment (suitable for a screening assessment) requires the highest predicted concentration from a proposal is added to the highest observed concentration in a data set which provides measurements of PM_{10} concentrations representative of conditions at the site being assessed. The second method, a Level 2 assessment, provides a more rigorous approach and requires (1) that the highest observed 24-hour PM_{10} concentrations are added to the predicted concentrations at the same days and (2) the highest predicted 24-hour PM_{10} concentrations are added to the observed concentrations for the same days.

Both methods assume that a data set exists that can provide information on 24-hour PM_{10} concentrations representative of the sites being assessed. Some 24-hour PM_{10} monitoring data (collected every sixth day) for the area are available from Boggabri Coal's monitoring program and similar data are available for Tarrawonga.

There are no continuous measurements of PM_{10} available in the Maules Creek area that could be considered "background" (i.e. the ambient concentration due to all other sources including the impact due to the current operations of Boggabri Coal Mine and Tarrawonga Coal Mine). The HVAS monitors located in the vicinity of Boggabri Coal Mine and Tarrawonga Coal Mine would be expected to record higher levels of PM_{10} than would be expected at Maules Creek, due to the increased separation distance from these sources.

There are also no monitoring data that would characterise background in the absence of these other mining operations as the data collected at the Boggabri Coal Mine HVAS and Tarrawonga HVAS is already influenced by existing mining operations. The data collected to date also only considers current operations at Boggabri and does not account for the Boggabri modification project.

However the approach taken for this assessment is to use the monitoring data collected at the Tarrawonga HVAS to characterise background 24-hour PM_{10}, including the contributions of current mining operations at Boggabri and Tarrawonga. These monitoring data would provide a conservatively high indication of background for the residences most influenced by the Maules Creek project, given the separation distances from the mining operations of Boggabri and Tarrawonga. While the current monitoring data do not account for the proposed increase in mining production (i.e. Boggarbri Continuation project) using background data close to the existing mining sources to characterise background air quality for the Maules Creek area located 5 km on the other side of the ridge is considered conservative enough to account for increases in mining into the future. The Tarrawonga HVAS data is presented as this dataset is generally higher and therefore more conservative.

The assessment is also conservative for residences that would be most impacted from the Boggabri continuation. Days when the highest impacts are predicted from Maules Creek will not correspond to days when highest impacts are experienced from Boggabri and Tarrawonga coal mines.

The approach for cumulative 24-hour PM_{10} assessment is to consider the probability that the dust contribution from the Project will occur when background concentrations are sufficiently high to result in cumulative dust concentrations greater than 50 µg/m^3. The probability assessment does not take into account the days when the highest impacts are occurring but rather presents the frequency of occurrence at each resident based on data (modelled and measured) for <u>all</u> days of the year. As the high impact days from Maules Creek will not correspond to highest impact days from Boggabri and Tarrawonga (and high background for all other souces) this approach is considered conservative.

The analysis was completed for the following scenarios, chosen to reflect 4 different scenarios where increment and background levels combined would result in concentrations greater than 50 µg/m^3:

- Probability that the background is greater than or equal to 40 µg/m^{3}AND the predicted impact from modelling is greater than 10 µg/m^3;
- Probability that the background is greater than or equal to 30 µg/m^3 AND the predicted impact from modelling is greater than 20 µg/m^3;
- Probability that the background is greater than or equal to 20 µg/m^3 AND the predicted impact from modelling is greater than 30 µg/m^3; and

- Probability that the background is greater than or equal to 10 μg/m^3 AND the predicted impact from modelling is greater than 40 μg/m^3.

Results are shown for predicted 24-hour PM_{10} concentrations at each residence for only the worst case year of impact, for that resident.

Table 8.3 presents an estimation of the statistical probability that the cumulative impacts would result in a 24-hour average PM_{10} concentration greater than 50 μg/m^3. The results are presented only where the cumulative probability of the 24-hour concentration exceeding 50 μg/m^3 is 1% or greater. The analysis indicates that the residences most likely to experience cumulative 24-hour PM_{10} impacts are those that are already predicted to be impacted from the project alone. There are eight additional residences where there probability of cumulative impacts is greater than 1% (residences 53, 104, 105, 106, 111b, 122, 123 and 281a).

Table 8.3: Probability of Cumulative 24-hour Impacts

ID	Year	Background probability >40	Increment probability >10	Total Cumulative Probability	Background probability >30	Increment probability >20	Total Cumulative Probability	Background probability >20	Increment probability >30	Total Cumulative Probability	Background probability >10	Increment probability >40	Total Cumulative Probability
R53	Y10	4.4%	24.5%	**1.1%**	13.8%	2.7%	**0.4%**	29.3%	0.3%	**0.1%**	60.2%	0.3%	**0.2%**
R104	Y10	4.4%	23.9%	**1.1%**	13.8%	2.5%	**0.3%**	29.3%	0.3%	**0.1%**	60.2%	0.0%	**0.0%**
R105	Y10	4.4%	29.4%	**1.3%**	13.8%	6.3%	**0.9%**	29.3%	1.1%	**0.3%**	60.2%	0.0%	**0.0%**
R106	Y21	4.4%	29.7%	**1.3%**	13.8%	4.4%	**0.6%**	29.3%	0.3%	**0.1%**	60.2%	0.0%	**0.0%**
R108a	Y10	4.4%	48.4%	**2.1%**	13.8%	24.2%	**3.3%**	29.3%	6.9%	**2.0%**	60.2%	2.7%	**1.7%**
R108b	Y10	4.4%	48.1%	**2.1%**	13.8%	22.3%	**3.1%**	29.3%	6.0%	**1.8%**	60.2%	2.7%	**1.7%**
R111a	Y10	4.4%	53.0%	**2.3%**	13.8%	26.1%	**3.6%**	29.3%	9.3%	**2.7%**	60.2%	2.7%	**1.7%**
R111b	Y5	4.4%	25.8%	**1.1%**	13.8%	2.2%	**0.3%**	29.3%	0.3%	**0.1%**	60.2%	0.3%	**0.2%**
R116	Y10	4.4%	34.6%	**1.5%**	13.8%	4.7%	**0.6%**	29.3%	0.8%	**0.2%**	60.2%	0.3%	**0.2%**
R118a	Y10	4.4%	31.6%	**1.4%**	13.8%	4.9%	**0.7%**	29.3%	0.8%	**0.2%**	60.2%	0.0%	**0.0%**
R118b	Y10	4.4%	62.4%	**2.8%**	13.8%	34.6%	**4.8%**	29.3%	15.9%	**4.7%**	60.2%	5.5%	**3.3%**
R122	Y10	4.4%	37.1%	**1.6%**	13.8%	8.2%	**1.1%**	29.3%	1.9%	**0.6%**	60.2%	0.5%	**0.3%**
R123	Y10	4.4%	33.5%	**1.5%**	13.8%	7.7%	**1.1%**	29.3%	1.4%	**0.4%**	60.2%	0.8%	**0.5%**
R126	Y10	4.4%	9.6%	**0.4%**	13.8%	3.0%	**0.4%**	29.3%	28.3%	**8.3%**	60.2%	12.1%	**7.3%**
R281a	Y21	4.4%	100.0%	**4.4%**	13.8%	100.0%	**13.8%**	29.3%	100.0%	**29.3%**	60.2%	100.0%	**60.2%**

8.1.2 Long-Term (Annual Average) PM_{10} Impacts

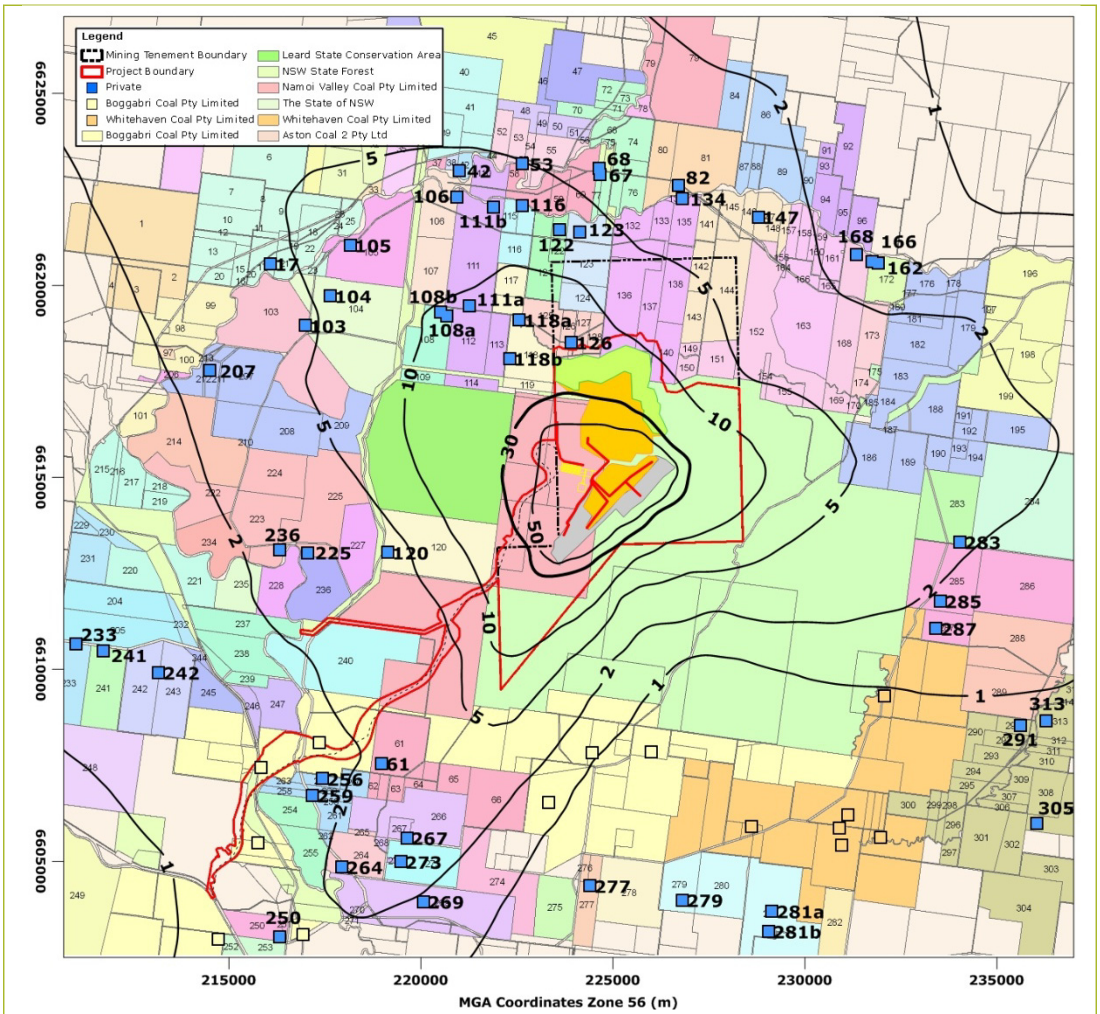
The predicted impacts contribution of the Project alone for annual average PM_{10} concentrations are presented in **Figure 8.5** through **Figure 8.8** for each modelled year. The cumulative results are presented in **Figure 8.9** through **Figure 8.12** and assessed against the DECCW criterion for annual average PM_{10} concentration is 30 µg/m^3. The model predictions for annual average PM_{10} concentrations have also been presented in **Table 8.4**.

A summary of the predicted impacts for annual average PM_{10} concentrations that are likely to be experienced is provided below.

There are no private or mine-owned residences predicted to experience annual average PM_{10} concentrations above the DECCW goal of 30 µg/m^3 for the operation of the Project alone.

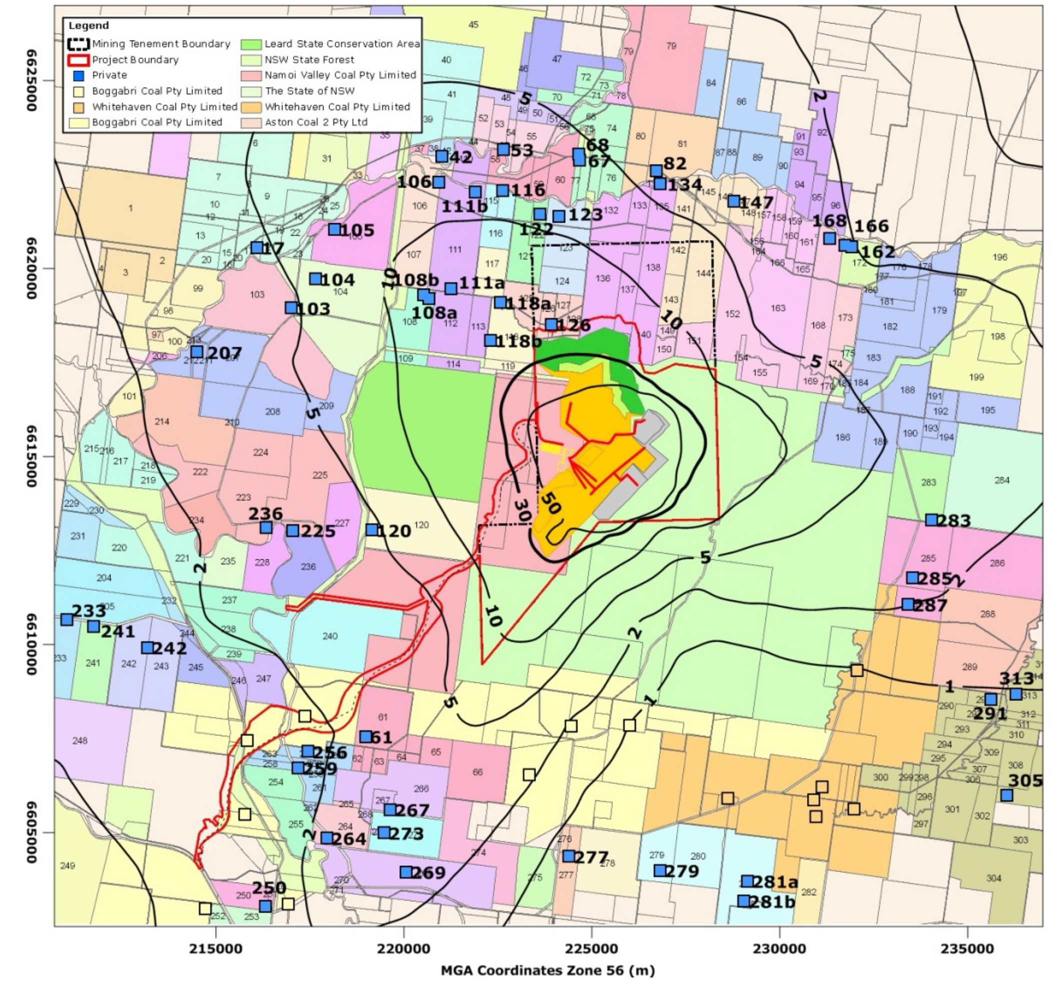
When the contribution of other mining activity (including the Boggabri Continuation Project and the Tarrawonga Modification) are added along with a background for all other sources, the following residences are predicted to be impacted.

- Year 5 – one privately owned residence (118b);
- Year 10 – three privately owned residences (118a, 118b and 126);
- Year 15 – two privately owned residences (118b and 126); and
- Year 21 - two privately owned residences (118b and 126).



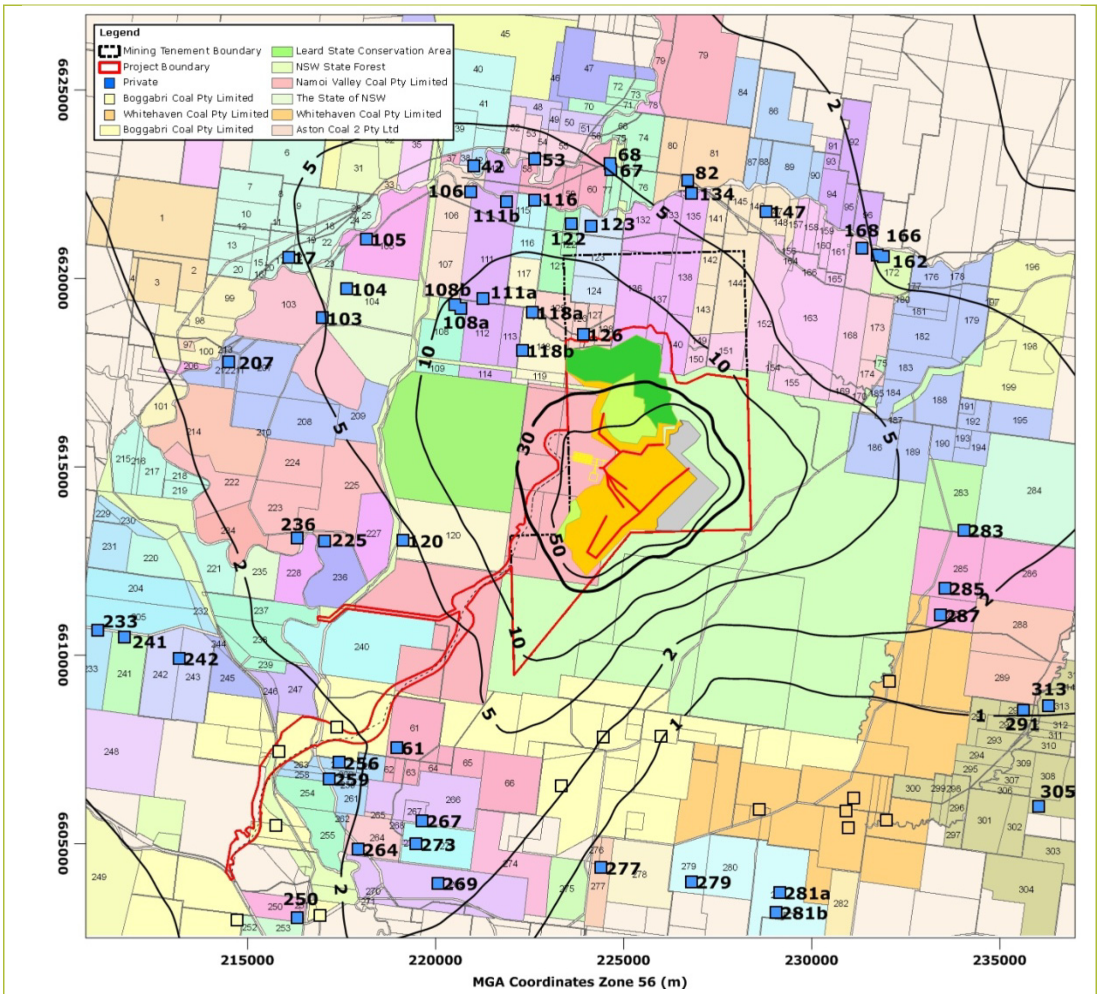
Species:	Location:	Scenario:	Percentile:	Averaging Time:
PM_{10}	Maules Creek	Year 5	-	Annual
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
ISCMOD	µg/m^3	-	CALMET	J. Beaney

Figure 8.5: Model predictions for annual average PM_{10} concentrations: Year 5 - Project in isolation



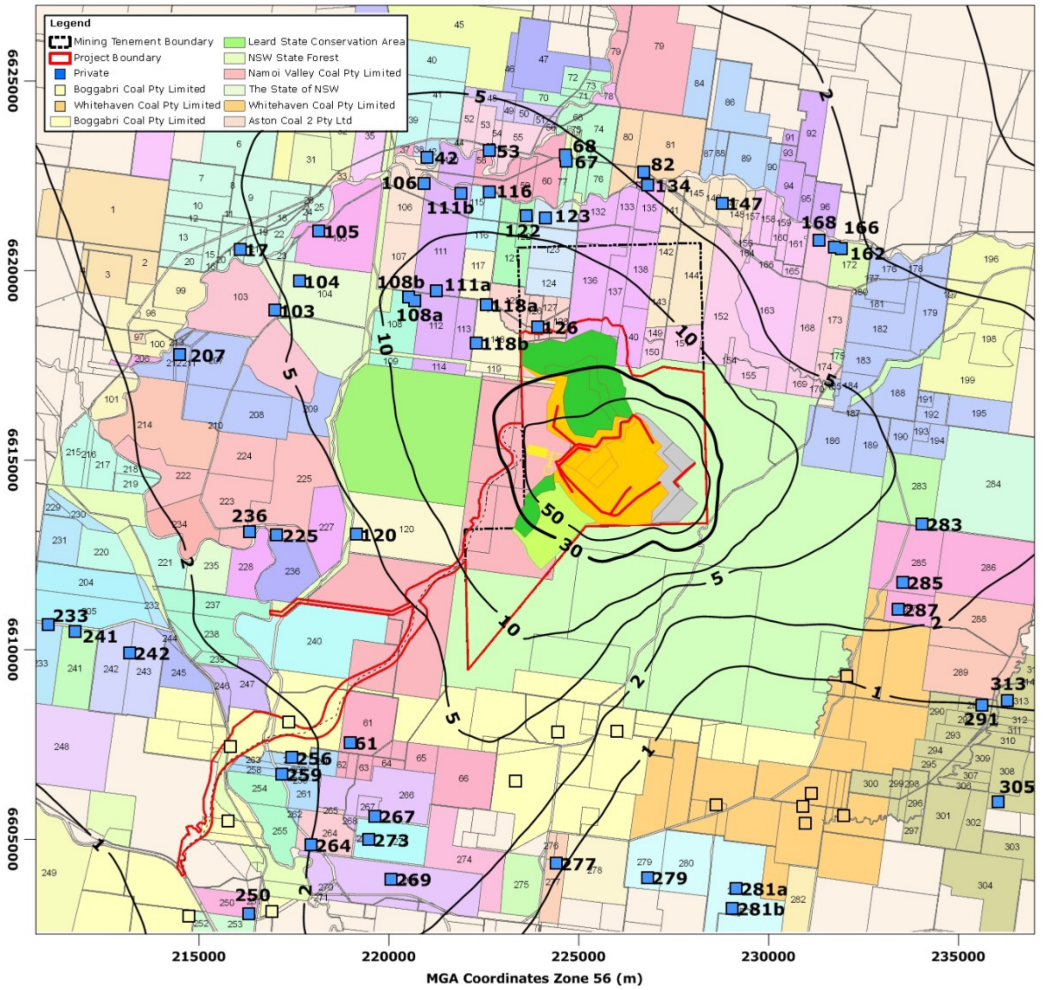
Species:	Location:	Scenario:	Percentile:	Averaging Time:
PM_{10}	Maules Creek	Year 10	-	Annual
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
ISCMOD	$\mu g/m^3$	-	CALMET	J. Beaney

Figure 8.6: Model predictions for annual average PM_{10} concentrations: Year 10 - Project in isolation



Species:	Location:	Scenario:	Percentile:	Averaging Time:
PM_{10}	Maules Creek	Year 15	-	Annual
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
ISCMOD	$\mu g/m^3$	-	CALMET	J. Beaney

Figure 8.7: Model predictions for annual average PM_{10} concentrations: Year 15 - Project in isolation



Species: PM$_{10}$	Location: Maules Creek	Scenario: Year 21	Percentile: -	Averaging Time: Annual
Model Used: ISCMOD	**Units:** µg/m^3	**Guideline:** -	**Met Data:** CALMET	**Plot:** J. Beaney

Figure 8.8: Model predictions for annual average PM$_{10}$ concentrations: Year 21 – Project in isolation