PROJECT CHINA STONE

Air Quality Report

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Air Quality and Greenhouse Gas Assessment for Project China Stone

Prepared for

Hansen Bailey

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Glossary

Term	Definition
$\mu g/m^3$	micrograms per cubic metre
µm	microns
°C	degrees Celsius
CO	Carbon monoxide
CO_2	Carbon dioxide
km	kilometre
km/h	kilometre per hour
m	metre
m/s	metres per second
m^2	square metres
m^3	cubic metres
m^3/s	cubic metres per second
mg	milligram
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
SO_2	Sulfur dioxide
t	tonnes
tpa	tonnes per annum
Nomenclature	
ou	Odour units
PM	Particulate matter (fine dust)
$PM_{2.5}$ and PM_{10}	Particulate matter less than 2.5 or 10 microns, respectively
TSP	Total suspended particles
VOC	Volatile organic compounds
Abbreviations	
EHP	Department of Environment and Heritage Protection
EA	Environmental Authority
EM Plan	Environmental Management Plan
ML	Mine Lease
NPI	National Pollutant Inventory
US EPA	United States Environmental Protection Agency

1. INTRODUCTION

Katestone Environmental Pty Ltd (Katestone) was commissioned by Hansen Bailey on behalf of MacMines Austasia Pty Ltd (the proponent) to complete an air quality and greenhouse gas impact assessment as part of the Environmental Impact Statement (EIS) for Project China Stone (the project).

The project involves the construction and operation of a large-scale coal mine on a greenfield site in Central Queensland. The project site (the area that will ultimately form the mining leases for the project) is remote, being located approximately 270 km south of Townsville and 300 km west of Mackay at the northern end of the Galilee Basin (Figure 1). The closest townships are Charters Towers, approximately 285 km by road to the north, and Clermont, approximately 260 km by road to the south-east. The project site comprises approximately 20,000 ha of well vegetated land, with low-lying scrub in the south and east and a densely vegetated ridgeline, known as 'Darkies Range', running north to south through the western portion of the site.

The mine will produce up to approximately 55 million tonnes per annum (Mtpa) of Run of Mine (ROM) thermal coal. Coal will be mined using both open cut and underground mining methods (Figure 2). Open cut mining operations will involve multiple draglines and truck and shovel pre-stripping. Underground mining will involve up to three operating longwalls. Coal will be washed and processed on site and product coal will be transported from site by rail. It is anticipated that mine construction will commence in 2016 and the mine life will be in the order of 50 years.

The majority of the mine infrastructure will be located in the eastern portion of the project site (Figure 2). Infrastructure will include coal handling and preparation plants (CHPPs), stockpiles, conveyors, rail loop and train loading facilities, workshops, dams, tailings storage facility (TSF) and a power station. A workforce accommodation village and private airstrip will also be located in the eastern part of the project site.

The scope of this air quality and greenhouse gas impact assessment is restricted to assessing activities that are proposed to be undertaken within the project site and no off-lease activities are considered in this assessment.

Figure 1 Project location

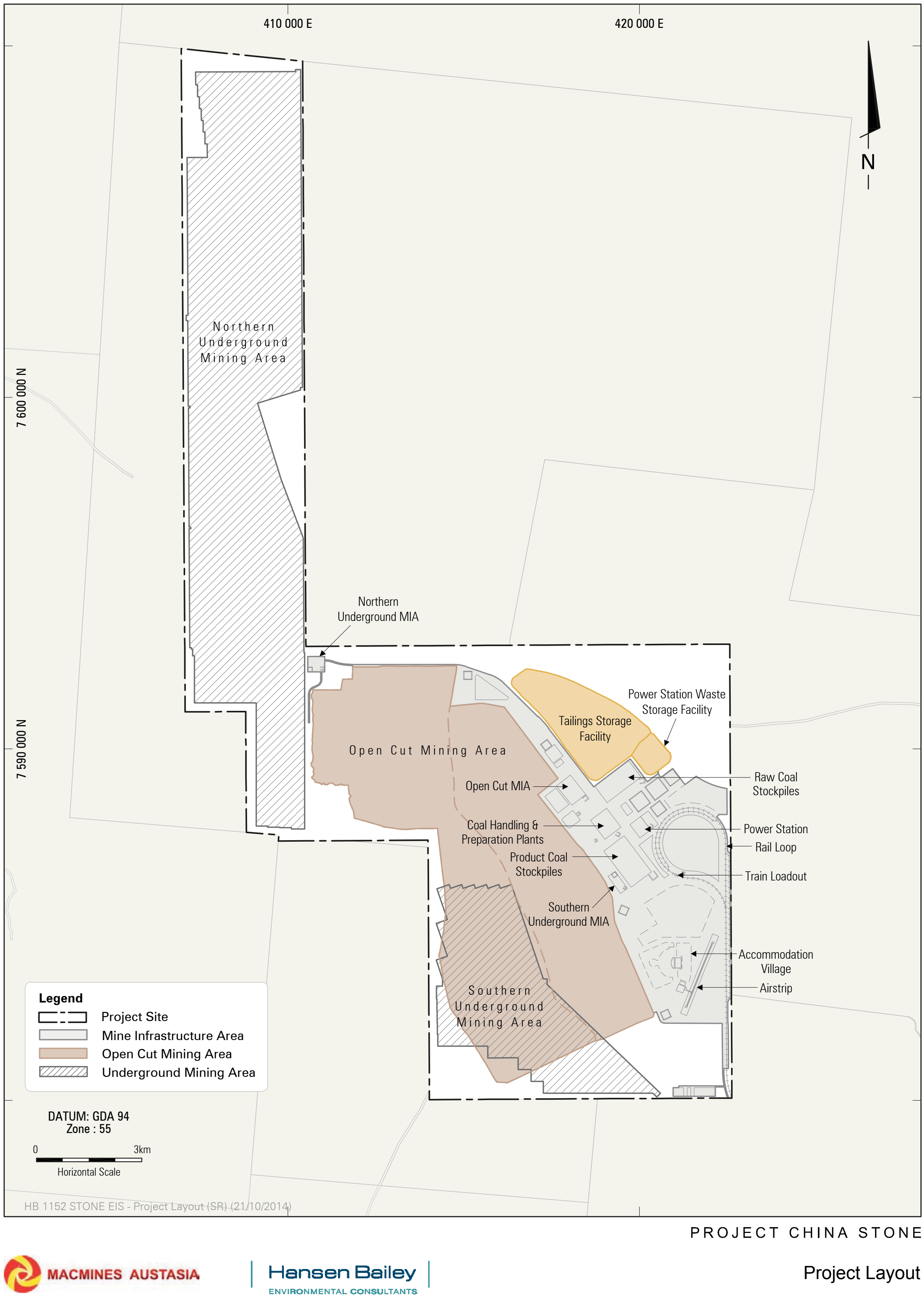

Figure 2 **Project layout**

1.1 Scope of works

The purpose of this assessment is to:

- Describe the current climate in the region including meteorology and air quality;
- Evaluate the impacts of the project on the surrounding environment and existing air quality;
- Evaluate the cumulative air quality impacts of the project and currently proposed and approved mining projects;
- Compare results of the assessment with relevant air quality objectives; and
- Assess the greenhouse gas emissions associated with the project.

This study summarises the aspects of the project that may result in emissions to the atmosphere, as well as the legislation, policies and guidelines that are relevant to the assessment and management of air emissions in Queensland and Australia. The key emissions to the atmosphere from the mining operations are dust and greenhouse gases. The key emissions to the atmosphere from the power station are nitrogen dioxide (NO_2), particulate matter less than 10 microns (PM_{10}) and greenhouse gases.

Dust emissions will occur as a result of construction and operation of the mine. Elevated levels of dust can adversely impact the amenity and health of people living in the vicinity. Dispersion modelling has been conducted to estimate ground-level concentrations of air pollutants associated with the project for assessment against amenity and health objectives.

A greenhouse gas assessment for the project has also been conducted. The greenhouse gas assessment includes a discussion of the relevant legislation, the methodology for the assessment, the estimated greenhouse gas emissions and mitigation strategies.

2. CONSIDERATIONS FOR ASSESSING EMISSIONS TO THE ATMOSPHERE

2.1 Air quality legislation and objectives

The potential for adverse health effects is typically assessed by comparing airborne concentrations of dust with air quality objectives. Annoyance and nuisance caused by soiling of surfaces can be difficult to quantify. This is because the perceived level of annoyance depends on physical and social factors. Community surveys have been used to develop the annoyance thresholds that are currently recognised in Queensland.

The *Environmental Protection Act 1994* (EP Act) provides for the management of the air environment in Queensland. The EP Act gives the Minister of the Department of Environment and Heritage Protection (EHP) the power to create Environmental Protection Policies that identify, and aim to protect, environmental values of the atmosphere that are conducive to the health and well-being of humans and biological integrity. The *Environmental Protection (Air) Policy 2008* (Air EPP) was established under the EP Act and contains a range of air quality objectives. The administering authority must consider the requirements of the Air EPP when it decides an application for an environmental authority (EA). Schedule 1 of the Air EPP specifies air quality objectives for various pollutants including total suspended particulates (TSP), PM_{10} and particulate matter less than 2.5 microns ($PM_{2.5}$), which are reproduced in Table 1. These objectives have been adopted for the project to ensure that air quality is maintained at levels that minimise the risk of adverse health impacts due to fine suspended dust in ambient air.

Dust nuisance can occur due to the deposition of larger dust particles in residential areas. Dust nuisance can be in the form of reduced public amenity, as an example through soiling of clothes, building surfaces and other surfaces. Table 1 includes the dust deposition criteria of the EHP Model Mining Conditions. The dust deposition guideline is not defined in the Air EPP.

Table 1 Ambient air quality objectives relevant to mine operations

Indicator	Environmental value	Averaging period	Air quality objective
Particulates in the form of $PM_{2.5}$	Health and wellbeing	24-hour	25 µg/m³
		1-year	8 µg/m³
Particulates in the form of PM_{10}	Health and wellbeing	24-hour [a]	50 µg/m³
Total suspended particulates	Health and wellbeing	1-year	90 µg/m³
Dust deposition rate	Amenity	1-month	120 mg/m²/day

Note
[a] Five days per year allowed to exceed the objective

The combustion of coal in the power station will also produce emissions of air pollutants in addition to particulate matter. Table 2 presents the relevant air quality objectives for individual air pollutants relevant to the combustion of coal.

Not all air pollutants that are generated by a coal-fired power station are recognised as indicators under the Air EPP. It is common practice to consider, and where appropriate adopt, impact assessment criterion for air quality indicators from another jurisdiction if an objective is not defined in the Air EPP. Accordingly, impact assessment criteria from the following guidelines and standards have been adopted:

- *Approved methods for the modelling and assessment of air pollutants in New South Wales* (NSW) (NSW DEC, 2005)
- *Texas Commission on Environmental Quality Effects Screening Levels 2009* (TCEQ, 2009) Ontario Ministry of the Environment, Ambient Air Quality Criteria, 2008 (OME, 2008)

Table 2 Ambient air quality objectives relevant to power station operations (Air EPP except where stated)

Indicator	Environmental value	Averaging period	Air quality objective
Arsenic and compounds	Health and wellbeing	Annual	6 ng/m³
Beryllium and compounds	Health and wellbeing	1-hour	4 ng/m³
Boron and compounds	Health and wellbeing	1-hour [a]	50 µg/m³
	Health and wellbeing	Annual [a]	5 µg/m³
Cadmium and compounds	Health and wellbeing	Annual	5 ng/m³
Chromium (III) and compounds	Health and wellbeing	1-hour [b]	9 µg/m³
Chromium (VI) and compounds	Health and wellbeing	1-hour [b]	0.09 µg/m³
Cobalt and compounds	Health and wellbeing	1-hour [a]	0.2 µg/m³
	Health and wellbeing	24-hour [c]	0.1 µg/m³
	Health and wellbeing	Annual [a]	0.02 µg/m³
Copper and compounds (dust)	Health and wellbeing	1-hour [b]	18 µg/m³
Copper and compounds (fumes)	Health and wellbeing	1-hour [b]	3.7 µg/m³
Cumene	Health and wellbeing	1-hour [b]	21 µg/m³
Carbon monoxide (CO)	Health and wellbeing	8-hour	11 mg/m³
Fluoride and compounds	Health and biodiversity of ecosystems (other than protected areas)	24-hour	2.9 µg/m³
		30-day	0.84 µg/m³
		90-day	0.5 µg/m³
	Health and biodiversity of ecosystems (for protected areas)	90-day	0.1 µg/m³
	Protecting agriculture	24-hour	1.5 µg/m³
		30-day	0.4 µg/m³
		90-day	0.25 µg/m³
Lead and compounds	Health and wellbeing	Annual [b]	0.5 µg/m³
Manganese and compounds	Health and wellbeing	Annual	0.16 µg/m³
Mercury and compounds (organic)	Health and wellbeing	1-hour [b]	0.18 µg/m³
Mercury and compounds (inorganic)	Health and wellbeing	1-hour [b]	1.8 µg/m³
Nickel and compounds	Health and wellbeing	Annual	20 ng/m³
Nitrogen dioxide (NO_2)	Health and wellbeing	1-hour	250 µg/m³
		Annual	62 µg/m³
	Health and biodiversity of ecosystems	Annual	33 µg/m³
Sulfuric acid	Health and wellbeing	1-hour [b]	18 µg/m³

Indicator	Environmental value	Averaging period	Air quality objective
Sulfur dioxide (SO_2)	Health and wellbeing	1-hour	570 µg/m³
		24-hour	230 µg/m³
		Annual	57 µg/m³
	Protecting agriculture	Annual	32 µg/m³
	Health and biodiversity of ecosystems (for forests and natural vegetation)	Annual	22 µg/m³
Zinc and compounds (zinc chloride fumes)	Health and wellbeing	1-hour [b]	18 µg/m³
Zinc and compounds (zinc oxide fumes)	Health and wellbeing	1-hour [b]	90 µg/m³
a Objective from TCEQ 2009 b Objective from NSW DEC 2005 c Objective from OME 2008			

2.2 Crops, agriculture and ecosystems

The dust deposition guideline that is recommended by the EHP and referred to in previous sections has been determined on the basis of avoiding nuisance in residential areas and consequently is not relevant as a threshold for avoiding adverse impacts on plants and animals. However, studies have shown that the threshold for avoiding nuisance in residential areas is significantly stricter than that required to avoid adverse impacts on plants and animals.

The project is located within an area used for cattle grazing. The effects of coal dust on cattle productivity has been the focus of a study undertaken at the University of Western Sydney (Andrews *et al*., 1992), which found that:

- Cattle did not find feed unpalatable if coal mine dust was present at a level equivalent to a dust deposition rate of 4,000 mg/m^2/day;
- The presence of coal mine dust in feed did not affect the amount of feed that the cattle ate at a level equivalent to a dust deposition rate of 4,000 mg/m^2/day; and
- When the cattle were able to choose between feed that was free of coal mine dust, feed that contained 4,000 mg/m^2/day of coal mine dust, and feed that contained 8,000 mg/m^2/day of coal mine dust, the cattle did not preferentially eat feed that did not contain coal mine dust.

These results demonstrate no effects upon cattle productivity at dust deposition rates an order of magnitude greater than the dust deposition guideline adopted for this assessment (Table 1). Therefore, adopting the dust deposition guideline is a conservative approach for cattle grazing.

The majority of dust generated by the mine will be associated with crustal matter and is not toxic to flora or fauna. Any dust deposited on leaves and vegetation would be periodically removed by wind, morning dew and rainfall. The effects of dust on plant growth have been studied extensively (NSW Minerals Council, 2000 and Lodge *et al.*, 1981) and these studies have consistently shown that dust at the levels associated with mining has no effect on growth.

2.3 Visibility

The Air EPP does not specify an objective to protect against dust levels that may cause a hazard because of their visibility. An example of a hazard might be a thick dust plume that travels across a roadway that hampers a driver's ability to see oncoming traffic. In general it is expected that the health and amenity objectives specified in the Air EPP will also protect against the problems associated with visible dust because, at levels equivalent to the Air EPP objectives, dust is essentially invisible. Further detail on visibility is provided in Section 6.10.

2.4 Odour

Underground coal mines are ventilated to ensure that coal seam gases do not build up and become hazardous. At some coal mines in the Hunter Valley in NSW, the ventilation air from underground coal mines has been investigated as a possible source of odour annoyance at residential areas nearby.

The EP Act places a general environmental duty on a person carrying out an activity that causes, or is likely to cause, environmental harm to take all reasonable and practicable measures to prevent or minimise the harm. Under the EP Act, environmental harm includes nuisance potentially associated with odorous emissions.

The EHP has published odour guidelines (EPA, 2004) that define its expectations in relation to odour including generic criteria in terms of odour units (ou) for assessing odour annoyance using dispersion modelling. The guideline defines generic criteria for assessing odour annoyance as follows:

- 0.5 ou for a 1-hour average, 99.5^{th} percentile concentration for tall stacks; and
- 2.5 ou for a 1-hour average, 99.5^{th} percentile concentration for ground-level sources and downwashed plumes from short stacks.

Mine ventilation sources are typically approximately 2 m high. Consequently, an odour performance criterion of 2.5 ou, 99.5^{th} percentile for a 1-hour average is relevant.

2.5 Stack emission limits

Industrial stack emissions are commonly regulated in Queensland through the application of emission limits in EA conditions that apply in the stack prior to the point of discharge to the atmosphere. The Queensland Government has not enacted legislation that specifies generic emission limits for any industries in Queensland. Stack emission limits are usually determined on a case-by-case basis from the information provided by a proponent during an EIS or other approvals process. The EHP may also consider legislation in force in other Australian jurisdictions as a means of determining appropriateness of proposed emission limits.

In NSW, generic emission limits are applied on an industry and/or activity basis through Section 128 of the *Protection of the Environment Operations Act (1997)* (POEO Act). Under this section, licensed premises in NSW are required to comply with any air emissions standards prescribed by regulation. One regulation relating to air emissions has been made under the POEO Act; the *Protection of the Environment Operations (Clean Air) Regulation 2010* (Clean Air Regulation).

The concentration limits for electricity generation are reproduced from the Clean Air Regulation in Table 3. The emission concentration limits are the maximum emissions permissible for an industrial source anywhere in NSW.

The emission concentration limits are divided into six groups based on the age of the installation. Stricter emission concentration limits are applied to newer installations to account for improved abatement technologies. The project's power station falls under Group 6 that applies to all installations commencing operations after 1 September 2005.

Table 3 NSW stack emissions concentration limits for coal-fired power plant associated with electricity generation

Air impurity	Activity or plant	Standard of concentration
Nitrogen dioxide (NO_2) or nitric oxide (NO) or both, as NO_2 equivalent	Any boiler operating on a fuel other than gas, including a boiler used in connection with an electricity generator that forms part of an electricity generating system with a capacity of 30 MW or more	500 mg/Nm³
Carbon monoxide (CO), as a marker for VOCs	Any activity or plant using a non-standard fuel	125 mg/Nm³
Solid particles (total)	Any activity or plant using a liquid or solid standard fuel or a non-standard fuel	50 mg/Nm³
Table note: Reference conditions: Dry, 273 K, 101.3 kPa, 7% oxygen content		

2.6 Greenhouse gases

A greenhouse gas assessment has been undertaken for the project in accordance with relevant legislation. The approach to the greenhouse gas assessment and results are presented in Section 9.

3. AIR QUALITY IMPACT ASSESSMENT METHODOLOGY

This air quality assessment was conducted in accordance with recognised techniques for dispersion modelling and emission estimation. The air quality assessment is based on a dispersion modelling study that incorporates source characteristics and air pollution emission rates, local meteorology, terrain, land use and the geographical location of sensitive receptors.

3.1 Meteorology

The meteorological data for this study was generated by coupling TAPM (version 4.0.5), a prognostic mesoscale model, to CALMET (version 6.334), a diagnostic meteorological model. The coupled methodology for the TAPM/CALMET modelling system was developed by Katestone to enable high resolution modelling capabilities for regulatory and environmental assessments. The modelling system can incorporate synoptic, mesoscale and local atmospheric conditions, detailed topography and land use categorisation schemes to simulate synoptic and regional scale meteorology for input into pollutant dispersion models, such as CALPUFF.

The meteorological model simulation was run for the year 2007. Further details of the model configuration and output are supplied in Appendix A. An evaluation of the model output was not possible due to the absence of detailed meteorological monitoring data in the region.

3.2 Emissions

3.2.1 Coal mine

Emission rates of dust associated with the underground and open cut coal mining areas were estimated accounting for proposed emission controls using emission factors published in authoritative sources, including the National Pollutant Inventory (NPI) Emission Estimation Technique (EET) handbooks or the USEPA AP42 Emission Estimation Manuals (USEPA, 1998; USEPA, 2004; USEPA, 2006; NPI, 2012). Operating parameters, such as stockpile dimensions and location of equipment, were based on information supplied by the proponent, as detailed in Appendix B. Details of the methodology and the emission factors used for estimating dust emissions are provided in Appendix C.

Section 5.2.1 provides a comprehensive discussion of the sources of dust that were included in the dust assessment.

Emission rates of dust from the project have been conservatively estimated and this is attributed to the following:

- Studies of dust emission rates at several Queensland coal terminals have shown that the USEPA AP42 emission factor equations that have been used can overestimate the emission rates from raw coal processing;
- It was assumed that conveyors would operate continuously, which is unlikely to occur in practice;
- The ROM, raw and product coal stockpiles have been assumed to be full to capacity at all times. Whilst this is a theoretical possibility, it will rarely occur in practice; and
- The coal stockpiles will, in practice, shelter bulldozing (within the ROM coal stockyard) and stockpiling operations from the wind and prevent some of the dust emissions. The sheltering effect of stockpiles has not been accounted for in the emission estimates.

3.2.2 Power station

Emissions from the power station have been estimated assuming the plant will be designed and operated to meet the NSW emission limits for oxides of nitrogen (as NO_2), particulate matter and carbon monoxide (CO). Emissions of other pollutants including sulfur dioxide and metals have been based on the NPI EET handbook for fossil fuel electric power generation (NPI, 2012). These emissions have been based on analysis of samples of the project coal by ALS (ALS, 2013) and accounting for the proposed emission control measures. Details of the inputs to the emission calculations are provided in Appendix C. Section 5.3.2 provides all emission rates used in the assessment.

3.2.3 Vehicle traffic

Small quantities of air pollutants such as oxides of nitrogen, carbon monoxide and sulfur dioxide may also be emitted from vehicle traffic within the project site. The emission rates of these air pollutants from vehicles are extremely low compared to the emission rates of these air pollutants from the power station and will be accounted for in the background concentrations of these pollutants used in the assessment. Therefore, these air pollutants do not require further assessment.

3.3 Dispersion modelling

The dispersion modelling of emissions from the mine and power station has been undertaken using the CALPUFF dispersion model. The CALPUFF model utilises the three-dimensional wind fields from CALMET to simulate the dispersion of air pollutants to predict ground-level concentrations across a gridded domain. CALPUFF is a non-steady-state Lagrangian Gaussian puff model containing parameterisations for complex terrain effects, overwater transport, coastal interaction effects, building downwash, wet and dry removal, and simple chemical transformation. CALPUFF employs the three dimensional meteorological fields generated from the CALMET model by simulating the effects of time and space varying meteorological conditions on pollutant transport, transformation and removal. CALPUFF contains algorithms that can resolve near-source effects such as building downwash, transitional plume rise, partial plume penetration, sub-grid scale terrain interactions, as well as the long range effects of removal, transformation, vertical wind shear, overwater transport and coastal interactions. Emission sources can be characterised as arbitrarily-varying point, area, volume and lines or any combination of those sources within the modelling domain.

The model has been adopted by the US EPA in its guideline on air quality models (40 CFR, Part 51, Appendix W) as the preferred model for assessing long range transport of pollutants and on a case-by-case basis for certain near-field applications involving complex meteorological conditions. CALPUFF is accepted for use by the EHP for modelling of air pollutants emitted from mining and power stations. The EHP accepts CALPUFF along with models such as AUSPLUME, ISC and others for use in similar projects in Queensland. This is consistent with the requirements of other environmental jurisdictions throughout Australia.

Details of the CALPUFF model configuration are provided in Appendix A.

3.4 Limitations of dispersion modelling

This study necessarily relies on the accuracy of a number of data sets including, but not limited to:

- Meteorological information;
- Calculation of emission rates from mining activities; and
- Analysis and representativeness of coal samples.

Where uncertainty exists in important properties of the proposed activities within the project or the environment, this assessment has erred on the side of caution and selected inputs that would provide for overestimates of ground-level concentrations of air pollutants. A number of assumptions have been applied.

It is important to note that numerical models are based on an approximation of governing equations and will inherently be associated with some degree of uncertainty. The more complex the physical model, the greater the number of physical processes that must be included.

There will be physical processes that are not explicitly accounted for in the model and, in general, these approximations tend to lead to an over prediction of air pollutant levels. For example, in the real world when a plume of dust reaches an area of sloping terrain, mass from the plume will be removed through impaction on the surface. In a dust model, however, the dust plume is treated as a gas and the plume will pass over or around the obstacle with no loss of mass. This difference in characterisation can lead to an over prediction of dust levels downwind from the source.

3.5 Presentation of results

Modelling results have been presented as ground-level concentrations or dust deposition rates at sensitive receptors as well as contours across the modelling domain.

4. EXISTING ENVIRONMENT

The existing environment in the region surrounding the project is discussed in this section. Important aspects of the existing environment in the region include existing sources of air pollutants, the location of sensitive receptors and proximity to activities producing air pollutants, geographical features, climate and meteorological conditions.

4.1 Climate and meteorology

There is little meteorological monitoring data available for the region immediately surrounding the project site. There are four Bureau of Meteorology (BoM) monitoring stations within approximately 50 km of the centre of the project site which record rainfall – these are Ronlow Park (~30 km to the west), Carmichael (~12 km southwest), Ulcanbah (~25 km southwest) and Bulliwallah (~43 km east-northeast). However, there are no currently operating monitors that record other important parameters within 150 km of the project site. Meteorological monitoring data from the BoM stations at Emerald and Clermont have been used to characterise the long-term regional climate of the project site for parameters other than rainfall.

The Emerald and Clermont BoM monitoring stations are located approximately 280 km to the southeast and 180 km to the southeast of the project site, respectively. The most complete available climatic data has been analysed for the stations at Clermont (1910 to 2011) and Emerald (1992 to 2013).

Central Queensland has a climate characterised by high variability in rainfall, temperature and evaporation. The region experiences droughts, floods, heatwaves and frosts. In general, winter days are warm and nights are cool, while summer days are hot and nights are warm. Rainfall is summer dominant with half of the average annual rainfall occurring from December to February due to storms and tropical lows associated with cyclones.

In general, it is under hot, dry and windy conditions where dust emissions from mining activities have the highest potential to adversely impact on air quality away from their point of release. In relation to power station emissions released from a tall stack, convective atmospheric conditions are most critical. Convective conditions are characterised by a highly unstable atmosphere that occurs due to heating by solar radiation. As the depth of the mixing layer grows above the height of stack, convection can bring the plume to ground, leading to high concentrations. Under stable conditions a buoyant plume will remain elevated and is unlikely to impact at ground level.

The meteorological parameters that may lead to these conditions are summarised in the following sections.

4.1.1 Temperature

The average daily maximum and minimum temperatures at the monitoring stations are presented in Table 4 for each month and in Figure 3. The analysis identifies a seasonal temperature profile typical of the Central Queensland climate, with cooler winter months of June, July and August and warmer summer months of December, January and February.

The maximum monthly-average daily maximum temperatures at the Clermont and Emerald BoM monitoring stations are 34.8°C (December) and 34.3°C (January), respectively. The minimum monthly-average daily minimum temperatures at the Clermont and Emerald monitoring stations are 6.7°C (July) and 8.8°C (July), respectively.

Table 4 **Average minimum and maximum daily temperature in Clermont and Emerald by month (°C)**

Mean maximum temperature													
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Clermont[1]	34.3	33.0	32.0	29.5	26.1	23.1	23.1	25.3	28.8	31.9	33.9	34.8	29.7
Emerald[2]	34.3	33.4	32.6	29.8	26.1	23.2	23.1	25.3	28.9	31.6	33.2	34.2	29.6
Mean minimum temperature													
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Clermont[1]	21.6	21.1	19.4	15.7	11.4	8.1	6.7	8.3	12.1	16.3	19.0	20.8	15.0
Emerald[2]	22.2	22.0	20.2	16.9	12.9	10.1	8.8	10.0	13.5	17.0	19.4	21.3	16.2

Note

[1] Averages based on recording period : 1910 – 2011

[2] Averages based on recording period : 1992 – 2013

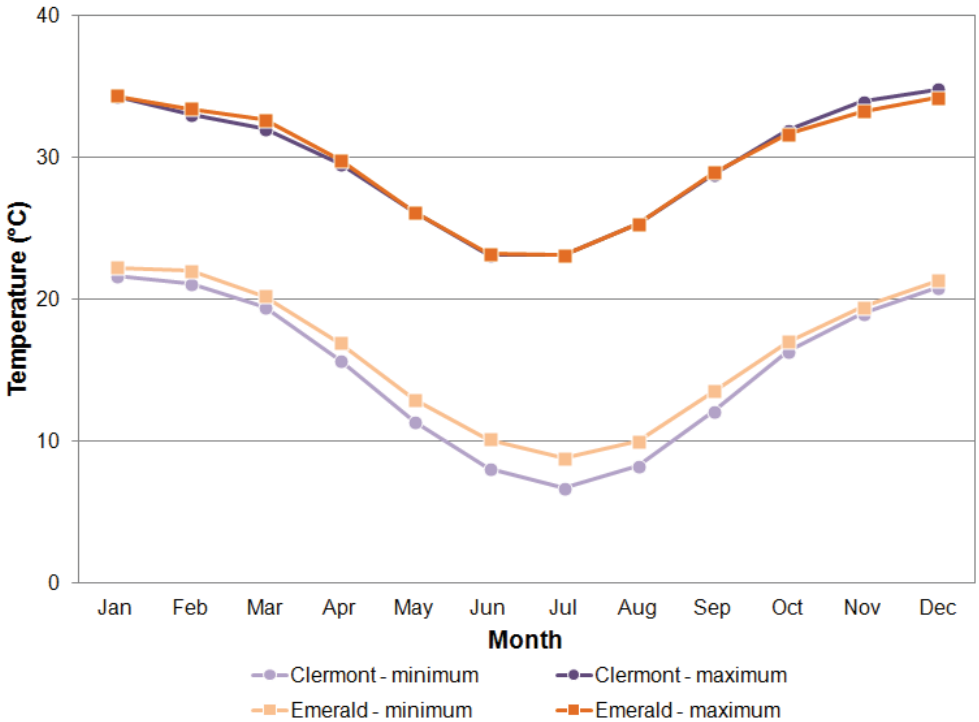

Figure 3 **Mean recorded daily minimum and maximum temperatures at Clermont and Emerald by month**

4.1.2 Rainfall

The annual pattern of rainfall illustrates the tropical climate in the region, with 52 – 55% of the annual precipitation occurring during the summer months of December to February, and just 8 – 10% in the winter months of June to August. The average and highest recorded monthly rainfall recorded by the four operating BoM monitoring stations within approximately 50 km of the centre of the project site are presented in Table 5, Figure 4 and Figure 5.

Table 5 **Average and highest monthly rainfall at BoM stations within 50 km of the project (mm)**

Average rainfall													
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Carmichael[1]	127	122	55	33	15	24	16	12	21	18	62	65	525
Ulcanbah[2]	111	116	67	35	24	18	17	14	11	25	45	65	551
Ronlow Park[3]	113	115	67	33	23	16	17	14	13	28	57	77	573
Bulliwallah[4]	110	119	75	39	25	25	22	14	13	29	51	83	599
Maximum rainfall													
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Carmichael[1]	291	242	192	105	50	172	70	42	161	41	150	159	928
Ulcanbah[2]	745	425	301	220	183	144	156	87	138	193	189	346	1312
Ronlow Park[3]	736	461	277	149	182	111	147	89	161	125	186	342	1192
Bulliwallah[4]	605	397	361	215	178	203	239	119	138	158	355	258	1426

Table notes:

1 Rainfall at Carmichael based on recording period : 2003 – 2013

2 Rainfall at Ulcanbah based on recording period : 1887 – 2013

3 Rainfall at Ronlow Park based on recording period : 1961 – 2013

4 Rainfall at Bulliwallah based on recording period : 1912 – 2013

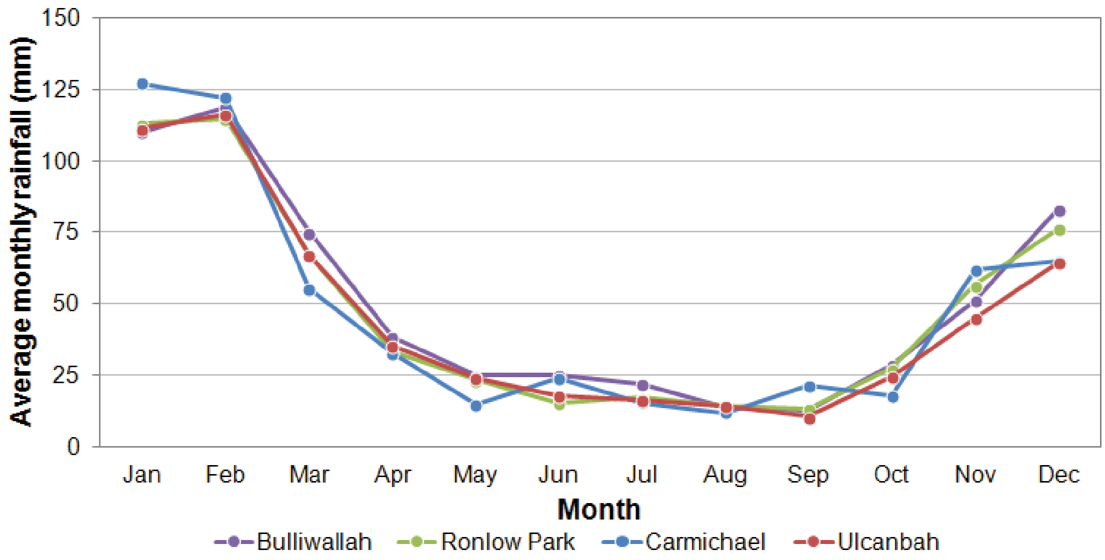

Figure 4 **Average monthly rainfall at the four operating BoM stations within approximately 50 km of the project**

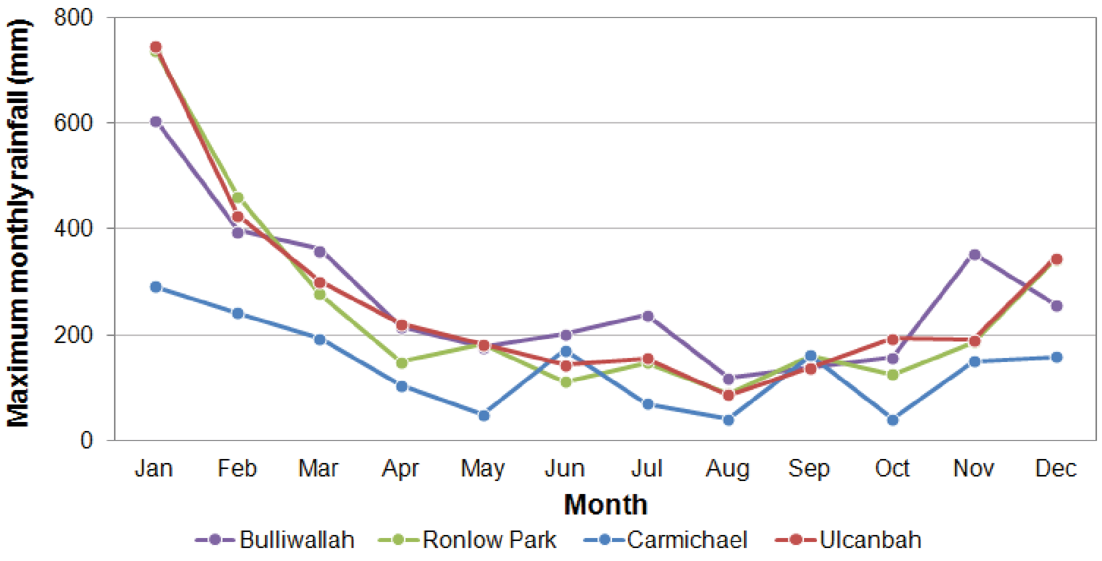

Figure 5 **Maximum monthly rainfall at the four operating BoM stations within approximately 50 km of the project**

4.1.3 Relative humidity

The availability of atmospheric moisture is an important factor that influences the climate by affecting the transfer of heat in the atmosphere through the balance between sensible and latent heat fluxes, and the occurrence of precipitation. Relative humidity is one of several measures used to describe the quantity of moisture in the atmosphere, and is the ratio of the actual amount of moisture in the atmosphere to the maximum amount that could be held, at a given temperature.

Relative humidity has been analysed from long-term averages based on daily measurements collected at 9am and 3pm at the Clermont and Emerald monitoring sites. The monthly average relative humidity at 9am and 3pm at the two sites is presented in Table 6 and illustrated in Figure 6. In regard to average daily variations, the analysis indicates that relative humidity was approximately 20% higher at 9am than at 3pm across the region on average over the period. This is the result of the relatively low annual rainfall at the site and the drying effect of the sun as the day progresses.

Table 6 **Average 9am and 3pm relative humidity at Clermont and Emerald by month (%)**

Location	Time	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Clermont[1]	9am	66	71	69	67	68	69	66	61	55	54	57	60	64
	3pm	42	47	42	41	42	41	37	33	29	30	34	38	38
Emerald[2]	9am	63	68	61	60	60	64	60	57	54	53	55	58	59
	3pm	41	45	37	36	37	41	36	32	30	31	33	36	36

Note

1 Averages based on recording period : 1938 – 2010 (9am); 1962-2010 (3am)

2 Averages based on recording period : 1992 – 2010

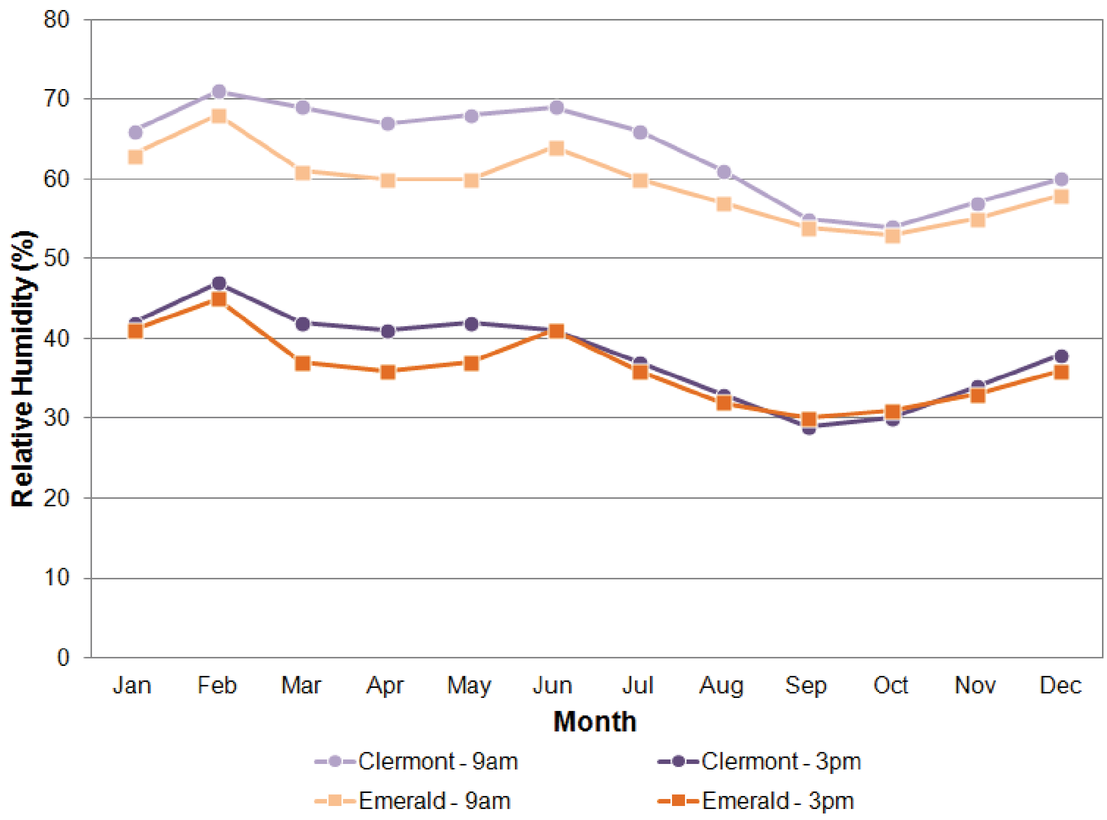

Figure 6 Mean 9am and 3pm relative humidity recorded at Clermont and Emerald by month

4.1.4 Wind speed and direction

Site-specific wind speed and wind direction data is required for dispersion modelling. Wind speed and wind direction data is not available for the project site and the closest BoM monitoring stations that collect wind speed and wind direction data are over 150 km away. In the absence of site specific meteorological data for dispersion modelling, the TAPM and CALMET meteorological models have been used to characterise site conditions. This approach is accepted by the EHP and has been conducted in accordance with industry guidelines. Details of the model configuration are provided in Section 3.1 and in Appendix A.

An annual wind rose for the project site is presented in Figure 7. The wind rose shows that winds are commonly from the north-eastern quadrant and blow least often from the south-western quadrant, with the most dominant individual wind directions being the north-northwest, south-southeast, and east. Winds from the north around to east-southeast are stronger than winds from other directions. Analyses of winds on a diurnal and seasonal basis are presented in Appendix A.

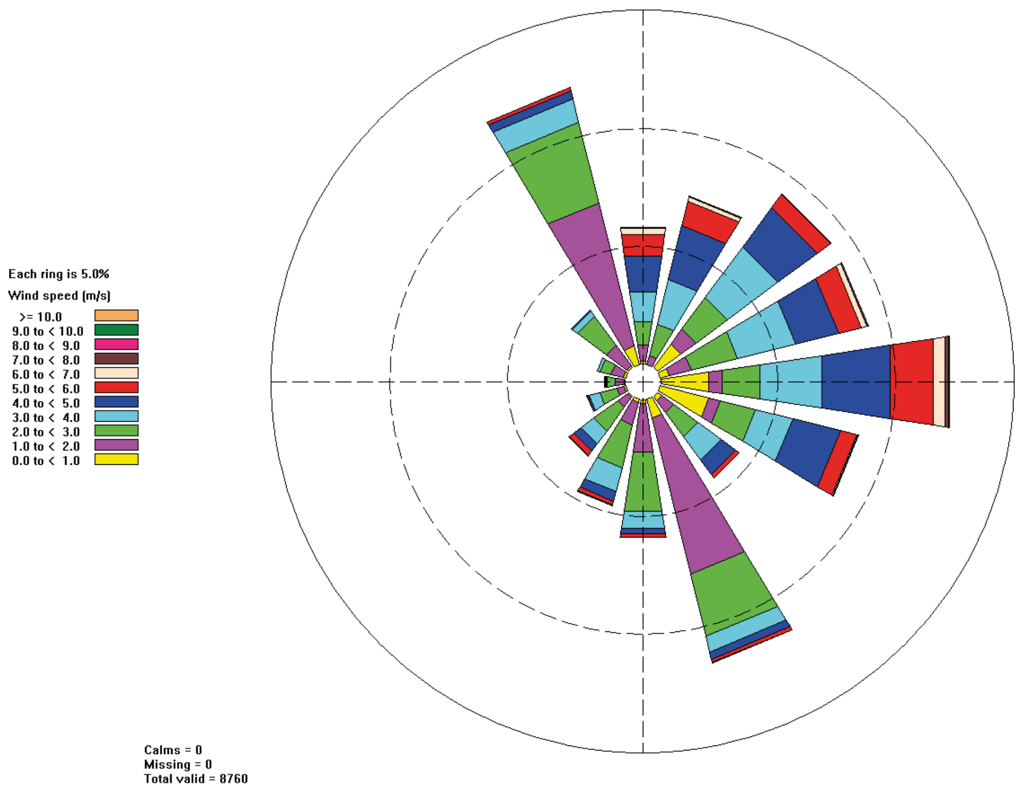

Figure 7 Annual wind rose from CALMET data at the project site

4.2 Local terrain and land use

The terrain in the region is generally flat at around 200 - 300 m above sea level. Terrain features in the area include a ridge reaching heights of 500 m running north-south along the western edge of the project site and continuing north. Lake Buchanan is located approximately 18 km northwest from the project site.

The main existing land uses in the region are cattle grazing and coal exploration. The region is sparsely populated, with a few isolated homesteads but no towns or cities nearby.

4.3 Sensitive receptors

The sensitive receptors considered in this assessment are presented in Table 7 and are also shown in Figure 8. With the exception of the proposed accommodation village for the Carmichael Coal Mine and Rail Project (CCM&RP), the receptors are individual rural homesteads with the closest (Moonoomoo Homestead) being located approximately 7 km from the project site. The Dooyne Outstation is not occupied and is only used intermittently; however it has conservatively been included in this assessment.

The Labona Homestead is located within the CCM&RP project boundary, in very close proximity to the proposed mining activities. The homestead was not considered to be a sensitive receptor by the CCM&RP Supplementary EIS (SEIS) and is therefore assumed to not be occupied at the commencement of the CCM&RP. It is not considered further in this assessment.

Table 7 Sensitive receptor locations considered in the assessment

Receptor ID	Receptor Name	Distance from Project Site	Location (UTM Z55S)	
			Easting (m)	Northing (m)
R1	Moonoomoo Homestead	7.2 km west	402,365	7,584,444
R2	Dooyne Outstation	9.9 km east	432,541	7,588,505
R3	Carmichael Homestead	11.8 km south-west	406,412	7,571,007
R4	Old Hyde Park Homestead	20.2 km north-east	441,637	7,599,565
R5	Bowie Homestead	17.4 km west	389,708	7,589,881
R6	Hyde Park Homestead	22.8 km north-east	443,426	7,602,282
R7	CCM&RP Accommodation Village	27.7 km south-east	448,412	7,569,905
R8	Doongmabulla Homestead	20.6 km south	422,016	7,559,462
R9	Ulcanbah Homestead	24.7 km south-west	395,073	7,564,172
R10	Kyong Homestead	31.5 km south-west	383,829	7,570,838
R11	Scott Homestead	27.6 km west	382,339	7,579,701
R12	Ronlow Park Homestead	28.9 km west	378,067	7,595,246
R13	Bulliwallah Homestead	42.8 km north-east	461,962	7,609,699
R14	Moray Downs Homestead	40.0 km south-east	462,027	7,572,602
R15	Yarrowmere Homestead	29.7 km north-west	382,749	7,627,056
R16	Plain Creek Homestead	51.0 km north-east	463,718	7,623,213

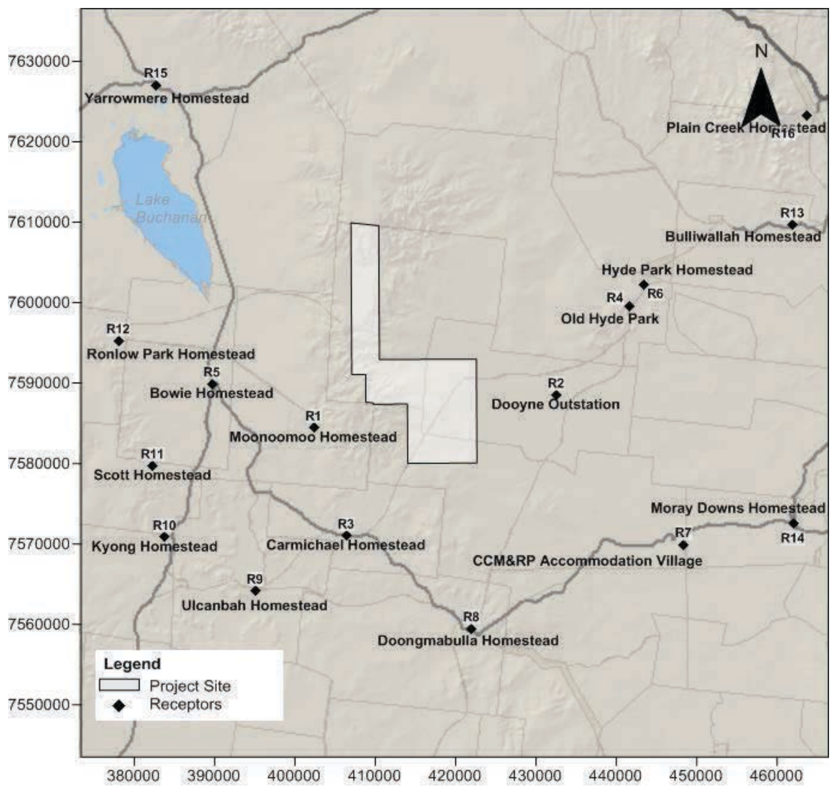

Figure 8 Sensitive receptor locations

4.4 Existing air quality

There are currently no EHP monitoring stations operating in the vicinity of the project site and therefore data has been sourced from air quality assessments for other coal mines in the region and from the EHP monitoring stations deemed likely to give the best representation of the area.

Concentrations of PM_{10}, $PM_{2.5}$, TSP and dust deposition have been summarised from the following reports:

- Caval Ridge Air Quality Assessment – Supplementary Report, URS 2009;
- Air Quality Impact Assessment for the Grosvenor Mine Project, Katestone Environmental 2010;
- Air Quality Assessment Report for the Minyango Project, Katestone Environmental 2013; and
- CCM&RP: Mine Air Quality Assessment, GHD 2012.

Concentrations of NO_2, CO and SO_2 have been summarised from data collected at the following the EHP monitoring stations:

- Toowoomba (2004 - 2010);
- Townsville Stuart (2003 – 2012); and
- Townsville Pimlico (2004 - 2012).

4.4.1 Particulate matter as PM_{10}

Table 8 summarises the 24-hour concentrations of PM_{10} used for the various air quality assessments for mines in the region.

Table 8 Summary of 24-hour average PM_{10} concentrations used as backgrounds in air quality assessments in the region

Project	24-hour average PM_{10} (µg/m³)
Caval Ridge Mine Project	18.8
Grosvenor Mine Project	19.5
Minyango Project	20.3
CCM&RP	11.0

This assessment has used a 24-hour average PM_{10} background of 18.8 µg/m³, consistent with the Caval Ridge Mine Project SEIS.

4.4.2 Particulate matter as $PM_{2.5}$

Table 9 summarises the 24-hour and annual average concentrations of $PM_{2.5}$ used for the various air quality assessments for mines in the region. For consistency with the nearby CCM&RP, this assessment has used a concentration of 3.3 µg/m³ for 24-hour and annual average background $PM_{2.5}$ levels.

Table 9 **Summary of 24-hour and annual average $PM_{2.5}$ concentrations used as backgrounds in air quality assessments in the region**

Project	24-hour average $PM_{2.5}$ (µg/m³)	Annual average $PM_{2.5}$ (µg/m³)
Caval Ridge Mine Project	2.9	1.6
Grosvenor Mine Project	7.4	5.9
Minyango Project	3.3	2.6
CCM&RP	3.3	3.3

4.4.3 Particulate matter as TSP

Table 10 summarises annual average concentrations of TSP used for the various air quality assessments for mines in the region. For consistency with the nearby CCM&RP, this assessment has used a concentration of 22 µg/m³ for annual average background TSP levels.

Table 10 **Summary of annual average TSP concentrations used as backgrounds in air quality assessments in the region**

Project	Annual average TSP (µg/m³)
Caval Ridge Mine Project	26.2
Grosvenor Mine Project	31.1
Minyango Project	20.1
CCM&RP	22.0

4.4.4 Dust deposition rate

Table 11 summarises average dust deposition rates used for the various air quality assessments for mines in the region. For consistency with the nearby CCM&RP, this assessment has used a concentration of 52 mg/m²/day (1.6 g/m²/month) for monthly average background dust deposition rates.

Table 11 **Summary of average dust deposition rates used as backgrounds in air quality assessments in the region**

Project	Average dust deposition rate	
	g/m²/month	mg/m²/day
Caval Ridge Mine Project	1.5	49
Grosvenor Mine Project	1.4	45
Minyango Project	1.5	50
CCM&RP	1.6	52

4.4.5 Nitrogen dioxide and sulfur dioxide

The closest EHP monitors that measures NO_2 or SO_2 are Stuart and Pimlico, both located in the Townsville region, approximately 280 km north of the project. The Stuart monitoring station is located adjacent to an industrial area to the south of Townsville and has been monitoring SO_2 since late 2002. The Pimlico monitoring station is located within the grounds of the Barrier Reef Institute of TAFE Pimlico Campus, in an area of residential land use. The site has been operating since 2004 and is representative of background pollutant concentrations in the urban areas of Townsville.

The main sources of air pollutants in Townsville are local industries and motor vehicles. The 1-hour, 95th percentile concentration of NO_2 is expected to be dominated by emissions from motor vehicles. The area surrounding the project site is rural and sparsely populated with no industries and consequently levels of NO_2 and SO_2 will be much lower than indicated by the Pimlico measurements. The highest 95th percentile value has been included in the assessment as a conservative estimate of the background levels of NO_2.

A summary of the background monitoring data of NO_2 and SO_2 collected at Stuart and Pimlico as reported by the EHP is shown in Table 12 and Table 13. This assessment has conservatively taken the highest reported 95th percentile concentrations for any year from either monitoring station as a background concentration.

Table 12 Concentrations of sulfur dioxide at Stuart monitoring station 2003-2012

Year	Sulfur dioxide (µg/m^3)		
	1-hour average, 95th percentile	24-hour average, 95th percentile	Annual average
2003	8.6	2.9	0.0[1]
2004	5.7	2.9	0.0[1]
2005	8.6	2.9	0.0[1]
2006	11.4	2.9	0.0[1]
2007	5.7	2.9	0.0[1]
2008	8.6	2.9	0.0[1]
2009	5.7	2.9	0.0[1]
2010	5.7	2.9	2.9
2011	5.7	2.9	ND
2012	NA	NA	2.9

Table note:

[1] Value of zero reported

ND: Insufficient data for period for statistic to be calculated

NA: Statistic not reported in the EHP monitoring reports

Table 13 **Concentrations of nitrogen dioxide and sulfur dioxide at Pimlico monitoring station 2004-2012**

Year	Nitrogen dioxide (µg/m^3)		Sulfur dioxide (µg/m^3)		
	1-hour average, 95th percentile	Annual average	1-hour average, 95th percentile	24-hour average, 95th percentile	Annual average
2004	61.6	12.3	-	-	-
2005	57.5	10.3	5.7	2.9	ND
2006	51.3	12.3	8.6	5.7	0.0[1]
2007	47.2	8.2	8.6	5.7	2.9
2008	51.3	12.3	5.7	2.9	0.0[1]
2009	51.3	10.3	8.6	2.9	0.0[1]
2010	47.2	10.3	8.6	5.7	0.0[1]
2011	63.6	12.3	14.3	11.4	2.9
2012	NA	10.3	NA	NA	2.9

Table note:

[1] Value of zero reported

ND: Insufficient data for period for statistic to be calculated

NA: Statistic not reported in the EHP monitoring reports

SO_2 not measured in 2004

4.4.6 Carbon monoxide

Carbon monoxide (CO) is not measured at the Pimlico monitoring station. Monitoring data from Toowoomba monitoring station in southeast Queensland has been used to estimate background levels of CO.

The monitoring station located in Toowoomba was established in July 2003 and continued until December 2010 when it was de-commissioned. The monitoring station was located in a valley and was representative of maximum pollutant levels in the Toowoomba region. It is highly likely that background levels of CO are higher in Toowoomba than at the project site and hence the data used is considered conservative.

A summary of the background monitoring data of CO collected at Toowoomba as reported by the EHP is shown in Table 14.

Table 14 **Concentrations of carbon monoxide at the Toowoomba monitoring station 2003-2010**

Year	Carbon monoxide (µg/m^3)
	8-hour average
2003	2,749
2004	2,499
2005	1,375
2006	1,625
2007	1,250
2008	1,375

Year	Carbon monoxide (µg/m³)
	8-hour average
2009	1,250
2010	1,125

4.4.7 Other pollutants

The background concentrations of all other pollutants are expected to be low as there are no activities known to emit other air pollutants within the region surrounding the project site. Therefore the assessment of other pollutants likely to be emitted from the project has considered those air pollutants in isolation.

4.4.8 Summary of ambient air quality

The assessment has considered background levels of pollutants in the region. Table 15 shows the ambient background concentrations selected for this assessment.

Table 15 Background concentrations of pollutants used in the assessment

Pollutant	Averaging period	Concentration (µg/m³)
NO_2	1-hour average	63.6
	Annual average	12.3
CO	8-hour average	2,749
SO_2	1-hour average	14.3
	24-hour average	11.4
	Annual average	2.9
PM_{10}	24-hour average	18.8
$PM_{2.5}$	24-hour average	3.3
	Annual average	3.3
TSP	Annual average	22.0
Dust deposition	Annual average	52 mg/m²/day

4.5 Contribution from CCM&RP

The CCM&RP is a 60 Mtpa ROM coal mine that was approved in July 2014. The CCM&RP is proposed to be located to the southeast of the project. It is possible that emissions from both projects may contribute to air quality impacts at some of the sensitive receptors. The most critical air pollutant that is common to both projects is PM_{10}. Consequently, the cumulative assessment has concentrated on PM_{10}, however the findings for PM_{10} are considered to be indicative of potential cumulative issues associated with other air pollutants.

The contribution of the CCM&RP to ground-level concentrations of PM_{10} has been obtained from the *Carmichael Coal Mine and Rail Project SEIS Report* (SEIS Report) *for Revised Mine Air Quality Assessment* (GHD, October 2013).

The CCM&RP SEIS Report provided tabulated predictions of ground-level concentrations of PM_{10} at four of the 16 receptors identified in Table 7. The CCM&RP SEIS Report presented maximum 24-hour average concentrations of PM_{10} rather than 6th highest concentrations (Table 16). The CCM&RP SEIS Report also included contour plots of maximum 24-hour average concentrations of PM_{10}, from which dust levels can be inferred for the remaining sensitive receptors contained in Table 7. The CCM&RP SEIS Report did not extend to all sensitive receptors that are relevant to the project. For these sensitive receptors, the concentration represented by the nearest contour was used.

A summary of predicted concentrations of PM_{10} due to CCM&RP used in this assessment is presented in Table 16.

Table 16 Contribution from CCM&RP on PM_{10} concentrations

Receptor		Maximum 24-hour PM_{10} (µg/m³)	Additional comments
ID	Name		
R1	Moonoomoo Homestead	9	Inferred from Figure 17 SEIS Report minus 11 µg/m³ (background assumed by GHD in SEIS Report)
R2	Dooyne Outstation	39	Inferred from Figure 17 SEIS Report minus 11 µg/m³ (background assumed by GHD in SEIS Report)
R3	Carmichael Homestead	15.6	Table 11 SEIS Report
R4	Old Hyde Park Homestead	19	Inferred from Figure 17 SEIS Report minus 11 µg/m³ (background assumed by GHD in SEIS Report)
R5	Bowie Homestead	9	
R6	Hyde Park Homestead	9	
R7	CCM&RP Accommodation Village	42.5	Table 12 SEIS Report
R8	Doongmabulla Homestead	25.7	Table 11 SEIS Report
R9	Ulcanbah Homestead	9	Inferred from Figure 17 SEIS Report minus 11 µg/m³ (background assumed by GHD in SEIS Report)
R10	Kyong Homestead	9	
R11	Scott Homestead	9	
R12	Ronlow Park Homestead	9	
R13	Bulliwallah Homestead	9	
R14	Moray Downs Homestead	20.1	Table 11 SEIS Report
R15	Yarrowmere Homestead	9	Inferred from Figure 17 SEIS Report minus 11 µg/m³ (background assumed by GHD in SEIS Report)
R16	Plain Creek Homestead	9	

4.6 Contribution from Moray Power Station

A development application for the Moray Power Station was lodged in November 2014. The Moray Power Station is proposed to be located directly to the east of the CCM&RP and approximately 23 km to the southeast of the project site.

The most critical air pollutant that is common to both projects is NO_2. Consequently, the cumulative assessment has concentrated on NO_2, however the findings for NO_2 are considered to be indicative of potential cumulative issues associated with other air pollutants. A cumulative assessment of PM_{10} has also been included as PM_{10} was found to be the most critical air pollutant for Project China Stone.

The contribution of the Moray Power Station to ground-level concentrations of NO_2 and PM_{10} has been obtained from the *Moray Power Station: Air Quality and Greenhouse Gas Assessment* (MPS Report) (Katestone, November 2014).

The MPS Report provided tabulated predictions of ground-level concentrations of NO_2 at four of the 16 receptors identified in Table 7.

A summary of predicted concentrations of NO_2 due to Moray Power Station used in this assessment is presented in Table 17.

Table 17 Contribution from Moray Power Station on NO_2 and PM_{10} concentrations

Receptor		Maximum 1-hour NO_2 (µg/m³)	Maximum 24-hour PM_{10} (µg/m³)	Additional comments
ID	Name			
R1	Moonoomoo Homestead	18.6	0.3	NO_2 inferred from Plate 3 MPS Report, PM_{10} inferred from Table 15 of MPS Report
R2	Dooyne Outstation	18.6	0.3	
R3	Carmichael Homestead	18.6	0.3	Table 15 of MPS Report minus background of 63.6 µg/m³ for 1-hour NO_2 and 11 µg/m³ for 24-hour PM_{10} (background assumed by Katestone in MPS Report)
R4	Old Hyde Park Homestead	18.6	0.3	NO_2 inferred from Plate 3 MPS Report, PM_{10} inferred from Table 15 of MPS Report
R5	Bowie Homestead	18.6	0.3	
R6	Hyde Park Homestead	18.6	0.3	
R7	CCM&RP Accommodation Village	113	2.0	Table 15 of MPS Report minus background of 63.6 µg/m³ for 1-hour NO_2 and 11 µg/m³ for 24-hour PM_{10} (background assumed by Katestone in MPS Report)
R8	Doongmabulla Homestead	14.8	0.3	
R9	Ulcanbah Homestead	18.6	0.3	NO_2 inferred from Plate 3 MPS Report, PM_{10} inferred from Table 15 of MPS Report
R10	Kyong Homestead	18.6	0.3	
R11	Scott Homestead	18.6	0.3	
R12	Ronlow Park Homestead	18.6	0.3	
R13	Bulliwallah Homestead	18.6	0.3	
R14	Moray Downs Homestead	7.50	0.1	Table 15 of MPS Report minus background of 63.6 µg/m³ for 1-hour NO_2 and 11 µg/m³ for 24-hour PM_{10} (background assumed by Katestone in MPS Report)
R15	Yarrowmere Homestead	18.6	0.3	NO_2 inferred from Plate 3 MPS Report, PM_{10} inferred from Table 15 of MPS Report
R16	Plain Creek Homestead	18.6	0.3	

5. EMISSIONS TO THE ATMOSPHERE

Emissions to the atmosphere are likely to be produced during construction and operation of the project. Dust emissions will be generated through handling and transportation of overburden and coal, as well as processing of coal. Wind erosion of exposed areas including cleared areas and stockpiles will also generate dust emissions. Operation of the power station will generate combustion emissions, including particulates, oxides of nitrogen, carbon monoxide and metals. The power station will incorporate contemporary air pollutant emission controls, with residual emissions discharged via a tall stack.

Details of the construction and operations phases of the project, controls and mitigation measures and an emissions inventory for each phase are provided in the following sections.

5.1 Construction

5.1.1 Activities and controls

The construction phase of the project has the potential to cause elevated levels of dust if not managed appropriately. Construction phase activities at the project site can be broadly described as:

- Site clearance of areas, including vegetation clearance, topsoil removal and storage, and earthworks;
- Civil works including temporary and permanent drainage works;
- Structure and plant erection and installation including: coal and rejects conveyors, CHPP, rail spur and train loading facility, airstrip and power station;
- Commissioning and testing of plant and equipment; and
- Construction site demobilisation.

Dust emissions during the construction phase of the project will be managed through the implementation of the following controls and mitigation measures:

- Watering of haul roads;
- Minimising exposed areas as far as practicable; and
- Limiting vehicle speeds.

The construction phase of the project is necessarily temporary and is expected to have a smaller dust generation potential than the mine when operating at full capacity.

5.2 Mining operations

The project is projected to operate for approximately 50 years and will include both open cut and underground mining operations. Open cut mining will occur between Project Years 3 and 30, with a peak extraction rate of 32 Mtpa of ROM coal. Underground mining will also commence in Project Year 3 and continue through the life of the mine. Peak underground extraction is expected to be a rate of 23 Mtpa of ROM coal.

The primary source of dust from open cut mining activities is wheel generated dust from haul roads; the dust emissions from underground activities are minor in comparison. Therefore this assessment focuses on Project Year 20 due to it featuring significant open cut throughput and relatively long haul distances. Additionally, during this year open cut mining activities extend the full length of the open cut mining area.

5.2.1 Activities and controls

Key activities undertaken as part of the project that contribute to dust generation include:

- Trucking ROM coal from the open cut mining areas to the ROM coal stockpiles;
- Trucking overburden from the open cut mining areas to the overburden emplacements;
- Transport of coal by conveyor;
- Crushing and processing of coal at the CHPP;
- Wind erosion of stockpiles;
- Stacking and reclaiming of coal at stockpiles; and
- Loading trains with coal.

Activities will be controlled appropriately to ensure that dust emissions are minimised. The controls outlined in Table 18 were included in the emissions estimation.

Table 18 Controls applied in emissions estimation

Emission source	Control implemented	Reduction [a]
Wheel generated dust on unsealed haul roads	Water trucks implementing level 2 watering (> 2 L/m²/hour)	75%
Inactive overburden emplacements	Rehabilitation	90%
Table note: [a] Control based on NPI (2012)		

5.2.2 Emissions inventory

Table 19 shows the emissions estimated for Project Year 20, which was considered to be the worst case for potential air quality impacts. A detailed description of the emission estimation techniques used to derive this inventory is provided in Appendix C. The emission rates specified in Table 19 assume that the controls detailed in the preceding section have been applied.

Emissions for Project Year 5 and Project Year 15 were also estimated. The emissions inventories for these years are provided in Appendix D.

Table 19 Emission rates for mine operation – Project Year 20

Activity	Project Year 20		
	TSP (g/s)	PM_{10} (g/s)	$PM_{2.5}$ (g/s)
TOTAL	**997.8**	**363.0**	**41.4**
Open cut pit activities	164.7	94.3	9.6
Dragline (overburden)	21.2	8.1	0.7
Rope Shovel (overburden)	0.6	0.5	0.1
Hydraulic Excavator (overburden)	0.5	0.5	0.1
Surface Miner (coal)	43.0	27.7	1.9
Bulldozing (overburden)	2.6	0.9	0.6
Drilling	1.1	1.1	0.1

Activity	Project Year 20		
	TSP (g/s)	PM_{10} (g/s)	$PM_{2.5}$ (g/s)
Blasting	0.1	0.1	0.0
Overburden Haul	73.7	39.9	4.2
ROM Haul	13.3	7.2	0.8
Wind erosion active pit area	8.5	8.1	1.3
Activities associated with underground coal	4.3	1.6	0.2
Drift conveyor	0.01	0.004	0.001
Transfers	0.14	0.07	0.01
Crushing	1.3	0.6	0.1
Bulldozing	2.6	0.9	0.06
Overland conveyor	0.2	0.1	0.02
Out of Pit haulage	600.0	171.1	17.2
Overburden	454.1	129.5	12.9
ROM	125.5	35.8	3.6
Fly ash	18.9	5.4	0.5
Graders	1.4	0.5	0.1
CHPP Area	100.0	32.4	4.7
Truck dump	*45.3*	*6.2*	*0.9*
Bulldozing	*5.3*	*1.8*	*0.1*
Transfers	*1.8*	*0.9*	*0.1*
Conveyors	*0.5*	*0.2*	*0.0*
Stackers/Reclaimers	*0.7*	*0.4*	*0.1*
Crushing/Sizing	*4.3*	*1.9*	*0.4*
Wind erosion	*42.2*	*21.1*	*3.2*
Product Stockpile	61.9	30.9	4.6
Exposed Areas (including overburden dumping)	66.4	32.3	5.0
Overburden dumps	48.4	23.3	3.7
Rehabilitated	4.4	2.2	0.3
Fly ash facility	1.8	0.9	0.1
Rejects	9.0	4.5	0.7
Underground ROM stockpile	2.8	1.4	0.2
Rail Loadout	0.6	0.3	0.04

5.3 Power station

Power for the mining operations will be generated on-site by a coal-fired power station consisting of 3 x 350 Megawatt (MW) units. Two units will operate to provide the peak power demands of the project, with the third unit provided as redundancy. The power station will begin operations in Project Year 5, and is planned to be decommissioned at the end of the project.

5.3.1 Emission control technology

Emissions from the power station will be related to the combustion of coal. The final specifications of the power station have not been confirmed; however, the power station will be built to conform with the emission limits described in Section 2.5.

This assessment has assumed that particulate emissions are controlled using an ElectroStatic Precipitator (ESP) that can achieve a 99.2% control efficiency. This is the default control efficiency described in the NPI EET for fossil fuel electric power generation (NPI, 2012).

5.3.2 Emissions inventory

Stack characteristics for the power station were based on information supplied by the proponent and are shown in Table 20. Combustion emissions have been estimated using a combination of supplied information, relevant emission limits and the default black coal emission factors in the NPI EET for fossil fuel electric power generation (NPI, 2012). Modelled emission rates are presented in Table 21.

Table 20 Stack characteristics for the power station

Parameter	Units	Parameter
Number of flues		3
Number of stacks		1
Stack height	m	210
Total inner diameter of effective stack	m	10.1
Exhaust velocity	m/s	20
Exhaust temperature	°C	48
PM_{10} concentration	mg/Nm³	50
NO_X (as NO_2) concentration	mg/Nm³	500
CO concentration	mg/Nm³	125

Table 21 Emission rates for the power station

Pollutant	Emission rate (g/s)
PM_{10}	68
NO_X	681
CO	170
Cumene	7.03E-04
Fluoride	1.95E+01
Sulfuric acid	9.38E+00
Sulfur dioxide	8.91E+02
Arsenic and compounds	1.14E-04
Beryllium and compounds	2.28E-03
Boron and compounds	6.51E+00
Cadmium and compounds	5.87E-04
Chromium (III) compounds	4.36E-04
Chromium (VI) compounds	2.30E-05
Cobalt and compounds	1.29E-04
Copper and compounds	1.44E-05
Lead & compounds	1.57E-04

Pollutant	Emission rate (g/s)
Manganese and compounds	4.30E-04
Mercury and compounds	1.05E-04
Nickel and compounds	8.55E-04
Zinc and compounds	3.86E-02

5.4 Airstrip

To provide access for its Fly-In, Fly-Out workforce, the project includes an airstrip. The airstrip will be constructed for this purpose only and therefore will not service a large number of aircraft. The airstrip is estimated to handle approximately 20 return flights in total per week, comprising jets, turboprop and prop aircraft. At most, six aircraft are anticipated to land and take-off during any one day.

The impact of the airstrip activities in local and regional air quality is expected to be minor for the following reasons:

- Aircraft will operate intermittently and infrequently;
- The airstrip is located a significant distance from any receptor; and
- Aircraft will not fly low enough to influence ground-level concentrations of air pollutants at a sensitive receptor.

It is not anticipated that the aircraft will be operated by the proponent of the project. Therefore, emissions of Greenhouse Gases (GHGs) from aircraft activities will not fall under the Scope 1 or 2 categories for the project and are not relevant to the GHG assessment in Section 9.

Operation of the airstrip has not been considered further in this assessment.

6. IMPACT ASSESSMENT

This section presents the results of the dispersion modelling of the Project Year 20 mine scenario. Modelling results have been presented as ground-level concentrations or dust deposition rates at sensitive receptors as well as contours across the modelling domain. Project Year 20 has been chosen because it is estimated to produce the highest dust emission rates. Potential impacts during other years will be lower.

6.1 Particulate matter as PM_{10}

The predicted maximum and 6th highest 24-hour average concentrations of PM_{10} are presented in Table 22 for each sensitive receptor. Contours of the predicted 24-hour average concentrations of PM_{10} across the modelling domain, including ambient background concentrations, are presented in Plate 1 (maximum) and Plate 2 (6th highest). The results show that:

- Predicted 24-hour average ground-level concentrations of PM_{10} due to the mine and power station, including ambient background concentrations, comply with the Air EPP objective of 50 µg/m³ at all sensitive receptors; and
- The power station makes a minor contribution to the predicted ground-level concentrations of PM_{10}.

Table 22 Predicted maximum and 6th highest 24-hour average concentrations of PM_{10} (µg/m³)

Receptor		Mine in isolation		Mine and power station isolation		Mine, power station with ambient background	
ID	Name	Maximum	6th high	Maximum	6th high	Maximum	6th high
R1	Moonoomoo Homestead	26.1	18.2	26.1	18.2	44.9	37.0
R2	Dooyne Outstation	26.1	6.9	26.1	7.5	44.9	26.3
R3	Carmichael Homestead	15.4	10.2	15.4	10.6	34.2	29.4
R4	Old Hyde Park Homestead	6.0	3.1	6.0	3.1	24.8	21.9
R5	Bowie Homestead	25.5	9.4	25.7	9.4	44.5	28.2
R6	Hyde Park Homestead	4.8	2.1	4.8	2.1	23.6	20.9
R7	CCM&RP Accommodation Village	8.2	1.8	8.3	1.9	27.1	20.7
R8	Doongmabulla Homestead	8.5	4.4	8.8	4.5	27.6	23.3
R9	Ulcanbah Homestead	7.2	5.1	7.4	5.1	26.2	23.9
R10	Kyong Homestead	7.6	4.3	7.9	4.5	26.7	23.3
R11	Scott Homestead	10.1	5.5	10.1	5.8	28.9	24.6
R12	Ronlow Park Homestead	8.6	4.3	8.8	4.3	27.6	23.1
R13	Bulliwallah Homestead	2.6	0.4	2.6	0.5	21.4	19.3
R14	Moray Downs Homestead	3.4	0.8	3.5	0.8	22.3	19.6
R15	Yarrowmere Homestead	1.9	1.4	2.0	1.6	20.8	20.4
R16	Plain Creek Homestead	1.1	0.4	1.1	0.4	19.9	19.2
Air EPP objective		**-**	**50**	**-**	**50**	**-**	**50**

6.2 Particulate matter as $PM_{2.5}$

The predicted maximum 24-hour and annual average concentrations of $PM_{2.5}$ are presented in Table 23 for each sensitive receptor. Contours of the predicted concentrations of $PM_{2.5}$ across the modelling domain, including ambient background concentrations, are presented in Plate 3 (maximum 24-hour) and Plate 4 (annual average). The results show that:

- Predicted maximum 24-hour average ground-level concentrations of $PM_{2.5}$ due to the mine and power station, including ambient background concentrations, are well below the Air EPP objective of 25 µg/m³ at all sensitive receptors; and
- Predicted annual average ground-level concentrations of $PM_{2.5}$ due to the mine and power station, including ambient background concentrations, are well below the Air EPP objective of 8 µg/m³ at all sensitive receptors

Table 23 Predicted maximum 24-hour and annual average concentrations of $PM_{2.5}$ (µg/m³)

Receptor		Mine in isolation		Mine and power station isolation		Mine, power station with ambient background	
ID	**Name**	**Maximum 24-hour**	**Annual average**	**Maximum 24-hour**	**Annual average**	**Maximum 24-hour**	**Annual average**
R1	Moonoomoo Homestead	4.0	0.78	4.0	0.92	7.3	4.2
R2	Dooyne Outstation	5.2	0.07	5.2	0.09	8.5	3.4
R3	Carmichael Homestead	2.6	0.38	2.6	0.48	5.9	3.8
R4	Old Hyde Park Homestead	1.8	0.03	1.8	0.05	5.1	3.3
R5	Bowie Homestead	4.9	0.34	5.1	0.42	8.4	3.7
R6	Hyde Park Homestead	1.5	0.03	1.5	0.04	4.8	3.3
R7	CCM&RP Accommodation Village	1.4	0.02	1.5	0.03	4.8	3.3
R8	Doongmabulla Homestead	1.9	0.09	2.2	0.12	5.5	3.4
R9	Ulcanbah Homestead	1.4	0.20	1.6	0.26	4.9	3.6
R10	Kyong Homestead	1.5	0.18	1.8	0.23	5.1	3.5
R11	Scott Homestead	1.8	0.22	1.9	0.29	5.2	3.6
R12	Ronlow Park Homestead	1.9	0.15	2.2	0.19	5.5	3.5
R13	Bulliwallah Homestead	0.8	0.01	0.8	0.01	4.1	3.3
R14	Moray Downs Homestead	0.6	0.01	0.6	0.02	3.9	3.3
R15	Yarrowmere Homestead	0.6	0.04	0.7	0.05	4.0	3.4
R16	Plain Creek Homestead	0.4	0.01	0.4	0.01	3.7	3.3
Air EPP objective		**25**	**8**	**25**	**8**	**25**	**8**

6.3 Particulate matter as TSP

The predicted annual average concentrations of TSP are presented in Table 24 for each sensitive receptor. Contours of the predicted annual average concentrations of TSP across the modelling domain, including ambient background concentrations, are presented in Plate 5. The results show that:

- Predicted annual average ground-level concentrations of TSP due to the mine and power station, including ambient background concentrations, are well below the Air EPP objective of 90 µg/m³ at all sensitive receptors.

Table 24 Predicted annual average concentrations of TSP (µg/m³)

Receptor		Mine in isolation	Mine and power station isolation	Mine, power station with ambient background
ID	**Name**			
R1	Moonoomoo Homestead	6.08	6.21	28.2
R2	Dooyne Outstation	0.48	0.50	22.5
R3	Carmichael Homestead	2.56	2.65	24.7
R4	Old Hyde Park Homestead	0.17	0.19	22.2
R5	Bowie Homestead	1.99	2.08	24.1
R6	Hyde Park Homestead	0.14	0.15	22.2
R7	CCM&RP Accommodation Village	0.12	0.13	22.1
R8	Doongmabulla Homestead	0.45	0.48	22.5
R9	Ulcanbah Homestead	1.12	1.17	23.2
R10	Kyong Homestead	0.92	0.97	23.0
R11	Scott Homestead	1.21	1.27	23.3
R12	Ronlow Park Homestead	0.73	0.77	22.8
R13	Bulliwallah Homestead	0.04	0.04	22.0
R14	Moray Downs Homestead	0.05	0.06	22.1
R15	Yarrowmere Homestead	0.14	0.15	22.2
R16	Plain Creek Homestead	0.02	0.02	22.0
Air EPP objective		**90**		

6.4 Dust deposition rate

Dust deposition is related predominantly to the coarse fraction of TSP. Particulate emissions from the power station will be combustion related particles in the fine and ultrafine fractions and will make a negligible impact to dust deposition rates and is therefore not considered further.

The predicted annual average dust deposition rates are presented in Table 25 for each sensitive receptor. Contours of the predicted annual average dust deposition rate across the modelling domain, including ambient background concentrations, are presented in Plate 6. The results show that:

- Predicted annual average dust deposition rates due to the mine, including ambient background concentrations, are well below the objective of 120 mg/m²/day at all sensitive receptors.

Table 25 Predicted maximum monthly average dust deposition rates (mg/m²/day)

Receptor		Mine in isolation	Mine with ambient background
ID	Name		
R1	Moonoomoo Homestead	45.5	97.5
R2	Dooyne Outstation	1.6	53.6
R3	Carmichael Homestead	26.8	78.8
R4	Old Hyde Park Homestead	1.3	53.3
R5	Bowie Homestead	22.3	74.3
R6	Hyde Park Homestead	0.9	52.9
R7	CCM&RP Accommodation Village	0.4	52.4
R8	Doongmabulla Homestead	3.2	55.2
R9	Ulcanbah Homestead	8.8	60.8
R10	Kyong Homestead	7.1	59.1
R11	Scott Homestead	9.3	61.3
R12	Ronlow Park Homestead	8.9	60.9
R13	Bulliwallah Homestead	0.2	52.2
R14	Moray Downs Homestead	0.2	52.2
R15	Yarrowmere Homestead	0.7	52.7
R16	Plain Creek Homestead	0.3	52.3
Air quality objective		**120**	

6.5 Nitrogen dioxide

The predicted maximum 1-hour average and annual average ground-level concentrations of NO_2 due to operation of the power station are presented in Table 26 for each sensitive receptor. Contours of the predicted concentrations of NO_2 across the modelling domain, including ambient background concentrations, are presented in Plate 7 (maximum 1-hour) and Plate 8 (annual average). The results show that:

- Predicted maximum 1-hour average ground-level concentrations of NO_2 due to the power station, including ambient background concentrations, are well below the Air EPP objective of 250 µg/m³ at all sensitive receptors
- Predicted annual average ground-level concentrations of NO_2 due to the power station, including ambient background concentrations, are well below the Air EPP objective of 62 µg/m³ at all sensitive receptors

Table 26 Predicted 1-hour and annual average ground-level concentrations of NO_2, including ambient background (µg/m³)

Receptor		Power station in isolation		Power station with ambient background	
ID	**Name**	**Max 1-hour**	**Annual average**	**Max 1-hour**	**Annual average**
R1	Moonoomoo Homestead	37.0	0.40	101	12.7
R2	Dooyne Outstation	14.9	0.06	78	12.4
R3	Carmichael Homestead	24.5	0.28	88	12.6
R4	Old Hyde Park Homestead	22.3	0.04	86	12.3
R5	Bowie Homestead	23.6	0.25	87	12.6
R6	Hyde Park Homestead	7.8	0.03	71	12.3
R7	CCM&RP Accommodation Village	21.6	0.03	85	12.3
R8	Doongmabulla Homestead	12.4	0.08	76	12.4
R9	Ulcanbah Homestead	9.8	0.16	73	12.5
R10	Kyong Homestead	17.1	0.15	81	12.5
R11	Scott Homestead	16.9	0.19	80	12.5
R12	Ronlow Park Homestead	11.9	0.12	76	12.4
R13	Bulliwallah Homestead	2.8	0.01	66	12.3
R14	Moray Downs Homestead	3.5	0.02	67	12.3
R15	Yarrowmere Homestead	3.7	0.03	67	12.3
R16	Plain Creek Homestead	2.5	0.01	66	12.3
Air EPP objective		**250**	**62**	**250**	**62**

6.6 Sulfur dioxide

The predicted maximum 1-hour, maximum 24-hour and annual average ground-level concentrations of SO_2 due to operation of the power station, including background concentrations, are presented in Table 27. Contours of the predicted concentrations of SO_2 across the modelling domain, including ambient background concentrations, are presented in Plate 9 (maximum 1-hour), Plate 10 (maximum 24-hour) and Plate 11 (annual average). The results show that:

- Predicted maximum 1-hour average ground-level concentrations of SO_2 due to the power station, including background concentrations, are well below the Air EPP objective of 570 µg/m³ at all sensitive receptors;
- Predicted maximum 24-hour average ground-level concentrations of SO_2 due to the power station, including background concentrations, are well below the Air EPP objective of 230 µg/m³ at all sensitive receptors; and
- Predicted annual average ground-level concentrations of SO_2 due to the power station, including background concentrations, are well below the Air EPP objective of 57 µg/m³ at all sensitive receptors.

Table 27 Predicted 1-hour, 24-hour and annual average ground-level concentrations of SO_2, including ambient background (µg/m³)

Receptor		Power station in isolation			Power station with ambient background		
ID	**Name**	**Max 1-hour**	**Max 24-hour**	**Annual average**	**Max 1-hour**	**Max 24-hour**	**Annual average**
R1	Moonoomoo Homestead	161	19	1.8	175	30	4.7
R2	Dooyne Outstation	65	10	0.3	79	21	3.2
R3	Carmichael Homestead	107	14	1.2	121	25	4.1
R4	Old Hyde Park Homestead	97	6	0.2	112	17	3.1
R5	Bowie Homestead	103	13	1.1	117	24	4.0
R6	Hyde Park Homestead	34	5	0.1	48	17	3.0
R7	CCM&RP Accommodation Village	94	6	0.1	108	18	3.0
R8	Doongmabulla Homestead	54	9	0.4	68	21	3.3
R9	Ulcanbah Homestead	43	10	0.7	57	21	3.6
R10	Kyong Homestead	75	8	0.7	89	19	3.6
R11	Scott Homestead	73	8	0.8	88	20	3.7
R12	Ronlow Park Homestead	52	7	0.5	66	19	3.4
R13	Bulliwallah Homestead	12	2	0.1	26	13	3.0
R14	Moray Downs Homestead	15	4	0.1	29	15	3.0
R15	Yarrowmere Homestead	16	3	0.2	31	15	3.1
R16	Plain Creek Homestead	11	2	0.0	25	14	2.9
Air EPP objective		**570**	**230**	**57**	**570**	**230**	**57**

6.7 Carbon monoxide

The predicted maximum 8-hour average ground-level concentrations of CO due to operation of the power station, including background concentrations, are presented in Table 28. Contours of the predicted 8-hour average concentrations of CO across the modelling domain, including ambient background concentrations, are presented in Plate 12. The results show that:

- Predicted maximum 8-hour average CO concentrations due to the power station, including background concentrations, are well below the Air EPP objective of 11,000 µg/m³ at all sensitive receptors.

Table 28 Predicted 8-hour average ground-level concentrations of CO, including ambient background (µg/m³)

Receptor		Power station in isolation	Power station with ambient background
ID	**Name**	**Max 8-hour**	**Max 8-hour**
R1	Moonoomoo Homestead	7.9	2,757
R2	Dooyne Outstation	4.7	2,754
R3	Carmichael Homestead	6.8	2,756
R4	Old Hyde Park Homestead	2.5	2,752
R5	Bowie Homestead	6.4	2,755
R6	Hyde Park Homestead	2.5	2,752
R7	CCM&RP Accommodation Village	3.2	2,752
R8	Doongmabulla Homestead	3.2	2,752
R9	Ulcanbah Homestead	4.1	2,753
R10	Kyong Homestead	3.4	2,752
R11	Scott Homestead	2.9	2,752
R12	Ronlow Park Homestead	3.0	2,752
R13	Bulliwallah Homestead	0.8	2,750
R14	Moray Downs Homestead	1.4	2,750
R15	Yarrowmere Homestead	1.5	2,751
R16	Plain Creek Homestead	1.0	2,750
Air EPP objective		**11,000**	**11,000**

6.8 Other air pollutants

The predicted ground-level concentrations of beryllium, boron, fluoride and sulphuric acid due to the power station are presented in Table 29. The results show that:

- Concentrations are predicted to be well below all relevant objectives at all sensitive receptor locations

Ground-level concentrations of the following air pollutants were predicted to be less than 0.1% of their respective objectives at all sensitive receptors:

- Arsenic
- Cadmium
- Chromium (III) and Chromium (VI)
- Cobalt
- Copper
- Cumene
- Lead
- Manganese
- Mercury
- Nickel
- Zinc

Table 29 Predicted ground-level concentration of Air Toxics as a percentage of the air quality objective (µg/m^3)

Receptor		Beryllium	Boron			Fluoride			Sulfuric Acid
ID	Name	99.9th %ile 1-hour	Max 1-hour	Max 24-hour	Annual average	Max 24-hour	Max 30-day	Max 90-day	Max 1-hour
R1	Moonoomoo Homestead	4.1%	2.4%	0.1%	0.3%	27.4%	21.6%	27.6%	9.4%
R2	Dooyne Outstation	2.4%	0.9%	<0.1%	<0.1%	14.2%	4.2%	3.6%	3.8%
R3	Carmichael Homestead	3.4%	1.6%	<0.1%	0.2%	20.0%	16.4%	21.4%	6.3%
R4	Old Hyde Park Homestead	1.3%	1.4%	<0.1%	<0.1%	8.1%	2.9%	2.3%	5.7%
R5	Bowie Homestead	3.3%	1.5%	<0.1%	0.2%	18.9%	16.6%	16.9%	6.0%
R6	Hyde Park Homestead	1.3%	0.5%	<0.1%	<0.1%	7.5%	2.5%	2.0%	2.0%
R7	CCM&RP Accommodation Village	0.9%	1.4%	<0.1%	<0.1%	9.1%	2.7%	2.1%	5.5%
R8	Doongmabulla Homestead	1.6%	0.8%	<0.1%	<0.1%	13.3%	6.2%	6.1%	3.2%
R9	Ulcanbah Homestead	1.9%	0.6%	<0.1%	0.1%	14.0%	9.1%	9.8%	2.5%
R10	Kyong Homestead	2.0%	1.1%	<0.1%	<0.1%	11.3%	7.0%	7.3%	4.4%
R11	Scott Homestead	1.7%	1.1%	<0.1%	0.1%	11.8%	10.2%	12.9%	4.3%
R12	Ronlow Park Homestead	1.6%	0.8%	<0.1%	<0.1%	10.9%	6.2%	7.0%	3.0%
R13	Bulliwallah Homestead	0.4%	0.2%	<0.1%	<0.1%	2.7%	0.9%	0.8%	0.7%
R14	Moray Downs Homestead	0.6%	0.2%	<0.1%	<0.1%	5.5%	1.2%	1.0%	0.9%
R15	Yarrowmere Homestead	0.8%	0.2%	<0.1%	<0.1%	5.0%	2.5%	3.1%	0.9%
R16	Plain Creek Homestead	0.4%	0.2%	<0.1%	<0.1%	3.3%	0.9%	0.6%	0.6%
Air EPP objective		**0.004**	**50**	**120**	**5**	**1.5**	**0.4**	**0.25**	**18**

6.9 Odour

Underground coal mines are ventilated to ensure that coal seam gases do not build up and become hazardous. At some coal mines in the Hunter Valley in NSW, the ventilation air from underground coal mines has been investigated as a possible source of odour annoyance at residential areas nearby. Sampling and analysis has been undertaken to quantify odour emission rates and odour concentrations. Detailed odour impact assessment studies (Holmes Air Sciences, 2003) have concluded that mine ventilation emissions are not likely to cause elevated odour levels. The distance of 7.5 km between the closest part of the underground mining areas and the closest sensitive receptor means that potential odour impacts from ventilation are extremely unlikely for the project.

6.10 Visibility

As noted in Section 2.3, meeting the air quality objectives in the Air EPP (designed for health and amenity) will also protect against problems associated with visible dust because, at levels equivalent to the Air EPP objectives, dust is essentially invisible. The preceding sections have confirmed that dust emissions from the project, even when considered with existing background dust levels, are not predicted to give rise to any exceedances of air quality objectives at sensitive receptors. The project is consequently not predicted to give rise to visible dust that could be a hazard at sensitive receptors.

7. CUMULATIVE IMPACTS

The CCM&RP is a proposed open cut and underground coal mine located to the immediate southeast of the project site. The Moray Power Station (MPS) is proposed to provide power for the CCM&RP and is located adjacent to the CCM&RP, approximately 23 km to the southeast of the project site. As the CCM&RP and MPS are proposed to be operating at the same time as the project, a cumulative assessment has been conducted. PM_{10} concentrations from CCM&RP have been determined from the CCM&RP SEIS Report, as described in Section 4.5. PM_{10} and NO_2 concentrations from MPS have been determined from the MPS Report, as described in Section 4.6.

7.1 Particulates as PM_{10}

The cumulative assessment is based on the 6^{th} highest predicted 24-hour average concentration of PM_{10} from the project added to the maximum prediction from the CCM&RP SEIS Report and MPS Report including background concentrations. This is a conservative assessment because worst-case operational years of the project and CCM&RP have been assumed for the purpose of the cumulative assessment to occur at the same time, but this is not likely to be the case in reality. The CCM&RP SEIS Report modelled Year 2025, indicative of activities occurring between 2025 and 2029. This air quality assessment of the project has modelled Project Year 20, which is estimated to occur in 2035 assuming operations beginning in 2016.

The cumulative predicted PM_{10} concentrations are presented in Table 30. The results show that:

- Predicted cumulative concentrations of PM_{10} are below the Air EPP objective of 50 µg/m³ at all receptors except for Dooyne Outstation and the CCM&RP Accommodation Village; and
- Whilst the cumulative concentrations of PM_{10} are above the Air EPP objective of 50 µg/m³ at Dooyne Outstation and the CCM&RP Accommodation Village the contribution of the project to the cumulative impact is minor at the Dooyne Outstation (11.4%) and the CCM&RP Accommodation Village (2.8%).

Table 30 Predicted cumulative 24-hour average concentrations of PM_{10}, including the project, the CCM&RP and ambient background

Receptor		Project Year 20 including power station, CCM&RP, MPS with ambient background (µg/m³)	Contribution to predicted dust level (%)			
ID	Name		Project Year 20 including power station	CCM&RP	MPS	Ambient background
R1	Moonoomoo Homestead	46.3	39.3	19.4	0.6	40.6
R2	Dooyne Outstation	65.6	11.4	59.5	0.5	28.7
R3	Carmichael Homestead	45.3	23.4	34.5	0.7	41.5
R4	Old Hyde Park Homestead	41.2	7.5	46.1	0.7	45.6
R5	Bowie Homestead	37.5	25.2	24.0	0.8	50.1
R6	Hyde Park Homestead	30.2	6.9	29.8	1.0	62.3
R7	CCM&RP Accommodation Village	65.2	2.8	65.2	3.1	28.9
R8	Doongmabulla Homestead	49.3	9.2	52.1	0.6	38.1
R9	Ulcanbah Homestead	33.2	15.3	27.1	0.9	56.6
R10	Kyong Homestead	32.6	13.7	27.6	0.9	57.7
R11	Scott Homestead	33.9	17.0	26.6	0.9	55.5

Receptor		Project Year 20 including power station, CCM&RP, MPS with ambient background (µg/m³)	Contribution to predicted dust level (%)			
ID	Name		Project Year 20 including power station	CCM& RP	MPS	Ambient backgroun d
R12	Ronlow Park Homestead	32.4	13.4	27.7	0.9	58.0
R13	Bulliwallah Homestead	28.6	1.8	31.4	1.0	65.7
R14	Moray Downs Homestead	39.8	1.9	50.5	0.3	47.3
R15	Yarrowmere Homestead	29.7	5.2	30.3	1.0	63.4
R16	Plain Creek Homestead	28.5	1.4	31.6	1.1	66.0
Air EPP objective		**50**	-			

7.2 Nitrogen dioxide

The cumulative assessment of NO_2 has been based on the maximum predicted 1-hour average concentration of NO_2 from the project added to the maximum prediction from the MPS Report and including regional background concentrations. This is a conservative assessment because it is based on the assumption that the maximum 1-hour concentrations occur at same time, but this is not likely to be the case in reality due to the location of the power stations relative to the sensitive receptors and prevailing winds.

The cumulative predicted NO_2 concentrations are presented in Table 31. The results show that the predicted cumulative maximum 1-hour average concentrations of NO_2 are well below the Air EPP objective of 250 µg/m³ at all receptors.

Table 31 Predicted cumulative 1-hour average concentrations of NO_2, including the project, Moray Power Station and ambient background

Receptor		Project (including power station), and MPS with ambient background (µg/m³)	Contribution to predicted dust level (%)		
ID	Name		Project (including power station)	MPS	Ambient background
R1	Moonoomoo Homestead	119	31.0	15.6	53.4
R2	Dooyne Outstation	97	15.3	19.2	65.5
R3	Carmichael Homestead	107	23.0	17.4	59.6
R4	Old Hyde Park Homestead	104	21.3	17.8	60.9
R5	Bowie Homestead	106	22.3	17.6	60.1
R6	Hyde Park Homestead	90	8.6	20.7	70.7
R7	CCM&RP Accommodation Village	198	10.9	57.0	32.1
R8	Doongmabulla Homestead	91	13.7	16.3	70.0
R9	Ulcanbah Homestead	92	10.7	20.2	69.1
R10	Kyong Homestead	99	17.2	18.7	64.0
R11	Scott Homestead	99	17.0	18.8	64.2
R12	Ronlow Park Homestead	94	12.6	19.8	67.6
R13	Bulliwallah Homestead	85	3.3	21.9	74.8

Receptor		Project (including power station), and MPS with ambient background (µg/m³)	Contribution to predicted dust level (%)		
ID	Name		Project (including power station)	MPS	Ambient background
R14	Moray Downs Homestead	75	4.7	10.1	85.3
R15	Yarrowmere Homestead	86	4.3	21.6	74.0
R16	Plain Creek Homestead	85	2.9	22.0	75.1
Air EPP objective		**250**	**-**		

8. DUST IMPACT MITIGATION MEASURES

The following key measures to control and manage dust emissions and minimise the potential impact of the project are proposed:

- Haul roads will be watered to minimise dust emissions;
- Inactive disturbed areas will be rehabilitated as soon as possible; and
- Electrostatic precipitators will be installed on the power station to minimise emissions of particulate matter.

Further a meteorological station will also be installed for the project site. This station will utilise a continuous monitor to collect ambient data such as rainfall, temperature, relative humidity, wind speeds and wind direction. Data from this station will provide suitable meteorological data for the project.

The proponent will also develop and maintain a complaints handling procedure. The procedure will include the investigation of any complaints in relation to air quality impacts. These investigations would include air quality monitoring, if necessary.

9. GREENHOUSE GAS ASSESSMENT

9.1 Introduction

The EIS Terms of Reference requires that the air quality assessment provide an inventory of projected annual emissions for the life of the mine for each relevant greenhouse gas, with total emissions expressed in 'CO_2 equivalent' terms for Scope 1 and Scope 2 emissions. Scope 1 emissions result predominantly from coal combustion for power generation as well as fugitive methane emissions from coal extraction and diesel usage for site equipment and vehicles and back-up diesel generators. Grid electricity will not be used on-site and as a result there will be no Scope 2 emissions relevant to the project.

Accordingly Scope 1 GHG emissions associated with the project have been estimated for each year of operations. A summary of estimated emissions, expressed as tonnes per annum of CO_2 equivalent ($CO_{2\text{-}e}$) is presented. Reporting obligations based on conservative estimates of annual GHG emissions are summarised, along with measures to mitigate GHG emissions through avoidance and minimisation.

GHG emissions and storage associated with both land clearing offset by progressive rehabilitation of the mine site are summarised in Section 9.4.1.

9.2 Greenhouse gas emission estimation methodology

The methodologies used to estimate the GHG emissions resulting from the Project are consistent with:

- *National Greenhouse and Energy Reporting (NGER) (Measurement) Determination 2008* (NGER Determination);
- The National Greenhouse Accounts, July 2013 (DIICCSCRTE, 2013); and
- The Greenhouse Gas Protocol.

In particular, the methodology is generally consistent with a Method 1 approach as detailed in the NGER Determination.

Greenhouse gases considered for this assessment and their associated global warming potential (GWP) are summarised in Table 32.

Table 32 Greenhouse gases and their Global Warming Potential

Greenhouse Gas	Chemical formula	GWP
Carbon Dioxide	CO_2	1
Methane	CH_4	21
Nitrous oxide	N_2O	310
Sulphur Hexafluoride	SF_6	23,900
Table notes: Source- NGA Factors July 2013,		

9.2.1 Coal combustion

GHG emissions resulting from the combustion of coal for power generation have been estimated using a methodology consistent with a Method 2 approach (*Division 2.2.3 Method 2 – emissions from solid fuels*) for CO_2 and a Method 1 approach for CH_4 and N_2O (*Division 2.2.2 - Method 1—emissions of carbon dioxide, methane and nitrous oxide from solid fuels*). The Method 2 approach used to estimate CO_2 emissions is based on the following equation. An effective Emissions Factor (EF) for CO_2 has been estimated based on this approach, listed in Table 33.

$$E_{ico_2} = \frac{Q_i \times EC_i \times EF_{ico_2oxec}}{1\,000} - \gamma RCCS_{co_2}$$

where:

E_{ico_2}	emissions of carbon dioxide released from the combustion of fuel type (***i***) from the operation of the facility during the year measured in CO_2-e tonnes.
Q_i	quantity of fuel type (***i***) measured in tonnes.
EC_i	energy content factor of fuel type ***(i)***
EF_{ico_2oxec}	carbon dioxide emission factor for fuel type (***i***) measured in kilograms of CO_2-e per gigajoule.
γ	factor 1.861 × 10^{-3} for converting a quantity of carbon dioxide from cubic metres at standard conditions of pressure and temperature to CO_2-e tonnes.
$RCCS_{CO_2}$	carbon dioxide captured for permanent storage measured in cubic metres

The Method 1 approach used to estimate CH_4 and N_2O emissions is based on the following equation.

$$E_{ij} = \frac{Q_i \times EC_i \times EF_{ijoxec}}{1\,000}$$

where:

E_{ij}	emissions of gas type (***j***), being carbon dioxide, methane or nitrous oxide, released from the combustion of fuel type (***i***) from the operation of the facility during the year measured in CO_2-e tonnes.
Q_i	quantity of fuel type ***(i)*** measured in tonnes.
EC_i	energy content factor of fuel type ***(i)***.
EF_{ijoxec}	emission factor for each gas type (***j***) (which includes the effect of an oxidation factor) released from the combustion of fuel type (***i***) measured in kilograms of CO_2-e per gigajoule.

9.2.2 Diesel combustion

GHG emissions relating to diesel combustion have been calculated based on a Method 1 approach as detailed in NGER Determination (*Division 2.4.2 Method 1 – emissions of carbon dioxide, methane and nitrous oxide from liquid fuels other than petroleum based oils or greases*), based on the following equation.

$$E_{ij} = \frac{Q_i \times EC_i \times EF_{ijoxec}}{1000}$$

where:

E_{ij}	emissions of gas type (***j***) being CO_2, CH_4 or N_2O released from the combustion of fuel type (***i***) measured in tonnes CO_2-e (tCO_2-e).
Q_i	quantity of fuel type (i) measured in kilolitres
EC_i	energy content factor for fuel type (i)
EF_{ijoxec}	emission factor for each gas type (j) measured in $kgCO_2$-e/GJ of fuel type (i)

9.2.3 Land clearing

The carbon loss attributable to land clearing associated with the project has been calculated using the simplified equation, based on Equation 2.16, Volume 4 (IPCC, 2006):

$$C_{LOSS} = (B_{AFTER} - B_{BEFORE})\ x\ A\ x\ CF$$

C_{LOSS}	Carbon loss associated with clearing (tC/yr)
B_{AFTER}	Biomass stock on land immediately after clearing (tonnes d.m. (dry matter)/ha)
B_{BEFORE}	Biomass stock on land immediately before clearing (tonnes d.m./ha)
A	Area of land being converted
CF	Carbon fraction of dry matter (tC/tonnes d.m.)

The following assumptions have been made to provide an estimation of GHG emissions associated with land clearing:

- The ecological zone for the project area has been determined as 'Asia/Oceania Continental – Subtropical steppe/Tropical shrubland', equal to a biomass stock level of 60 tonnes d.m./ha. (IPCC, 2006, Table 4.7 (Chapter 4, Forest Land) and Australia Pacific LNG, 2010)
- The regrowth of rehabilitated forest has been determined to occur at a rate of 5 tonnes d.m./ha based on classification of the project area 'Asia/Oceania Continental – Subtropical steppe/Tropical shrubland', consistent with land clearing (IPCC, 2006, Table 4.9 (Chapter 4, Forest Land))
- In order to make a conservative estimate, the biomass stock on land immediately after clearing has been determined to equal zero, assuming complete clearing of the mine site areas.
- The carbon fraction of dry matter is 0.47 in line with the default value for forest land (IPCC, 2006, Table 4.3 (Volume 4))

9.3 Greenhouse gas emission factors

EF and energy content factors used for this assessment are summarised in Table 33.

Table 33 Emission factor summary (Schedule 1, NGER Determination)

Emission source description	Energy content	Units	EF CO_2	EF CH_4	EF N_2O	EF CO_2-e	Units
Coal combustion	15[1]	GJ/t	83.2[2]	0.06	0.3	93.0	kgCO_2-e/GJ
Diesel	38.6	GJ/kL	69.2	0.1	0.2	69.5	kgCO_2-e/GJ
Extraction of coal (Open cut)	-	-	-	-	-	0.017	tCO_2-e/tROM
Extraction of coal (Underground)	-	-	-	-	-	0.008	tCO_2-e/tROM

Table notes:
[1] Conservative assumption for by-product coal in similar applications
[2] Effective EF calculated based on a NGER Determination Method 2 approach

9.4 Greenhouse gas emissions

GHG emission sources for the project operating phase will be:

- Coal for power generation. Coal from the mine will be the fuel source for the power station;
- Fugitive emission resulting from extraction of coal from open cut and underground operations;
- Diesel usage for site equipment and vehicles ;
- Land clearing offset by progressive rehabilitation of previously cleared areas. The majority of land clearing is associated with the open-cut mine and mine infrastructure areas of the project (Section 9.4.1); and
- A small amount of fugitive SF_6 emissions will occur from switch-gear and transformer applications, GHG emission associated with SF_6 have been estimated and are insignificant in comparison to annual project emissions, on this basis these emissions have been excluded from the assessment.

GHG emissions sources for the project are summarised in Appendix F.

A summary of anticipated annual GHG emissions and energy consumption and production are summarised in Table 34 and Table 35, respectively. For comparative purposes the latest GHG inventory estimates for Australia and Queensland (excluding emissions from Land Use, Land Use Change and Forestry (LULUCF)) are 557 $MtCO_2$-e and 155.5 $MtCO_2$-e, respectively (Commonwealth of Australia, 2013a and Commonwealth of Australia, 2013b).

Table 34 Summary of annual Scope 1 GHG emissions for the project

Project Year	Diesel O/C	Diesel U/G	Fugitive emissions	Power Station	Land clearing/ regrowth	TOTAL	Carbon Intensity	
	$ktCO_2$-e	$ktCO_2$-e	$ktCO_2$-e	$ktCO_2$-e	$ktCO_2$-e	$ktCO_2$-e	tCO_2-e/ tproduct[1]	$kgCO_2$-e/ kWh
Year 1	254	0	-	-	269	522	-	-
Year 2	423	1	1	-	-	424	-	-
Year 3	613	6	328	-	-	947	0.09	-
Year 4	385	11	498	1,903	-	2,798	0.16	0.98
Year 5	369	16	653	3,806	234	5,079	0.16	0.98
Year 6	392	20	671	5,710	(2)	6,791	0.21	0.98
Year 7	409	20	686	5,710	(2)	6,823	0.20	0.98
Year 8	359	20	721	5,710	(2)	6,807	0.18	0.98
Year 9	378	20	725	5,710	(2)	6,830	0.18	0.98
Year 10	400	20	726	5,710	134	6,989	0.19	0.98

Project Year	Diesel O/C	Diesel U/G	Fugitive emissions	Power Station	Land clearing/ regrowth	TOTAL	Carbon Intensity	
	$ktCO_2$-e	$ktCO_2$-e	$ktCO_2$-e	$ktCO_2$-e	$ktCO_2$-e	$ktCO_2$-e	tCO_2-e/ tproduct[1]	$kgCO_2$-e/ kWh
Year 11	400	20	725	5,710	(5)	6,849	0.18	0.98
Year 12	407	20	724	5,710	(5)	6,855	0.18	0.98
Year 13	407	20	723	5,710	(5)	6,853	0.19	0.98
Year 14	407	20	719	5,710	(5)	6,850	0.19	0.98
Year 15	407	20	716	5,710	67	6,918	0.19	0.98
Year 16	407	15	595	5,710	(8)	6,718	0.23	0.98
Year 17	431	15	595	5,710	(6)	6,744	0.23	0.98
Year 18	431	15	580	5,710	(6)	6,728	0.24	0.98
Year 19	431	15	545	5,710	(6)	6,693	0.25	0.98
Year 20	431	15	545	5,710	141	6,840	0.25	0.98
Year 21	370	15	545	5,710	(16)	6,623	0.25	0.98
Year 22	370	15	544	5,710	(12)	6,626	0.25	0.98
Year 23	370	15	544	5,710	(12)	6,626	0.25	0.98
Year 24	370	15	545	5,710	(12)	6,627	0.25	0.98
Year 25	370	15	522	5,710	(12)	6,604	0.25	0.98
Year 26	370	15	442	5,710	(12)	6,524	0.28	0.98
Year 27	370	15	391	5,710	(10)	6,476	0.31	0.98
Year 28	337	15	295	5,710	(10)	6,346	0.37	0.98
Year 29	322	15	301	5,710	(10)	6,337	0.37	0.98
Year 30	125	15	278	5,710	75	6,202	0.38	0.98
Year 31	154	15	289	5,710	(13)	6,154	0.36	0.98
Year 32	30	15	64	2,867	(4)	2,973	0.53	0.98

Project Year	Diesel O/C	Diesel U/G	Fugitive emissions	Power Station	Land clearing/ regrowth	TOTAL	Carbon Intensity	
	$ktCO_2$-e	$ktCO_2$-e	$ktCO_2$-e	$ktCO_2$-e	$ktCO_2$-e	$ktCO_2$-e	tCO_2-e/ tproduct[1]	$kgCO_2$-e/ kWh
Year 33	30	15	60	2,867	(4)	2,968	0.57	0.98
Year 34	30	15	61	2,867	(4)	2,969	0.56	0.98
Year 35	13	15	60	2,867	(4)	2,951	0.57	0.98
Year 36	13	15	60	2,867	(4)	2,952	0.57	0.98
Year 37	13	15	59	2,867	(4)	2,951	0.58	0.98
Year 38	13	15	59	2,867	(4)	2,951	0.58	0.98
Year 39	13	15	60	2,867	(4)	2,951	0.57	0.98
Year 40	13	15	59	2,867	(4)	2,951	0.58	0.98
Year 41	13	15	59	2,867	(4)	2,951	0.58	0.98
Year 42	13	15	60	2,867	-	2,955	0.57	0.98
Year 43	13	15	59	2,867	-	2,955	0.58	0.98
Year 44	13	15	59	2,867	-	2,955	0.58	0.98
Year 45	13	15	60	2,867	-	2,955	0.57	0.98
Year 46	13	15	59	2,867	-	2,955	0.58	0.98
Year 47	13	15	59	2,867	-	2,954	0.58	0.98
Year 48	13	15	58	-	-	86	0.00	0.00
Year 49	13	15	49	-	-	77	0.00	0.00
TOTALS	**11,952**	**735**	**17,238**	**200,036**	**705**	**230,666**	**0.36**	**0.98**

The majority of GHG emissions associated with the project are related to the combustion of coal in the power station, this is further illustrated in Figure 9 summarising the total project emissions by source category.

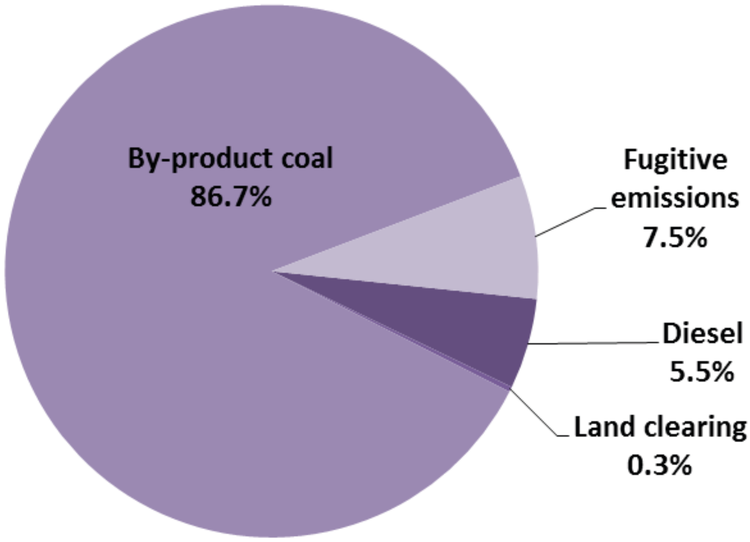

Figure 9 Project GHG emissions by source category

Table 35 Summary of annual energy consumption for the project

Production Year	Consumption			TOTAL	Energy Intensity
	Diesel O/C	Diesel U/G	Coal	Consumed	
	TJ	TJ	TJ	TJ	GJ/t product
Year 1	3,420	1	-	3,420	-
Year 2	5,699	9	-	5,708	-
Year 3	8,263	86	-	8,348	0.78
Year 4	5,193	151	22,815	28,159	1.66
Year 5	4,975	220	45,630	50,825	1.64
Year 6	5,287	266	68,445	73,998	2.27
Year 7	5,515	266	68,445	74,226	2.19
Year 8	4,831	266	68,445	73,542	1.99
Year 9	5,086	266	68,445	73,797	1.98
Year 10	5,388	266	68,445	74,098	1.98
Year 11	5,393	266	68,445	74,103	1.99
Year 12	5,482	266	68,445	74,193	2.00
Year 13	5,482	266	68,445	74,193	2.00
Year 14	5,482	266	68,445	74,193	2.02
Year 15	5,482	266	68,445	74,193	2.03
Year 16	5,482	199	68,445	74,126	2.57
Year 17	5,800	199	68,445	74,444	2.58
Year 18	5,800	199	68,445	74,444	2.63
Year 19	5,800	199	68,445	74,444	2.77
Year 20	5,800	199	68,445	74,444	2.77
Year 21	4,982	199	68,445	73,627	2.74
Year 22	4,982	199	68,445	73,627	2.74
Year 23	4,982	199	68,445	73,627	2.74
Year 24	4,982	199	68,445	73,627	2.73
Year 25	4,982	199	68,445	73,627	2.83
Year 26	4,982	199	68,445	73,627	3.21
Year 27	4,982	199	68,445	73,627	3.52
Year 28	4,533	199	68,445	73,178	4.26
Year 29	4,336	199	68,445	72,980	4.21
Year 30	1,677	199	68,445	70,322	4.27
Year 31	2,078	199	68,445	70,722	4.19
Year 32	401	199	34,375	34,975	6.29
Year 33	401	199	34,375	34,975	6.74
Year 34	401	199	34,375	34,975	6.65
Year 35	177	199	34,375	34,751	6.74
Year 36	177	199	34,375	34,751	6.70
Year 37	177	199	34,375	34,751	6.83
Year 38	177	199	34,375	34,751	6.81

Production Year	Consumption			TOTAL	Energy Intensity
	Diesel O/C	Diesel U/G	Coal	Consumed	
	TJ	TJ	TJ	TJ	GJ/t product
Year 39	177	199	34,375	34,751	6.74
Year 40	177	199	34,375	34,751	6.82
Year 41	177	199	34,375	34,751	6.81
Year 42	177	199	34,375	34,751	6.73
Year 43	177	199	34,375	34,751	6.81
Year 44	177	199	34,375	34,751	6.80
Year 45	177	199	34,375	34,751	6.73
Year 46	177	199	34,375	34,751	6.80
Year 47	177	199	34,375	34,751	6.83
Year 48	177	199	-	376	0.08
Year 49	177	199	-	376	0.09
TOTALS	**161,013**	**9,896**	**2,398,015**	**2,568,925**	**3.90**

9.4.1 GHG emissions from land clearing

Land clearing is necessary for the development of mining operations associated with the project.

Throughout the life of mine, land will be progressively rehabilitated according to a mine rehabilitation program. At the mine closure (Project Year 50), an estimated 257 ktCO_2-e will have been restored over a rehabilitated area of 2,485 ha.

From a carbon storage perspective, regrowth of rehabilitated areas occurs over an estimated period of twelve years to a point that is practically equivalent to the vegetation in place prior to the commencement of the project. As a result, approximately twelve years following finalisation of revegetation programs and subsequent mine closure, the carbon storage associated with rehabilitated areas will be restored to levels equivalent to vegetation in place prior to the commencement of the project. This leads to a position of neutral net GHG emissions taking into account the operational and rehabilitation phases of the project.

GHG emissions associated with land clearing and progressive land rehabilitation are detailed in Appendix F.

9.4.2 NGER obligations

As indicated in Table 34, the estimated annual GHG emissions ranging from 424 ktCO_2-e to 6,989 ktCO_2-e exceed the NGER facility threshold of 25 ktCO_2-e. In addition to this, annual energy consumption and production is estimated to exceed the NGER threshold of 100 TJ in all production years. On a facility basis the proponent would be required to report on GHG emissions and energy use/production for the project in accordance with the NGER Act and supporting legislation.

9.5 Greenhouse gas mitigation strategies

The project has significant energy requirements in terms of diesel and electricity. Any reduction in energy consumption will result in decreased GHG emission while at the same time providing a potential financial incentive. Anticipated initiatives that may mitigate, reduce, control or manage GHG emissions through energy efficiency include:

- Regular assessment, review and evaluation of GHG reduction opportunities;

- Procurement policies that require the selection of energy efficient equipment and vehicles;
- Monitoring and maintenance of equipment in accordance with manufacturer recommendations;
- Optimisation of diesel consumption through logistics analysis and planning; and
- Progressive rehabilitation of land areas to manage and limit the cumulative loss of carbon storage associated with land clearing.

10. CONCLUSIONS

An air quality and greenhouse gas assessment was undertaken to assess the potential impacts from the project. This assessment was conducted in accordance with recognized techniques for dispersion modelling and emission estimation in order to determine potential impacts to identified sensitive receptors and the surrounding environment.

The assessment of dust impacts due to the worst case operations scenario (Project Year 20) was conducted based on a dispersion modelling study that incorporates source characteristics, estimated emissions, local meteorology, terrain, land use and the geographical location of sensitive receptors. Emissions from project operations were estimated using emission factors from the NPI and the USEPA AP-42. The site-specific meteorological dataset was generated by coupling the meteorological models TAPM and CALMET. The CALPUFF model was used to estimate ground-level concentrations of $PM_{2.5}$, PM_{10}, TSP and dust deposition rates at identified sensitive receptors and the surrounding environment.

Key sources of dust emissions due to the project include:

- Wheel generated dust from unpaved haul roads;
- Wind erosion of stockpiles and exposed surfaces;
- Crushing and processing of coal in the CHPP; and
- Transfer of material between conveyors, onto stockpiles and train loading.

The assessment of dust emissions from the project shows that:

- Predicted ground-level concentrations of TSP, PM_{10}, $PM_{2.5}$ and dust deposition, when considered in conjunction with existing ambient background levels, **comply** with the relevant objectives at all sensitive receptors.

The potential for cumulative dust impacts was assessed and it was concluded that the project's contribution to any cumulative dust impacts would be minor, relative to contributions from the adjacent open cut mines. Nevertheless, the proponent will work collaboratively with other project proponents to ensure that cumulative dust impacts do not give rise to significant impacts at sensitive receptors.

The project includes the operation of a coal-fired power station to supply electricity for mine activities. The assessment of emissions to air from the power station shows that the predicted ground-level concentrations of all emitted pollutants comply with the relevant objectives at all sensitive receptors.

The major activity of the project that is associated with the release of greenhouse gases is the burning of coal for power generation. The maximum annual greenhouse gas emission rate due to the project is 6989 kt CO_2-e.

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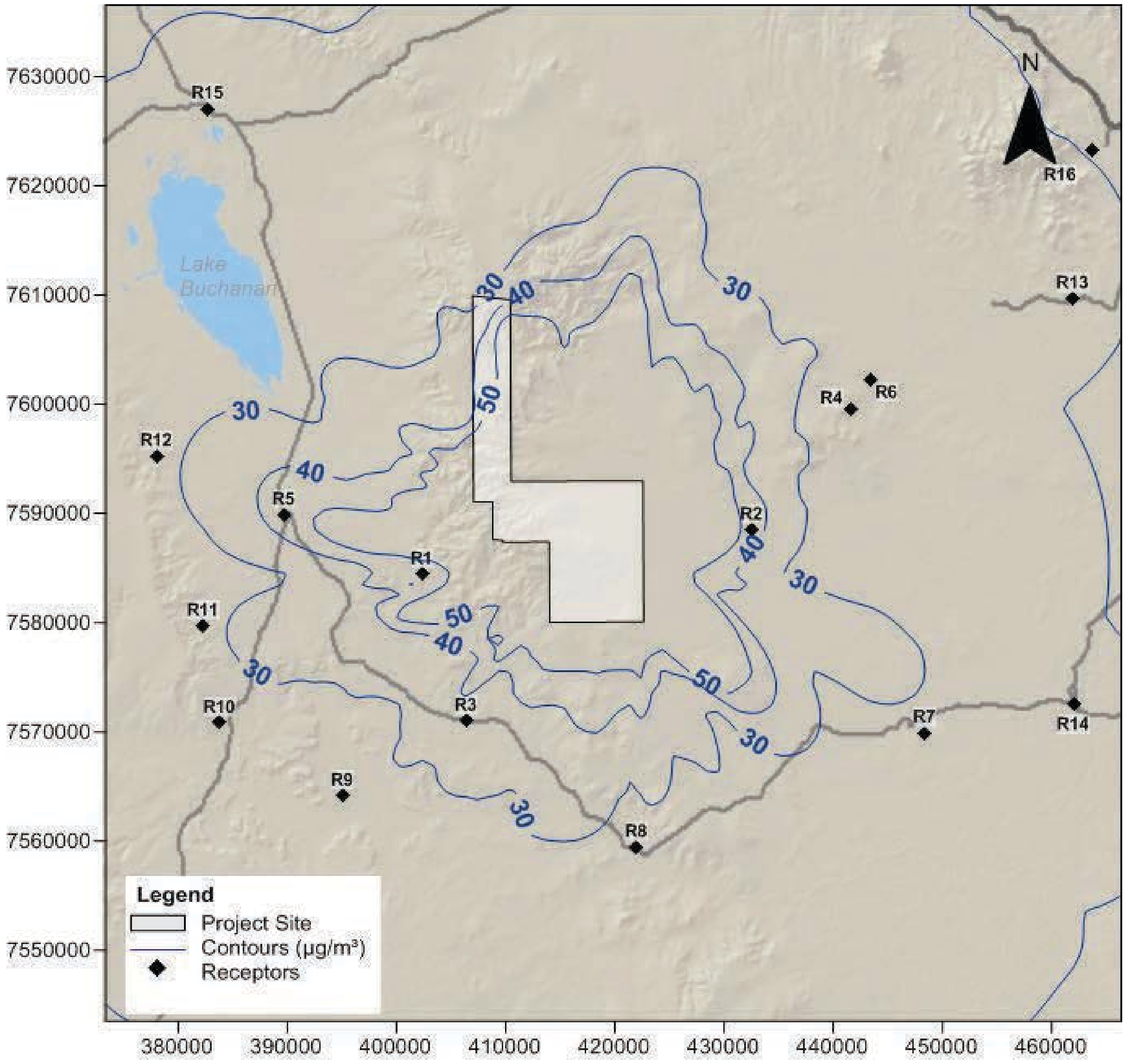

Plate 1	**Predicted maximum 24-hour average ground-level concentrations of PM_{10} due to the project, including the power station and ambient background**

Location:	**Data source:**	**Units:**
Project China Stone, Central Queensland	CALPUFF	µg/m³
Type:	**Prepared by:**	**Date:**
Contour plot	Michael Burchill	August 2014

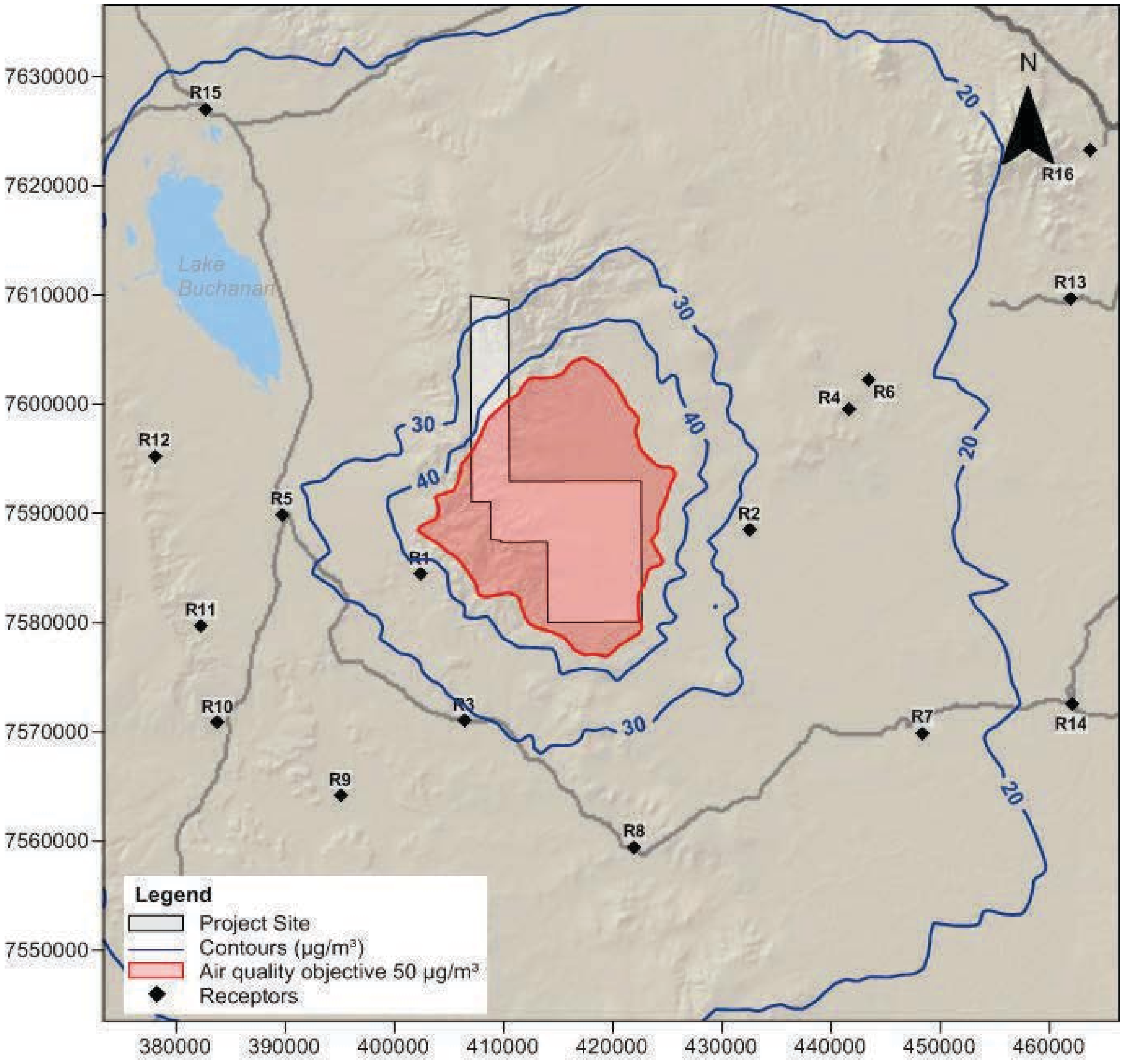

Plate 2	**Predicted 6th highest 24-hour average ground-level concentrations of PM_{10} due to the project, including the power station and ambient background**

Location:	**Data source:**	**Units:**
Project China Stone, Central Queensland	CALPUFF	µg/m³
Type:	**Prepared by:**	**Date:**
Contour plot	Michael Burchill	August 2014

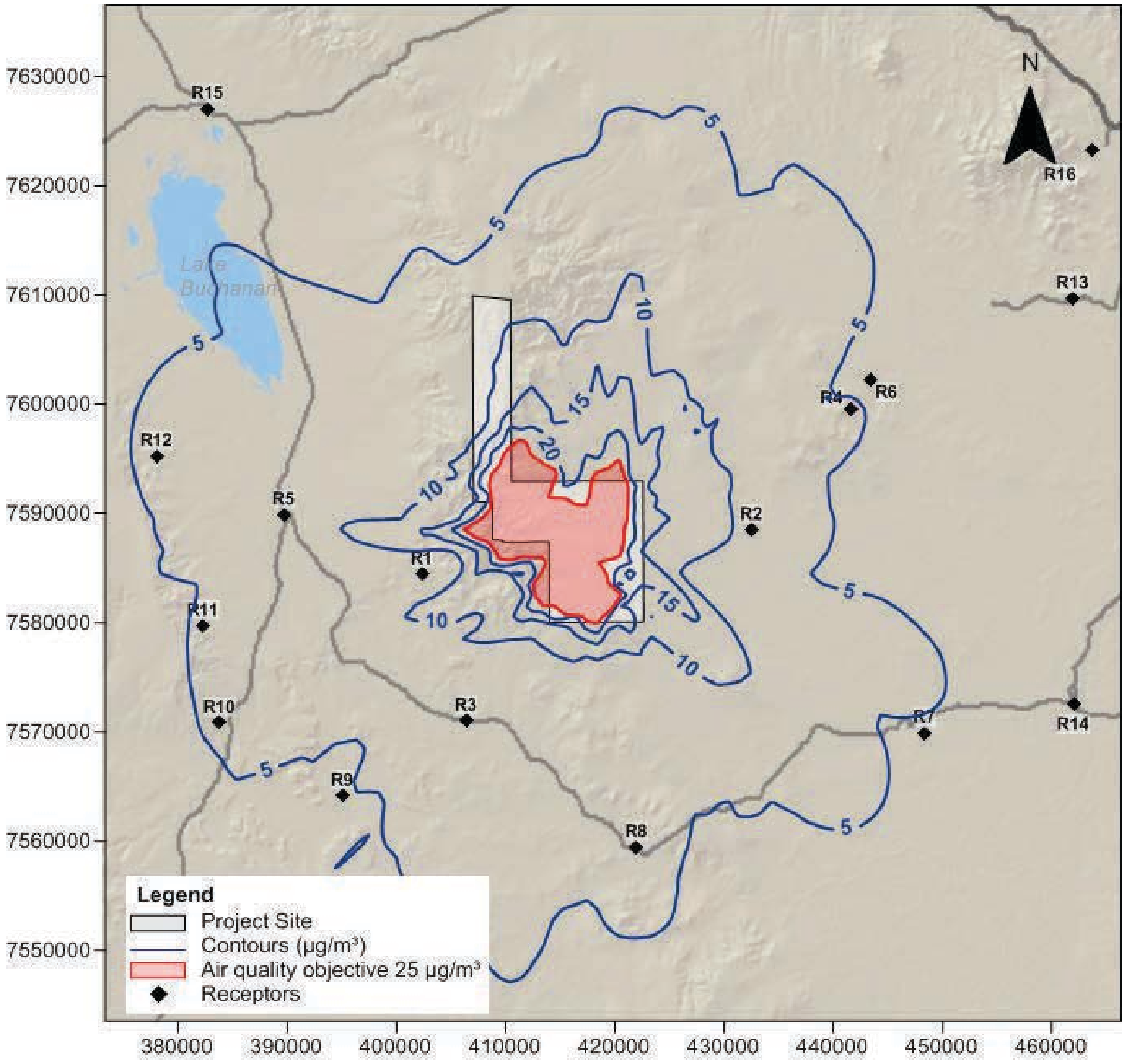

Plate 3	**Predicted maximum 24-hour average ground-level concentrations of $PM_{2.5}$ due to the project, including the power station and ambient background**

Location: Project China Stone, Central Queensland	**Data source:** CALPUFF	**Units:** µg/m³
Type: Contour plot	**Prepared by:** Michael Burchill	**Date:** August 2014

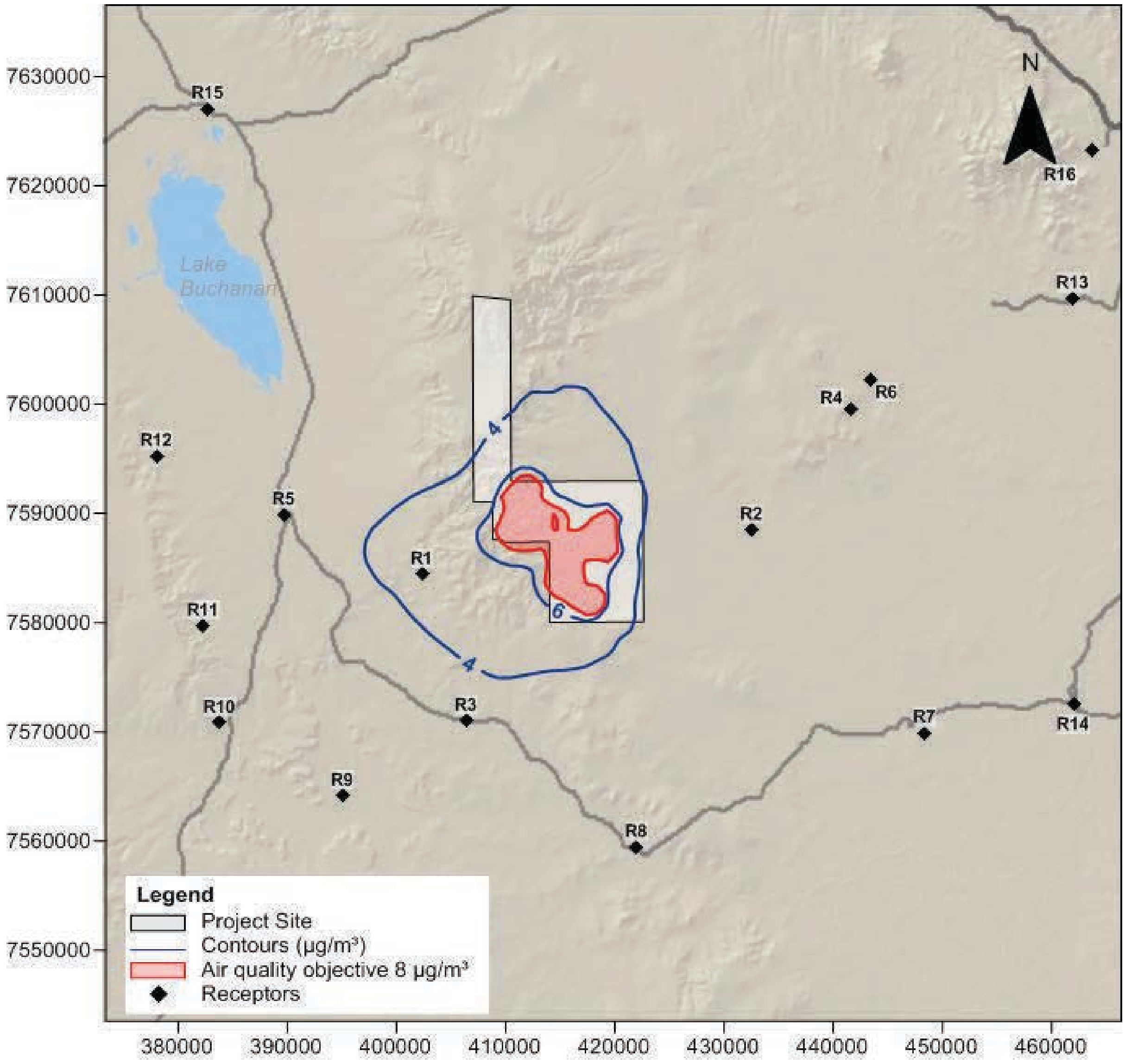

Plate 4	**Predicted annual average ground-level concentrations of $PM_{2.5}$ due to the project, including the power station and ambient background**

Location:	**Data source:**	**Units:**
Project China Stone, Central Queensland	CALPUFF	µg/m³
Type:	**Prepared by:**	**Date:**
Contour plot	Michael Burchill	August 2014

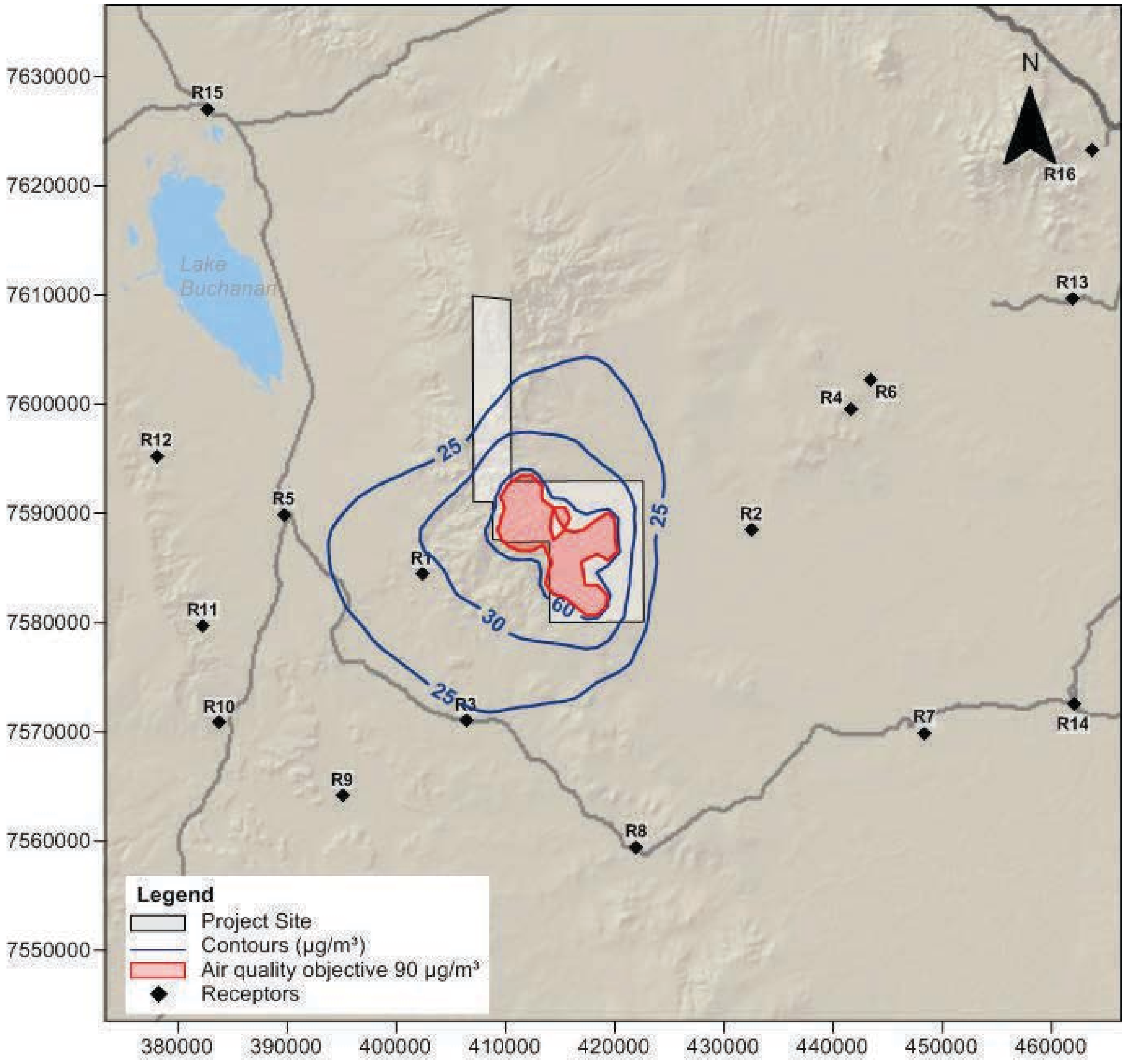

Plate 5	**Predicted annual average ground-level concentrations of TSP due to the project, including the power station and ambient background**

Location:	**Data source:**	**Units:**
Project China Stone, Central Queensland	CALPUFF	µg/m³
Type:	**Prepared by:**	**Date:**
Contour plot	Michael Burchill	August 2014

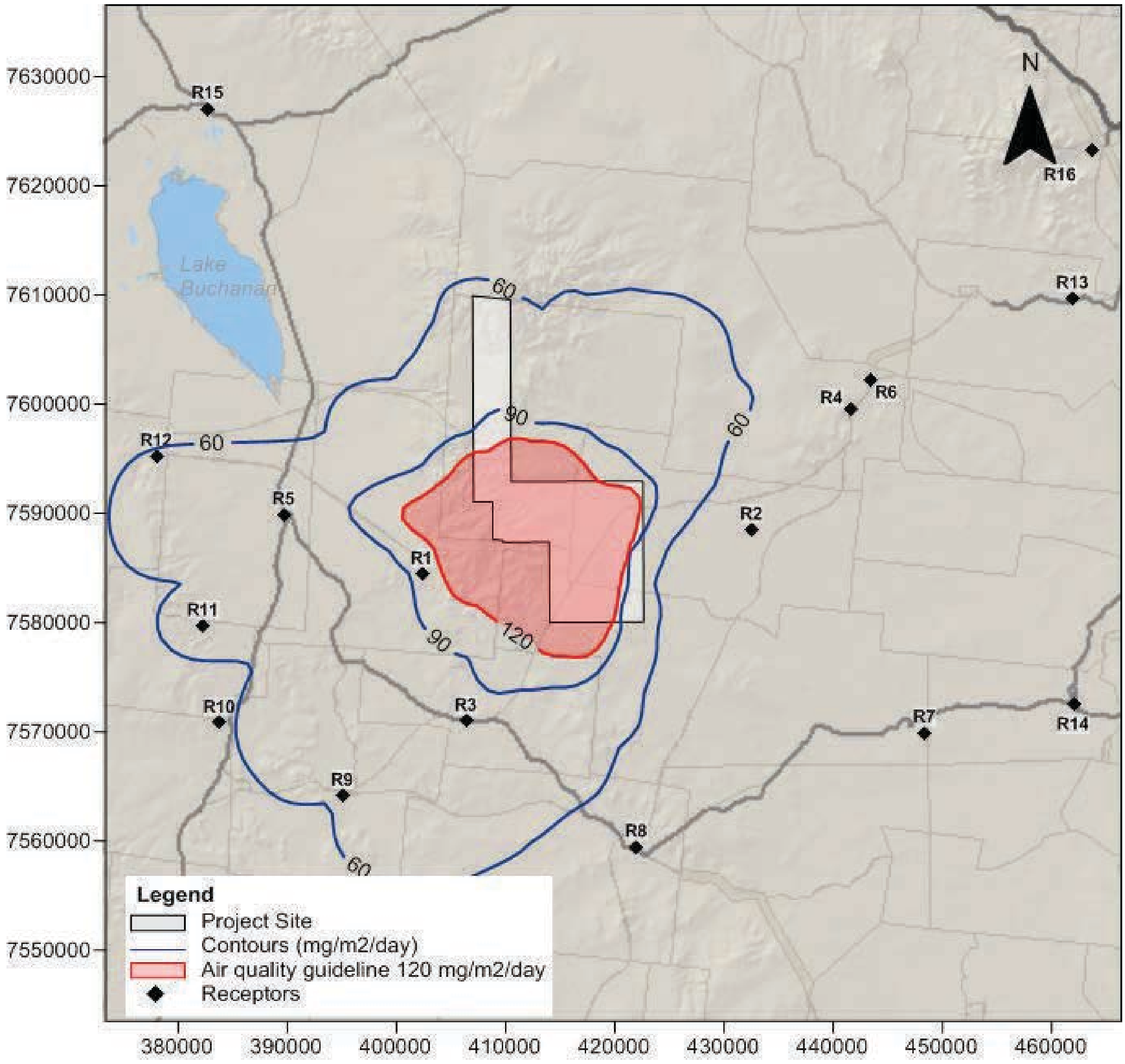

Plate 6	**Predicted maximum monthly dust deposition rates due to the project, including ambient background**	
Location: Project China Stone, Central Queensland	**Data source:** CALPUFF	**Units:** mg/m²/day
Type: Contour plot	**Prepared by:** Michael Burchill	**Date:** August 2014

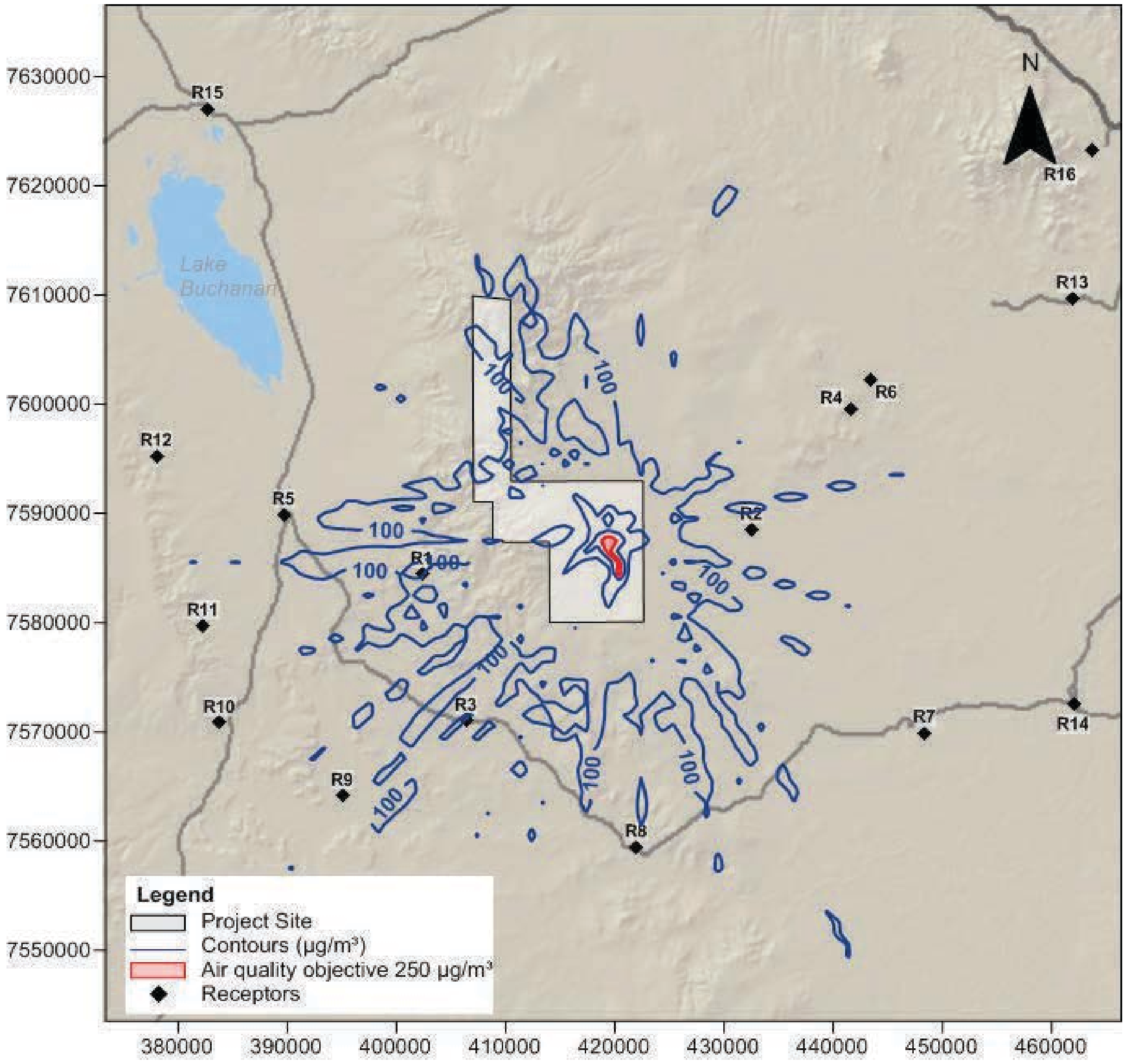

Plate 7	**Predicted maximum 1-hour average ground-level concentrations of NO_2 due to the power station, including ambient background**	
Location: Project China Stone, Central Queensland	**Data source:** CALPUFF	**Units:** µg/m³
Type: Contour plot	**Prepared by:** Michael Burchill	**Date:** August 2014

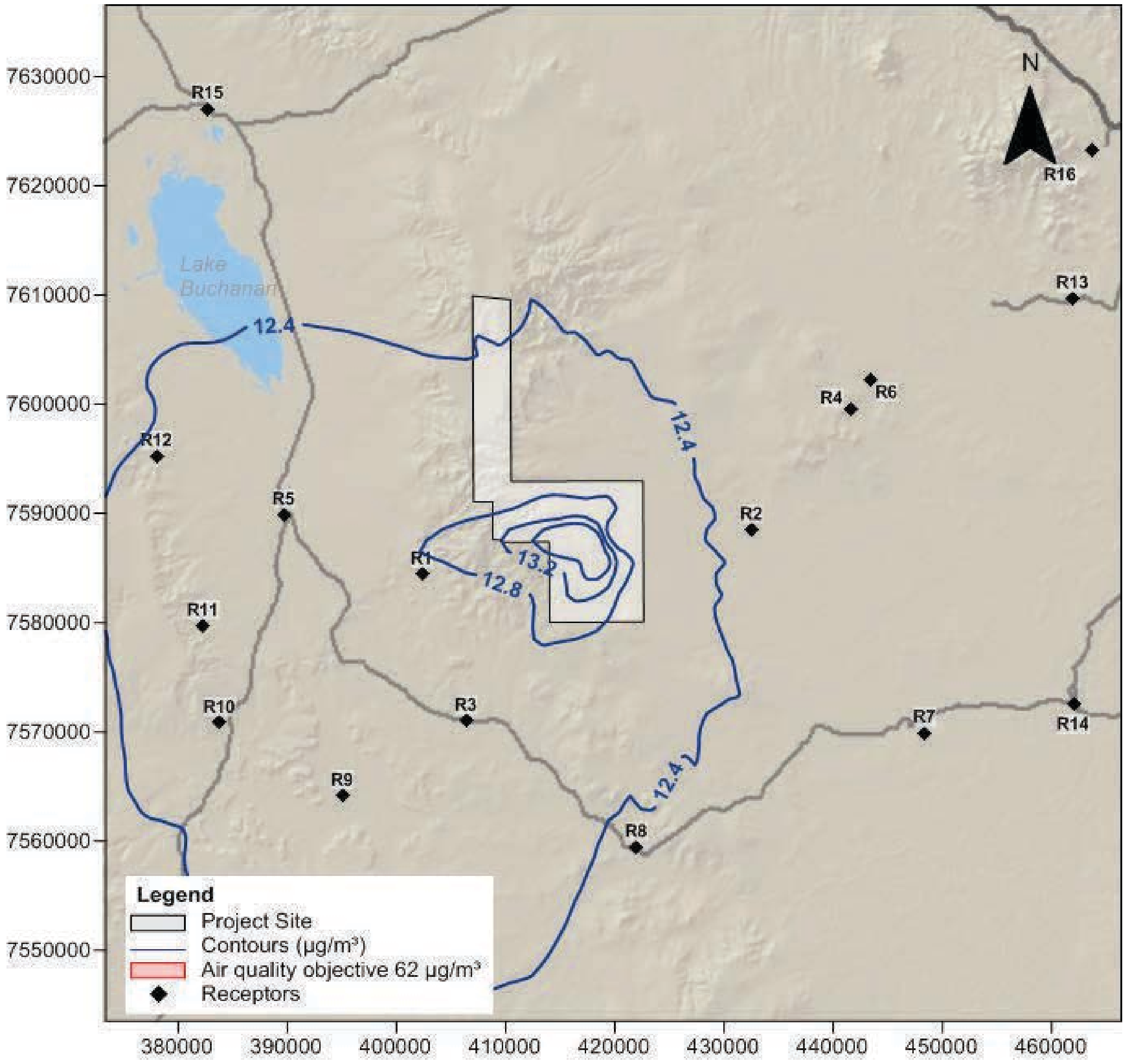

Plate 8	**Predicted annual average ground-level concentrations of NO_2 due to the power station, including ambient background**

Location: Project China Stone, Central Queensland	**Data source:** CALPUFF	**Units:** µg/m³
Type: Contour plot	**Prepared by:** Michael Burchill	**Date:** August 2014

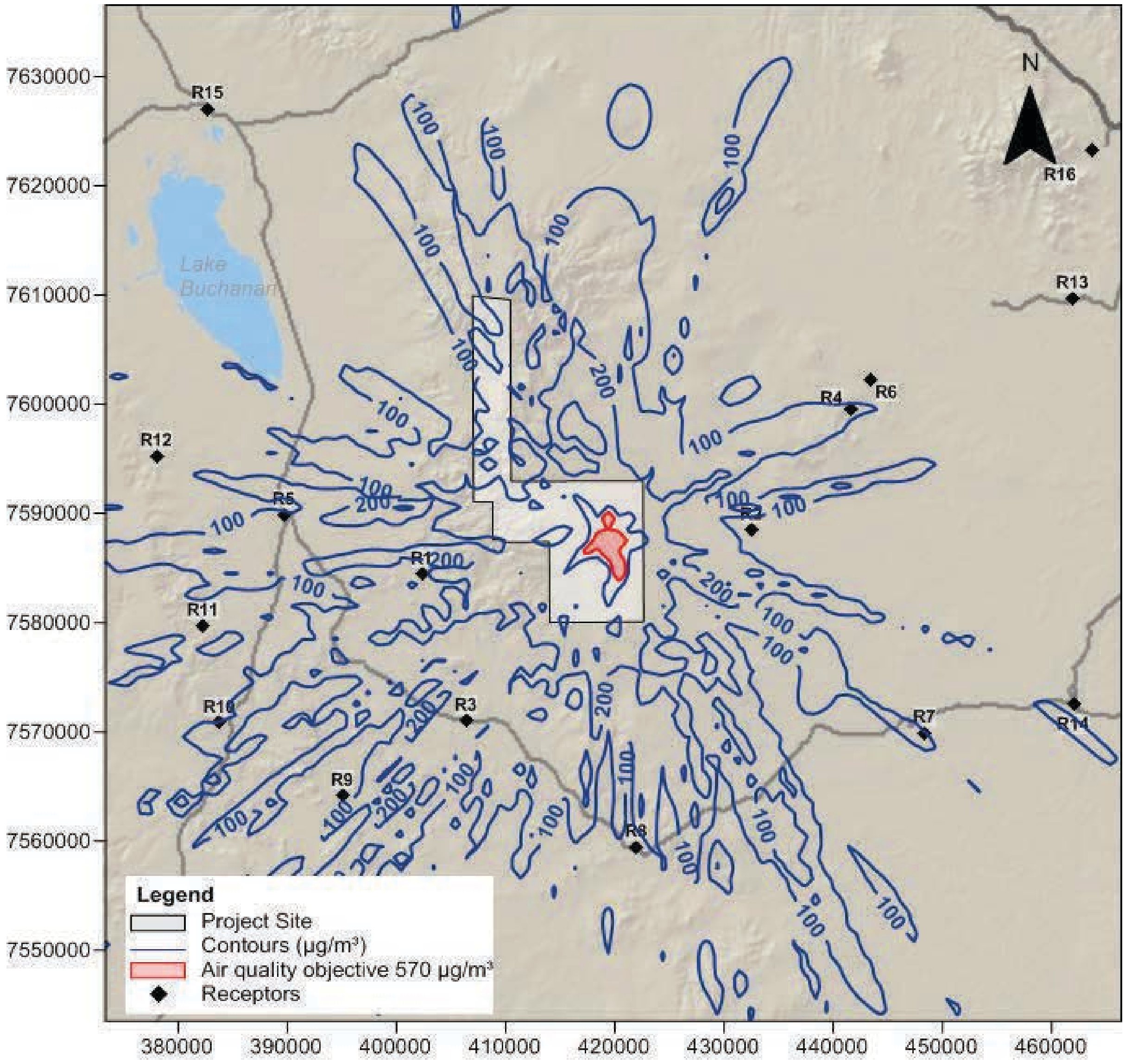

Plate 9	**Predicted 1-hour average ground-level concentrations of SO_2 due to the power station, including ambient background**	
Location: Project China Stone, Central Queensland	**Data source:** CALPUFF	**Units:** µg/m³
Type: Contour plot	**Prepared by:** Michael Burchill	**Date:** August 2014

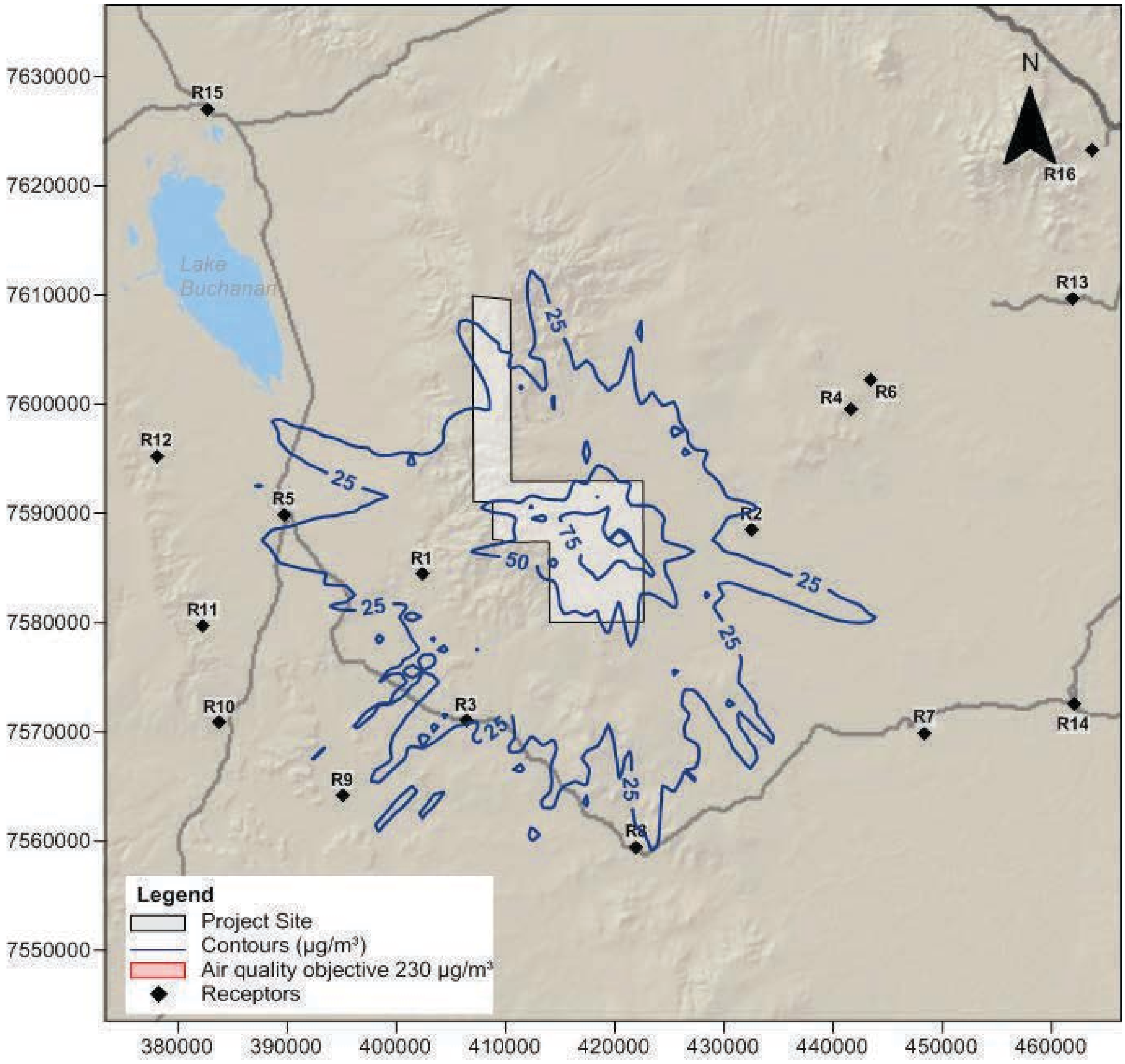

Plate 10	**Predicted 24-hour average ground-level concentrations of SO_2 due to the power station, including ambient background**

Location: Project China Stone, Central Queensland	**Data source:** CALPUFF	**Units:** µg/m³
Type: Contour plot	**Prepared by:** Michael Burchill	**Date:** August 2014

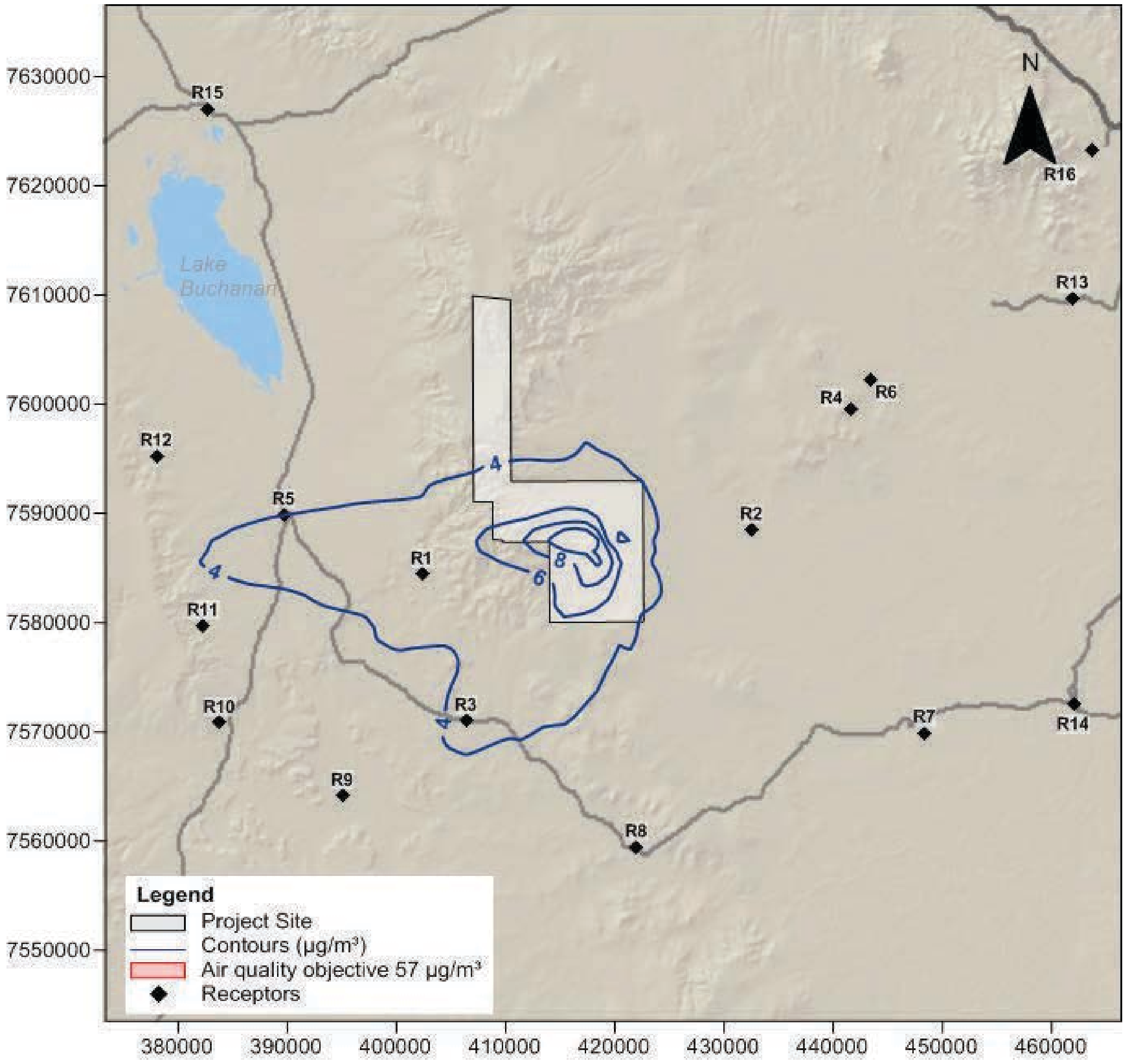

Plate 11	**Predicted annual average ground-level concentrations of SO_2 due to the power station, including ambient background**

Location:	Data source:	Units:
Project China Stone, Central Queensland	CALPUFF	µg/m³
Type:	**Prepared by:**	**Date:**
Contour plot	Michael Burchill	August 2014

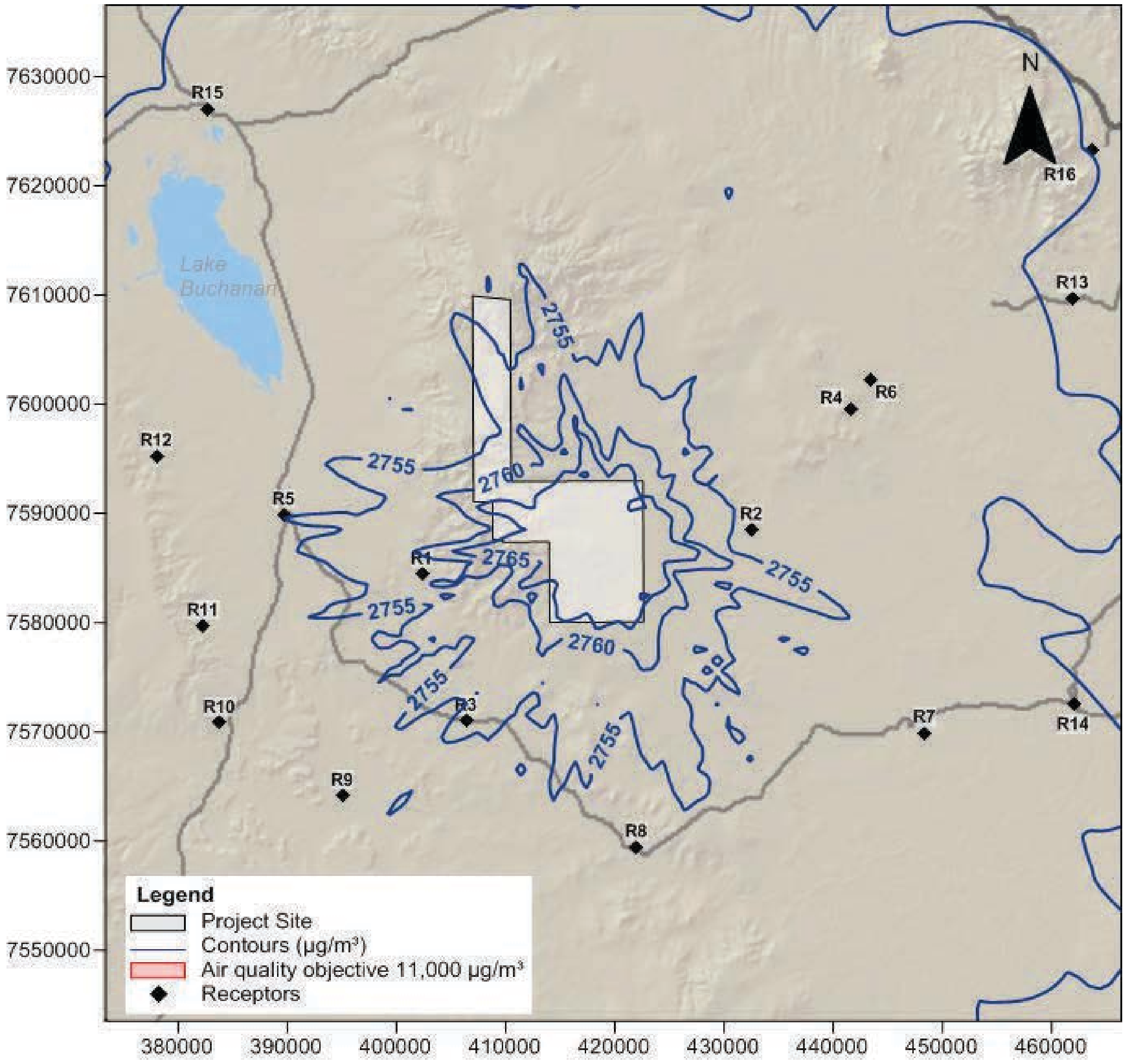

Plate 12	**Predicted 8-hour average ground-level concentrations of CO due to the power station, including ambient background**

Location:	**Data source:**	**Units:**
Project China Stone, Central Queensland	CALPUFF	µg/m³
Type:	**Prepared by:**	**Date:**
Contour plot	Michael Burchill	August 2014

APPENDIX A METEOROLOGICAL AND DISPERSION MODELLING METHODOLOGY

The meteorological data for this study was generated by TAPM and CALMET, for use in the CALPUFF dispersion model. Details of the model configurations are supplied in the following sections.

A1 TAPM METEOROLOGICAL SIMULATION

The meteorological model, TAPM (The Air Pollution Model) Version 4.0.5, was developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and has been validated by the CSIRO, Katestone and others for many locations in Australia, in southeast Asia and in North America (see www.cmar.csiro.au/research/tapm for more details on the model and validation results from the CSIRO). Katestone has used the TAPM model throughout Australia and has performed well for simulating regional winds patterns. TAPM has proven to be a useful model for simulating meteorology in locations where monitoring data is unavailable.

TAPM requires synoptic meteorological information for the region surrounding the project. This information is generated by a global model similar to the large-scale models used to forecast the weather. The data are supplied on a grid resolution of approximately 75 km, and at elevations of 100 metres to five kilometres above the ground. TAPM uses this synoptic information, along with specific details of the location such as surrounding terrain, land-use, soil moisture content and soil type to simulate the meteorology of a region as well as at a specific location.

TAPM resolves local terrain and land-use features that may influence local meteorology, and generates a meteorological dataset that is representative of site-specific geographic conditions. A year of synoptic data must be selected as input for TAPM. The selection of this year should be such that the year is representative of typical meteorological conditions (and therefore is not necessarily the most recent year of available data) and whether monitoring data is available for the time period to validate the output dataset. In addition, Katestone's experience elsewhere in Central Queensland suggests that variability of dispersion meteorological conditions from year to year are unlikely to change the outcome of the air quality assessment. For this study, the period January to December 2007 was modelled.

TAPM was configured as follows:

- 70 x 70 grid point domain with an outer grid of 20 km and nesting grids of six km, three km
- Grid centred near the site of the project at latitude -21.792° and longitude 146.225°
- Geoscience Australia 9-second digital elevation model terrain data
- 25 vertical grid levels

The TAPM configuration is consistent with the guidance provided in the TAPM user manual and the *NSW Office of Environment and Heritage's (OEH) Approved Methods for the Modelling and Assessment of Air Pollutants in NSW.*

A2 CALMET METEOROLOGICAL SIMULATION

CALMET is an advanced non-steady-state diagnostic three-dimensional meteorological model with micro-meteorological modules for overwater and overland boundary layers. The model is the meteorological pre-processor for the CALPUFF Modelling system. CALMET is capable of reading hourly meteorological data from multiple sites within the modelling domain; it can also be initialised with the gridded three-dimensional prognostic output from other meteorological models such as TAPM. This can improve dispersion model output, particularly over complex terrain as the near surface meteorological conditions are calculated for each grid point.

CALMET (version 6.334) was used to simulate meteorological conditions in the study region. The CALMET simulation was initialised with the gridded TAPM three dimensional wind field data from the innermost grid (3 km resolution). CALMET treats the prognostic model output as the initial guess field for the CALMET diagnostic model wind fields. CALMET then adjusts the initial guess field for the kinematic effects of terrain, slope flows, blocking effects and 3-dimensional divergence minimisation.

Key features of CALMET used to generate the wind fields are as follows:

- Domain area of 94 by 94 at 1 km spacing;
- 365 days modelled (1 January to 31 December 2007);
- Prognostic wind fields input as MM5/3D.dat for "initial guess" field only (as generated from TAPM);
- Gridded cloud cover from prognostic relative humidity at all levels;
- No Froude number adjustment, kinematic effects or slope effects;
- No extrapolation of surface wind observations to upper layers;
- Terrain radius of influence set to 1 km; and
- All other parameters set to default.

The geophysical data (land use and terrain heights) were generated to be consistent with the geophysical dataset for TAPM.

A3 CALPUFF DISPERSION SIMULATION

CALPUFF (version 6.42) was used to simulate the dispersion characteristics and concentrations of pollutants generated by the proposed activities. Hourly varying meteorological conditions used to drive the dispersion model were generated by CALMET as described in the previous section.

The dispersion model has been used to predict pollutant concentrations on a gridded receptor network corresponding to the modelling domain and at discrete points corresponding to the locations of sensitive receptors.

Key features of CALPUFF used to simulate dispersion:

- Domain area of 94 x 94 grids at 1 km spacing, equivalent to the domain defined in CALMET;
- 365 days modelled (1 January to 31 December 2007);
- No chemical transformation or wet removal;
- Dispersion coefficients internally calculated from sigma v and sigma w using micrometeorological variables;
- Dry depletion on for dust sources, dry depletion off for power station;
- Minimum wind speed for non-calm conditions set to 0.2 m/s; and
- All other options set to default.

A4 ANALYSIS OF DISPERSION METEOROLOGY

This section presents an analysis of the site-specific meteorological data generated by the coupled TAPM/CALMET modelling system. The meteorological data cover the twelve-month period from 1 January to 31 December 2007. The analysis presented is for a point representative of the project site.

A4.1 Predicted wind speed and direction

The annual, diurnal and seasonal distributions of winds at the project site are presented as wind roses in Figure A1, Figure A2 and Figure A3, respectively.

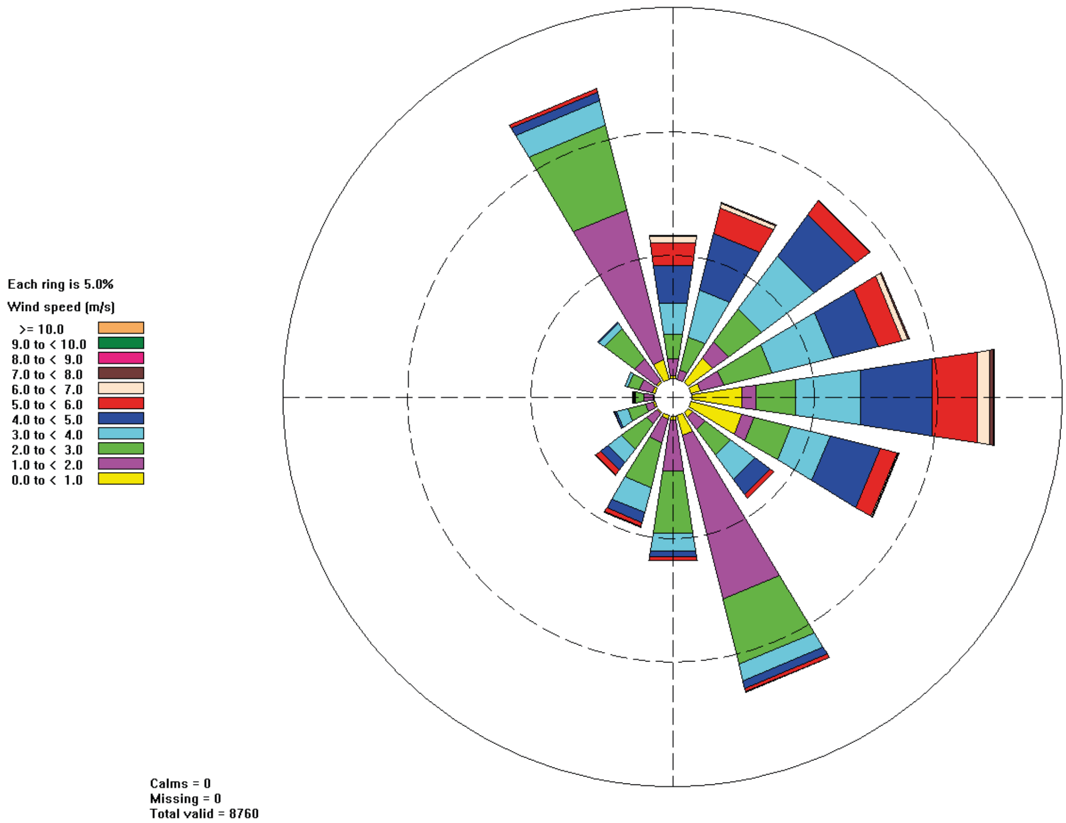

Figure A1 Wind rose for all hours at the project site

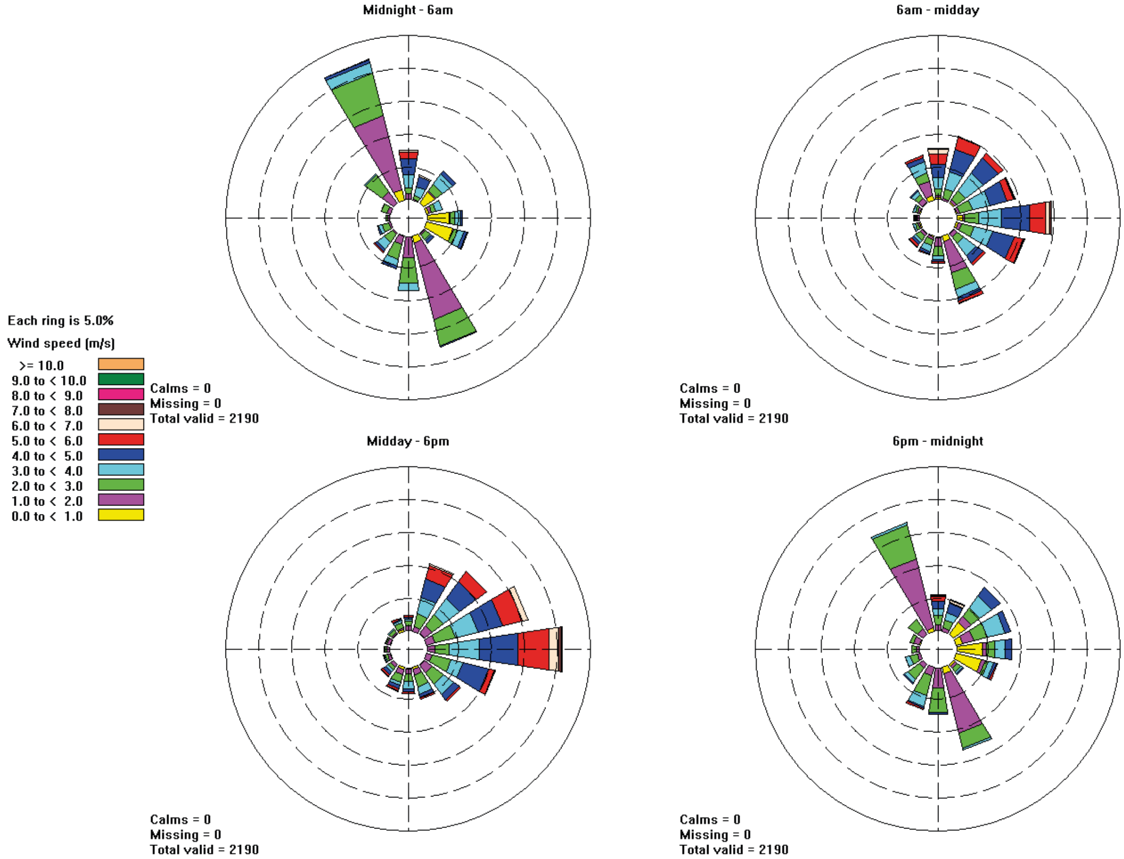

Figure A2 Diurnal wind rose for all hours at the project site

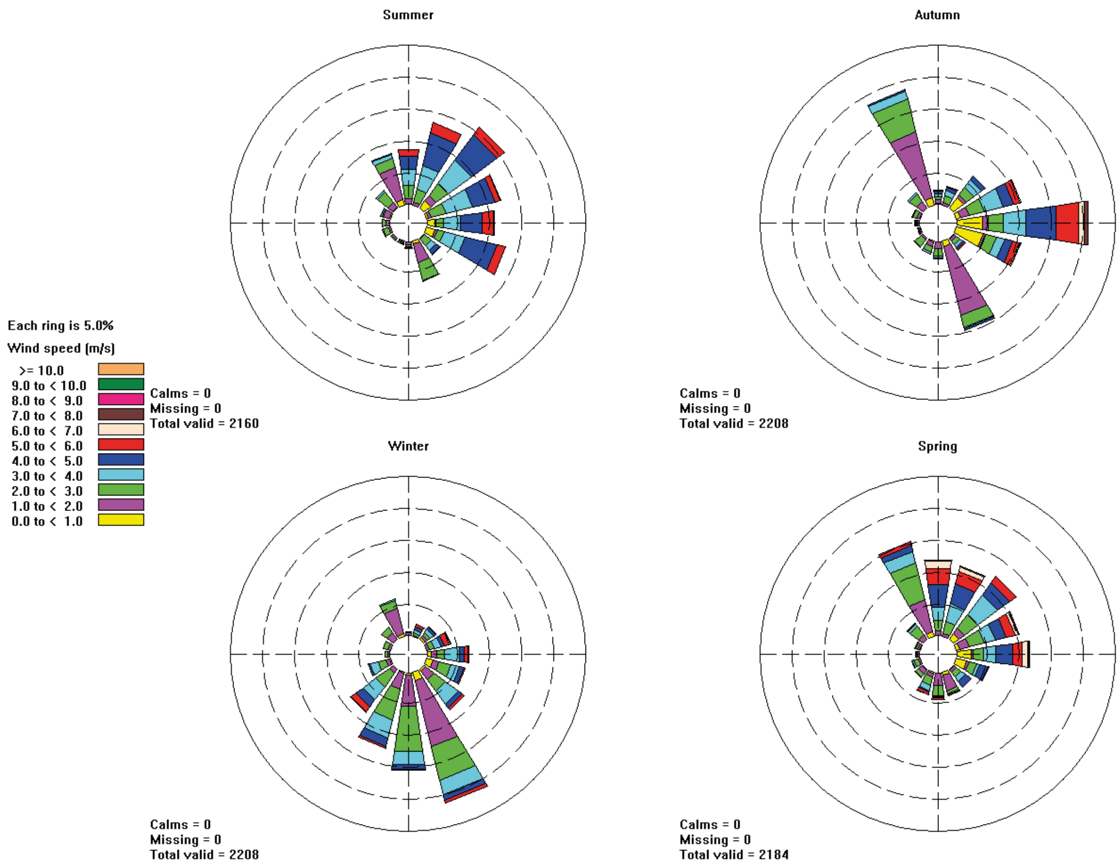

Figure A3 Seasonal wind rose for all hours at the project site

The annual wind rose (Figure A1) shows the predominant wind directions are from the north-northwest, south-southeast and the east. The winds are typical of an inland Central Queensland location, with few winds from the west and a strong easterly component which is the influence of the southern hemisphere trade winds. The diurnal pattern of the Queensland trough is shown in Figure A2 where the deflection of the southeast trade winds to the east and northeast is evident as the day progresses.

The lighter winds (generally less than 4 m/s) occur from the north-northwest and the south-southeast. These conditions occur in the early morning and late evening and are typical during autumn and winter. These conditions show the presence of localised valley drainage flows most likely due to channeling of air in the local area.

The strongest winds (over 6 m/s) occur from the east-northeast and the east during the daytime and are most frequent during summer and spring. These conditions will be important for dust lift off. The high proportion of north to northeasterly winds in spring is due to development of the Cloncurry heat low in the northern tropical regions from intense solar heating of the earth's surface. As spring progresses into summer, the heat low extends further south and the trough takes up its mean offshore position. The winter pattern is typical of the Australian east coast with a strong southwest to southeast wind component due largely to the passing of fronts associated with mid-latitude depressions.

In terms of the project, the frequency of wind speed and distribution of wind direction are key factors in the dispersion of pollutants. For example:

- Operations from the mine and power station will have the greatest potential for impact on the closest sensitive receptor (Moonoomoo Homestead) when the winds are from the east.
- Wind speed is important for dust emissions from a mine site. Exposed dust sources, such as stockpiles or exposed land, will have higher dust emissions during strong winds than during light winds. During

strong winds, dust particles are more likely to be lifted by the wind and carried further off-site than during light winds. The strongest winds (over 6 m/s) occur from the east-northeast and the east during the daytime and are most frequent during summer and spring.

- For stacks, convective conditions (highly unstable conditions) have the tendency to bring a plume to the ground, resulting in relatively elevated ground-level concentrations of air pollutants. These conditions generally occur during the day.
- For odour impacts, worst-case meteorological conditions are generally light winds during the evening or early morning.

A4.2 Atmospheric Stability

Stability classification is a measure of the stability of the atmosphere and can be determined from wind measurements and other atmospheric measurements. The stability classes range from A Class, which represents very unstable atmospheric conditions that may typically occur on a sunny day, to F Class stability which represents very stable atmospheric conditions that typically occur during light wind conditions at night. Unstable conditions (A to C Classes) are characterised by strong solar heating of the ground that induces turbulent mixing in the atmosphere close to the ground. This turbulent mixing is the main driver of dispersion during unstable conditions. Dispersion processes for D Class conditions are dominated by mechanical turbulence generated as the wind passes over irregularities in the local surface. During the night, the atmospheric conditions are generally stable (often E and F Classes).

Table A1 shows the percentage of stability classes at the project site for the January to December 2007 period at the project site.

Table A1 Frequency of occurrence (%) of surface atmospheric stability at the project site under Pasquil-Gifford stability classification scheme

Pasquil-Gifford stability class	Classification	Frequency (%)
A	Extremely unstable	0.8
B	Unstable	7.1
C	Slightly unstable	12.5
D	Neutral	42
E	Slightly stable	8.6
F	Stable	28.9

A4.3 Mixing height

The mixing height refers to the height above ground within which particulates or other pollutants released at or near ground can mix with ambient air. During stable atmospheric conditions, the mixing height is often quite low and particulate dispersion is limited to within this layer. During the day, solar radiation heats the air at the ground level and causes the mixing height to rise. The air above the mixing height during the day is generally cooler. The growth of the mixing height is dependent on how well the air can mix with the cooler upper level air and therefore depends on meteorological factors such as the intensity of solar radiation and wind speed. During strong wind speed conditions the air will be well mixed, resulting in a high mixing height.

Mixing height information has been extracted from the CALMET simulation at the project site and is presented in Figure A4. The data shows that the mixing height develops around 7 am, increases to a peak around 3 pm before descending rapidly.

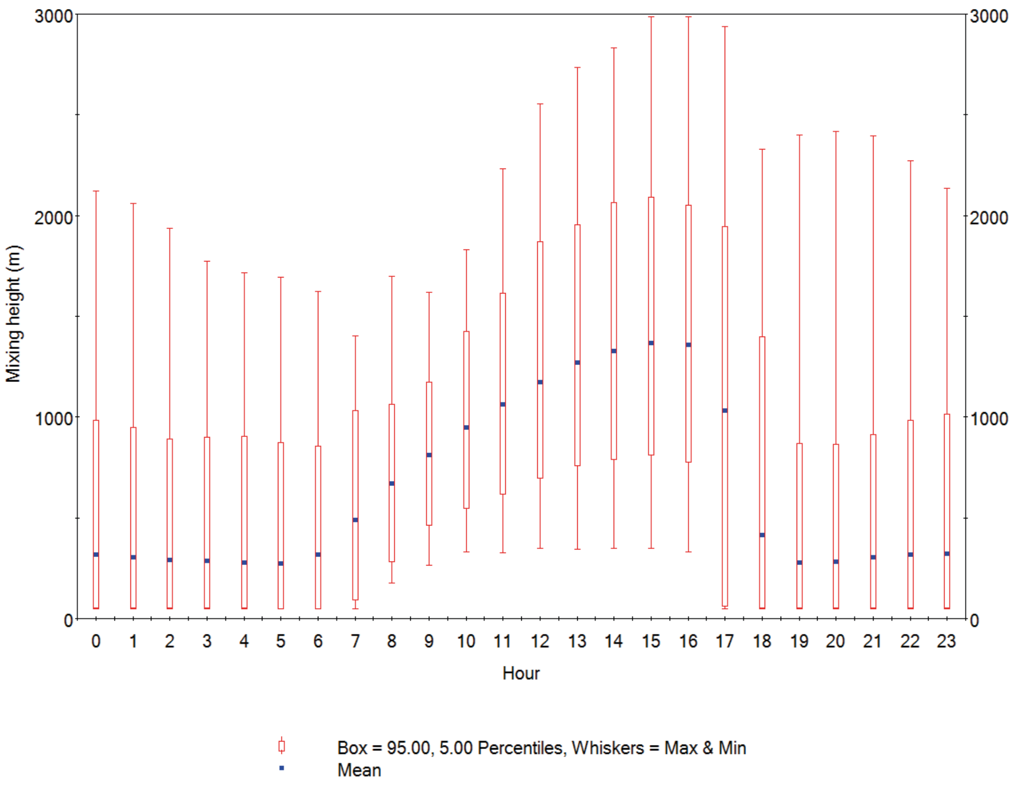

Figure A4 Diurnal profile of mixing height at the project site

APPENDIX B ACTIVITY DATA

Table B1 Activity data used in estimating emissions for representative project years

Activity	Units	Year5	Year15	Year20
General operational parameters				
Opencut throughput - ROM	Mtpa	31.2	31.9	25.0
Opencut throughput - Product	Mtpa	21.1	21.0	16.5
Underground throughput - ROM	Mtpa	13.7	21.8	15.0
Underground throughput - Product	Mtpa	9.9	15.5	10.4
Tailings	Mtpa	3.7	4.3	3.3
Rejects	Mtpa	11.0	12.8	9.8
Fly Ash	Mtpa	0.9	2.7	2.7
Overburden	Mt/year	233	329	379
	Mbcm/year	126	178	205
Operating hours per day	hours/day	24	24	24
Operating days per year	days/year	365	365	365
Material characteristics				
Overburden density	t/bcm	1.85	1.85	1.85
Overburden moisture content	%	7.9	7.9	7.9
Overburden silt content	%	6.9	6.9	6.9
Coal moisture content	%	6.9	6.9	6.9
Coal silt content	%	8.6	8.6	8.6
Haul silt content	%	8.4	8.4	8.4
Equipment				
Dragline drop height	m	8.6	8.6	8.6
Total Draglines	#	1.52	1.4	1.52
Total Rope Shovels	#	2.1	2.1	4.2
Total Hydraulic Excavators	#	0.7	4.2	3.5
Full time equivalent operating bulldozers	#	9.1	13.1	17.3
Drilling/Blasting				
Total Holes drilled per year	holes/year	75,540	106,680	122,820
Total Blasts per year	blasts/year	365	365	365
Area per blast	m²	2,000	2,000	2,000
Surface Miner				
Weight	Mg	211	211	211
Full time equivalent operating surface miners	#	4.2	8.4	9.8
Operating Speed	m/min	10	10	10
Vehicle Kilometres Travelled per year	VKT/year	22,075	44,150	51,509
Length of primary conveyor	m	7	7	7
Haul trucks				
CAT 797 - Overburden Haul				
Nominal payload capacity	Mg	363	363	363
Empty Weight	Mg	266.1	266.1	266.1

Activity	Units	Year5	Year15	Year20
Average operating weight	Mg	447.6	447.6	447.6
CAT 789 - ROM Haul				
Nominal payload capacity	Mg	177	177	177
Empty Weight	Mg	127.4	127.4	127.4
Average operating weight	Mg	215.9	215.9	215.9
Graders				
Full time equivalent graders operating	#	2.1	2.8	4.2
Grader speed	km/hr	8	8	8
Grader distance travelled annually	VKT/yr	147,168	196,224	294,336
Overburden Haul				
Trips per year	#	362,865	627,369	785,358
Trips per hour	#	41	72	90
Average In Pit Distance per trip	km	1.4	1.3	1.1
Total In Pit VKT	km/year	1,000,000	1,590,000	1,740,000
Average Out of Pit Distance per trip	km	4.3	3.3	3.4
Total Out of Pit VKT	km/year	3,130,000	4,170,000	5,360,000
ROM Haul				
Trips per year	#	176,307	179,976	141,243
Trips per hour	#	20	21	16
Average In Pit Distance per trip	km	1.1	1.2	1.5
Total In Pit VKT	km/year	400,000	440,000	440,000
Average Out of Pit Distance per trip	km	6.1	6.9	7.3
Total Out of Pit VKT	km/year	2,170,000	2,500,000	2,060,000
Fly Ash Haul				
Trips per year	#	5,156	15,468	15,468
Trips per hour	#	0.6	1.8	1.8
Average distance per trip	km	2.0	9.9	10.0
Total VKT	km/year	20,417	305,613	309,882
Conveyor lengths				
Drift	m	540	540	540
Overland (underground coal)	m	7,889	7,889	7,889
Stockpiles (including stacking/reclaiming conveyors)	m	23,769	23,769	23,769
Product to rail load out	m	1,014	1,014	1,014
CHPP to rejects stockpile	m	687	687	687
Stockpile areas				
ROM stockpile (at drift)	ha	4.4	4.4	2.0
Raw coal stockpile	ha	29.4	29.4	29.4
Product stockpile	ha	42.3	42.3	42.3
Tailings storage facility	ha	338.5	603.3	603.3
Fly ash facility	ha	78.9	78.9	78.9
Fines and middling rejects stockpile	ha	6.3	6.3	6.3
Exposed Areas				
Exposed Overburden Dumps (former pit areas)	ha	360.9	1180.5	818.7

Activity	Units	Year5	Year15	Year20
Exposed Overburden Dumps (non-pit areas)	ha	573.5	270.7	1103.4
Rehabbed Areas	ha	177.9	819.0	1936.2
Rail Wagons				
Trains per day	#	6	6	6
Train capacity	t	25,000	25,000	25,000
Load out rate	tph	6150	6150	6150
Wagon capacity	t	106	106	106
Rail wagons	ha	0.8	0.8	0.8
Number of wagons per train	#	236	236	236
Exposed area per wagon	m²	65	65	65
Average residence time of loaded wagons	%	50.8	50.8	50.8
Meteorology				
Mean wind speed	m/s	2.87		
Average rain days	days/year	57.5		
% of time WS > 5.4m/s	%	4.7		

APPENDIX C METHODOLOGY FOR CALCULATING DUST EMISSIONS FROM INDIVIDUAL EMISSION SOURCES

C1 CONVEYOR EMISSIONS

Emission rates for conveyors were calculated using the following equation:

$$EF_{TSP} = 0.031 \times 0.2 \times \frac{aU_{avg}^2 + bU_{avg} + c}{aU_{ref}^2 + bU_{ref} + c}$$

where:

EF_{TSP} emission factor for TSP (g/m/s)

U_{avg} average wind speed on-site (m/s)

U_{ref} reference wind speed

a constant (0.00006)

b constant (-0.0002)

c constant (0.0001)

TSP emissions are based on the speed of prevailing winds, referenced on the study by GHD and Oceanics Australia (GHD-Oceanics, 1975), using a reference emission rate of 0.031 g/s/m at a reference wind velocity of 10 m/s (U_{ref}). A factor of 0.2 is used to account for the difference in particle size distribution between particulate matter sampled in the GHD Oceanics study and the normal TSP size fraction of PM_{30-50}.

The remaining ratio of quadratics is a correction for the wind speed based on the of Witt et al. (1999)

Of TSP emissions, 47% are estimated to be PM_{10} and 7% of TSP emissions are estimated to be $PM_{2.5}$. The particulate matter distribution is based on size ratios of dust emitted from transfers.

The emission factor defines emissions of dust based on the length of the conveyor (g/m/s). Total emissions are dependent on conveyor length.

C2 TRANSFER POINTS

Transfer points are locations within the coal processing where coal is transferred from one conveyor to another or through a transfer station. Emissions are dependent on amount of materials transferred (kg/tonne of material).

Emission rates for transfer points were calculated using the following equation (NPI, 2001):

$$EF = k \times 0.0016 \times \left(\frac{U}{2.2}\right)^{1.3} \left(\frac{2}{M}\right)^{1.4}$$

where:

k: 0.74 for particles less than 30 μm

0.35 for particles less than 10 μm

0.053 for particles less than 2.5 μm

U: Mean wind speed in m/s

M: Material moisture content, 6.9% adopted in this study based on the mean value defined in AP42

Movement of coal and overburden including through hydraulic excavators and rope shovels, stacking and reclaiming activities at stockpiles and train loading were also modelled as transfer operations.

C3 BULLDOZING

Bulldozing of overburden occurs in-pit as well as at overburden stockpiles while bulldozing of coal occurs at the ROM stockpiles. Emissions from dozing are dependent on hours of operation (kg/hr).

The TSP and PM_{10} emission factors for bulldozing on coal were calculated using the following equations (NPI, 2012):

$$EF_{TSP} = 35.6 \times \frac{s^{1.2}}{M^{1.4}}$$

$$EF_{PM10} = 6.33 \times \frac{s^{1.5}}{M^{1.4}}$$

where

s: Coal silt content, 8.6% adopted in this study based on the mean value defined in AP42

M: Coil moisture content, 6.9% adopted in this study based on the mean value defined in AP42

$PM_{2.5}$ emissions are assumed to be 2.2% of TSP emissions, based on the $PM_{2.5}$ to TSP ratio for dozing coal defined in AP42 Ch. 11.9.

The TSP and PM_{10} emission factors for bulldozing of overburden were calculated using the equation for materials other than coal, as defined in the NPI and AP42 (NPI, 2012):

$$EF_{TSP} = 2.6 \times \frac{s^{1.2}}{M^{1.3}}$$

$$EF_{PM10} = 0.34 \times \frac{s^{1.5}}{M^{1.4}}$$

where

s: Silt content, 6.9% adopted in this study based on the mean value defined in AP42

M: Moisture content, 7.9% adopted in this study based on the mean value defined in AP42

$PM_{2.5}$ emissions are assumed to be 10.5% of TSP emissions, based on the $PM_{2.5}$ to TSP ratio for dozing materials other than coal defined in AP42 Ch. 11.9

No control factors have been applied for dozer activity.

C4 DRAGLINE

The emission rate for dragline operations has been calculated using the following equations (NPI, 2012):

$$EF_{TSP} = 0.0046 \times \left(\frac{d^{1.1}}{\mathrm{M}^{0.3}}\right)$$

$$EF_{PM10} = 0.0022 \times \left(\frac{d^{0.7}}{\mathrm{M}^{0.3}}\right)$$

where:

EF_{TSP}: TSP emission factor (kg/bcm)

EF_{PM10}: PM_{10} emission factor (kg/bcm)

d: drop height (m)

M: moisture content (%)

Of TSP emissions, 1.7% are estimated to be $PM_{2.5}$ as defined in the AP42.

C5 DRILLING

Dust emitted during drilling was estimated based on the emission factor defined in the NPI. The TSP emission factor is 0.59 kg/hole. The ratio of PM_{10} and $PM_{2.5}$ to TSP emissions is 52% and 3.5% respectively.

C6 BLASTING

The emission rate for blasting has been calculated using the following equation (NPI, 2012):

$$EF_{TSP} = 0.00022 \times A^{1.5}$$

where:

EF_{TSP}: TSP blasting emission factor (kg/blast)

A: Area blasted (m²)

Blasting was assumed to occur during daylight hours and was modelled between 6 am and 6 pm. Of TSP emissions, 52% are estimated to be PM_{10} and 3.0% are estimated to be $PM_{2.5}$. The particulate matter distribution is based on size particle distribution for blasting as defined in the AP42.

C7 SURFACE MINING

The AP42 and NPI do not have an emission factor for surface mining. The emissions from the surface mining activities have been estimated using the sum of the following three activities:

- Bulldozing
- A single 7 m conveyor per surface miner
- 1 transfer per surface miner

C8 WIND EROSION OF ACTIVE STOCKPILES

Emissions of dust from wind erosion of stockpiles are dependent on the surface area of the stockpiles (kg/ha/hr). The emission rate of dust from the stockpiles has been calculated using the emission factor for active storage piles from the AP42 Chapter 11.9. In equation form, the emission factor for TSP is defined as:

$$EF_{TSP} = 1.8 \times \mathrm{u}$$

where

u: Wind speed (m/s)

Of TSP emissions, 50% are estimated to be PM_{10} and 7.5% of TSP emissions are estimated to be $PM_{2.5}$. The particulate matter distribution is based on size particle distribution for wind erosion as defined in the AP42 and the NPI.

C9 WIND EROSION OF EXPOSED AREAS

Emissions of dust from wind erosion of exposed areas are dependent on the size of the exposed areas (Mg/ha/yr). The emission rate is based on the equation defined in the AP42 for estimating emissions of wind exposed areas. A rain factor was also considered. The TSP emission factor was estimated using the following equation:

$$EF_{TSP} = 0.85 \times \frac{(365 - p)}{365}$$

where:

p: number of days when rainfall is greater than 0.25 mm

Of TSP emissions, 50% are estimated to be PM_{10} and 7.5% are estimated to be $PM_{2.5}$. The particulate matter distribution is based on the size particle distribution for wind erosion as defined in the AP42 and the NPI.

Areas that are inactive or undisturbed were assumed to have been rehabilitated, resulting in a reduction of 90% of emissions.

C10 WHEEL GENERATED DUST FROM UNPAVED HAUL ROADS

Wheel-generated dust was estimated using the emission factor defined in AP42 for haulage of materials through unpaved roads. The emission factor for wheel-generated dust on haul roads is dependent on the size of the truck and the silt content of the road. In equation form, the emission factors (g/VKT) for dust are defined using the following equations:

$$EF_{TSP} = 281.9 \times 4.9 \times \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W}{3}\right)^{0.45}$$

$$EF_{PM10} = 281.9 \times 1.5 \times \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W}{3}\right)^{0.45}$$

$$EF_{PM2.5} = 281.9 \times 0.15 \times \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W}{3}\right)^{0.45}$$

where:

s: Silt content of the road, 8.4% adopted in this study based on the mean value defined in AP42

W: mean vehicle weight in tons

The total emissions are dependent on the total distance travelled by the truck, which is based on truck capacity and the length of the haul road to be travelled. Level 2 watering is assumed to be applied, which would result in a reduction of 75% of emissions (NPI, 2012).

C11 GRADING

Maintenance of haul roads would be achieved with the use of a grader. Emissions of TSP during grading were estimated using the equation defined in AP42:

$$EF_{TSP} = 0.0034 \times (S)^{2.5}$$

$$EF_{PM10} = 0.0034 \times (S)^{2}$$

7.5% of TSP emissions are estimated to be $PM_{2.5}$.

C12 CRUSHING

Dust emitted during crushing of coal at the processing plants was estimated based on the uncontrolled emission factors defined in AP42 for tertiary crushing. TSP and PM_{10} emission factors are 0.0027 kg/Mg and 0.0012 kg/Mg, respectively. The ratio of $PM_{2.5}$ to PM_{10} emissions is based on the size distribution of the emission factors defined for controlled tertiary crushing (18.5%). This ratio was applied to the PM_{10} emission rate in order to estimate $PM_{2.5}$ emissions.

APPENDIX D EMISSIONS INVENTORIES PROJECT YEARS 5 AND 15

Table D1 presents the emissions estimated for Project Year 5 and Table D2 presents the emissions estimated for Project Year 15.

All mine years include open cut pit and underground mining. The open cut pits are proposed to be mined progressively to the west and southwest throughout the life of the mine. As mining progresses, the emissions due to hauling overburden increases, with Project Year 20 (Table 19) representing worst-case emissions.

Table D1 Emission rates for mine operation – Project Year 5

Activity	Project Year 5		
	TSP (g/s)	PM_{10} (g/s)	$PM_{2.5}$ (g/s)
TOTAL	**758.1**	**266.3**	**31.1**
Open cut pit activities	102.5	56.1	5.7
Dragline (overburden)	22.9	8.8	0.8
Rope Shovel (overburden)	0.4	0.3	0.1
Hydraulic Excavator (overburden)	0.1	0.1	0.0
Surface Miner (coal)	18.5	12.0	0.8
Bulldozing (overburden)	0.8	0.3	0.2
Drilling	0.7	0.7	0.0
Blasting	0.1	0.1	0.0
Overburden Haul	42.0	22.8	2.4
ROM Haul	12.2	6.6	0.7
Wind erosion active pit area	4.6	4.4	0.7
Activities associated with underground coal	26.2	8.0	0.7
Drift conveyor	0.02	0.008	0.001
Transfers	0.13	0.06	0.009
Crushing	0.6	0.3	0.05
Bulldozing	7.0	2.4	0.2
Overland conveyor	0.2	0.1	0.02
Haul	18.2	5.2	0.5
Out of Pit haulage	399.4	113.9	11.4
Overburden	*265.2*	*75.6*	*7.6*
ROM	*132.2*	*37.7*	*3.8*
Fly ash	*1.2*	*0.4*	*0.04*
Graders	*0.7*	*0.3*	*0.1*

Activity	Project Year 5		
	TSP (g/s)	PM_{10} (g/s)	$PM_{2.5}$ (g/s)
CHPP Area	125.7	36.8	5.4
Truck dump	*68.3*	*9.4*	*1.3*
Bulldozing	*5.3*	*1.8*	*0.1*
Transfers	*2.1*	*1.0*	*0.2*
Conveyors	*0.5*	*0.2*	*0.03*
Stackers/Reclaimers	*0.8*	*0.4*	*0.1*
Crushing/Sizing	*6.5*	*2.9*	*0.5*
Wind erosion	*42.2*	*21.1*	*3.2*
Product Stockpile	62.0	31.0	4.6
Exposed Areas (including overburden dumping)	41.7	20.2	3.2
Overburden dumps	24.2	11.5	1.9
Rehabilitated	0.4	0.2	0.03
Fly ash facility	1.8	0.9	0.1
Rejects	9.0	4.5	0.7
Underground ROM stockpile	6.3	3.1	0.5
Rail Loadout	0.6	0.3	0.05

Table D2 Emission rates for mine operation – Project Year 15

Activity	Project Year 15		
	TSP (g/s)	PM_{10} (g/s)	$PM_{2.5}$ (g/s)
TOTAL	**952.2**	**341.5**	**39.2**
Open cut pit activities	153.6	87.5	9.0
Dragline (overburden)	22.9	8.8	0.8
Rope Shovel (overburden)	0.3	0.3	0.04
Hydraulic Excavator (overburden)	0.6	0.5	0.1
Surface Miner (coal)	36.9	23.8	1.6
Bulldozing (overburden)	2.3	0.8	0.5
Drilling	1.0	1.0	0.1
Blasting	0.1	0.1	0.01
Overburden Haul	67.0	36.3	3.8
ROM Haul	13.3	7.2	0.8
Wind erosion active pit area	9.1	8.6	1.4
Activities associated with underground coal	27.5	8.5	0.8

Activity	Project Year 15		
	TSP (g/s)	PM_{10} (g/s)	$PM_{2.5}$ (g/s)
Drift conveyor	0.02	0.008	0.001
Transfers	0.2	0.1	0.01
Crushing	1.3	0.6	0.1
Bulldozing	7.0	2.4	0.2
Overland conveyor	0.2	0.1	0.02
Haul	18.8	5.4	0.5
Out of Pit haulage	525.6	149.9	15.0
Overburden	*353.4*	*100.7*	*10.1*
ROM	*152.6*	*43.5*	*4.3*
Fly ash	*18.7*	*5.3*	*0.5*
Graders	*1.0*	*0.3*	*0.1*
CHPP Area	127.9	37.3	5.4
Truck dump	*69.9*	*9.6*	*1.3*
Bulldozing	*5.3*	*1.8*	*0.1*
Transfers	*2.5*	*1.2*	*0.2*
Conveyors	*0.5*	*0.2*	*0.0*
Stackers/Reclaimers	*1.0*	*0.5*	*0.1*
Crushing/Sizing	*6.6*	*2.9*	*0.5*
Wind erosion	*42.2*	*21.1*	*3.2*
Product Stockpile	62.2	31.1	4.7
Exposed Areas (including overburden dumping)	54.6	27.0	4.1
Overburden dumps	35.7	17.5	2.7
Rehabilitated	1.9	0.9	0.1
Fly ash facility	1.8	0.9	0.1
Rejects	9.0	4.5	0.7
Underground ROM stockpile	6.3	3.1	0.5
Rail Loadout	0.7	0.3	0.1

APPENDIX E DISPERSION MODELLING RESULTS

E1 POWER STATION IMPACTS

For all averaging periods, the closest receptor (Moonoomoo Homestead) has been shown to have the highest impacts. Table E1 presents the predicted ground-level concentrations of pollutants emitted by the power station at Moonoomoo Homestead.

Table E1 Predicted ground-level concentrations of pollutants at Moonoomoo Homestead due to operation of the power station in isolation

Pollutant	Averaging Period	Concentration (µg/m³)	Objective (µg/m³)
NO_2	1-hour, maximum	36.97	250
	Annual average	0.4019	62
CO	8-hour, maximum	7.852	11000
Arsenic and compounds	Annual average	2.24E-07	0.006
Beryllium and compounds	1-hour, 99.9th percentile	0.000162	0.004
Boron and compounds	1-hour, maximum	1.178	50
	24-hour, maximum	0.1370	120
	Annual average	0.01281	5
Cadmium and compounds	Annual average	1.16E-06	0.005
Chromium (III) compounds	1-hour, maximum	7.89E-05	9
Chromium (VI) compounds	1-hour, maximum	4.15E-06	0.09
Cobalt and compounds	1-hour, maximum	2.33E-05	0.2
	24-hour, maximum	2.71E-06	0.1
	Annual average	2.53E-07	0.02
Copper and compounds (fumes)	1-hour, maximum	2.61E-06	18
Copper and compounds (dust)	1-hour, maximum	2.61E-06	3.7
Cumene	1-hour, maximum	0.000127	21
Fluoride compounds	24-hour, maximum	0.4110	1.5
	30-day, maximum	0.08621	0.4
	90-day, maximum	0.06911	0.25
Lead and compounds	Annual average	3.08E-07	0.5
Manganese and compounds	Annual average	8.46E-07	0.16
Mercury and compounds (organic)	1-hour, maximum	3.63E-06	0.18
Mercury and compounds (inorganic)	1-hour, maximum	3.63E-06	1.8
Nickel and compounds	Annual average	1.68E-06	0.02
Sulfuric acid	1-hour, maximum	1.696498	18
Sulfur dioxide	1-hour, maximum	161.2	570
	24-hour, maximum	41.14	230
	Annual average	1.752	57
Zinc and compounds (zinc chloride fumes)	1-hour, maximum	0.001783	18
Zinc and compounds (zinc oxide fumes)	1-hour, maximum	0.001783	90

APPENDIX F GREENHOUSE GAS EMISSIONS

Table F 1 presents the operational data used to calculated emissions of GHG by mine production year.

Table F 1 Annual GHG emission source and selected mining operation data summary for the Project

Production Year	Mining operations			GHG Emission Sources		
				Diesel		Power Station
	ROM	Product Coal	Electricity required	Open cut	Underground	By-product coal
	kt	kt	GWh	kL	kL	kt
Year 1	-	-	172	88,590	18	-
Year 2	77	54	257	147,649	224	-
Year 3	19,590	10,682	890	214,060	2,217	-
Year 4	30,787	16,959	978	134,536	3,901	1,521
Year 5	45,660	31,006	1,469	128,887	5,696	3,042
Year 6	47,929	32,654	1,696	136,967	6,882	4,563
Year 7	49,783	33,931	1,763	142,874	6,882	4,563
Year 8	54,121	36,912	1,784	125,160	6,882	4,563
Year 9	54,582	37,238	1,880	131,759	6,882	4,563
Year 10	54,794	37,388	1,917	139,580	6,882	4,563
Year 11	54,572	37,227	2,024	139,705	6,882	4,563
Year 12	54,525	37,187	2,014	142,022	6,882	4,563
Year 13	54,314	37,034	2,032	142,022	6,882	4,563
Year 14	53,913	36,740	2,025	142,022	6,882	4,563
Year 15	53,621	36,522	2,016	142,022	6,882	4,563
Year 16	42,872	28,816	1,792	142,022	5,162	4,563
Year 17	42,936	28,861	1,819	150,261	5,162	4,563
Year 18	42,025	28,259	1,821	150,261	5,162	4,563
Year 19	39,961	26,898	1,822	150,261	5,162	4,563
Year 20	39,975	26,908	1,796	150,261	5,162	4,563
Year 21	39,969	26,903	1,796	129,077	5,162	4,563
Year 22	39,904	26,859	1,796	129,077	5,162	4,563
Year 23	39,913	26,864	1,796	129,077	5,162	4,563
Year 24	40,056	26,964	1,796	129,077	5,162	4,563
Year 25	38,637	26,025	1,796	129,077	5,162	4,563
Year 26	33,920	22,912	1,796	129,077	5,162	4,563
Year 27	30,893	20,909	1,080	129,077	5,162	4,563
Year 28	25,226	17,166	1,092	117,444	5,162	4,563
Year 29	25,491	17,339	1,092	112,335	5,162	4,563
Year 30	24,174	16,469	1,092	43,456	5,162	4,563
Year 31	24,818	16,893	1,366	53,838	5,162	4,563

Production Year	Mining operations			GHG Emission Sources		
	ROM	Product Coal	Electricity required	Diesel		Power Station
				Open cut	Underground	By-product coal
	kt	kt	GWh	kL	kL	kt
Year 32	8,048	5,559	1,007	10,382	5,162	2,292
Year 33	7,523	5,191	1,007	10,382	5,162	2,292
Year 34	7,621	5,258	1,007	10,382	5,162	2,292
Year 35	7,475	5,158	1,007	4,576	5,162	2,292
Year 36	7,520	5,189	1,007	4,576	5,162	2,292
Year 37	7,376	5,089	1,007	4,576	5,162	2,292
Year 38	7,395	5,103	966	4,576	5,162	2,292
Year 39	7,475	5,158	842	4,576	5,162	2,292
Year 40	7,389	5,098	842	4,576	5,162	2,292
Year 41	7,395	5,103	842	4,576	5,162	2,292
Year 42	7,481	5,162	842	4,576	5,162	2,292
Year 43	7,397	5,104	842	4,576	5,162	2,292
Year 44	7,412	5,114	842	4,576	5,162	2,292
Year 45	7,482	5,163	842	4,576	5,162	2,292
Year 46	7,410	5,113	842	4,576	5,162	2,292
Year 47	7,375	5,089	842	4,576	5,162	2,292
Year 48	7,224	4,985	842	4,576	5,162	-
Year 49	6,151	4,244	842	4,576	5,162	-
TOTALS	**1,332,184**	**898,456**	**64,735**	**4,171,323**	**256,382**	**159,868**

Table F2 presents the annualised estimate of GHG emissions due to carbon loss and storage associated with land clearing and subsequent rehabilitation by mine production year.

Table F2 GHG emissions associated with land clearing and rehabilitation for the Project

Production Year	Disturbance areas		Change in vegetation biomass		Carbon emissions
	Area cleared	Area rehabilitated	Biomass loss	Biomass regrowth	
	(ha)	(ha)	(ktCO2-e)	(ktCO2-e)	(ktCO2-e)
Pre Mining	2,597	-	269	-	269
Year 1	No land clearing or rehabilitation occurs during this period.				
Year 2					
Year 3					
Year 4					
Year 5	2,276	197	235	2	234
Year 6	-	-	-	2	(2)
Year 7	-	-	-	2	(2)

Production Year	Disturbance areas		Change in vegetation biomass		Carbon emissions
	Area cleared	Area rehabilitated	Biomass loss	Biomass regrowth	
	(ha)	(ha)	(ktCO2-e)	(ktCO2-e)	(ktCO2-e)
Year 8	-	-	-	2	(2)
Year 9	-	-	-	2	(2)
Year 10	1,348	434	139	5	134
Year 11	-	-	-	5	(5)
Year 12	-	-	-	5	(5)
Year 13	-	-	-	5	(5)
Year 14	-	-	-	5	(5)
Year 15	720	290	74	8	67
Year 16	-	-	-	8	(8)
Year 17	-	-	-	6	(6)
Year 18	-	-	-	6	(6)
Year 19	-	-	-	6	(6)
Year 20	1,514	1,135	157	16	141
Year 21	-	-	-	16	(16)
Year 22	-	-	-	12	(12)
Year 23	-	-	-	12	(12)
Year 24	-	-	-	12	(12)
Year 25	-	-	-	12	(12)
Year 26	-	-	-	12	(12)
Year 27	-	-	-	10	(10)
Year 28	-	-	-	10	(10)
Year 29	-	-	-	10	(10)
Year 30	851	430	88	13	75
Year 31	-	-	-	13	(13)
Year 32	-	-	-	4	(4)
Year 33	-	-	-	4	(4)
Year 34	-	-	-	4	(4)
Year 35	-	-	-	4	(4)
Year 36	-	-	-	4	(4)
Year 37	-	-	-	4	(4)
Year 38	-	-	-	4	(4)
Year 39	-	-	-	4	(4)
Year 40	-	-	-	4	(4)
Year 41	-	-	-	4	(4)
Year 42	No land clearing or active rehabilitation of overburden emplacement areas occurs during this period.				
Year 43					
Year 44					
Year 45					

Production Year	Disturbance areas		Change in vegetation biomass		Carbon emissions
	Area cleared	Area rehabilitated	Biomass loss	Biomass regrowth	
	(ha)	(ha)	(ktCO2-e)	(ktCO2-e)	(ktCO2-e)
Year 46					
Year 47					
Year 48					
Year 49					
Year 50	1,691	7,551	175	65	110
Year 51	-	-	-	65	(65)
Year 52	-	-	-	65	(65)
Year 53	-	-	-	65	(65)
Year 54	-	-	-	65	(65)
Year 55	-	-	-	65	(65)
Year 56	-	-	-	65	(65)
Year 57	-	-	-	65	(65)
Year 58	-	-	-	65	(65)
Year 59	-	-	-	65	(65)
Year 60	-	-	-	65	(65)
Year 61	-	-	-	65	(65)
TOTAL	10,997	10,036	1,137	1,038	99

Table notes:
(Numbers in brackets) indicate annual quantity of net carbon storage due to forest regrowth exceeding land clearing in that year
Post mining rehabilitation period