Adani Mining Pty Ltd

adani

Carmichael Coal Mine and Rail Project SEIS

Report for Revised Mine Air Quality Assessment

17 October 2013

GHD

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Executive summary

Adani Mining Pty Ltd (Adani, the Proponent), commenced an Environmental Impact Statement (EIS) process for the Carmichael Coal Mine and Rail Project (the Project) in 2010. On 26 November 2010, the Queensland (Qld) Office of the Coordinator General declared the Project a 'significant project' and the Project was referred to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (referral No. 2010/5736). The Project was assessed to be a controlled action on the 6 January 2011 under section 75 and section 87 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Project components are as follows:

- The Project (Mine): a greenfield coal mine over EPC 1690 and the eastern portion of EPC 1080, which includes both open cut and underground mining, on mine infrastructure and associated mine processing facilities (the Mine) and the Mine (offsite) infrastructure including a workers accommodation village and associated facilities, a permanent airport site, an industrial area and water supply infrastructure
- The Project (Rail): a greenfield rail line connecting to mine to the existing Goonyella and Newlands rail systems to provide for the export of coal via the Port of Hay Point (Dudgeon Point expansion) and the Port of Abbot Point, respectively including:
  - Rail (west): a 120 km dual gauge portion running east from the Mine site to west of Diamond Creek
  - Rail (east): a 69 km narrow gauge portion running east from Diamond Creek connecting to the Goonyella rail system south of Moranbah.
  - Quarries: five local quarries to extract quarry materials for construction and operational purposes

The Project (Mine) has an expected operational life of 60 years during which a mixture of underground and open-pit mining operations will occur and significant dust generating potential exists.

An initial air quality assessment was undertaken as part of the EIS. Since the completion of the EIS assessment, changes are proposed to the operation of the Project (Mine). This report addresses the emissions from revised Project (Mine) activities. This report also addresses the combined effect of emissions from the Project (Mine) with windblown coal dust from the Project (Rail), to the extent to which the railway overlaps with dust contours of the Project (Mine).

The *Environmental Protection (Air) Policy 2008* (Air EPP) defines air quality objectives such that indicator pollutants do not adversely affect environmental values. The indicators relevant to the Project (Mine) are Particulate Matter (total suspended particulate – TSP, PM_{10} and $PM_{2.5}$) with health and wellbeing of humans being the environmental value of concern. Air quality impacts are measured against the objectives of the Air EPP, which are defined as concentrations of particulate matter at receptor locations that people are likely to occupy for extended periods of time. Locations inside the Project (Mine) site perimeter are therefore excluded from this assessment.

Existing environmental conditions were defined for background (or ambient) dust levels and dispersion meteorology. Available background data assessed focused on PM_{10} and dust deposition rates from similar exposed central Queensland mining areas (Bowen Basin). The Proponent has been monitoring dust deposition at several nearby homestead sites since late 2012. Comparable background information for TSP and the finer $PM_{2.5}$ dust fractions were derived by use of dust fraction ratios.

Dispersion meteorology characteristics are driven by the various climatic indicators. Climatically, the inland areas surrounding the Project can be described as 'subtropical' with a sub-classification of 'moderately dry winter'. The prevailing wind directions have a strong easterly component associated with the trade winds. A derived dispersion modelling dataset for the Mine site using the prognostic meteorological model MM5 and further enhanced by the diagnostic model CALMET was found to be site-representative for the Project with validation of wind characteristics against a full annual cycle of on-site measurements (single point).

Air emissions during the operation of the open cut and underground mines have been estimated using standard techniques from the Australian National Pollutant Inventory and the USEPA AP-42 database. The estimates are based upon the revised project description provided in SEIS Volume 4 Appendix B.

Dust was modelled from the entire Project (Mine) site as emanating from a total of 25 individual mining activity sources and 29 sources associated with wind dependent wind erosions. The dispersion model CALPUFF was used for this purpose involving area and volume sources as appropriate. In addition to predicting ambient levels of particulate matter, dust deposition was also assessed. For completeness, dust emissions from the coal train hauling to the east of the Project (Mine) site were included. It was found that the greatest single source of dust emissions is from haul trucks, being potentially responsible for over approximately 70 percent of uncontrolled dust emissions due to active coal production.

Dispersion modelling was established based on predicted emissions for the year 2025, which was considered to be the worst-case. In the Project (Mine) plan, the years 2025 to 2029 corresponds to operations from both the underground and open-pit mines.

The air quality assessment required the estimation of maximum ground-level concentrations and monthly average dust deposition values at the nearest sensitive receptors with a total of eight offsite sensitivity receptor locations being identified within the model domain.

Ambient PM_{10} levels have also been assessed to the EPP Air criterion of 50 µg/m³ (including background) averaged over 24 hours. Results at the existing offsite sensitive receptors for the modelled year of 2025 show worst case impacts do not exceed 85 percent of the criterion, including assumed background dust levels. Results for the proposed location of the airport terminal are compliant with EPP Air objectives. However, the proposed location of the mine worker accommodation village is predicted to have at least two small exceedances of the EPP Air objectives of no greater than 107 percent of criterion. This small level of predicted exceedance is considered as manageable using best practice dust minimisation methods.

Contour plots of predicted maximum 24 hour average PM_{10} GLCs for the modelled year of the project (Mine) indicate the criterion is met at identified sensitive receptors, except the mine worker accommodation village, but not all locations beyond the Project (Mine) boundary. The extent of the non-compliance in uninhabited areas is considered to be manageable and should be monitored as part of a site wide dust management plan.

For averaged $PM_{2.5}$ levels, all existing off-site sensitive receptors were below the assessment criteria of 25 µg/m³ (24 hour averaged) and 8 µg/m³ (annual average). For the proposed workers accommodation village and airport terminal, all $PM_{2.5}$ levels were below regulatory requirements.

Ambient TSP levels were assessed for the modelled year of 2025. It was found that all of the identified off-site sensitive receptors, including those of the mine worker accommodation village and airport terminal were compliant with the annual average criterion. Deposited dust levels were found to decrease rapidly beyond their source so that at all offsite sensitive receptor locations rates were significantly below the assessment criteria.

The impact assessment demonstrated the dust impacts are consistent with the goals of the EPP Air. This is with respect to human health effects at 'remote' off-site receptor locations. Dust impacts beyond the site boundary may require management at the peak production phases of the mine life.

In the event that further control measures are required, the dust management tool of installing ambient air quality and dust deposition monitors to quantify the actual dust impacts near the site boundaries can be used to quantify actual dust impacts rather than the theoretical levels assessed in this report. A system of monitors can be installed in which up-wind stations measure background dust levels, while down-wind stations are able to quantify the impact from mine operations. An expanded network will supplement the existing background dust deposition gauge network. If off-site ambient dust levels are demonstrated to be significantly detrimental due to mining operations beyond the site boundary, additional options for reducing emissions include:

- increased use of conveyors rather than trucks to move coal
- use of conveyors to haul a proportion of overburden
- construction of haul roads using low silt material
- sealing of haul roads with bitumen or similar
- implementation of a dust management plan including the use of a meteorological forecasting system coupled with a dust impact index for the management and control of significant dust sources during adverse conditions.

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Abbreviations and glossary

Project Specific Terminology	
Abbreviation	Term
MWAV	Mine Worker Accommodation Village
the EIS	Carmichael Coal Mine and Rail Project Environmental Impact Statement- refers to the original particular document that GHD is preparing to facilitate approval of the Project
the SEIS	Carmichael Coal Mine and Rail Project Supplementary Environmental Impact Statement- refers to the particular document that GHD is preparing to facilitate approval of the Project
the Proponent	Adani Mining Pty Ltd
the Project	Carmichael Coal Mine and Rail Project

Generic Terminology	
Abbreviation	Term
A	Activity data (units dependent on emission factors)
AP-42	US EPA Database on Air Pollutant Emission Factors
bcm	Bank Cubic Metres
bhp	Brake Horse Power
BoM	Bureau of Meteorology
CALPUFF	Gaussian puff modelling system for the simulation of atmospheric pollution dispersion distributed
CALMET	Atmospheric meteorological modelling system
CE	Control efficiency (%)
CO2	Carbon Dioxide
CSIRO	Australian Government agency Commonwealth Scientific and Industrial Research Organisation
Ei	Emission rate of pollutant i (kg per activity)
EAD	Equivalent aerodynamic diameter
EFi	Uncontrolled emissions factor for pollutant i (kg per activity)
EPA	Environment Protection Act
EPP	Environment Protection Policy
ERA	Environmentally Relevant Activities
GLC	Ground Level Concentration
ha	hectare
k	Proportional constant to maintain total annual emissions as constant
kg	Kilogram
M	Soil moisture content
MM5	Mesoscale Model for weather forecasts and climate projections (Fifth Generation Penn State)
NCAR	National Centre for Atmospheric Research
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NOx	Oxides of nitrogen
NO2	Nitrogen dioxide

Generic Terminology	
NPI	National Pollutant Inventory
OH&S	Occupation Health and Safety
PM2.5	Particulate Matter less than 2.5 µm
PM10	Particulate Matter less than 10 µm
PSU/NCAR	Pennsylvania State University/National Center for Atmospheric Research
ROM	Run-Of-Mine
SO2	Sulphur dioxide
TSP	Total Suspended Particulates
U	Wind speed at the reference height of 10 m
veh	Vehicle
VKT	Vehicle Kilometres Travelled
VOC	Volatile Organic Compound

1. Introduction

1.1 Project overview

Adani Mining Pty Ltd (Adani, the Proponent), commenced an Environmental Impact Statement (EIS) process for the Carmichael Coal Mine and Rail Project (the Project) in 2010. On 26 November 2010, the Queensland (Qld) Office of the Coordinator General declared the Project a 'significant project' and the Project was referred to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (referral No. 2010/5736). The Project was assessed to be a controlled action on the 6 January 2011 under section 75 and section 87 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The controlling provisions for the Project include:

- World Heritage properties (sections 12 & 15A)
- National Heritage places (sections 15B & 15C)
- Wetlands (Ramsar) (sections 16 & 17B)
- Listed threatened species and communities (sections 18 & 18A)
- Listed migratory species (sections 20 & 20A)
- The Great Barrier Reef Marine Park (GBRMP) (sections 24B & 24C)
- Protection of water resources (sections 24D & 24E)

The Qld Government's EIS process has been accredited for the assessment under Part 8 of the EPBC Act (1999) in accordance with the bilateral agreement between the Commonwealth of Australia and the State of Queensland.

The Proponent prepared an EIS in accordance with the Terms of Reference (ToR) issued by the Qld Coordinator-General in May 2011 (Qld Government, 2011). The EIS process is managed under section 26(1) (a) of the *State Development and Public Works Act 1971* (SDPWO Act), which is administered by the Qld Government's Department of State Development, Infrastructure and Planning (DSDIP).

The EIS, submitted in December 2012, assessed the environmental, social and economic impacts associated with developing a 60 million tonne (product) per annum (Mtpa) thermal coal mine in the northern Galilee Basin, approximately 160 kilometres (km) north-west of Clermont, Central Queensland, Australia. Coal from the Project will be transported by rail to the existing Goonyella and Newlands rail systems, operated by Aurizon Operations Limited (Aurizon). The coal will be exported via the Port of Hay Point and the Point of Abbot Point over the 60 year (90 years in the EIS) mine life.

Project components are as follows:

- The Project (Mine): a greenfield coal mine over EPC 1690 and the eastern portion of EPC 1080, which includes both open cut and underground mining, on mine infrastructure and associated mine processing facilities (the Mine) and the Mine (offsite) infrastructure including a workers accommodation village and associated facilities, a permanent airport site, an industrial area and water supply infrastructure

- The Project (Rail): a greenfield rail line connecting to mine to the existing Goonyella and Newlands rail systems to provide for the export of coal via the Port of Hay Point (Dudgeon Point expansion) and the Port of Abbot Point, respectively including:
  – Rail (west): a 120 km dual gauge portion running west from the Mine site east to Diamond Creek
  – Rail (east): a 69 km narrow gauge portion running east from Diamond Creek connecting to the Goonyella rail system south of Moranbah.
  – Quarries: five local quarries to extract quarry materials for construction and operational purposes

The location of the Project is illustrated in Figure 1.

1.2 Project location

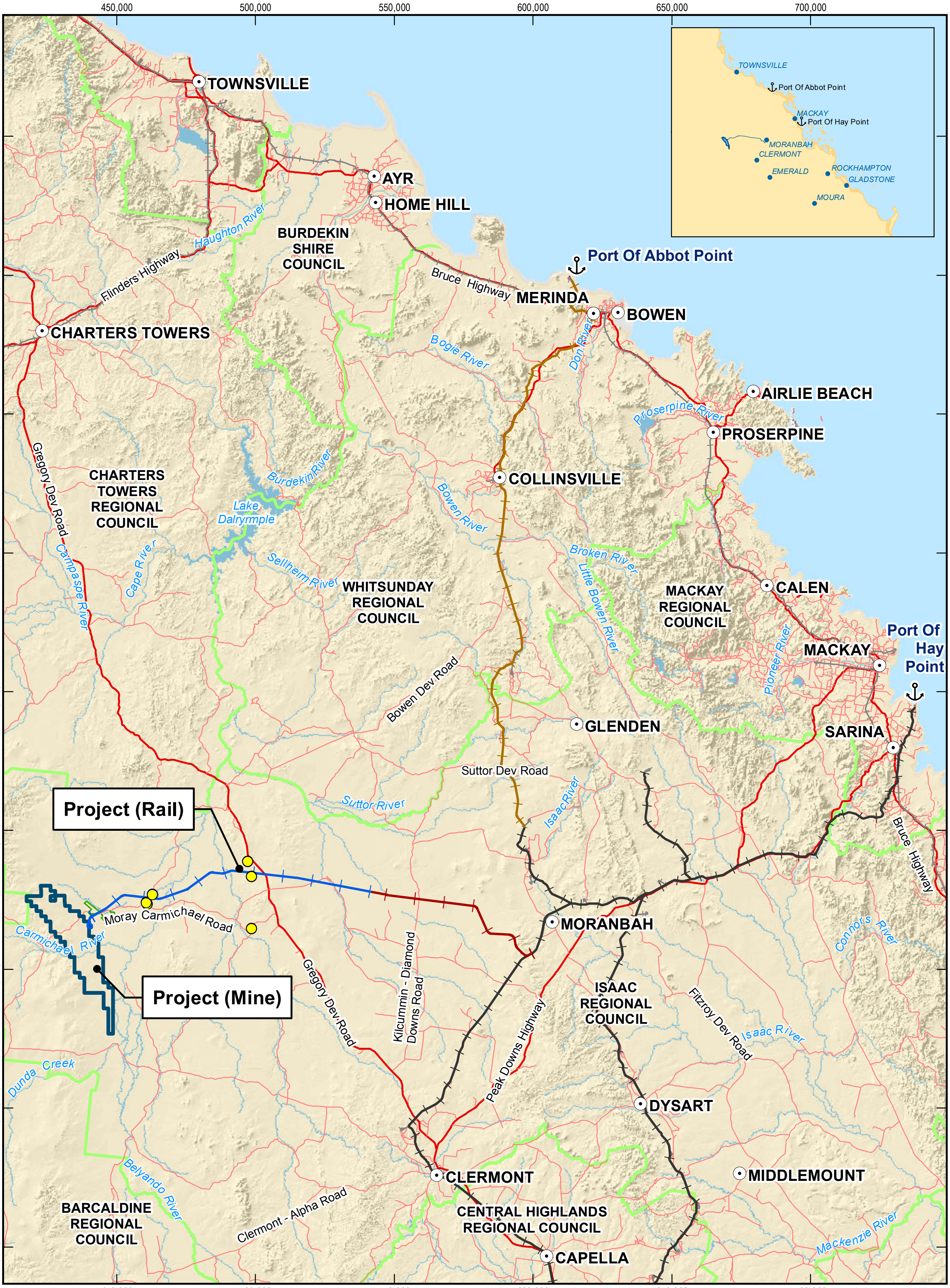
The Project (Mine) is located in the Galilee Basin, Central Queensland located approximately 160 km north-west of the town of Clermont, Central Queensland (refer to Figure 1). The Project (Mine) is predominantly within the Local Government Area (LGA) of Isaac Regional Council (IRC), with the exception of 167 ha within the north-western corner of the EPC1690, which is located within the LGA of Charters Towers Regional Council (CTRC). The IRC is located within the Isaac, Mackay and Whitsunday Region while the CTRC is located within the Northern Region of Queensland.

1.3 Scope of reporting

This report addresses emissions from Project (Mine) activities. The combined effect of emissions from Project (Mine) activities with windblown coal dust from the Project (Rail) are also addressed, to the extent that dust contours from the Project (Mine) and Project (Rail) overlap.

1.4 Limitations

The report is based on conditions encountered and information reviewed, including assumptions made by GHD, at the time of preparing the Report. Assumptions made by GHD are contained through the Report, including (but not limited to) mine planning information provided by Adani, ambient air quality monitoring and meteorological data (see Section 3.3), the coding of regulatory approved computer models (TAPM, Ausroads and Ausplume) and meteorological models (MM5 and CALMET), and emissions estimation methods and techniques (see Section 4).



LEGEND

Town	Local Road	Project (Rail)	Project (Mine)
Major Port	Watercourse	Rail (West)	Mine (Offsite)
Other Rail Network	Local Government Area	Rail (East)	Quarry
Goonyella System			
Newlands System			

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:2,000,000 (at A4)

0 10 20 30 40 50

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project SEIS

Job Number 41-26422
Revision 2
Date 14-10-2013

Project Location

Figure 1

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Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: © Commonwealth of Australia (Geoscience Australia): Town, Railways, Watercourses (2007); DNRM: LGA, (2011), Hillshade (2009); DMR: State Roads (2008);
Adani: Project Rail 1 (Opt11 Rev2) & 2 (Opt9 Rev3), Offsite, Quarry (2013). Created by: MS

2. Approach and methodology

2.1 Commonwealth legislation

The Environment Protection and Heritage Council, formerly known as the National Environment Protection Council, specify national air quality guidelines. The National Environment Protection (Ambient Air Quality) Measure (NEPM) sets standards for ambient air quality in Australia. The measure was released in 1998 and was varied in 2003 to include an advisory reporting standard for $PM_{2.5}$.

The NEPM specifies national ambient air quality standards and goals for the following common air pollutants:

- Carbon monoxide
- Nitrogen dioxide
- Sulphur dioxide
- Ozone
- Particulates (as PM_{10} and $PM_{2.5}$)
- Lead

In 2004, the National Environment Protection (Air Toxics) Measure was released which included monitoring investigation guidelines, principally for large cities with significant traffic emissions, for five compounds classified as air toxics:

- Benzene
- Benzo(a)pyrene
- Formaldehyde
- Toluene
- Xylenes.

These toxic air pollutants would only be released in significant quantities from the Project (Mine) if significant on-site power generation were installed. However, the principal power source for the Project (Mine) will be offsite and will be the subject of a separate air quality assessment, pending confirmation from the client on the outcome of the power source feasibility study. Onsite power generation is therefore deemed negligible and not considered further in this report.

Ambient concentrations of $PM_{2.5}$ are included as advisory reporting standards in the NEPM. These finer fraction particulates are typically emitted from combustion sources, including vehicle engines. Emissions from mining operations are dominated by the PM_{10} (and deposited dust) fraction of particulate matter. Potential particulate emissions and impacts are addressed within this report through consideration of the impacts of total suspended particulates (TSPs) and PM_{10}.

All of the above air pollutants have been included in the Queensland Government Environmental *Protection (Air) Policy 2008* (Air EPP).

2.2 State legislation and policy

The Air EPP commenced 1 January 2009 and is still current in the state of Queensland. The policy has the purpose of achieving the objectives of the *Environmental Protection Act 1994* in relation to the air environment. Part 3 of Air EPP sets environmental values for the air environment that enhance or protect qualities relating to:

- Health and biodiversity of ecosystems
- Human health and wellbeing
- Aesthetics
- Agricultural use

Schedule 1 of the policy defines air quality objectives for indicators such that environmental values are enhanced or protected. The indicators relevant to the Project (Mine) are Particulate Matter (TSP, PM_{10} and $PM_{2.5}$). Table 1 contains the evaluation criteria for the relevant indicators and objectives from the Air EPP. The non-'dust' air quality objective indicators are included for completeness in the case the Project (Mine) is expanded to include a power generation source.

Deposited dust is not included in the Air EPP for Queensland or any current Environmentally Relevant Activity (ERA) relating to mining or coal transport. "*There is currently no EPP (Air) air quality objective for deposited matter*" (DERM, 2010, p.40). The New Zealand Ministry for the Environment has a recommended dust deposition investigation level (insoluble solids fraction) of 4.0 g/m^2 over a 30 day averaging period (equivalent to an average daily deposition rate of 130 mg/m^2) to minimise nuisance complaints (Ministry for the Environment, 2001). This NZ recommended trigger level is for "*above background concentration* (sic)" (ibid. Table 7.1, p.32). The originating, comparable standard is the long established deposited dust impact assessment criteria used in New South Wales of 2.0 g/m^2/month (insoluble solids, annually averaged) of maximum increase in deposited matter with the maximum level, inclusive of background, of 4.0 g/m^2/month (DEC, 2005). For the purpose of this air quality assessment, the NSW deposited dust impact assessment criteria of 2.0 g/m^2/month (insoluble solids, annually averaged) has been used for the maximum incremental increase in deposited matter.

Table 1 Indicator objective criteria to protect the air environment in Queensland

Indicator	Environmental value	Air Quality Objective (µg/m^3)	Period
Total suspended particles (TSP)	Health and wellbeing	90	1 year
PM_{10}	Health and wellbeing	50	24 hours
$PM_{2.5}$	Health and wellbeing	25	24 hours
		8	1 year
Benzene	Health and wellbeing	10	1 year
Carbon Monoxide	Health and wellbeing	11,000	8 hours
Formaldehyde	Health and wellbeing	54	24 hours
	Protecting aesthetic environment	110	30 minutes

Indicator	Environmental value	Air Quality Objective (µg/m^3)	Period
Nitrogen dioxide	Health and wellbeing	250	1 hour
		62	1 year
	Health and biodiversity of ecosystems	33	1 year
Sulphur dioxide	Health and wellbeing	570	1 hour
		230	1 day
		57	1 year
	Protecting agriculture	32	1 year
	Health and biodiversity of ecosystems (for forests and natural vegetation)	22	1 year
Toluene	Health and wellbeing	4,100	24 hours
		410	1 year
	Protecting aesthetic environment	1,100	30 minutes
Xylenes	Health and wellbeing	1,200	24 hours
		950	1 year

2.3 Methodology

2.3.1 Model considerations

Due to the large geographical extent of the mine operations, especially in the north-south direction, standard, steady state, Gaussian plume dispersion models do not adequately simulate the dispersion of air emissions for the prediction of ground-level concentrations. Consequently, the three-dimensional, non-steady state, lagrangian puff model, CALPUFF, was used to simulate the long-range (in this case greater than 15 km for which Gaussian assumptions become invalid) transport of plumes with concentrations carried over from one hour to the next. CALPUFF also allows for the varying terrain, land uses and meteorology (wind direction, wind speed and atmospheric stability change) enabling the model to track releases (puff modelling) across the model domain is required. This provides for the tracking of the plume over varying terrain and land uses.

The model of choice to couple with CALPUFF is the diagnostic mass consistent CALMET model. The large model domain and lack of substantive smaller scale terrain features that would influence or diverge the broader regional flows introduced via the prognostic Pennsylvania State University/National Centre for Atmospheric Research (PSU/NCAR) mesoscale meteorological model (known as MM5) mean that a three-dimensional wind-field model with a grid resolution of one kilometre is justified. Various aspects of the model features are discussed in the following sections.

2.3.2 Derived wind model

A synthetic site-representative dataset was derived using a prognostic modelling approach coupled with a diagnostic wind model to correct for mass consistent flows around topographical features. The prognostic model used was MM5 which is a limited-area, non-hydrostatic, terrain-following sigma-coordinate meteorological model designed to simulate and predict atmospheric circulation to near one kilometre resolution (PSU/NCAR 2008). The MM5 modelling system software is freely provided and supported by the Mesoscale Prediction Group in the Mesoscale and Microscale Meteorology Division of NCAR (Boulder, Colorado). The MM5 data were obtained from the Atmospheric Studies Group at TRC Environmental Corp (ASG 2011) for the modelling year 2007. Available years for the data were 2006, 2007 and 2008. The middle year was selected as it involved the least number of extreme individual monthly rainfall totals (compared to the long-term average although an unseasonal rain event occurred during June) and the annual rain was the closest to the long-term annual mean (2006 was very dry and 2008 was wetter than average).

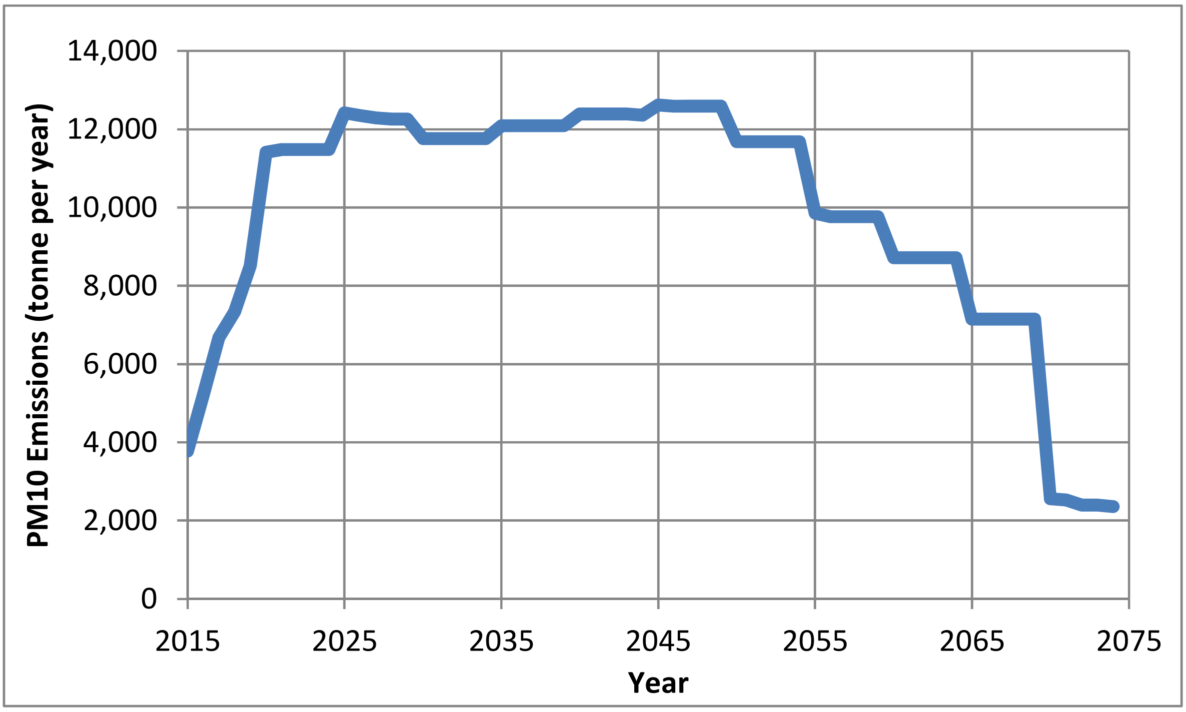
The diagnostic wind model used was the freely available CALMET meteorological model with Version 5.8 approved by the US Environmental Protection Agency (US EPA 2011) and includes an MM5 interface to incorporate the above prognostic modelling in a ‘no-observations’ mode. A CALMET modelling domain was established to have coverage of the Project Area from Eastings 400 – 476 km and Northings 7,525 to 7,601 km with a 1 km resolution. The model therefore had an extent of 75 by 75, 1 km grid points that fully included the mining operations. Additionally, the model extended 10 – 15 km beyond the perimeter of dust generating activity in all directions (excluding the rail spur). Vertical levels were defined to be concentrated in the lower levels (especially up to 500 m) with ten levels at 0, 20, 40, 80, 120, 210, 300, 500, 1,000, 2,000 and 3,000 m. Terrain and land use data with one kilometre resolution were modified to reflect actual ground surface land use as determined by aerial imagery.

2.3.3 Emissions modelling

The emissions modelling has been developed utilising recognised techniques for dispersion modelling and emission estimation. The CALPUFF dispersion model was used in the assessment to estimate ground-level concentrations of air pollutants emitted by the activities of the Project (Mine). CALPUFF is a Gaussian puff modelling system used to simulate the dispersion of atmospheric pollutants.

Emission estimates from mechanically generated sources were made for all years of the Mine’s 60 year lifespan, based on five year production rates and estimated equipment usage. A plot of the estimated PM_{10} emissions from the year 2015 to 2074 is shown in Figure 2. The predicted peak PM_{10} emissions year was 2025, with 5,684 tonne of controlled PM_{10} emissions (after standard controls applied). However, there are many years predicted to have controlled PM_{10} annual emissions within 2 percent of the 2025 estimate. As supplied estimates of production rates, production methods and equipment types are likely to be more accurate for 2025 as compared to later years such as 2045, the emission estimates for 2025 were used in the modelling. Furthermore, this year is also considered representative of worst-case dust emissions conditions as almost all areas of the mine are expected to be operational, based on the five year plan for 2025 – 2029. Further details on the emissions modelling are provided in Section 4.

Figure 2 Estimated annual PM_{10} mechanical generated emissions



3. Description of environmental values

3.1 Introduction

This section describes the existing air quality that may be affected by the Project (Mine) in the context of environmental values as defined by the Air EPP.

As discussed in Section 2.2, the Air EPP defines air quality objectives, in terms of concentration levels over various averaging periods (refer to Table 1), such that indicator pollutants do not affect various environmental values. The main indicator pollutant of concern for a coal mining project is particulate matter and the health and wellbeing of humans is the environmental value of concern. Therefore, the concentrations of particulate matter at locations people are likely to occupy for extended periods of time, such as, but not solely, housing, schools and hospitals (known as sensitive receptor locations) define the air quality impact so that the objectives of the Air EPP are met.

Section 8 (5) of Air EPP specifies that air quality objectives for indicator pollutants do not apply for a workplace if the emission is released from that workplace. Therefore, locations inside the Project (Mine) site perimeter are excluded from assessment. Workplace air quality will be managed according to appropriate workplace health and safety guidelines.

3.2 Pollutants

3.2.1 Regional overview

The Project (Mine) is located in the Galilee Basin, Central Queensland (refer Figure 1). This Project Area is remote from sources of non-natural pollutant loads. The remoteness of the area also indicates that existing background air quality measurements are very limited.

3.2.2 Particulates

'Particulate matter' and 'dust' are used as interchangeable terms for convenience. There is a lack of publically available datasets that concern particulate matter levels in the general region of the Galilee Basin. Further east there is some data on existing and proposed projects in the Bowen Basin. There is also some data available from monitoring undertaken by the Government regulator, the Department of Environment and Heritage Protection (DEHP), at west Mackay and Townsville on the coast. However, particulate matter data collected at coastal locations may not be directly comparable to the air environment at the Galilee Basin due to influences of seaborne salt particulates which would not be present inland. Available data assessed were concerned with PM_{10} and dust deposition rates. Comparable background information for TSP and the finer $PM_{2.5}$ dust fractions were derived by use of suitable ratios found for agricultural-use dominated dust sources.

For an estimate of background PM_{10} levels, the Caval Ridge Air Quality Impact Assessment Report (URS 2009) in the Moranbah region gives statistics for up to 18 months of PM_{10} monitoring. During a monitoring period involving two dry seasons, April 2007 to October 2008, homestead sites generally upwind of mining operations at Caval Ridge had a 70^{th} percentile statistic of 11.0 µg/m^3. The area of the Project (Mine) has a drier climate than the Bowen Basin but less existing mining operations and other anthropogenic sources. Therefore, ambient (or

background) dust levels for the Project (Mine) are likely to be similar to this level rather than higher estimates closer to 20 µg/m^3 in some inland agricultural areas of Australia. Particulate matter levels in coastal areas can be higher such as 26 µg/m^3 at west Mackay (PAE-Holmes, 2011) or a 75th percentile of 16.2 µg/m^3 at Townsville (DERM, 2011).

To determine background TSP levels, a PM_{10} to TSP ratio of 50 percent is preferred for ambient conditions for the Project (Mine) (NPI 2012, Table 2, p,16). This is due to the location where a higher proportion of suspended matter will originate from crustal dust rather than from the main sources of the finer particles associated with the sources that are industrial or combustion related. The assumed level for background TSP has been set at 22 µg/m^3.

For the respirable particle fraction of $PM_{2.5}$, it is assumed that a background $PM_{2.5}$ level can be based on a ratio to the background PM_{10} level. However, even with well documented studies involving co-located instruments, the ratio has been shown to vary "*depending on season and location, and can range from 0.3 to 0.9*" (NEPC, 2002, p.5) across a range of conditions within Australia. Since the Project Area is remote from urban populations, involving high emission contributions from vehicle and other combustion process, the ratio of $PM_{2.5}$ to PM_{10} adopted for this report is at 30 percent which is the lower estimate from the NEPC study. The adopted $PM_{2.5}$ background level for the Project (Mine) is therefore set at 3.3 µg/m^3.

The dust deposition criterion for the Project (Mine) is 4.0 g/m^2 of insoluble matter over a 30 day averaging period (equivalent to an average daily deposition rate of 133 mg/m^2).

To characterise the background level of deposited dust, the Ensham Central Project (Katestone, 2006) within the Bowen Basin (to the east of the Galilee Basin) was assessed as having the most comprehensive data in the publically available literature. The Ensham Central Project EIS reported on a number of dust deposition monitoring sites around the Ensham Coal Mine, one of which showed consistently low deposition rates thought to be representative of places relatively unaffected by coal mining activities. As such this site which would therefore be appropriate to represent the true ambient 'background' away from existing mine and other sources (such as found currently in the Galilee Basin). The rolling annual average ranged from 0.09 to 1.6 g/m^2/month with the conservatively highest level assumed for this assessment.

3.2.3 Gaseous compounds

Due to the inland location and lack of any concentrated form of emission sources (such as industrial, urban or combustion sources), the ambient background levels of gaseous pollutants was considered to be negligible, at a level of zero.

3.2.4 Odorous compounds

Due to the inland location and lack of any concentrated form of emission sources (such as intensive animal husbandry or wastewater), the ambient background levels of odours was considered to be negligible, at a level of zero.

3.3 Local meteorology

3.3.1 Climate

The Project Area is located near Latitude 21.960 ^{o}S, Longitude 146.090 ^{o}E, which is around 350 km southwest of Townsville by road and approximately 160 km north-west of Clermont. The local and regional context of the existing air shed can be described by the closest site-representative observations of temperature, rainfall and wind speed and direction. The closest BoM stations to the Project Area with sufficient data were Twin Hills to the east and Hughenden to the west. The important air dispersion parameters of atmospheric stability and mixing depth are derived parameters best described by reported or calculated conditions over a larger regional context (inland central Queensland).

Visually, through map referencing (Stern et al., 2000), the inland areas surrounding the Project (Mine) can be described as between a 'grassland' climate with a sub-classification of 'hot (winter drought)' or 'hot (persistently dry)'such as found in Hughenden to the west and a 'subtropical' climate with a sub-classification of 'moderately dry winter' such as found at Twin Hills to the east. The lowest average monthly rain is in May at 11.2 mm.

The climate in Hughenden is summarised as follows. The lowest average monthly rain in winter is 7.9 mm. This area has an annual mean maximum temperature of 31.6 ^{o}C. The Hughenden Post Office has acted as a Bureau of Meteorology (Site number: 030024) climatic observing site since 1884 and remains operational. It is located approximately 239 km north-west of the Project Area, at Latitude 20.84 °S and Longitude 144.20 °E (elevation: 324 m). The rainfall record at Hughenden spans 117 years while the temperature record spans 113 years.

The climate in Twin Hills area is slightly hotter on average per month than Moranbah, however, on an annual basis it has slightly more rainfall at 609.8 mm. The Twin Hills Post Office had acted as a Bureau of Meteorology (Site number: 036047) climatic observing site since 1905. It is located approximately 53 km east of the Project Area, at Latitude 21.95 °S and Longitude 146.95 °E (elevation: 195 m). The station closed on 31 December 1985, however, the rainfall record spans 80 years with a temperature record of 20 years.

The Carmichael meteorological station has acted as a Bureau of Meteorology (Site number: 036122) rainfall only observing site since January 2003. It is located in proximity to the Project Area, at Latitude 21.96 °S and Longitude 146.09 °E (elevation: 260 m), approximately 12 km from the Project (Mine). The Carmichael meteorological station has the operational status of 'open' however data records cease at 31 December 2010 with patchy data returns for all years except 2004-06 and 2008-09. The rainfall record therefore dates back for approximately 8 years. There is no temperature record. Hence, this site cannot be used to classify the climate albeit the limited record can be compared to the nearby climatic sites of Hughenden (grassland – hot winter drought) and Twin Hills (subtropical – moderately dry winter). The rainfall pattern at Carmichael suggests subtropical rather than grassland.

3.3.2 Air temperature and humidity

Monthly mean temperatures for the two relevant regional sites (Hughenden and Twin Hills) are displayed in Figure 3 to Figure 6. These show the seasonal variation in the temperature range. Mean monthly minimums with their associated upper and lower 10 percentiles (decile) are shown in blue and maximums are in red. Monthly mean relative humidity throughout the year is also displayed with both 9 am in the morning (red) and 3 pm in the afternoon (blue) observing times shown. These show both seasonal and diurnal patterns in humidity.

Monthly mean temperatures for Hughenden Post Office (Site Number 030024) show daytime summer temperatures are mostly in the mid-30s with winter overnight temperatures most commonly between 7 and 12 degrees (see Figure 3). The temperature record of approximately 36 years shows values ranging from -2 ^{o}C to 44 ^{o}C. 'Hot days', with temperatures exceeding 35^{o}C, can be expected up to 101 days per year. 'Frost days' with screen temperatures (white wooden box acts as radiation screen to the thermometers) below 2 °C can be expected up to 1.4 days per year. Relative humidity is highest in the mornings and during the February while the lowest is in the mid to late spring mornings and afternoons (see Figure 5).

Monthly mean temperatures for Twin Hills Post Office (Site Number 036047) show daytime summer temperatures are mostly in the early to mid-30s with winter overnight temperatures dropping to between 5 and 10 degrees (see Figure 5). The temperature record of approximately 20 years shows values ranging from -3.2 °C to 43.8 °C. 'Hot days', with temperatures exceeding 35 °C, can be expected up to 74.6 days per year. 'Frost days' with screen temperatures below 2 °C can be expected up to 10.4 days per year. Relative humidity is highest in the mornings and during the month of February and lowest in the late spring mornings and afternoons (see Figure 6).

Figure 3 Monthly mean and decile (10% and 90%) maximum and minimum temperatures (°C) at Hughenden post office

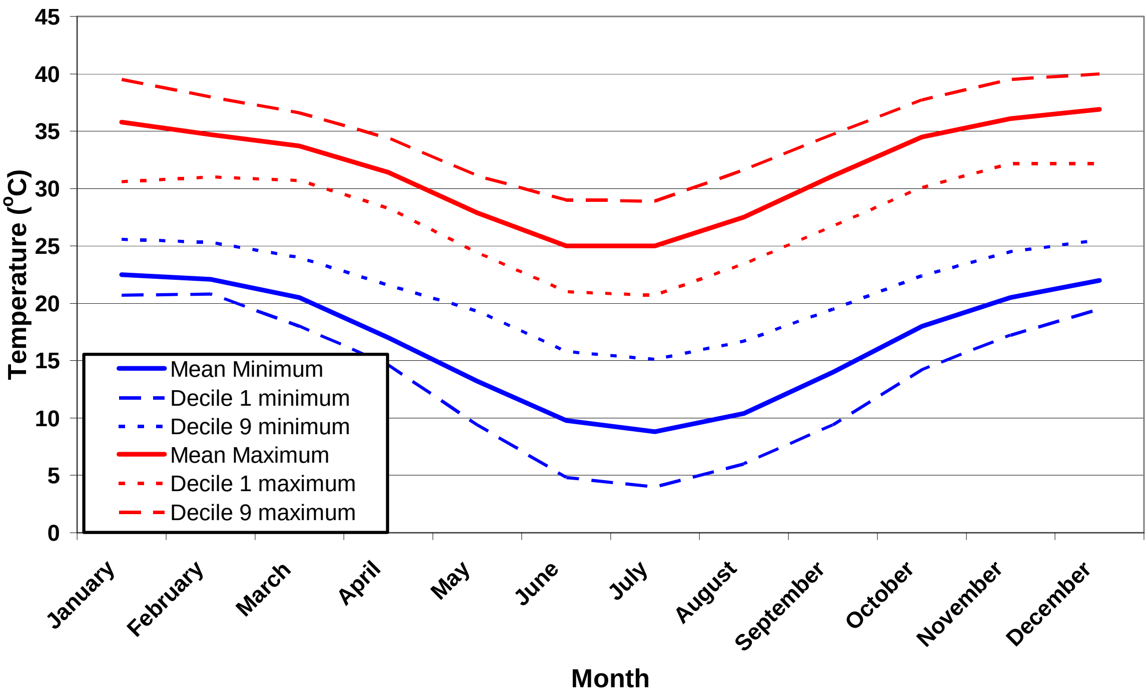


Figure 4 Morning and afternoon monthly mean relative humidity (%) at Hughenden post office

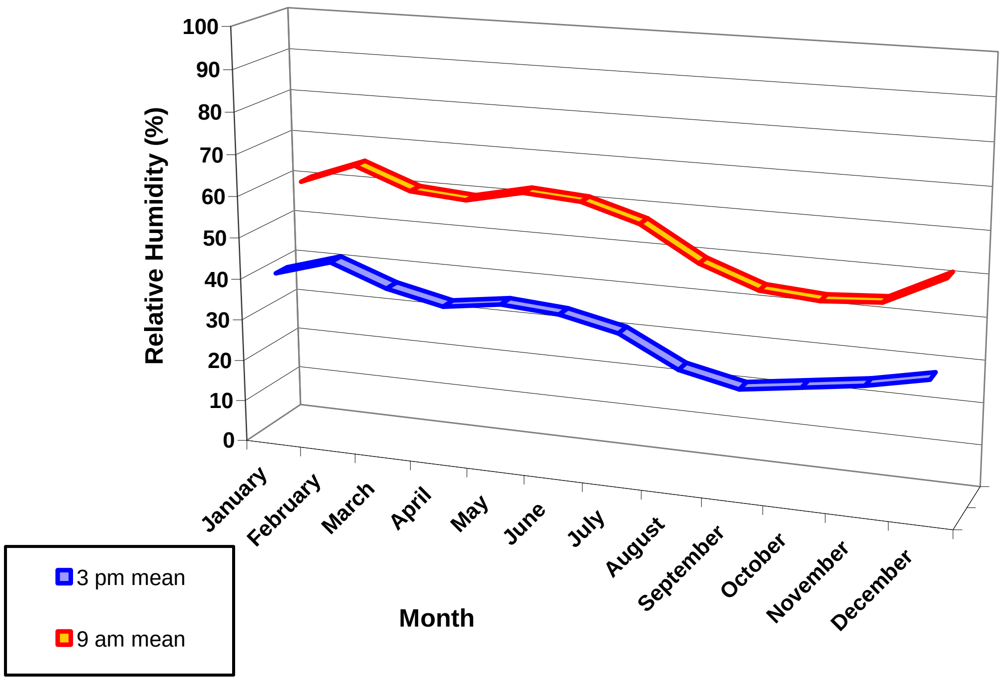


Figure 5 Monthly mean and decile (10% and 90%) maximum and minimum temperatures (^{0}C) at Twin Hills post office

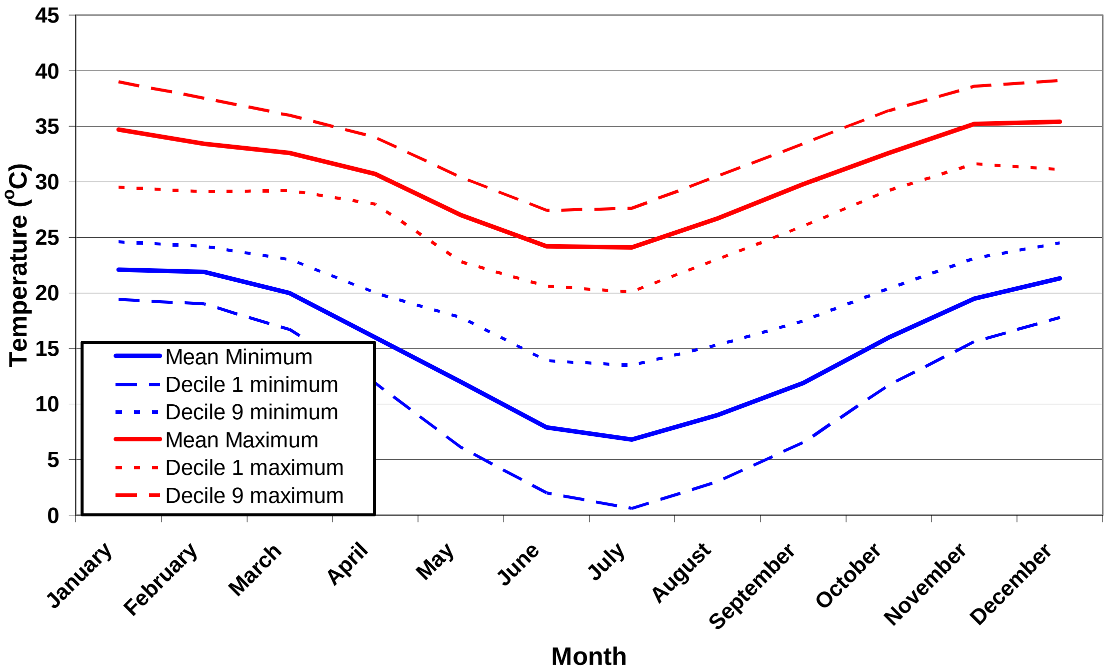
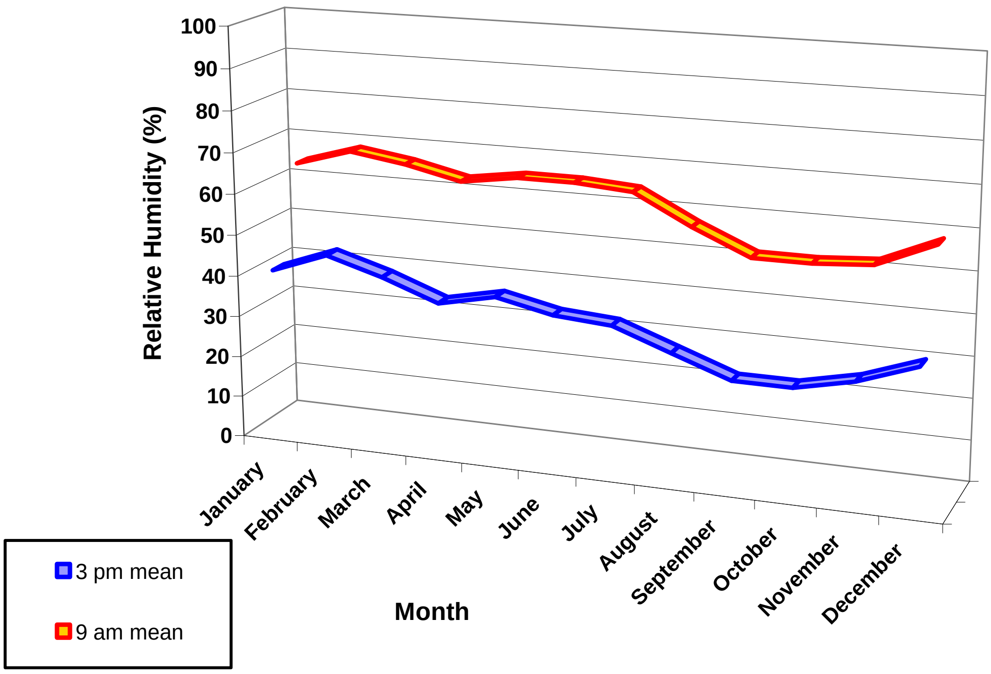


Figure 6 Morning and afternoon monthly mean relative humidity (%) at Twin Hills post office



3.3.3 Rainfall

The annual mean rainfall at Carmichael meteorological station 036122 is just over 524 mm and is dominated by the warm months producing convectively driven rainfall. This is graphically shown in Figure 7 with December through March, inclusive, accounting for 65 percent of the annual mean rainfall. The wettest month is January with a mean of 129.1 mm and the driest month is May with a mean of 11.2 mm.

The annual rainfall from the Carmichael site ranges from 252 to 700 mm, although the rain record for this site is quite limited, beginning in 2003, and so the range of rainfall cannot be accurately gauged from this site as yet.

Similar rainfall patterns can be seen at the other two regional sites, see Figure 8, with December through March inclusive accounting for the majority of the annual mean rainfall in the region. November is also a significant month for rainfall, although to a lesser extent at all regional sites.

The annual mean rainfall at the comparison sites is 610 mm for Twin Hills, and 492 mm at Hughenden. As expected, there is a clear pattern of rainfall decreasing with distance inland with the mean number of rain days per year at 46 and 43 days per year respectively. The range of annual rainfall at Twin Hills is 218 mm to 1,477 mm and Hughenden is 150 mm to 1085 mm per year, with the least amount of rain falling further inland at Hughenden.

Figure 7 Monthly mean rainfall (mm) proportions at Carmichael Site Number 036122 (January 2003 to December 2010)

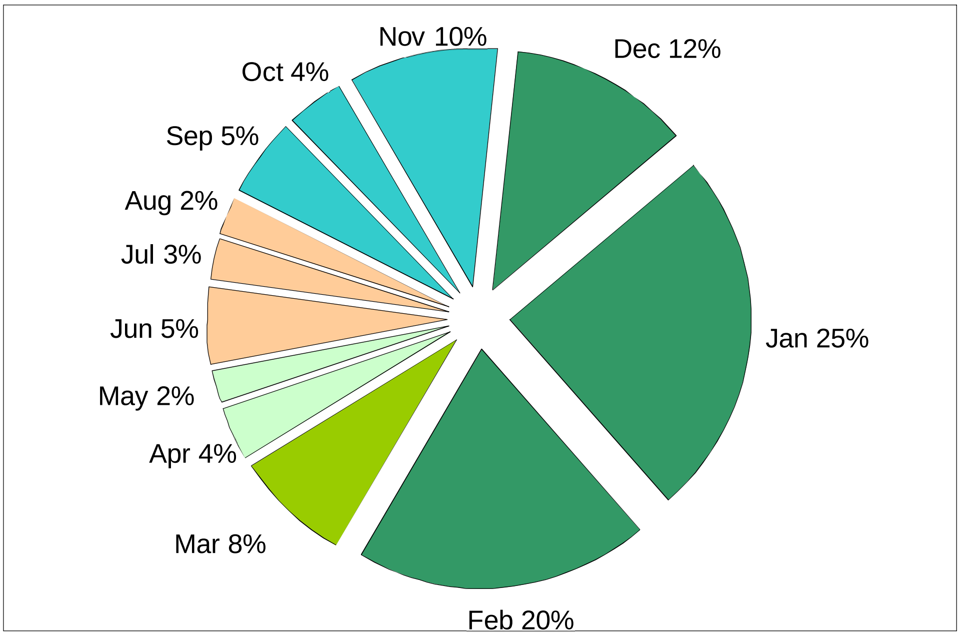
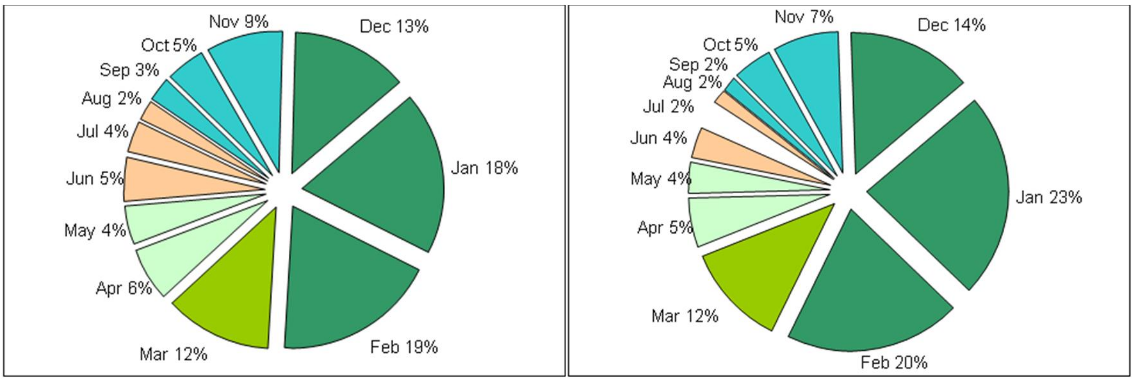


Figure 8 Comparison monthly mean rainfall (mm) proportions at Twin Hills post office (1905 to 1985) and Hughenden post office (1884 – 2010) (from left to right)



3.3.4 Wind speed and direction

The effect of wind on pollutant dispersion patterns can be examined using the general wind climate and atmospheric stability class distribution. The general wind climate at a site is most readily displayed by means of wind rose plots, giving the incidence of winds from different directions for various wind speed ranges.

The nearest available comprehensive dispersion climatology available is at the Sonoma Mine in the Bowen Basin south of Collinsville, approximately 230 km north-east of the Project (Mine). For the June 2008 to May 2009 period, hourly meteorological data from the on-site Automatic Weather Station (AWS) was used to develop a dispersion meteorological file for a full year. The Sonoma AWS recorded raw data on temperature, wind speed and direction and sigma-theta (standard deviation of wind direction). However, these data are considered to be too far east of the Project (Mine) and a synthetic site-representative dataset was derived using a prognostic modelling approach coupled with a diagnostic wind model to correct for mass consistent flows around topographical features. The derived wind data was produced using the MM5 and CALMET model described in Section 2.3.2.

An automated weather station (AWS) was installed on-site on 27 October 2011 to measure temperature (2 m and 10 m), wind speed and direction, pressure and solar radiation. Due to a solar panel fault no data was recorded from 22 January to 3 May 2012.

The AWS measures the following parameters:

- Temperature at 2 m and 10 m
- Solar radiation (in W/m^2)
- Wind speed and direction
- Rain

The Carmichael AWS (site number: 333300) was commissioned on 27 of October 2011. The coordinates are S 21.99971º, E 146.37653º. The AWS is shown in Plate 1.

Data was obtained from the Carmichael AWS for the purposes of this report from the 27 October 2011 until the 20 May 2013. Whilst an equipment malfunction resulted in missing meteorological data for the period 23 January 2012 to the 3 May 2012, a full annual cycle of meteorological data has been obtained for 2012/2013 to encompass a full wet and dry season. As such, it is possible to compare measured on-site data to modelled data to support previous inferences.

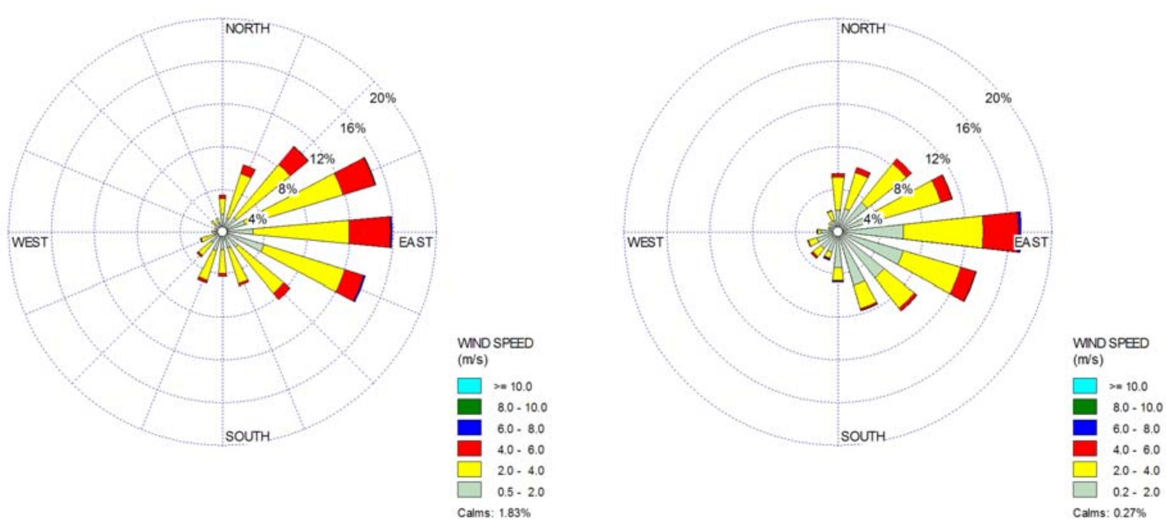
Plate 1 Carmichael AWS (Site number 333300)

The 10-minute recorded wind data was converted to hourly averaged values so as to be comparable to the synthetic wind data. This AWS represents the most accurate dataset for on-site meteorological conditions. A further check on the site-representativeness of the prognostic (MM5)/diagnostic (CALMET) wind field modelling is available by comparing wind roses that are predicted and available data from the on-site AWS. Figure 9 shows the comparison between the modelled (derived) wind rose for the mine site and the recorded measurements by the AWS

station on the mine site with a complete yearly cycle of data. The modelled wind rose was derived using the above meteorological modelling tools, and the corresponding meteorological data was used for dust modelling. For the modelled meteorological data, the prevailing wind directions have a strong easterly component. This is expected at this latitude of near 22° south being dominated by the (south-east) southern hemisphere trade winds. The strongest winds for the modelled data, those above 4.0 m/s, continue the pattern of being mostly out of the east. The annual average wind speed for this dataset is 2.64 m/s.

Figure 9 Derived and measured annual wind roses for the Project (Mine)

Derived Annual Wind Rose Project (Mine) AWS Recorded Wind Rose (Mine)



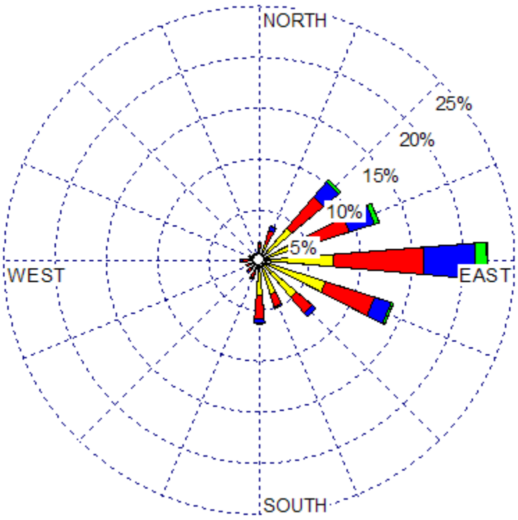
The measured meteorological data from the AWS site validates the findings of the modelled data set. There is still a strong disposition of prevailing easterly winds. However, there is a slight (~4 percent) reduction in the number of prevailing winds from the ENE and calm winds (between 0.2 and 2.0 m/s) make up a higher component of the prevailing winds.

Another test of how well the modelling system has represented the wind pattern is to compare annual wind roses from the nearest wind monitoring stations in the wider region (Sonoma as above, Hughenden January 2006 to November 2011 and Emerald February 2006 to Jan 2007). These are shown as annual wind roses in Figure 10, and can be compared to the Mine wind rose of Figure 9.

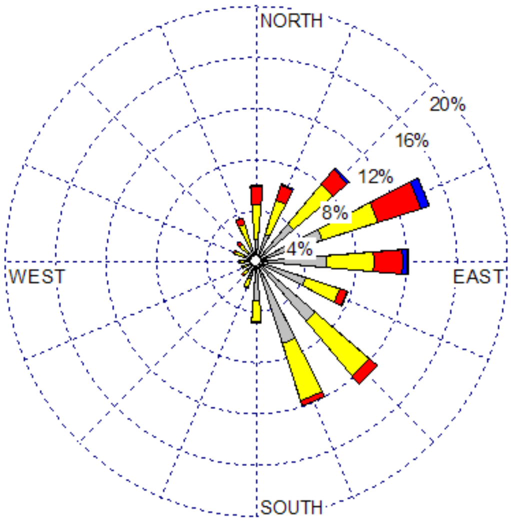
The wind climate of the wider geographic region of inland central Queensland shows that the patterns identified have common themes of an inland sub-tropical climate. These are consistent across the Bowen Basin and Galilee Basin, with measured data consistently showing the lack of westerly component winds and the trade wind south-easterlies at times coming out of the north-east sector, mostly associated with wet season disruption to the prevailing trade winds. This analysis suggests that the derived Project (Mine) wind data, for dispersion modelling purposes, is site-representative.

Figure 10 Comparison annual wind roses for inland Central Queensland

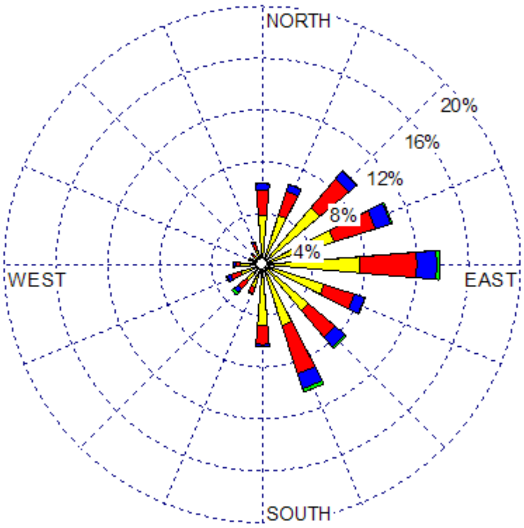
Hughenden (North-west)



Sonoma (North east)



Emerald (South-east)



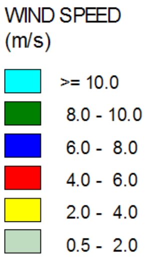
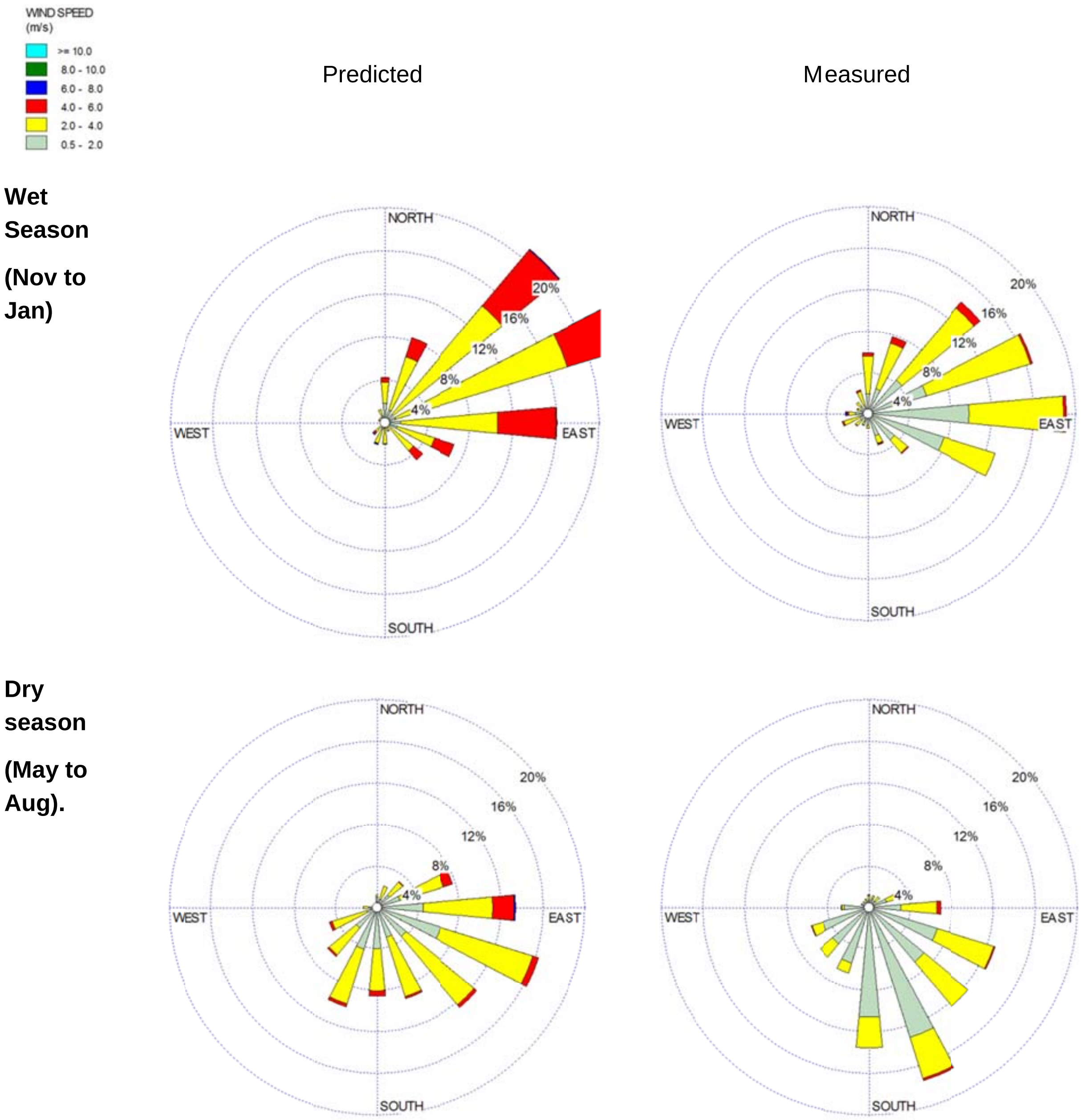


Figure 11 shows that the seasonal winds have been correctly modelled to be predominantly from the north-east sector during the wet season and predominantly from the south-east sector during the dry season. Overall, the modelled wind speeds, representative of the entire mine site, are higher than the observed wind speeds. This can be attributed to the measurement site being well vegetated with a higher surface roughness than the corresponding roughness used in the whole-of-mine model assumptions.

Figure 11 Comparison derived and measured wind roses



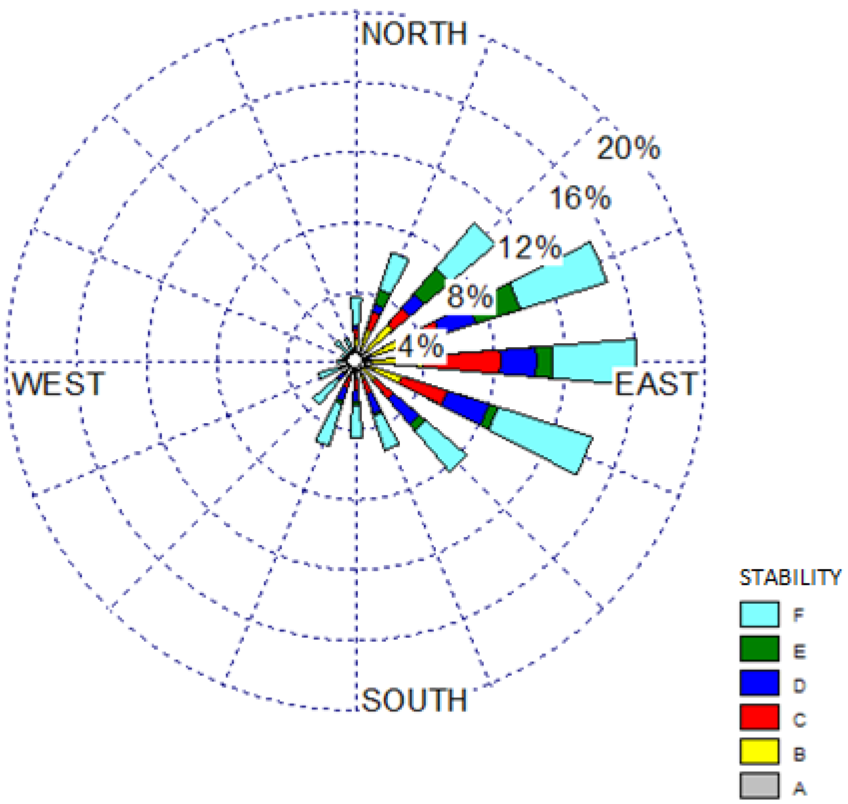
3.3.5 Atmospheric stability

Dispersion meteorology required for modelling air pollutants requires a time varying measure, or estimate, of atmospheric stability. The derived Project (Mine) meteorological data includes stability in the form of Pasquill-Gifford stabilities. This stability scheme assigns letter codes to varying degrees of atmospheric stability:

- A, B and C for unstable condition (very, moderate and slight, respectively)
- D for neutral stability
- E and F for stable conditions (moderate and slight, respectively).

As can be seen in the stability rose shown in Figure 12, the Project Area exhibits a dominant F-class which prevails most nights due to the light winds producing stable night-time conditions. In tropical regions, prognostic models such as MM5, which are themselves reliant on global scale Numerical Weather Prediction models with grid scales of tens of kilometres, tend to under-predict the higher wind speeds and therefore fall short with the determination of neutral conditions of D-class stability. North of the Tropic of Capricorn, strong solar radiation will result in most unstable conditions being highly convective, hence the derived stability class data frequency is under predicted for both the A and B class stability. The above two under-predictions are considered low in importance as this is a conservative consideration for dust dispersion for ground and near-ground sources.

Figure 12 Derived annual stability rose for the Project (Mine)



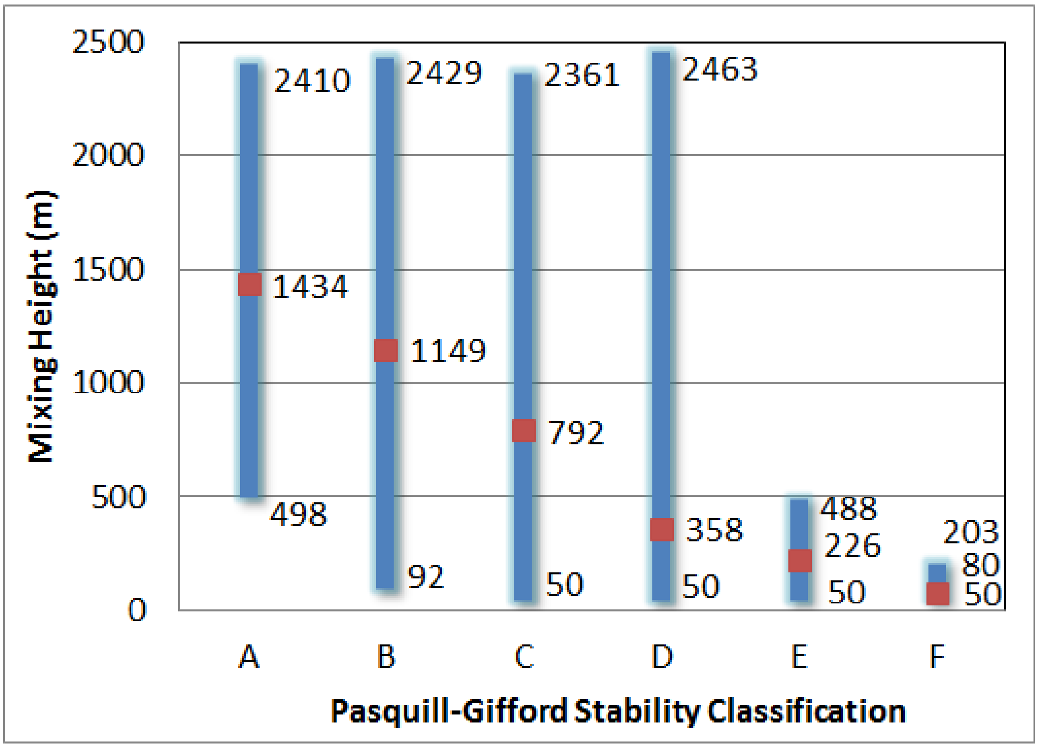
3.3.6 Mixing depth

The mixing depth is an important atmospheric parameter for air dispersion modelling. The mixing depth is an indicator of vertical dispersion potential of the atmosphere and is a mixture of mechanical and convective influences. The convective conditions will dominate during the day as temperature can become high in this tropical climate while the night-time mixing height is dominated by the strength of the vertical temperature gradient (and the formation of temperature inversions on most nights in a near desert climate) but which may be moderated by the mechanical mixing of wind speeds that occasionally continues beyond sunset.

No direct measurements of mixing depth are available for the Project Area. Therefore, CALMET was configured so as to calculate a suitable mixing height to be used in the dispersion modelling. The minimum daytime mixing heights were in the range of 50 to 500 m which is reasonable for the most unstable conditions (Class A) and some days likely to have cloudy to overcast skies. Night-time mixing heights were as low as 50 m during the calmest of conditions but could reach to near 500 m during nights with stable conditions but with stronger winds. A statistical analysis of mixing heights for each of the stability classes is shown in Figure 13.

The derived mixing heights are conservative for the circumstances of the Project (Mine) as the mining emission sources will be at, or near, ground level. Daytime mixing heights reaching no more than 2,500 m using this approach is technically an underestimate during highly convective conditions.

Figure 13 Stability class derived mixing heights - minimum, average and maximum



4. Project emissions

4.1 Introduction

Project emissions have been identified based on the outcomes of the supplied - Mine Plan and known similar emissions data. Emissions have been developed for all years of the Mine's projected lifespan. After an assessment of mechanically generated dust emissions, the year 2025 was selected as representative of the worst case emissions year to model as part of this air quality assessment and this is used throughout the following sections. This is detailed further in section 2.3.3. Emissions from the Project (Mine) offsite infrastructure will be assessed during the detailed design phase.

Quantities and types of equipment, the location and sequence of mining are based on indicative mine planning. There is potential for changes to these parameters as detailed mine planning progresses, however, the overall production rate is not expected to change. The Project (Mine) layout, to which the below described project emissions refer, is based on the mine plan for the years 2025 to 2029 and is illustrated in Figure 14.

4.2 Emissions during construction

The construction of the Project (Mine) will require land clearing and civil works. The land clearing is part of the overburden stripping operation and the latter, with associated large truck haulage, generates significant dust emissions. As this is part of the Project (Mine) operations assessment, construction is considered as part of the actual worst case mine operation (year 2025).

4.3 Emissions during operation

4.3.1 Emission sources

Air emissions during the operation of the open cut and underground mines have been estimated for the following activities for the operation of the mine:

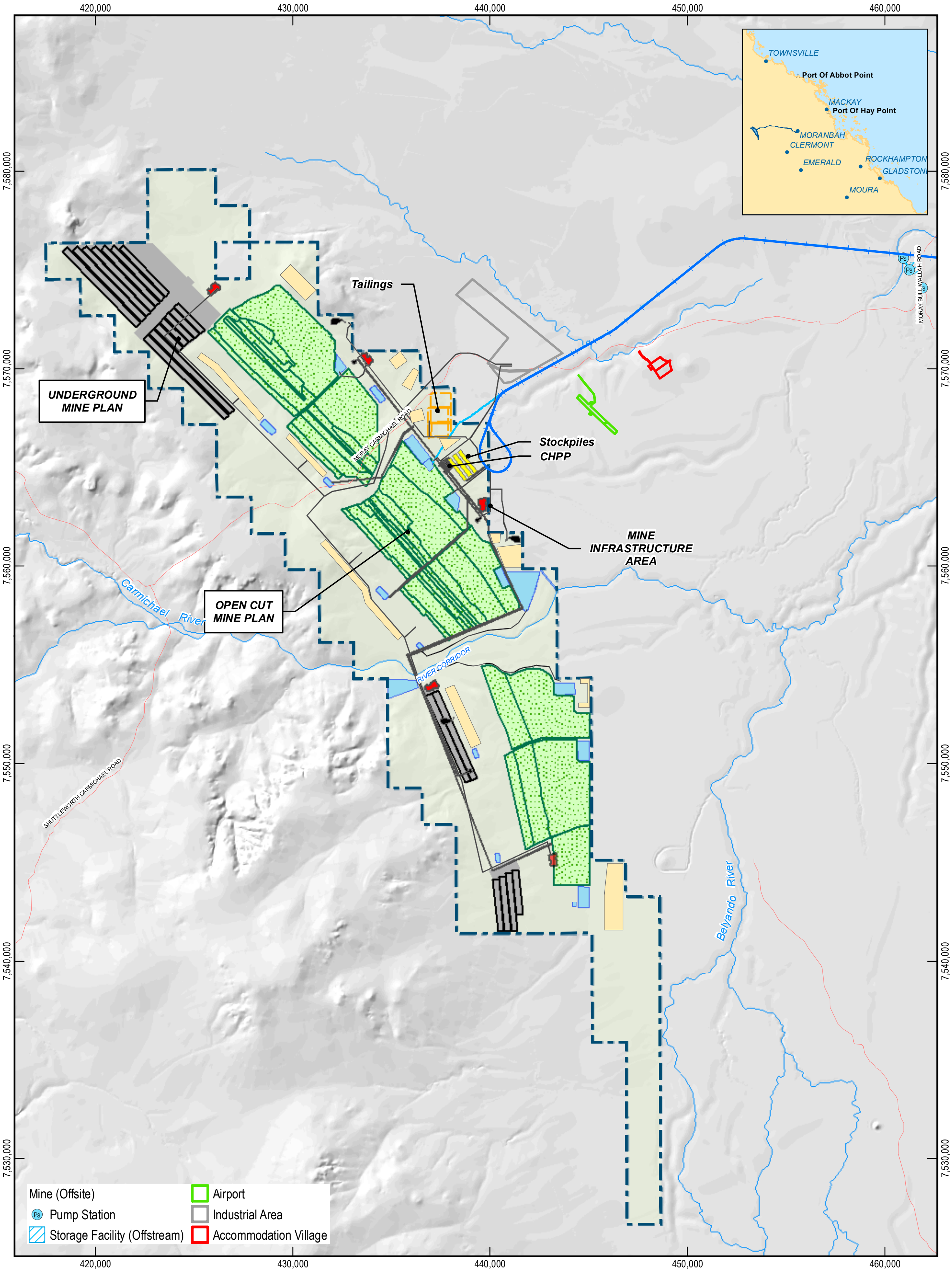
- Blasting
- Removal of topsoil (overburden) in the open cut mine (OCM) pits
- Removal of overburden by truck-shovels
- Removal of overburden by bulldozer
- Excavators mining coal and loading haul trucks
- Loading of haul trucks with overburden
- Transportation of coal by haul truck to nearest Run-Of-Mine (ROM) pad
- Transportation of overburden by haul truck to nearest waste dump
- Dumping of waste material at nearest out of pit waste dumps
- Coal handling (loading, unloading) at the OCM and underground mine (UGM) ROMs
- Coal handling at the coal handling preparation plant (CHPP)

- Underground mine ventilation
- Primary, secondary and tertiary crushing of coal
- Coal conveying from northern and southern ROMs to Central ROM
- Wind erosion from active coal stockpiles
- Wind erosion from exposed waste dumps
- Wind erosion from active OCM pits
- Train loading
- Dust emissions from train transport of coal within the vicinity of mine
- Grading of haul roads, waste dumps and OCM pits

Dust was modelled as emanating from a total of 54 dust sources within the Project (Mine) site, as shown in Figure 14. These are summarised as follows:

- OCM pits B to G – 6 area sources and 6 volume sources
- Waste dumps – 6 area sources and 6 volume sources
- Top soil dumps – 11 volume sources
- Raw coal storage stockpiles – 2 volume sources
- Reclaim coal storage stockpile – 1 volume source
- Railway line – 6 area sources
- Train loadout – 1 volume source
- Coal processing infrastructure – 1 volume source
- North, South and Central ROM pads – 3 volume sources
- UGM exhaust ventilation infrastructure – 5 volume sources

Included in the above 54 dust sources, there were 23 sources (12 area and 11 volume) associated with wind dependent wind erosion dust emissions for the 6 OCM pits, 6 waste dumps and 11 identified top soil areas. Wind erosion from clearly defined coal stockpiles were conservatively modelled at a constant emission rate.



LEGEND

- Local Road
- River / Watercourse
- Overland Conveyors
- Rail (West)
- Mine (Onsite)
- Open Cut Blocks
- Water Management Dams
- Mine Infrastructure Area
- Mine Infrastructure
- Stockpiles
- Tailings Cell
- Top Soil Storage

Based on or contains data provided by the State of QLD (DERM) [2010]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:275,000 (at A4)

0 2 4 6 8 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Job Number	41-26422
Revision	C
Date	23-10-2013

Mine Layout Progress Plot
Year 2025 - 2029

Figure 14

G:\41\26422\GIS\Maps\MXD\01000_Project_Description\41_26422_01007_rev_c.mxd

Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: GA: Road, River / Watercourse (2007); DME:EPC1690 (2010), EPC1080 (2011); Adani: Alignment, Offsite(2013), Mine Layout / Infrastructure (2013); Created by: MS

4.3.2 Target air pollutants

The follow air pollutants have been assessed:

- Total Suspended Particles (TSP)
- Particulate matter less than 10 µm in equivalent aerodynamic diameter (EAD) (PM_{10})
- Particulate matter less than 2.5 µm in EAD ($PM_{2.5}$)

In addition to predicting ambient levels of particulate matter, dust deposition was also assessed as this can cause nuisance and impacts on visual amenity.

Note that as per the Air EPP, TSP is defined as particles with an EAD of less than or equal to 50 µm.

Sulphur dioxide (SO_2) was not assessed. The current low sulphur content of Australian diesel fuel (maximum of 10 ppm as per Australian Diesel Fuel Standard since 1 January 2009), in combination with the widely dispersed equipment over many kilometres, makes it unlikely that SO_2 goals will be exceeded off-site or at any identified sensitive receptors.

Oxides of nitrogen, carbon monoxide and any other potentially harmful gaseous substances were assessed as unlikely to exceed air quality goals off-site, or at identified receptors, due to the comparatively low emission rates (with respect to dust impact) and the large distances between significant sources. Accordingly, no further assessment was of these emissions has been carried out.

4.3.3 Unit operations

The dust from the operations at the Project (Mine) was divided into ten different categories based on their locality. These are summarised as:

- OCM pits
- ROM pads
- CHPP
- Raw coal stockpile
- Reclaim coal stockpile
- Train loadout
- Waste dumps
- Top soil areas
- Railway line
- Underground mine exhaust vents

Emissions from the different dust generation processes are described below in Section 4.3.4. Sources can be related to one of the ten locations identified above. Haul road emissions due to haul truck movement were proportioned to either OCM pit or waste dump sources. Conveyor emissions were proportioned to waste dump or CHPP emissions as appropriate.

4.3.4 Dust generation

The general equation used to estimate TSP, PM_{10} and $PM_{2.5}$ emissions from mining activities is described mathematically as:

$$E_i = A \times EF_i \times \left(\frac{100 - CE}{100}\right)$$

Where:

E_i = Emission rate of pollutant *i* (kg per activity)

A = Activity data (units dependent on emission factors)

EF_i = Uncontrolled emissions factor for pollutant *i* (kg per activity)

CE = Control efficiency (%)

Where possible, the activity data and control efficiencies used in the modelling to estimate emissions from the sources described in Section 4.3 were based on the supplied Mine plan, project description and supplied equipment lists. Where required, emission factors used to estimate emissions of TSP and PM_{10} have been sourced from the publically available National Pollutant Inventory (NPI) Emissions Estimation Technique Manual for Mining (NPI, 2012).

Activity data is usually dependent on the amount of earth moved as kilograms of TSP/PM_{10} per tonne of material or on the total distance of a vehicle travelled (Vehicle Kilometres Travelled, VKT). Therefore, a reduction in the total gross amount of earth processed, or in the total number of kilometres travelled by vehicles will reduce emissions. Dust emissions, as per NPI (2012), are independent of vehicle speeds except for dust emissions from small vehicle movements, such as 4WD's, utility vehicles and graders.

NPI (2012) does not contain emission factors for $PM_{2.5}$. Therefore, emissions of $PM_{2.5}$ have been estimated as 15 per cent of TSP from all mechanical sources, 18.3 percent of TSP from wind erosion sources and 68.8 percent of the underground exhaust ventilation emissions. These values are conservative when compared against other reported values in EIS coal projects for the region (PAE-Holmes, 2011, p.7), which applies a generic value of 12.5 percent of $PM_{2.5}$, which is less than the value used for this modelling.

The moisture content for coal and overburden used in this modelling is described as follows:

- Coal: 16 percent (Runge, 2011)
- Overburden: 2 percent (PAE-Holmes, 2011, p. A-7)

In practice at an operating mine, the moisture content will naturally vary in-situ and also vary when being hauled and stockpiled dependant on varying weather conditions (dry or raining for example but also humidity and wind strength) and length of storage time. In dry conditions there is always potential for moisture to be continually liberated once the coal is mined. Some bituminous coal may well have a moisture content as low as 10 percent (Midwestern USA for example). The Client has advised of some test results for in-situ coal as low as 9 percent, compared with the previously supplied, and modelled, 16 percent. The sensitivity to the variability in coal moisture content was investigated by setting this lower bound value of 9 percent in the emissions inventory (see Section 4.3) and comparing the estimated total dust emissions. The overall site PM_{10} emissions with coal moisture set to 9 percent rather than 16 percent resulted in less than a 5 percent increase in dust emissions from 8,820 tonnes per year to 9,237 tonnes per year. This percentage increase is considered small when compared to the

other potential sources of error in any large scale mine emissions inventory. The silt content for the modelling was based on results from a medium intensity (1:100,000) soil survey over EPC1690 and associated soil testing, which put the average silt content for the surveyed area at 7.7 percent (see GHD, 2012). The average silt content for EPC1690 was judged a conservative estimate for dust modelling purposes over the Project (Mine). This will be confirmed as part of further survey work during detailed design of the Project (Mine).

A description of the sources of the emissions is provided in the following sections. A summary of the emission factors used for the modelling is provided in Table 2 with more detailed method derivation discussed in Sections 4.3.5 to 4.3.12.

Wind erosion was based on the AP-42 emissions estimation equation provided in the NPI Mining Manual (NPI, 2012, p.59-60, equation 22). This equation relates the annual average wind erosion rate to the silt content (7.7 percent), the number of days per year when the rainfall is greater than 0.25 mm and the percentage of the time when the wind speed is greater than 5.4 m/s at the mean height of a stockpile.

Bureau of Meteorology data for Clermont Post Office indicates that the mean number of rain days is 57.2. Clermont Post Office was the preferred site for collecting data on mean rain days as the record was longer and more recent than at Twin Hills Post Office. Analysis of the CALMET data indicates that the wind speed is greater than 5.4 m/s (at a reference height of 10 m) 1.53 percent of the time. This 1.53 percent value is conservative since most wind erosion takes place at ground level, where the wind speed is lower.

Furthermore, wind erosion was modelled as wind speed dependent, based on a third order relationship with respect to wind speed. That is:

$$EF_i = kU^3$$

Where:

EF_i = Uncontrolled emissions factor for pollutant *i* (kg per hectare per year)

U = the wind speed at the reference height of 10 m and

k = a proportional constant to maintain total annual emissions as constant.

In effect, the annualised emissions as determined by AP-42 are distributed throughout the year based on a wind dependent relationship. As the dispersion model CALPUFF does not allow a continuous function with respect to wind speed to be entered via the DEFAULT methods, a “binned” approach to the wind erosion EF’s was determined. The uncontrolled wind erosion EF’s are summarised in Table 3.

Table 2 Summary of uncontrolled emission factors

Activity	Required Information	Pollutant	Emission Factor	Units	Derivation
Graders	Operational hours	TSP PM10 PM2.5	0.19 0.059 0.029	kg/VKT	Calculated from operational hours and default speed
Excavators/shovels on overburden	Tonnes of overburden moved	TSP PM10 PM2.5	0.0015 0.00071 0.00023	kg/tonne	Calculated from moisture content and mean wind speed
Loading coal to trucks by shovel	Tonnes of coal moved	TSP PM10 PM2.5	0.029 0.014 0.0044	kg/tonne	Default
Bulldozers on overburden	Operational hours	TSP PM10 PM2.5	12.75 3.57 1.91	kg/h/veh	Calculated from moisture and silt content
Bulldozers on coal	Operational hours	TSP PM10 PM2.5	8.50 2.72 1.28	kg/h/veh	Calculated from moisture and silt content
Unpaved haul roads	Total kilometres travelled	TSP PM10 PM2.5	7.7 2.3 1.2	kg/VKT	Calculated from silt content and average vehicle weight
Blasting	Number of blasts	TSP PM10 PM2.5	6.2 3.2 0.94	kg/blast	Default
Trucks dumping overburden	Tonnes of overburden moved	TSP PM10 PM2.5	0.012 0.0042 0.0018	kg/tonne	Default
Trucks loading primary crusher	Tonnes of coal moved	TSP PM10 PM2.5	0.01 0.0042 0.0015	kg/tonne	Default
Unloading ROM coal stockpiles	Tonnes of coal moved	TSP PM10 PM2.5	0.00032 0.00015 0.000048	kg/tonne	Default

Activity	Required Information	Pollutant	Emission Factor	Units	Derivation
Coal transfer points	Tonnes of coal processed	TSP PM10 PM2.5	0.00032 0.00015 0.000048	kg/tonne	Default
Primary crushing	Tonnes of coal processed	TSP PM10 PM2.5	0.01 0.004 0.0015	kg/tonne	Default for high moisture
Secondary crushing	Tonnes of coal processed	TSP PM10 PM2.5	0.03 0.012 0.0045	kg/tonne	Default for high moisture
Tertiary crushing	Tonnes of coal processed	TSP PM10 PM2.5	0.03 0.01 0.0045	kg/tonne	Default for high moisture
Overland coal conveyors	Exposed area	TSP PM10 PM2.5	0.4 0.2 0.07	kg/h/ha	Default for stockpile wind erosion
Loading coal to trains	Tonnes of coal processed	TSP PM10 PM2.5	0.0004 0.00017 0.00006	kg/tonne	Default
Dust from trains	Tonnes of coal moved	TSP PM10 PM2.5	0.23 0.12 0.04	g/km/tonne @ 80 km/h	Train speed dependent
Wind erosion	Disturbed area	TSP PM10 PM2.5	475.5 237.8 87.0	kg/ha/y	Wind speed dependent, kU^3

Table 3 Summary of uncontrolled wind erosions emissions factors

CALPUFF Wind Speed Upper Value (m/s)	Category Fraction	Emission Factor (kg/ha/h)		
		TSP	PM10	PM2.5
1.54	0.176	0.00071	0.00035	0.00013
3.09	0.500	0.0192	0.00961	0.00352
5.14	0.297	0.108	0.054	0.0198
8.23	0.027	0.463	0.232	0.0847
10.80	0.000	–	–	–
10.8+	0.000	–	–	–

4.3.5 Open cut mine operations

The following activities were identified as occurring inside of the OCM pits:

- Excavation of overburden
- Bulldozers on overburden
- Bulldozers on coal
- Loading overburden onto trucks
- Loading coal onto trucks
- Blasting
- Graders
- Haul truck movement.

The dust emissions from the OCM operations were based on the information provided in the Mine plan and project description (SEIS Volume 4, Appendix B). This specified the amount of material (overburden and coal) that was estimated to be moved and the number and type of operational equipment for each year that the Mine was operational.

Bulldozer operations were based on the estimated number of operating vehicles in the Mine plan, 67 for the year 2025, with an operational load factor of 30 percent and two thirds of the bulldozers operating in the mine pits. As both silt and moisture content were known, the most accurate method to estimate dust emissions was by the use of the equations as opposed to the default values.

Loading overburden into haul trucks was assumed to be undertaken by front end and shovel loaders. NPI (2012) equations 10 and 11 were applied as information regarding the average moisture content and the average wind speed were known. The amount of overburden moved was provided in the Mine plan. This method was considered conservative as wind speeds inside the pit are likely to be lower than those outside of it, for which the average wind speed was determined. Furthermore, a 2 percent assumed moisture content for the overburden is unlikely to be representative of moisture levels at depths beyond 30 cm, which can be rapidly removed using modern earth moving equipment.

For estimation of the dust emissions from excavating and loading coal into haul trucks, the default NPI (2012) values were used. Application of the NPI (2012) equations 12 and 13 were investigated, however, for the high moisture content coal (at 16 percent), the equations predicted TSP emissions to be greater than PM_{10}. Therefore, for high moisture content coal, NPI (2012) equations 12 and 13 are considered unreliable compared to the default values. The total amount of coal moved was supplied by the Mine plan.

Blasting is not the primary mining method, but will be used as required. As such, a detailed blasting schedule was not available. It was assumed for the purposes of estimating air emissions that blasting was to occur once every day. The current default NPI emission rate was applied (NPI, 2012).

Dust emissions from grader operations were estimated from the number of graders an average grader speed of 5 km/h, which was used to estimate annual VKT, an operational load factor of 50 percent, with half of the graders operating in the pits and half outside of the pits.

4.3.6 Run-of-mine pads

Based on the supplied coal handling process flowchart, shown in Figure 15, the following activities were identified as occurring at the ROM pads,:

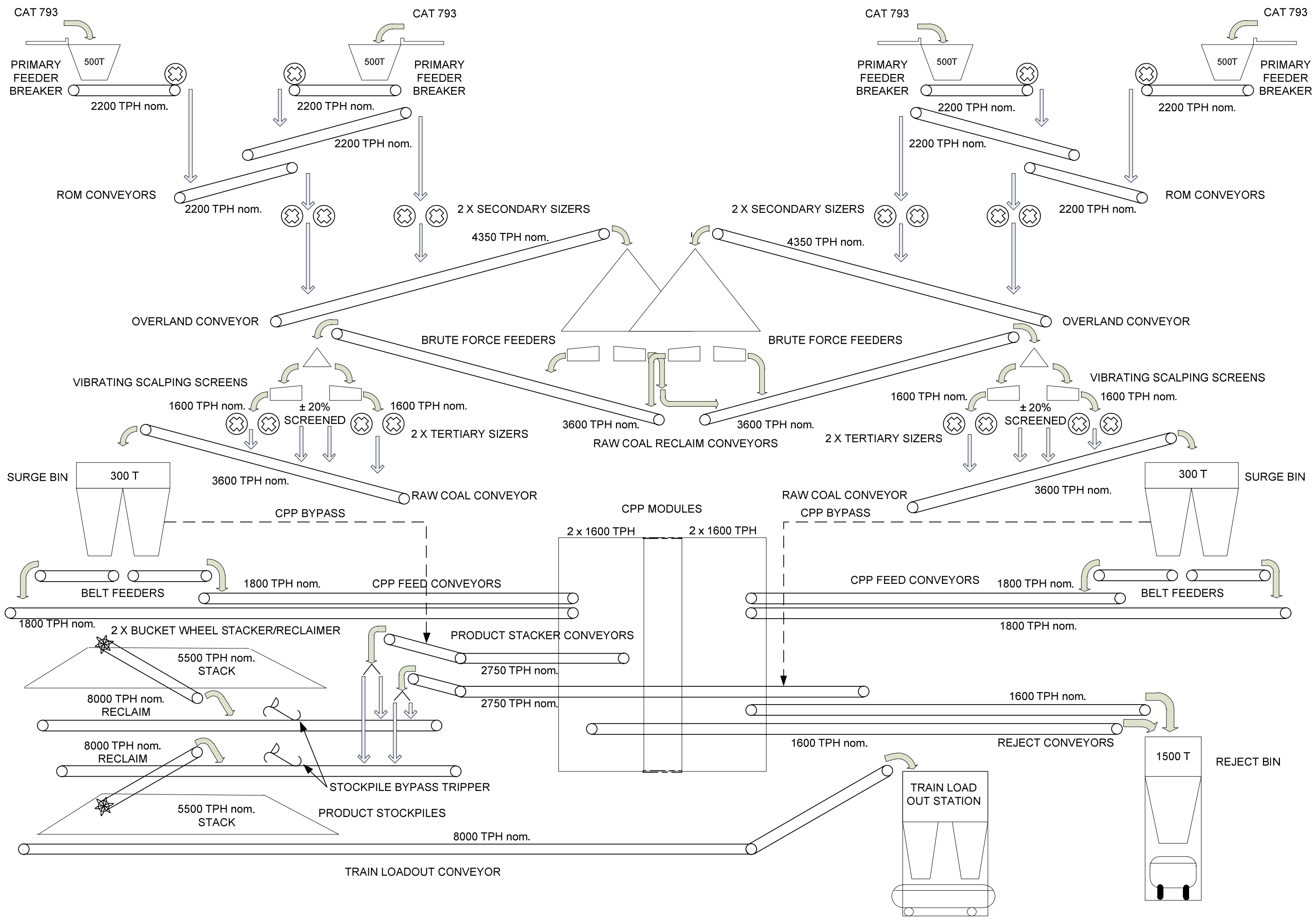
- Unloading coal haulage trucks into primary feed breaker
- Coal conveying and transfer points
- Primary coal crushing
- Secondary coal crushing

No stockpiling was assumed at the ROM pads.

The Mine plan specifies that there will be up to three ROM pads in operation for the duration of mining operations, north, south and central. It was assumed that all coal from either the UGM or the OCM pits would be processed at the closest ROM pad to which the coal was mined. The Mine plan specifies that there will be up to three ROM pads in operation for the duration of mining operations, north, south and central. It was assumed that all coal from either the UGM or the OCM pits would be initially processed at the closest ROM pad to which the coal was mined. The coal would be conveyed to the CHPP where it would be put through further processing, crushing, stockpiling and loaded onto a train, as shown in Figure 15.

Emissions from the ROM pads were assumed to be evenly distributed based on the total annual coal processed. Default NPI (2012) dust emission factors were assumed.

Figure 15 Proposed coal handling process flowchart



4.3.7 Haul roads

Dust emissions from haul roads were assumed to be 100 percent generated from the movement of large haul vehicles. Wind erosion emissions from the haul roads were not modelled as it was assumed that the haul roads would be within the confines of either an OCM pit or a waste dump. Therefore, haul road wind erosion emissions were not double accounted. Likewise, the dust emissions from haul truck movement were assumed to originate from either an OCM pit or a waste dump source.

Emissions were assumed to be evenly distributed across all of the active OCM pits and waste dumps as specific haul road paths have not been determined at this time, and would be likely to change during the Mine’s entire planned operation.

The dust generated from the movement of light vehicles was not modelled as:

- It was considered negligible in comparison to the heavy vehicle emissions
- For safety, it is unlikely that frequently traversed light vehicle roads would be combined with haul truck routes

The total earth moved (overburden and coal) in the OCM pits by haul trucks was assumed to be evenly distributed across all of the active pits. This assumption was confirmed after review of predicted output from each active OCM pit.

It was assumed that the average haul road one-way lengths were 5.15 km for coal haulage from pit to ROM and 2.5 km for overburden haulage from pit to WRD. Coal haulage was assumed to be by CAT 793 trucks, while overburden haulage was assumed to be a combination of CAT 793 and CAT 797.

NPI (2012) emission factors for mining, unlike previous NPI Mining Manual versions, separate heavy and light vehicle wheel generated dust into separate categories. Using the lightest capacity emission factor results is a conservative assessment of overall dust emissions from haul vehicles on unpaved roads as the bigger capacity trucks are more efficient and have a lower VKT to offset higher emissions due to total weight. Even with the best mine plan available, it is unrealistic to know exactly where each type of haul truck will be for each modelled hour – so a conservative adoption of worst-case dust emission was factored into the emission factor derivation. The default values specified in the NPI (2012) could not be used as it was deemed inappropriate for use as it is based on an assumption that the average vehicle weight (mass) is 48 tonnes.

The VKT of the haul trucks was estimated using information for the truck capacity, the amount of overburden and coal removed from the OCM pits and the straight line distance between the centres of the OCM pit and the nearest ROM pad or waste dump. It was assumed that the coal and overburden removal was evenly distributed to all of the active OCM pits and waste dumps.

4.3.8 Coal handling preparation plant

Based on the supplied coal handling process flowchart, shown in Figure 15, the following activities were identified as occurring at the CHPP:

- Loading the raw coal stockpile
- Unloading the raw coal stockpile
- Conveying and coal transfer points

- Coal screening
- Tertiary crushing
- Surge bin loading and unloading
- CHPP loading
- Loading and unloading product/reclaim stockpile

Wind erosion from the reclaim stockpile was considered as a separate item.

Default NPI (2012, Table 3) emission factors for each process were assumed. The coal is considered as “high moisture” content (NPI, 2012, p.62).

4.3.9 Coal transfer points

The following activities were identified as occurring at coal transfer points:

- Conveyor transfers
- Loading to trains

Default NPI (NPI, 2011) emission factors for each process were assumed.

4.3.10 Waste dumps

The following activity was identified as occurring at the out-of-pit waste dumps:

- Dumping of overburden

The default NPI (2012) factor was assumed

Wind erosion from the exposed areas of the waste dumps was considered as a separate item.

Dust emissions from grader operations were modelled at the waste dumps; however, they were calculated for OCM operations and assumed to be equally distributed between the Mine and the waste dumps.

4.3.11 Railway line

Dust emissions from the railway line were limited to those associated with windblown coal dust from the train as it moves away from the mine, fully loaded. These emissions were assessed cumulatively with those from the Project (Mine), to the extent to which the railway overlaps with dust contours of the Project (Mine). It was assumed that an individual train contained 10,020 tonnes of coal.

Wind erosion from exposed areas of the railway line was not considered as a dust source as any exposed areas during the construction phase are likely to have been revegetated by the time operations commence.

The emission factor of coal dust from the train motion was calculated using the equation detailed in Connell Hatch (Connell Hatch, 2008), as shown below:

$$EF_{train} = 0.0000378(V)^2 - 0.000126(V) + 0.000063 \quad \text{[g/km/tonne of coal]}$$

Where V is the speed of the train (km/h).

The railway line was modelled in CALPUFF as 10 individual length segments representing the nominal 40 km path from the Mine to the edge of the CALPUFF model domain. The majority of the segments were approximately 4 km long. The train was modelled as accelerating away from the loading area at a rate of 0.05 m/s^2 (initially), easing to 0.03 m/s^2 at 4 km from the mine site (Steimel, 2008, p.25), from a nominal starting speed of 10 km/h. This resulted in the maximum speed of 80 km/h being reached approximately 5.5 km from the rail loop at the mine site. The dust emissions from the rail sections of the model were calculated based on the average speed along each of the individual sections.

4.3.12 Underground mine infrastructure

The dust emissions from the UGM were assumed to be from the exhaust ventilation system and a single conveyor transfer point from the UGM to the overland conveyors. NPI (2012) default values were applied to the conveyor transfer point dust emissions, with the mass of coal for each of the three UGM infrastructure points as specified in the Mine plan. The exhaust ventilation for the UGM was based on dust concentration measurements for an existing UGM operated by Illawarra Coal (PAE-Holmes, 2010). This information has been used in previous EIS air quality assessments (PAE-Holmes, 2011) and is considered as a reasonable estimate for UGM ventilation emissions, which consist mostly of dust.

The calculated dust mass emissions rates for the Illawarra Coal mine were scaled pro-rata with the extracted coal capacity difference of the mine and that estimated for the Project (Mine) UGM. This assumes that for any given UGM, a doubling of the size of the mine requires twice the ventilation requirements, and therefore twice the mass emission of dust. In lieu of detailed ventilation specifications for the Project (Mine) UGM, this is considered as a reasonable approach for the estimation of ventilation emissions.

4.4 Modelled scenarios

4.4.1 Overview

A single scenario was modelled to represent the dust emissions from Mine operations during its projected lifespan. This was identified as the predicted dust emissions for the year 2025. A summary of the uncontrolled PM_{10} emissions is provided in Table 4.

The full operations are represented by both the UGM and OCM at full operations producing 60 Mtpa of product coal with six OCM pits active. Estimates of operational equipment hours and types start to have increased error the further into the future estimates are made.

Table 4 Summary of modelled mine operations

Parameter	Value
Representative Year	2025
UGM Capacity (M-tonnes)	20.2
OCM Capacity (M-tonnes)	54.0
Product Coal (M-tonnes)	60.1
OCM Overburden Moved (M-tonnes)	386.7
Uncontrolled PM10 Production Emissions (tonne/y)	32,400
Note: Includes pit retention passive controls and excludes wind erosion	

4.4.2 Uncontrolled emissions estimates

A breakdown of the estimated PM_{10} dust emissions for the worst-case phase of the Project (Mine) are provided in Table 5. These estimates are for uncontrolled PM_{10} emissions, excluding wind erosion emissions. Passive controls for pit retention have been applied, which equates to a 5 percent reduction for PM_{10} generated sources inside of any OCM pit, as per NPI (2012) guidelines. The summary in Table 5 clearly shows that the greatest single source of dust emissions is from haul trucks. The haul trucks are estimated to account for about 70 percent of production related PM_{10} emissions.

Dust emissions from haul trucks can be minimised using various control techniques (discussed in subsequent sections), however, emissions from dumping waste rock, excavating and bulldozers have no controls. Only unquantifiable operational controls can be applied to waste rock dumping and excavators. These operational controls include gentle unloading and loading of material.

Dust emissions from coal processing activities (19 percent), including all transfers and crushing, can be substantially reduced by enclosing equipment, reducing drop height or applying water sprays. The other miscellaneous dust generating activities at the Mine site, including UGM ventilation, comprise less than 2 percent of total uncontrolled PM_{10} emissions.

Table 5 Summary of uncontrolled PM_{10} dust source proportion

Source	Units	Value
Total PM_{10} Production Emissions	tonne/y	32,400
Haul Truck Movement	%	69.2
WRD Dumping	%	5.0
Excavating coal and overburden	%	3.8
Coal Processing	%	19.4
Bulldozers	%	1.4
Graders	%	0.1
UGM Ventilation	%	1.1
Other	%	0.1
Note: Includes pit retention passive controls and excludes wind erosion		

4.4.3 Uncontrolled wind erosion

Uncontrolled PM_{10} dust emissions from exposed areas due to wind erosion are summarised in Table 6 for the worst-case stage of the Mine. It was found that wind erosion accounts for about 11 percent of the total dust emissions from the project (Mine). As wind erosion has the potential to be a significant individual dust source, implementing appropriate and effective control measures is vital.

Passive controls for pit retention have been applied to the figure in Table 6, which equates to a 5 percent reduction for PM_{10} generated sources inside of any OCM pit, as per NPI (2011) emission estimation guidelines.

Table 6 Summary of uncontrolled PM_{10} wind erosion emissions

Phase	Production Emissions (tonne/y)	Wind Erosion Emissions (tonne/y)	Total Emissions (tonne/y)	Wind Erosion percentage of Total (%)
2025	32,400	3,139	35,539	11.3

4.5 Cumulative impacts

As there are no other known existing or proposed significant dust sources in the vicinity of the Project (Mine), cumulative impacts are considered by including (ambient) background levels (see Section 3.2) being added to the modelled increment levels to be compared to the assessment criteria.

Particulate matter from the train diesel exhaust is minor when compared to mine dust, hence this minor contribution has not been assessed. Cumulative impacts of the proposed rail operation have been incorporated into the model by considering dust emissions from railway operations to the extent which the railway overlaps with dust contours produced by the mine.

4.6 Pollution control

4.6.1 Overview

The modelling has been conducted with potential dust emissions with consideration of specific dust control measures. In line with normal mining practice, dust control techniques have been assumed and modelled for each of the sources identified at the Project (Mine). Some processes have no controls, while other dust sources can be completely removed through the application of full enclosures or the process is considered as “wet”.

4.6.2 Control techniques

A summary of the controls applied for the air emissions modelling are provided in Table 7.

Of the identified control measures, these have been applied and used to calculate emissions before and after application. A nominal 84 percent reduction in emissions from production activities was found to be achievable with the application of the routine control measures as summarised in Table 8.

Table 7 Summary of applied controls

Activity	Applied Controls	Percentage Reduction (%)
Graders	Moist soil	50
Excavators/shovels on overburden	None	0
Loading coal to trucks by shovel	None	0
Bulldozers on overburden	None	0
Bulldozers on coal	None	0
Unpaved haul roads	Chemical Sprays and Sealant	90
Blasting	None	0
Trucks dumping overburden	None	0
Trucks loading ROM coal stockpiles	Water Sprays	70
Unloading coal stockpiles	Water Sprays	50

Activity	Applied Controls	Percentage Reduction (%)
Loading primary crusher	Partly enclosed (70 %), Water sprays with chemical suppressant (90 %)	97
Primary crushing	Hooding with scrubber (75 %), water sprays (50 %)	87
Secondary crushing	Hooding with scrubber (75 %), water sprays (50 %)	87
Tertiary crushing	Hooding with scrubber (75 %), water sprays (50 %)	87
Coal Processing Plant (CHPP)	Enclosed. Wet process	100
Coal transfer points	Partly enclosed (70 %), Water sprays with chemical suppressant (90 %)	97
Overland coal conveyors	Partly enclosed	70
Loading coal to trains	Partly enclosed	70
Active coal stockpiles	Water sprays	50
Loading active coal stockpiles	Telescopic chute with water sprays	75
Dust from trains	None	0
Wind erosion (Inactive areas)	Revegetation	90
Wind erosion (Active areas)	None	0
UGM Ventilation	None	0

[1] Where water supply is limited an equivalent control is assumed

Table 8 Summary of PM_{10} dust emissions with maximum controls applied

Phase	Uncontrolled Production Emissions (tonne/y)	Controlled Production Emissions (tonne/y)	Percentage Reduction (%)
2025	32,400	5,684	82

Note: Excluding wind erosion

Pit retention factors

Pit retention is a passive control in that it emissions are mitigated by pit retention as a feature of the environment, rather than an applied mitigation measure. As such, pit retention factors were included in both the uncontrolled and controlled model scenarios.

NPI (2012) default pit retention factors were applied based on the following reduction factors:

- TSP – 50 percent pit reduction
- PM_{10} – 5 percent pit reduction
- $PM_{2.5}$ – 5 percent pit reduction

Pit retention factors were applied to all dust sources, including wind erosion, from within any OCM pit. This includes 50 percent of the emissions from the following sources:

- Haul roads
- Bulldozers on overburden
- Graders

Crushing operations

Crushing operations (primary, secondary and tertiary) have NPI (2012) defined enclosure controls applied. This model assumption is based on best practice dust control measures.

Wind erosion

No controls have been applied to wind erosion from exposed surfaces in active OCM pits, waste dumps and the identified top soil areas. The active coal stockpiles – raw coal and product stockpiles – has water spray controls applied.

Haul roads

As haul roads have been identified as being responsible for about 70 percent of dust emissions arising from active coal production, special attention has been applied to controlling these emissions. Preliminary analysis indicated that Level 2 watering, as described in NPI (2012) as greater than 2 litre/m^2/h, was found to be inadequate for reducing dust levels. The other control option specified in the NPI (2012) manual is for sealed or salt-encrusted roads. However, the requirements for sealing a roadway for 240+ tonne haul trucks is considered excessive, especially when the haul roads are likely to change over the life of the Mine. Furthermore, it is also considered unlikely that a potential dust source which may account for greater than 75 percent of uncontrolled emissions could be reduced to zero.

Upon further investigation, a more realistic, reasonable and achievable approach, investigated by Kinsey and Cowherd (Buonicore and Davis, 1992, p. 144) showed that dust emissions from unpaved roads can be reduced by greater than 90 percent by using chemical stabilisation. The chemicals generally have a petroleum resin basis, and need to be regularly re-applied.

A sensitivity study on the silt content of the haul roads indicated that total controlled production emissions could be reduced by 23 percent from 5,684 tonne/y to 4374 tonne/y if the silt content was reduced from the modelled 7.7 percent to 3 percent. Alternatively, the same magnitude increase (4.7 percent) in road silt content to 12.4 percent could increase total controlled emissions by more than 20 percent. Therefore, haul road dust emissions are highly sensitive to road silt content. It is the aim of the chemical stabilisation approach as discussed above to 'bind up' the silt particles on the haul roads so as to give the effective reduction in particulate emissions that would apply to lowering the silt content of the haul road.

4.7 Summary of emissions

4.7.1 Emissions with embedded control factors

A summary of the emission rates for each of the source locations input into the model for the modelled year of the Project (Mine) is provided in Table 9. All emissions are "as modelled", and as such include control measures and pit retention factors, e.g. TSP emissions from pit sources have been halved as 50 percent of emissions do not escape the pit. Therefore, the summary of emissions is a summary of the emissions that will affect the predicted GLCs.

Table 9 is segregated based on location of a particular dust generating operation. The various wind erosion sources are summarised as a separate items.

A total of 54 individual sources were used in the CALPUFF modelling to represent the emissions from the mine.

Table 9 Modelled emissions rates with full controls applied (2025)

Location	Total TSP Emissions (tonne/y)	Total PM_{10} Emissions (tonne/y)	Total $PM_{2.5}$ Emissions (tonne/y)
TOTAL	**16,972**	**8,820**	**3,285**
Coal Processing Plant	878	566	132
OCM Pits	4,042	2,777	1,152
Raw Coal Stockpile	78	37	12
Product Coal Stockpile	250	98	34
North, Central and South ROM Pads	565	229	85
Train Loadout	8.7	3.7	1.3
UGM Exhaust Vent 1	102	35	70
UGM Exhaust Vent 2	102	70	70
UGM Exhaust Vent 3	102	70	70
UGM Exhaust Vent 4	102	70	70
UGM Exhaust Vent 5	102	70	70
Waste Rock Dumps	5,333	1,657	370
Wind Erosion – Pits	1,074	1,020	373
Wind Erosion – WRDs	3,189	1,595	584
Wind Erosion – Top Soil	637	319	117
Wind Erosion – Train Coal Wagons	405	202	74
Note: Including pit retention			

4.7.2 Emissions not modelled

Potential emissions from the following sources have not been modelled in the assessment:

- Tailings dams, as tailing are assumed to be maintained as a wet paste
- Diesel combustion from vehicles and equipment, as particulate matter generation is small in comparison with wheel generated dust
- Light vehicle movements, general movement and employees arriving for work

4.7.3 Emission estimation errors

Emissions have been estimated using the methods and techniques described and detailed in NPI (2012) emission estimating techniques for Mining. All of the values in the NPI manual have associated errors due to either a lack of monitoring information or numerous different techniques that can be applied to achieve the same outcome. For example, the default values for wind erosion dust emissions are "Unclassified". Therefore, this source has a large amount of potential error in its estimate. Furthermore, small changes in some parameter values such as haul road silt content can have a significant impact on total emissions.

Within the next 50 or so years, it is likely that the methods for estimation of emissions will improve, as they have over the previous 50 years. Therefore, emissions estimates should be assessed with an understanding that circumstances are more than likely to change. Estimates can only be considered as indicative, based on 2013 technology and knowledge at the time. Moreover, some of the assumptions may change as real-world mining conditions are encountered. For example, geotechnical assumptions may prove to be different from originally assessed and therefore the derived emission estimations will change.

5. Impact assessment

5.1 Identified sensitive receptors

The air quality assessment requires the estimation of maximum ground level concentrations and monthly average dust deposition values at the nearest sensitive receptors. A total of eight existing sensitive receptors, excluding Project (Mine) offsite infrastructure, have been identified, as summarised in Table 10 and illustrated in Figure 16. These are currently established locations, pastoral lease homesteads, for which the ambient air quality was assessed with regards to dust emissions from the Project (Mine) and the short section of the railway line present inside of the modelled domain. Whilst the Labona homestead is located within the proposed Project (Mine) footprint (lease boundary), it is unoccupied and is to be demolished once mining activities start.

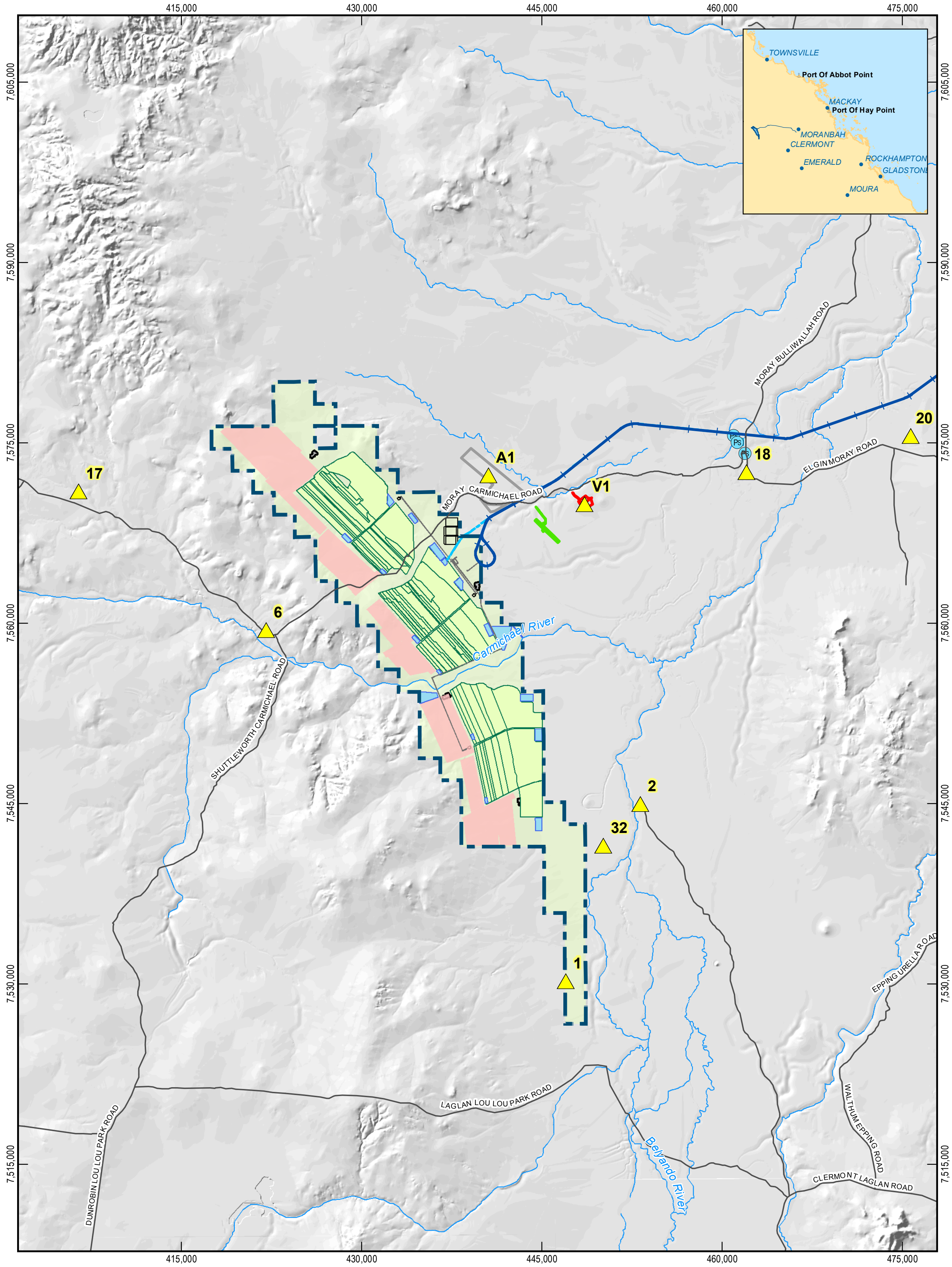
The mine worker accommodation village and permanent airport are proposed to be established east of the Project (Mine) site, adjacent to and straddling the Project (Rail). These two additional receptors are summarised in Table 10, and identified by alpha-numeric identifiers. Ambient air quality has been assessed at all nearby identified sensitive receptors. The majority of the existing sensitive receptors are at the extremes of the CALPUFF model domain, reflecting the isolated nature of the Mine site.

Lignum (ID 32) Homestead is the closest to the mine boundary but on the upwind side of prevailing winds (from the east-south-east). The existing receptors most remote from the Project (Mine) and are on the eastern side are associated with emissions from the railway line segment and are included for completeness. The sensitive receptor Moray Downs (ID 18) is potentially exposed to emissions from both the Project (Rail) and the Project (Mine) and has been included to take into account cumulative impacts from mine and rail operations. Therefore, the ambient air quality at all identified nearby existing receptors has been assessed.

Figure 16 shows the location of the identified sensitive receptors with regards to the modelled project (Mine). Bimbah East, Moonoomoo and Albinia homesteads were not considered sensitive receptors as they are at a significant distance from modelled dispersion contours.

Table 10 Summary of existing and proposed sensitive receptors

ID	Name	Distance from nearest source (m)	Nearest Feature	Easting (km)	Northing (km)
1	Mellaluka	15,200	Mine Site	446.973	7530.251
2	Bygana	9,000	Mine Site	453.157	7544.999
6	Doongmabulla	9,000	Mine Site	422.016	7559.462
17	Carmichael	16,500	Mine Site	406.412	7571.007
18	Moray Downs	2,400	Rail Segment	462.027	7572.602
20	Cassiopeia	3,090	Rail Segment	475.674	7575.617
32	Lignum	7,500	Mine Site	450.080	7541.530
V1	Workers accommodation village	2,600	Rail Segment	448.537	7569.930
A1	Airport Terminal centre	2,700	Rail Segment	440.512	7572.324



LEGEND

Sensitive Receptor
Local Road
River / Watercourse
Overland Conveyors
Rail (West)
Mine (Onsite)
Water Supply Pipeline
Open Cut Blocks
Water Management Dams
Underground Mine Plan
Mine (Offsite)
Pump Station
Storage Facility (Offstream)
Airport
Industrial Area
Accommodation Village

1:450,000 (at A4)

0 5 10 15

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

GHD adani

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Job Number	41-26422
Revision	D
Date	22-10-2013

Nearest Receptor Locations with respect to CALPUFF Modelled Layout

Figure 16

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Level 9, 145 Ann St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: GHD: Sensitive Receptors (2012); GA: Road, River / Watercourse (2007); DME:EPC1690 (2010), EPC1080 (2011);
Adani: Adani: Project Rail 1 (Opt11 Rev2) & 2 (Opt9 Rev3), Facilities (2013), Mine Layout / Infrastructure (2013). Created by: JVC

5.2 Assessment of ambient PM_{10} levels

5.2.1 Existing sensitive receptors

Ambient PM_{10} levels have been assessed with regards to Air EPP, which are assessed against a maximum ambient level criterion of 50 µg/m³ (including background) with an averaging period of 24 hours. There is an exceedance allowance of five days, which is designed to take into account high background dust levels due to 'natural events' such as dust storms and bushfires. A constant 70th percentile background level of 11 µg/m³ has been added to the predicted incremental PM_{10} GLCs.

Results at the existing sensitive receptors for the year 2025 of mine operations are shown in Table 11. No exceedences are predicted for any sensitive receptor.

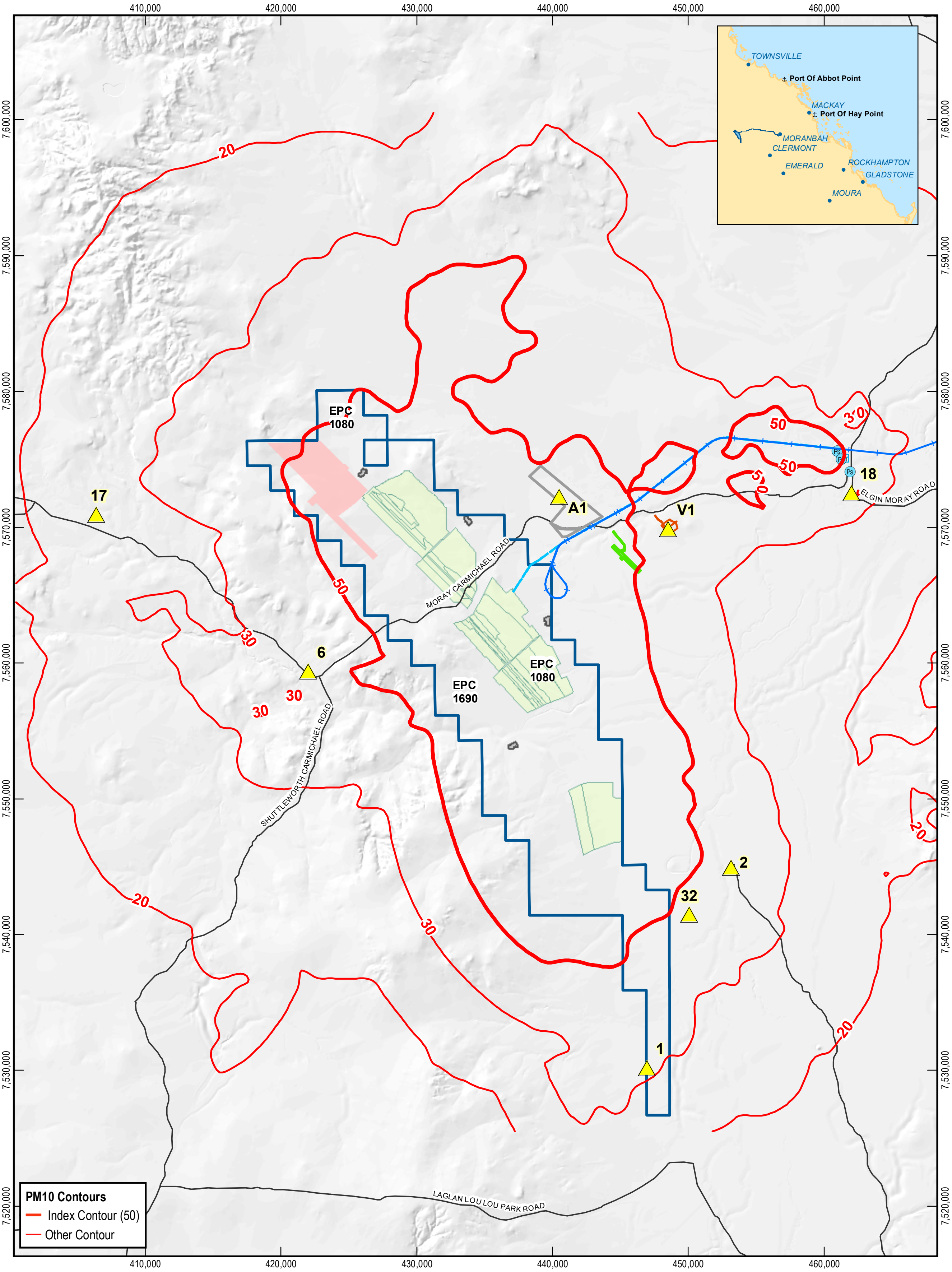
Table 11 Summary of existing sensitive receptor predicted PM_{10} GLCs (2025)

ID	Name	Maximum Predicted Incremental PM_{10} (24hr avg) (µg/m³)	Background PM_{10} (µg/m³)	Maximum Total PM_{10} (24hr avg) (µg/m³)	Percentage of EPP Air (%)
1	Mellaluka	20.7	11	31.7	63
2	Bygana	27.6	11	38.6	77
6	Doongmabulla	25.7	11	36.7	73
17	Carmichael	15.6	11	26.6	53
18	Moray Downs	20.1	11	31.1	62
32	Lignum	31.5	11	42.5	85
Note: Criterion = 50 µg/m³ (24 hour average)					

Contour plots of predicted maximum 24 hour average PM_{10} GLCs for the year 2025 of Mine operations, including background, is shown in Figure 17. It can be seen that the EPP Air criterion of 50 µg/m³ is not complied with at all locations beyond the site boundary of the Mine.

The 50 µg/m³ contour is close to the Lignum homestead (ID 32), indicating that even though the Lignum location is in the direction of the prevailing winds (nominally upwind), the worst case day can result in the daily averaged peak PM_{10} modelled values approaching the EPP Air criterion. As this is currently a residential location, it will be important to undertake ongoing monitoring to determine whether predicted levels of concern occur, and, if a criterion is exceeded, develop management measures to address this.

Predicted PM_{10} GLCs along the rail line segment, when combined with Mine impacts, are shown to be substantially higher than background levels due to lifted dust from the coal transport.



LEGEND

Sensitive Receptor
Local Road
Rail (West)
Mine (Onsite)
Mine Infrastructure Area
Open Cut Blocks
Underground Mine Plan
Mine (Offsite)
Pump Station
Storage Facility (Offstream)
Airport
Industrial Area
Accommodation Village

Based on or contains data provided by the State of QLD (DNRM) [2013]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:400,000 (at A4)

0 2.5 5 7.5 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project SEIS

Predicted maximum 24 hour average PM10 GLCs (2025)

Job Number	41-26422
Revision	C
Date	23-10-2013

Figure 17

Data Source: DME: EPC 1690 (2010)/EPC 1080 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Road (2007); Adani: Adani: Mine Layout, Alignment, Offsite (2013);GHD: Sensitive Receptor (2013), Modelling Contours (2013). Created by: MS

5.2.2 Proposed sensitive receptors

The offsite infrastructure to be developed as part of the Project (Offsite) includes the workers accommodation village, airport and industrial development area.

The EPP Air expressly excludes operational health and safety (OH&S) considerations with Part 3 Clause 8(5) stating it "does not apply to an air emission that may be experienced within a dwelling or workplace if the air emission is released within the dwelling or workplace." Here a “workplace” takes on the meaning defined in the *Workplace Health and Safety Act 1995*. In such a dwelling or workplace, dust is typically assessed via direct personal monitoring and dust management strategies as part of regulated workplace requirements including exposure to air pollutants. Further, the EM960 Guidelines describes a sensitive place concerning a workplace as “including an office for business or commercial purposes” (DEHP, 2013, p.6). This would therefore exclude industrial locations that have OH&S controls.

Emissions released within the Project (Mine) site boundary may be present within the workers accommodation village. As such air quality at the workers accommodation village must comply with the EPP Air objectives. The workers accommodation village does not qualify as the workplace as workers will be off-duty when present.

With respect to the airport, this may be considered commercial or public space so that air quality will also be required to comply with the EPP Air objectives (see the EM960 Guidelines as discussed above).I It will be important to undertake ongoing monitoring of any commercial or workers accommodation areas to determine whether levels of concern occur, and, if a criterion is exceeded, develop additional management measures to address this.

Therefore, the proposed sensitive receptors will be the workers accommodation village and airport terminal.

For the modelled emissions year of 2025, the peak daily PM_{10} average concentrations were predicted to exceed the EPP Air objective value at the workers accommodation village, but are not predicted to exceed the criterion at the proposed airport terminal location. The results are summarised in Table 12. A review of the predicted maximum, 2nd, 3rd, 6th and 10th highest 24 hour average PM_{10} GLCs at the workers village (Table 13) shows that the EPP criterion of 50 µg/m³ is only predicted to be exceeded twice in a calendar year. Furthermore, the magnitudes of the two predicted exceedances, on 3 July and 30 June respectively, are no greater than 107 percent of the EPP Air objective value. This small magnitude of exceedance is considered to be within the error associated with estimation dust emissions, as demonstrated by the discussion regarding haul road silt content.

Table 12 Summary of offsite sensitive receptor predicted PM_{10} GLCs (2025)

ID	Name	Maximum Predicted Incremental PM_{10} (24hr avg) (µg/m³)	Background PM_{10} (µg/m³)	Maximum Total PM_{10} (24hr avg) (µg/m³)	Percentage of EPP Air (%)
V1	Workers accommodation village	42.5	11	53.5	107
A1	Airport Terminal	28.8	11	39.8	80
Note: Criterion = 50 µg/m³ (24 hour average)					

Table 13 Predicted workers accommodation village exposure to PM_{10} GLCs (2025)

ID	Ranking	Predicted Incremental PM_{10} (24hr avg) (µg/m³)	Background PM_{10} (µg/m³)	Maximum Total PM_{10} (24hr avg) (µg/m³)	Percentage of EPP Air (%)
V1	Maximum	42.5	11	53.5	106.9
V1	2nd Rank	40.2	11	51.2	102.5
V1	3rd Rank	38.9	11	49.9	99.8
V1	6th Rank	34.0	11	45.0	90.0
V1	10th Rank	31.4	11	42.4	84.8
Note: Criterion = 50 µg/m³ (24 hour average)					

5.3 Assessment of ambient $PM_{2.5}$ levels

Ambient $PM_{2.5}$ levels have been assessed against the Air EPP maximum ambient level criteria, a 24 hour average of 25 µg/m³ (including background), and an annual average of 8 µg/m³ (including background). There is no exceedance allowance for these assessment criteria.

A constant 70th percentile background level of 3.3 µg/m³ has been added to the predicted incremental $PM_{2.5}$ GLCs to account for background levels. A constant 70th percentile background level of 3.3 µg/m³ has been added to the predicted incremental $PM_{2.5}$ GLCs to account for background levels. Results at the identified highest existing and future off-site sensitive receptors for the $PM_{2.5}$ assessment for the 2025 emissions predictions from the Project (Mine) are shown in Table 14 and Table 15 for both assessment criteria.

For the modelled scenario, the maximum predicted $PM_{2.5}$ GLCs at all existing and future offsite sensitive receptors were below the assessment criteria. All receptors except are predicted to comply with Air EPP $PM_{2.5}$ annual criterion.

Table 14 Summary of sensitive receptor predicted daily PM2.5 GLCs (2025)

ID	Name	Maximum Predicted Incremental $PM_{2.5}$ (24 hr avg) (µg/m³)	Background $PM_{2.5}$ (µg/m³)	Maximum Total $PM_{2.5}$ (24 hr avg) (µg/m³)	Percentage of EPP Air (%)
1	Mellaluka	7.7	3.3	11.0	44
2	Bygana	10.7	3.3	14.0	56
6	Doongmabulla	10.3	3.3	13.6	54
17	Carmichael	5.7	3.3	9.0	36
18	Moray Downs	13.5	3.3	16.8	67
32	Lignum	12.1	3.3	15.4	62
V1	MWAV	20.1	3.3	23.4	93
A1	Airport Terminal	13.4	3.3	16.7	67
Note: Criterion = 25 µg/m³ (24 hour average)					

Table 15 Summary of sensitive receptor predicted annual PM2.5 GLCs (2025)

ID	Name	Maximum Predicted Incremental $PM_{2.5}$ (Annual avg) (µg/m³)	Background $PM_{2.5}$ (µg/m³)	Maximum Total $PM_{2.5}$ (Annual avg) (µg/m³)	Percentage of EPP Air (%)
1	Mellaluka	0.3	3.3	3.6	45
2	Bygana	0.3	3.3	3.6	45
6	Doongmabulla	3.2	3.3	6.5	81
17	Carmichael	1.0	3.3	4.3	54
18	Moray Downs	0.9	3.3	4.2	53
32	Lignum	0.4	3.3	3.7	46
V1	MWAV	2.8	3.3	6.1	77
A1	Airport Terminal	1.4	3.3	4.7	59
Note: Criterion = 25 µg/m³ (24 hour average)					

5.4 Assessment of ambient TSP levels

Ambient TSP levels have been assessed with regards to the EPP Air regulations, which are assessed against a maximum ambient level criterion of 90 µg/m³ (including background), annually averaged. There is no exceedance allowance for this assessment criterion. A constant 70^{th} percentile background level of 22 µg/m³ has been added to the predicted incremental TSP GLCs. Results at the identified highest existing and future off-site sensitive receptors for the TSP assessment for the predicted 2025 emissions from the mine are shown in Table 16. For the modelled scenario, all of the identified sensitive receptors were compliant with the annual average criterion.

Table 16 Summary of sensitive receptor predicted TSP GLCs (2025)

ID	Name	Maximum Predicted Incremental TSP (Annual avg) (µg/m³)	Background TSP (µg/m³)	Maximum Total TSP (Annual avg) (µg/m³)	Percentage of EPP Air (%)
1	Mellaluka	0.8	22	22.8	25
2	Bygana	0.7	22	22.7	25
6	Doongmabulla	8.2	22	30.2	34
17	Carmichael	2.7	22	24.7	27
18	Moray Downs	1.7	22	23.7	26
32	Lignum	0.9	22	22.9	25
V1	MWAV	5.8	22	27.8	31
A1	Airport Terminal	3.1	22	25.1	28
Note: Criterion = 90 µg/m³ (Annual average)					

5.5 Assessment of deposited dust

Deposited dust has been assessed with regards to NSW Approved Methods (DEC, 2005), which specifies a maximum incremental deposited dust level, insoluble solids, of 2 $g/m^2/month$ (annually averaged). No background level has been applied as the criterion is of an incremental nature. Results at the identified existing and future off-site sensitive receptors with the highest deposited dust during the 2025 predicted emissions of the mine are shown in Table 17. Each of the sensitive receptors were significantly below the assessment criteria as deposited dust levels were found to decrease rapidly beyond their source and certainly by the limits of the mining lease boundary. With the addition of a background dust deposition of a conservative 1.6 $g/m^2/month$, deposited dust at all sensitive receptors is compliant with the 4 $g/m^2/month$ (annually averaged) criterion.

Table 17 Summary of sensitive receptor predicted incremental deposited dust

ID	Name	Predicted Incremental Deposited Dust (Annual average) ($g/m^2/month$)
1	Mellaluka	0.003
2	Bygana	0.002
6	Doongmabulla	0.043
17	Carmichael	0.015
18	Moray Downs	0.059
32	Lignum	0.003
V1	MWAV	0.172
A1	Airport Terminal	0.010
Note: Criterion = 2 $g/m^2/month$ (Annual average)		

5.6 Flora and fauna impacts

The pollutants of interest in this assessment are related to dust. In the EPP Air, all 'dust' indicators are concerned with impacts associated with 'health and wellbeing' (of humans). Impacts to flora and fauna are captured in the EPP Air under the clauses that protect the health and biodiversity of ecosystems (Clause 7 (a)) and the agricultural use of the environment (Clause 7 (b)). The EPP Air objectives relating to flora and fauna impacts are listed as fluoride, nitrogen dioxide, ozone and sulphur dioxide. The EM960 Guideline discusses sensitive natural ecosystems such as "adjacent to national parks" (DEHP, 2013, p.10) – this is not the case here. Further, a literature search is required if the released contaminants are not listed in EPP Air – but this is the case here as particulate matter (as TSP, PM_{10} and $PM_{2.5}$) are listed and assessed.

Impacts on agriculture are also discussed in the EM960 Guideline and here it is the importance of "location, size, scale and duration of the activity" (DEHP, 2013, p.10) that needs to be considered. Section 5.5 clearly demonstrates that deposited dust levels are very low at just a fraction of the ambient dust load.

5.7 Management and mitigation

5.7.1 Best practice dust control

The following best practice dust control measures should be employed, where practical:

- Disturb only the minimum area necessary for mining
- Reshape topsoil and rehabilitate completed overburden dumps as soon as practicable
- Revegetate long term stockpiles not regularly used
- Clearly define edges of haul roads and designated paths on overburden dumps
- Revegetate dis-used haul roads
- Minimise hauling distance
- Set appropriate vehicle speed limits
- Limit the number of minor roads
- Water frequently used minor roads and if possible, seal
- Assess meteorological conditions prior to any blasting and delay (if possible) during periods of higher wind speeds
- Limit the activities and drop heights of material transfers (if possible), especially during periods of high wind speed

5.7.2 Dust monitoring

Even though the modelling predicts compliance at all identified sensitive receptors, dust monitoring will be undertaken to determine whether predicted emissions levels occur. In order to monitor background dust levels, a system of dust monitors will be installed upwind and downwind of the Project (Mine). Dust deposition gauges have already been established at several nearby homesteads to establish a background. This pre-mining network will be augmented by monitoring at sensitive receptors, predicted to receive dust levels close to or reaching the EPP Air objectives, at the workers accommodation village for example. Dust monitoring of PM_{10} may also be performed at any post-mining offsite sensitive receptors identified as being ‘at risk’. By monitoring dust upwind of the Project (Mine), downwind of the Project (Mine) and at sensitive receptor locations, dust impacts can be quantified. The Carmichael AWS will record local wind conditions at the Project (Mine) that can be used to assess high-dust events. Management measures will be applied to mitigate emissions impacts wherever a criterion is shown to be exceeded.

5.7.3 Further mitigation

The control measures applied to the potential emissions from the Mine operations are considered to be near to the maximum that could be practicably applied to a mine of such large capacity and physical size. These measures have been found to be more than sufficient for minimising dust impact beyond the site boundary and achieving compliance with EPP Air objectives at identified sensitive receptors. However, there is potential for the real-world dust emissions to be different to those derived using all of the assumptions identified. In particular, the geotechnical assumptions may vary sufficiently for resultant dust emissions to be different to that modelled.

In the event that further control measures are required, increasing the conveyor system network, application of a filtration system to the underground mine venting and improved dust suppression on coal processing equipment, i.e. crushers, are seen as potential measures.

Where dust monitoring indicates actual or potential exceedances of dust criterion at any of the sensitive receptors, additional mitigation measures may include:

- Increased use of conveyors rather than trucks to move coal
- Use of conveyors to haul a proportion of overburden
- Sealing of haul roads with bitumen or similar (chemical treatments to be investigated)
- Implementation of a dust management plan including the use of a meteorological forecasting system coupled with a dust impact index for the management and control of significant dust sources during adverse conditions

Increased use of conveyors for coal and overburden haulage would be expected to produce a substantial reduction in emissions. Such a system would entail the coal conveyor system being integrated into the OCM pits as currently exists in other coal mines, e.g. Loy Yang OCM in the Latrobe Valley, Victoria. As the amount of overburden removed is far greater than the amount of coal being extracted, estimated to be in excess of five to one in the year 2025, a substantial reduction in dust emissions due to haulage would be obtained.

6. Conclusion

During the Project (Mine) operational life a mixture of underground and open-pit mining operations will occur and significant dust generating potential exists.

The EPP Air defines air quality objectives such that indicator pollutants do not adversely affect environmental values. The indicators relevant to the Project (Mine) are Particulate Matter (total suspended particulate – TSP, PM_{10} and $PM_{2.5}$) with health and wellbeing of humans being the environmental value of concern. It is the concentrations of particulate matter at locations where people are likely to occupy for extended periods of time that define the air quality impact of the objectives of the Air EPP. Locations inside the Mine site perimeter are therefore excluded from assessment.

Existing environmental conditions were defined for background (or ambient) dust levels and dispersion meteorology. Available background data assessed was concerned with PM_{10} and dust deposition rates from similar exposed central Queensland mining areas (Bowen Basin and part-year in the Galilee basin). Comparable background information for TSP and the finer $PM_{2.5}$ dust fractions were derived by use of dust fraction ratios.

Dispersion meteorology characteristics are driven by the various climatic indicators. Climatically, the inland areas surrounding the Project Area can be described as ‘subtropical’ with a sub-classification of ‘moderately dry winter’. The prevailing wind directions have a strong easterly component associated with the trade winds. A derived dispersion modelling dataset for the Mine site using the prognostic meteorological model MM5 and further enhanced by the diagnostic model CALMET was found to be site-representative for the Project. This included validation against a recently completed full year of weather monitoring on the Mine site. MM5 data were used in preference to on-site data as it accounts for more than just a single point and also has upper air information.

Air emissions during the operation of the open cut and underground mines have been estimated using standard techniques from the Australian National Pollutant Inventory and the USEPA AP-42 database. The estimates are based on the revised mine plan included in SEIS Volume 4 Appendix B.

Dust was modelled from the entire mine site as emanating from a total of 25 individual mining activity sources and 29 sources associated with wind dependent wind erosions. The regulatory dispersion model CALPUFF was used for this purpose involving area and volume sources as appropriate. In addition to predicting ambient levels of particulate matter, dust deposition was also assessed. For completeness, dust emissions from the coal train hauling to the east of the Mine site were included. It was found that the greatest single source of dust emissions is from haul trucks, being potentially responsible for about 70 percent of uncontrolled dust emissions due to active coal production.

Dispersion modelling was established based on predicted emissions for the year 2025, which was estimated to be the worst-case. In the Mine plan, the years 2025 to 2029 corresponds to operations from both the underground and open-pit mines.

The air quality assessment required the estimation of maximum ground level concentrations and monthly average dust deposition values at the nearest sensitive receptors with a total of six offsite existing sensitivity receptor locations being identified. Two future sensitive receptors were identified as the off-site Workers accommodation village and airport terminal.

Ambient PM_{10} levels have been assessed to EPP Air objectives with a criterion of 50 µg/m³ (including background) averaged over 24 hours. Results at the existing offsite sensitive receptors for the modelled year of 2025 do not exceed the criterion. Results for the proposed location of the airport terminal are compliant with EPP Air objectives. However, the proposed location of the MWAV is predicted to have two small exceedances of the EPP Air daily objective. This is therefore compliant with EPP Air as there is an allowance for up to five daily events in any given year.

Contour plots of predicted maximum 24 hour average PM_{10} GLCs for the modelled year 2025 of the Mine indicate that the criterion is not complied with at all locations, in all directions, beyond the Mine boundary. The extent of the non-compliance in uninhabited areas is considered manageable and should be monitored as part of a site wide dust management plan.

For averaged $PM_{2.5}$ levels, all existing off-site sensitive receptors were below the assessment criteria of 25 µg/m³ (24 hour averaged) and 8 µg/m³ (annual average). For the proposed workers accommodation village and airport terminal site, all $PM_{2.5}$ levels were below regulatory requirements.

Ambient TSP levels have been assessed for the modelled year of 2025. It was found that all of the identified off-site sensitive receptors, including those of the proposed off-site workers village and airport terminal were compliant with the annual average criterion. Deposited dust levels were found to decrease rapidly beyond their source so that at all offsite sensitive receptor locations rates were significantly below the assessment criteria.

The impact assessment has demonstrated that the dust impacts are consistent with the goals of the EPP Air. This is with respect to human health effects at 'remote' off-site receptor locations. Dust impacts beyond the site boundary may require management at the peak production phases of the mine life. In the event that further control measures are required, the simple dust management tool of ambient air quality and dust deposition monitors being installed to quantify the actual dust impacts near the site boundaries can be used to quantify actual dust impacts rather than the theoretical levels assessed in this report. A system of monitors can be installed in which up-wind stations measure background dust levels, while down-wind stations are able to quantify the impact from mine operations. If off-site ambient dust levels are demonstrated to be significantly detrimental due to mining operations beyond the site boundary, additional options for reducing emissions include:

- Increased use of conveyors rather than trucks to move coal
- Use of conveyors to haul a proportion of overburden
- Construction of haul roads using low silt material
- Sealing of haul roads (with, in part, bitumen or similar; revisit chemical stabilisation)
- Implementation of a dust management plan including the use of a meteorological forecasting system coupled with a dust impact index for the management and control of significant dust sources during adverse conditions.

7. References

Argus Media, 2011, BHP Billiton prepares for Illawarra coal upgrade. Available from: http://www.argusmedia.com/pages/NewsBody.aspx?id=774760&menu=yes (Accessed 10.12.11).

Atmospheric Studies Group (ASG), 2011, MM5 World Wide Data, TRC. Available from: http://www.src.com/mm5/MM5_Main_Page.html (Accessed 15.12.11).

Buonicore and Davis, 1992, 'Fugitive Emissions' in Air Pollution Engineering Manual, Ed. A. J. Buonicore and W. T. Davis, Air & Waste Management Association, New York, 1992.

Bureau of Meteorology (BOM), 2007, Climate Statistics For Australian Locations. Available from: http://www.bom.gov.au/climate/cdo/about/definitionstemp.shtml (Accessed 24.06.11).

Connell-Hatch, 2008, Final Report Environmental Evaluation of Fugitive Coal Dust Emission from Coal Trains Goonyella, Blackwater and Moura Coal Rail Systems. Queensland Rail Limited, 31 March 2008 Revision 1. Reference H327578-N00-EE00.00.

Department of Environment and Conservation (NSW) (DEC), 2005, Approved Methods for the Modelling and Assessment of Air Pollutants. Available from: http://www.environment.nsw.gov.au/resources/air/ammodelling05361.pdf (Accessed 11.09.2012).

DERM, 2004, Guideline – Odour Impact Assessment from Developments. Queensland Government. Environmental Protection Agency. Document No. 040720. 20 July 2004. Available from: http://www.derm.qld.gov.au/register/p01344aa.pdf (Accessed 11.09.2012).

DERM, 2010, Townsville Dust Monitoring Program, March 2008 to December 2009, Air Quality Sciences, Department of Environment and Resource Management, State of Queensland, March 2010.

DERM, 2011, Queensland 2010 air monitoring report, Air Quality Sciences, Department of Environment and Resource Management, State of Queensland, June 2011.

Katestone, 2006. Air Quality Impact Assessment Study of the Proposed Ensham Central Project, Katestone Environmental, Toowong, May 2006.

Ministry for Environment (New Zealand), 2001, Good practice guide for assessing and managing the environmental effects of dust emissions. Available from: http://www.mfe.govt.nz/publications/air/dust-guide-sep01.pdf (Accessed 11.09.2012).

NEPC, 2002, Impact Statement for $PM_{2.5}$ Variation, National Environment Protection (Ambient Air Quality) Measure, National Environment Protection Council, October 2002.

National Pollution Inventory (NPI), 2012, Emission Estimation Technique Manual for Mining, Version 3.1, National Pollutant Inventory, Canberra, January 2012.

PAE-Holmes, 2010, Air Quality impact assessment – BHP Billiton Illawarra Coal – Ventilation Shaft No.6 Project, October 2010.

PAE-Holmes, 2011, China First Project EIS - Air Quality Assessment, Waratah Coal, August 2011.

PSU/NCAR, 2008, Pennsylvania State University/ National Centre for Atmospheric Research - MM5 Community Model. Available from: http://www.mmm.ucar.edu/mm5/ (Accessed 15.12.11).

Runge Limited, 2011, Carmichael Coal Project Macro-conceptual Mine Plan. Report prepared for Adani Mining Limited.

Steimel, A., 2008, Electric Traction – Motive Power and Energy Supply, Basics and Practical Experience. Oldenbourg Industrieverlag GmbH. Munich 2008.

Stern, H., Hoedt, G., & Ernst, J., 2000. Objective Classification of Australian Climates. Australian Meteorological Magazine, 49(2), p. 87-96.

United States Environmental Protection Agency (US EPA), 2011, CALPUFF Regulatory Updates and Consequence Analysis, Available from: http://www.epa.gov/ttn/scram/dispersion_prefrec.htm (Accessed 15.12.11).

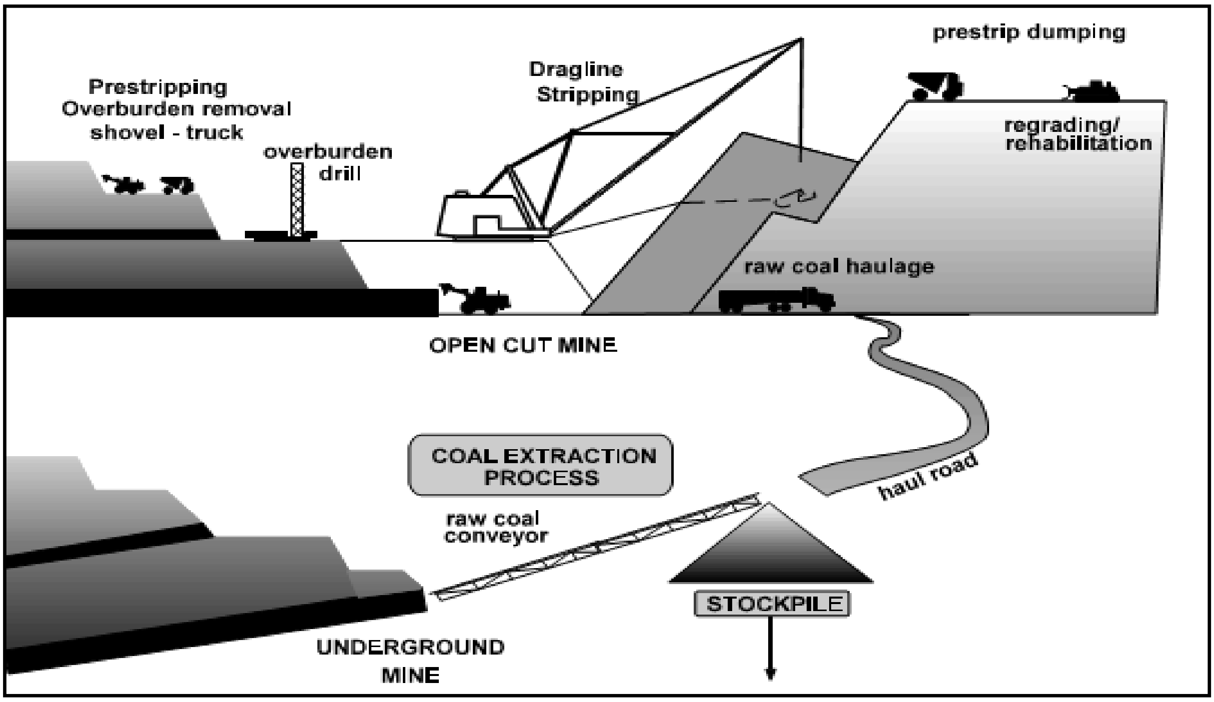
URS, 2009, Caval Ridge Air Quality Impact Assessment - Technical Report. Available from: http://www.bhpbilliton.com/home/aboutus/regulatory/Documents/creisAppLAirQualityReport.pdf (Accessed 11.09.2012).

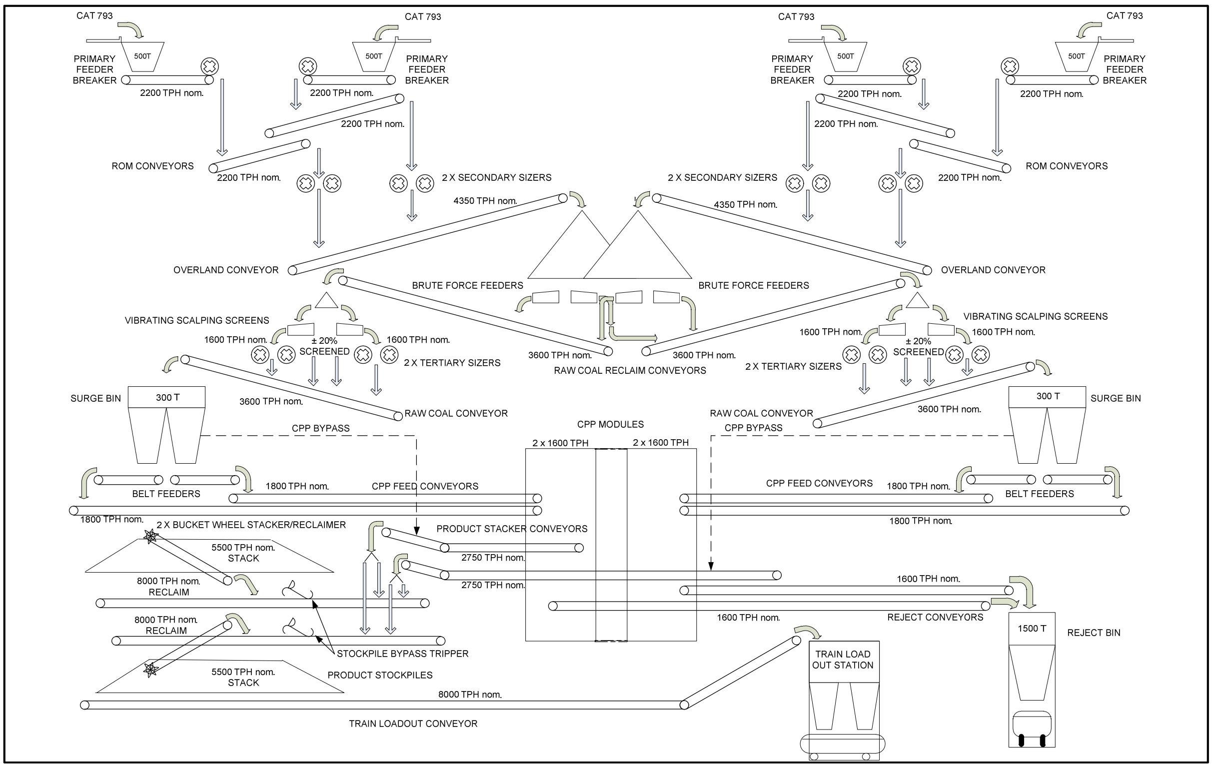
Appendices

Appendix A – Mine Operations Emissions Estimates

Emissions Inventory Calculations

A1.0 Process Flow Diagram





A1.1 Blasting

Emissions from blasting were estimated using the following equation:

$$E_i = n\,EF_i$$

where

E_i = emission rate of species i (kg/y)

n = number of blasts per year (blasts/y)

EF_i = Uncontrolled emissions factor for species i (kg/blast)

The number of blasts per year, n, was assumed to be 365, or one every day across the entire mine.

The uncontrolled emission factor for TSP was assumed to be equal to the NPI (2012) default.

EF_i = 6.25 [kg/blast]

where

PM_{10} was assumed to be 52 percent of TSP, as per NPI (2012).

$PM_{2.5}$ was assumed to be 15 percent of TSP

Blasting emissions were modelled as evenly distributed throughout the year and across active OCM pit sources.

A1.2 Graders

Emissions from grader operations were estimated using the following equation:

E_i = VKT x EF_i where

E_i = emission rate of species i (kg/y)

VKT = number of vehicle kilometres travelled per year (VKT/y)

EF_i = Uncontrolled emissions factor for species i (kg/VKT)

The number of VKT's for the graders was based on an assumed mean vehicle speed of 5 km/h and an estimate of the total number of operational hours graders were to operate. The operational grader VKTs per year for the year 2025 are summarised as:

- In-pit: 164,250 km/y
- Out-of-pit: 164,250 km/y

The uncontrolled emission factors for TSP and PM_{10} used the specified vehicle speed related equations as per NPI (2012, p.58).

$$EF_{TSP} = 0.0034\,S^{2.5} \text{ [kg/VKT]}$$

$$EF_{PM10} = 0.0034\,S^{2.0} \text{ [kg/VKT]}$$

where

S = vehicle speed in km/h.

$PM_{2.5}$ was assumed to be 15 percent of TSP.

Grader emissions were modelled as evenly distributed throughout the year and across active OCM pits and waste dump sources.

A1.3 Shovel Excavators on Overburden

Emissions from shovel excavator operations inside the pit to load haul trucks with overburden were estimated using the following equation:

$$E_i = (bcm \times \rho) \times EF_i$$

where

E_i = emission rate of species i (kg/y)

bcm = number of bank cubic metres of overburden removed per year (bcm/y)

ρ = nominal overburden density, assumed to be 1.4 tonne/bcm.

EF_i = Uncontrolled emissions factor for species i (kg/tonne)

The number of bcm's of overburden removed from the pits – to access the coal reserves – was based on details in the mine plan. The overburden volume (bcm's) per year for the year 2025 are:

- 2025:	276,2000,000 bcm/y

The uncontrolled emission factors for TSP and PM_{10} used the specified site average wind speed, U (m/s), and soil moisture content, M (%), related equations as per NPI (2012, p.48).

$$EF_{TSP} = 0.74 \times 0.0016 \left(\frac{U}{2.2}\right)^{1.3} \left(\frac{M}{2.0}\right)^{-1.4} \text{ [kg/tonne]}$$

$$EF_{PM10} = 0.35 \times 0.0016 \left(\frac{U}{2.2}\right)^{1.3} \left(\frac{M}{2.0}\right)^{-1.4} \text{ [kg/tonne]}$$

where

U = average wind speed of 2.64 m/s (From CALMET Modelling).

M = soil moisture content of 2 percent by weight (PAE-Holmes, 2011, p.A-7).

$PM_{2.5}$ was assumed to be 15 percent of TSP

Shovel excavator emissions were modelled as evenly distributed throughout the year and across active OCM pits sources.

A1.4 Shovel Excavators on Coal

Emissions from shovel excavator operations inside the pit to load haul trucks with coal was estimated using the default NPI (2012) values:

$$EF_{TSP} = 0.029 \text{ [kg/tonne]}$$

$$EF_{PM10} = 0.014 \text{ kg/tonne]}$$

The number of tonnes of coal removed from the pits was based on details in the mine plan for the modelled year. The coal extraction rate per year for 2025 are summarised below:

- 2025: 54,000,000 tonne/y

$PM_{2.5}$ was assumed to be 15 percent of TSP

Shovel excavator emissions were modelled as evenly distributed throughout the year and across active OCM pits sources.

A1.5 Bulldozers

Emissions from bulldozer operations inside and outside of the OCM pits was assumed to be distributed on overburden and coal. In pit operations were assumed to be solely on coal, while out-of-pit operations were assumed to be evenly distributed on coal and overburden (other material). They were estimated using the following equation:

$E_i = n \times EF_i$

where

E_i = emission rate of species i (kg/y)

n = total number of operational hours of all bulldozers per year (veh.h/y)

EF_i = Uncontrolled emissions factor for species i (kg/veh.h)

The total number of hours of bulldozer operations on overburden was based on the number of bulldozers at the mine for that year a load factor of 30 percent operational, i.e.a single bulldozer was generating dust for a total of 7.2 hours per day and 10 percent of the total bulldozer fleet are not operational for maintenance purposes. The operational hours per year for each phase of the mine are summarised below:

- Number of bulldozers: 67 for 2025
- Total operational hours: 158,468 h/y
- Operational hours in pit: 106,174 h/y
- Operational hours out-of-pit: 52,295 h/y

The uncontrolled emission factors for TSP and PM_{10} emissions on coal used the specified site silt content, s (%), and soil moisture content, M (%), EF_i, related equations as per NPI (2012, p.48).

$EF_{TSP} = 2.6\,(s)^{1.2}(M)^{-1.3}$ [kg/veh.hr]

$EF_{PM10} = 0.34\,(s)^{1.5}(M)^{-1.4}$ [kg/veh.hr]

where

s = average overburden silt content of 7.7 precent (Site specific soil testing). (Conservatively assumed to be the same as the overburden).

M = soil moisture content of coal of 16 percent by weight.

The emission factor for operations on overburden used the default NPI (2012) emissions factor of 17 kg/veh.h. The average of this overburden default and the coal emission factor was applied, 12.75 kg/veh.h.

$PM_{2.5}$ was assumed to be 15 percent of TSP

Bulldozer operation emissions on overburden were modelled as evenly distributed throughout the year and across active OCM pits and waste dump sources.

A1.6 Trucks Dumping Overburden

Emissions from haul trucks dumping overburden at the waste dumps were estimated using the following equation:

$$E_i = (bcm \times \rho) \times EF_i$$

where

E_i = emission rate of species i (kg/y)

bcm = number of bank cubic metres of overburden dumped per year (bcm/y)

ρ = nominal overburden density, assumed to be 1.4 tonne/bcm.

EF_i = Uncontrolled emissions factor for species i (kg/tonne)

The volume of overburden removed (bcm's) from the pits and dumped on the waste dumps was based on details in the mine plan and project descritption for the modelled year. The overburden bcm's per for the year 2025 is summarised below:

- 2025: 276,200,000 bcm/y

The uncontrolled emission factors, EF_i, for TSP and PM_{10} used the default factors as per NPI (2012, p.51).

$$EF_{TSP} = 0.012 \text{ [kg/tonne]}$$
$$EF_{PM10} = 0.0043 \text{ [kg/tonne]}$$

$PM_{2.5}$ was assumed to be 15 percent of TSP

Overburden dumping operation emissions were modelled as evenly distributed throughout the year and across active waste dump sources.

A1.7 Trucks Unloading Coal at ROM Pads

Emissions from haul trucks unloading coal at ROM pads were estimated using the following equation:

$$E_i = M \times EF_i$$

where

E_i = emission rate of species i (kg/y)

M = total mass of coal (in tonnes) removed per year (tonne/y)

EF_i = Uncontrolled emissions factor for species i (kg/tonne)

The number of tonnes of coal unloaded at all of the ROM pads from the pits was based on details in the mine plan and project description for the modelled year. The coal extraction rate per year for the year 2025 is summarised below:

- 2025: 54,000,000 tonne/y

The uncontrolled emission factors, EF_i, for TSP and PM_{10} used the default values as per NPI (2012, p.15).

EF_{TSP} = 0.01 kg/tonne

EF_{PM10} = 0.0041 kg/tonne

$PM_{2.5}$ was assumed to be 15 percent of TSP

Coal unloading from truck emissions was modelled as evenly distributed throughout the year and across all active ROM pad sources.

It was assumed that each ROM pad would have dedicated coal feed systems, as indicated in the coal process flowchart shown above, whereby unloaded coal would be moved to the conveyor, processed and sent to the main mine infrastructure for processing at the CHPP, thereby, minimising emissions through stockpiling at the outer ROM pads in a *just-in-time* process.

A1.8 Coal Transfer Points

Emissions from various and numerous coal transfers, including loading the various stockpiles, crushers and screens, during its processing at ROM pads and the CHPP were estimated using the following equation:

$$E_i = M \times EF_i$$

where

E_i = emission rate of species i (kg/y)

M = total mass of coal (in tonnes) transferred per year (tonne/y)

EF_i = Uncontrolled emissions factor for species i (kg/tonne)

The number of tonnes of coal transferred at all of the transfer points shown in the coal processing flowchart above were used in the modelling. Indicated transfer point "capacity" was applied as a worst case situation for a particular high capacity processing day.

The uncontrolled emission factors, EF_i, for TSP and PM_{10} used the default values as per NPI (2012, p.16).

EF_{TSP} = 0.00032 kg/tonne/transfer point

EF_{PM10} = 0.00015 kg/tonne/transfer point

$PM_{2.5}$ was assumed to be 15 percent of TSP.

Coal transfer emissions were modelled as evenly distributed throughout the year and across all active ROM pad sources and the CHPP.

It was assumed that all coal was stockpiled at both the raw coal stage and product coal stage and the reclaimed from the stockpile for further processing and/or loading trains. This is conservative to assume all the coal is stockpiled and re-processed.

A1.9 Primary Crusher Emissions

Emissions from the primary feeder breaker (crusher) at the ROMs was estimated using the following equation:

$$E_i = M \times EF_i$$

where

E_i = emission rate of species i (kg/y)

M = total mass of coal (in tonnes) process per year (tonne/y)

EF_i = Uncontrolled emissions factor for species i (kg/tonne)

The number of tonnes of coal processed by the primary feeder crusher from the Mine was based on details in the coal process flow chart of where each of four crushers has a 2200 tonne per hour capacity, or 77,088,000 tonne per year.

The uncontrolled emission factors, EF_i, for TSP and PM_{10} used the default values assuming that the coal was “high” in moisture as per NPI (2012, p.62) guidelines.

$EF_{TSP} = 0.01$ [kg/tonne]

$EF_{PM10} = 0.004$ [kg/tonne]

$PM_{2.5}$ was assumed to be 15 percent of TSP.

The primary feeder breakers were modelled as having operational hours evenly distributed throughout the year and occurring at each of the three ROM locations as volume sources.

It was assumed that all coal would be processed by the primary feeder breaker.

A1.10 Secondary Crusher Emissions

Emissions from secondary sizers (crusher) at the ROMs were estimated using the following equation:

$$E_i = M \times EF_i$$

where

E_i = emission rate of species i (kg/y)

M = total mass of coal (in tonnes) process per year (tonne/y)

EF_i = Uncontrolled emissions factor for species i (kg/tonne)

The number of tonnes of coal processed by the secondary sizer (crusher) from the Mine was based on details in the coal process flow chart of where each of four crushers has a 2200 tonne per hour capacity, or 77,088,000 tonne per year.

The uncontrolled emission factors, EF_i, for TSP and PM_{10} used the default values assuming that the coal was “high” in moisture as per NPI (2012, p.62) guidelines.

$EF_{TSP} = 0.03$ [kg/tonne]

$EF_{PM10} = 0.012$ [kg/tonne]

$PM_{2.5}$ was assumed to be 15 percent of TSP.

The secondary sizers were modelled as having operational hours evenly distributed throughout the year and occurring at each of the three ROM locations as volume sources.

A1.11 Vibrating Scalping Screens

Emissions from vibrating scalping screens (screen) at the CHPP were estimated using the following equation:

$$E_i = M \times EF_i$$

where

E_i = emission rate of species i (kg/y)

M = total mass of coal (in tonnes) process per year (tonne/y)

EF_i = Uncontrolled emissions factor for species i (kg/tonne)

The number of tonnes of coal processed by the vibrating scalping screens from the Mine was based on details in the coal process flow chart of where each of four screens has a 1800 tonne per hour capacity, or 63,072,000 tonne per year.

The uncontrolled emission factors, EF_i, for TSP and PM_{10} used the default values assuming that the coal was "low" in moisture as per NPI (2012, p.62) guidelines, as there is no emissions factors for high moisture screen emissions.

EF_{TSP} = 0.08 kg/tonne

EF_{PM10} = 0.06 kg/tonne

$PM_{2.5}$ was assumed to be 15 percent of TSP.

The vibrating scalping screens were modelled as having operational hours evenly distributed throughout the year and occurring at the CHPP location as a volume source.

A1.12 Tertiary Crusher Emissions

Emissions from tertiary sizers (crusher) at the CHPP was estimated using the following equation:

$$E_i = M \times EF_i$$

where

E_i = emission rate of species i (kg/y)

M = total mass of coal (in tonnes) process per year (tonne/y)

EF_i = Uncontrolled emissions factor for species i (kg/tonne)

The number of tonnes of coal processed by the tertiary sizers from the Mine was based on details in the coal process flow chart of where each of four sizers has a 1600 tonne per hour capacity, or 56,064,000 tonne per year. As per the process flowchart, 20 percent of coal was assumed to bypass the tertiary sizers.

The uncontrolled emission factors, EF_i, for TSP and PM_{10} used the default values assuming that the coal was "high" in moisture as per NPI (2012, p.62) guidelines.

$EF_{TSP} = 0.03$ [kg/tonne]
$EF_{PM10} = 0.01$ [kg/tonne]

$PM_{2.5}$ was assumed to be 15 percent of TSP.

Tertiary crusher was modelled as having operational hours evenly distributed throughout the year and occurring at the Mine infrastructure area source, where the CHPP is to be located.

A1.13 Overland Conveyor Emissions

Emissions from overland conveyors were estimated using the following equation:

$E_i = A \times EF_i$

where

E_i = emission rate of species i (kg/h)

A = exposed plan surface area (ha)

EF_i = Uncontrolled emissions factor for species i (kg/ha/h)

The uncontrolled emissions from the coal conveyors were assumed to be equivalent to the NPI (2012, p.60) defaults for wind erosion from exposed stockpiles.

EF_{TSP} = 0.4 kg/ha/h

EF_{PM10} = 0.2 kg/ha/h

$PM_{2.5}$ was assumed to be 18.3 percent of TSP.

Overland conveyor emissions were assessed using the relationship derived by Witt et al (1999); however, the emission rates were predicted to be negative as the average wind speed at the mine site is too low to be applicable. Applying the default NPI (2012) emissions factors for stockpile wind erosion is therefore considered to be conservative.

Approximate conveyor lengths were determined from supplied mine plan electronic drawings. The longest conveyors was determined to be the conveyor from the south ROM at 21.6 km. The assumed conveyor exposed width (for all conveyors) was 2 m. The main overland conveyor infrastructure was modelled as having an exposed surface area over about 7.8 hectares (ha).

A1.14 Loading Coal to Trains

Emissions from loading trains with coal were estimated using the following equation:

$$E_i = M \times EF_i$$

where

E_i = emission rate of species i (kg/y)

M = total mass of coal (in tonnes) loaded to trains per year (tonne/y)

EF_i = Uncontrolled emissions factor for species i (kg/tonne)

The number of tonnes of coal loaded to trains at the train load out was based on details in the Mine plan and project description – defined as “product coal”. The coal extraction rate for the modelled year of 2025 is summarised below:

- 2025: 60,120,000 tonne/y

The uncontrolled emission factors, EF_i, for TSP and PM_{10} used the default NPI (2012, p16) emissions factors.

$EF_{TSP} = 0.0004$ [kg/tonne]

$EF_{PM10} = 0.00017$ [kg/tonne]

$PM_{2.5}$ was assumed to be 15 percent of TSP.

Train loading operations were modelled as evenly distributed throughout the year and occurring at the train load out.

It was assumed that all coal would be transported away from site by train.

A1.15 Unpaved Haul Roads

Emissions from haul trucks travelling along unpaved haul roads were estimated using the following equation:

$$E_i = VKT \times EF_i$$

where

E_i = emission rate of species i (kg/y)

VKT = total vehicle kilometres travelled by all haul vehicles (in km) per year (VKT/y)

EF_i = Uncontrolled emissions factor for species i (kg/VKT)

The uncontrolled emission factors, EF_i, for TSP and PM_{10} used the as per NPI (2012, p.55) equations which relate to heavy vehicle movement at industrial sites.

$$EF_{TSP} = \frac{0.4536}{1.6093}\, 4.9 \left(\frac{s}{12}\right)^{0.7} \left(\frac{W}{3}\right)^{0.45} \text{ [kg/VKT]}$$

$$EF_{TSP} = \frac{0.4536}{1.6093}\, 1.5 \left(\frac{s}{12}\right)^{0.9} \left(\frac{W}{3}\right)^{0.45} \text{ [kg/VKT]}$$

where

s = average silt content of 7.7 precent. (Site specific soil testing.)

W = average haul truck total gross mass (tonne).

It is assumed that the haul roads will not be on areas of coal.

$PM_{2.5}$ was assumed to be 15 percent of TSP.

The NPI Mining (2012) emissions estimation equations separate emissions from heavy vehicles and light vehicles, with heavy vehicle movement generated dust emissions independent of vehicle speed and soil moisture content, unlike previous versions of the NPI Mining manual.

Haul truck movements were modelled as evenly distributed throughout the year and across all active OCM pits and waste dump sources as the exact location of the haul roads are not known. Furthermore, haul truck movement generated dust from within an OCM pit has been assumed to be “released from the pit” at ground level and in a homogenised state. The number of truck movements required to determine the total annual VKT were based on CAT 793 vehicles for coal with a 218 tonne capacity – average cvoal haul truck mass of 275 tonne. Overburden was modelled as being moved in a combination of trucks with 218 and 363 tonne capacities, with an average gross vehicle mass of 358 tonne.

The number of tonnes of coal and overburden required to be removed from the OCM pits was based on details in the Mine plan and project description. The total earth extraction rate per year for the modelled year of 2025 is summarised below:

- Coal: 54,000,000 tonne/y
- Overburden: 276,200,000 bcm/y

A nominal overburden density of 1.4 tonne/bcm was assumed.

It was assumed that equal amounts of coal and overburden were removed from each of the active OCM pits for the Mine phases investigated. Estimates of the required VKTs were made based on the straight line distance between the centre of each of the active OCM pits and either the closest ROM pad (for coal) or the closest active waste dump (for overburden). A "non-direct" scaling factor was applied to the straight line distances of 20 percent for coal and overburden.

A summary of the calculated VKTs for the each of the modelled Mine phases is given below.

- Coal haulage trips: 247,706 trips/y
- Overburden haulage trips: 1,331,084 trips/y
- Coal in-pit VKT: 2,041,652 km/y
- Coal out-of-pit VKT: 510,413 km/y
- Overburden in-pit VKT: 3,282,372 km/y
- Overburden out-of-pit VKT: 3,282,372 km/y

A1.16 Active Stockpile Wind Erosion

Emissions from the active stockpiles (raw and product coal) were estimated using the following equation:

$E_i = A \times EF_i$

where

E_i = emission rate of species i (kg/h)

A = exposed plan surface area (ha)

EF_i = Uncontrolled emissions factor for species i (kg/ha/h)

The uncontrolled emissions from the coal conveyors were assumed to be equivalent to the NPI (2012, p.60) defaults for wind erosion from exposed stockpiles.

EF_{TSP} = 0.4 kg/ha/h

EF_{PM10} = 0.2 kg/ha/h

$PM_{2.5}$ was assumed to be 18.3 percent of TSP.

Estimates of the stockpile plan areas were made from supplied electronic mine plans.

A1.17 Product Stockpile Wheel and Bucket Reclaim

Emissions from the product stockpiles wheel and bucket reclaimer were estimated using the following equation:

$$E_i = M \times EF_i$$

where

E_i = emission rate of species i (kg/y)

M = total mass of coal (in tonnes) reclaimed per year (tonne/y)

EF_i = Uncontrolled emissions factor for species i (kg/tonne)

The uncontrolled emissions from the wheel and bucket reclaimer were based on high moisture ore from NPI (2012, p.20). This is a reclaimer and not an excavator, which are defined for coal in NPI (2012, p. 16).

EF_{TSP} = 0.005 kg/tonne

EF_{PM10} = 0.002 kg/tonne

$PM_{2.5}$ was assumed to be 15 percent of TSP.

It was assumed that one of the two wheel and bucket reclaimers were operating at full capacity, 8000 tonnes per hour, for all hours of the year, i.e. 70,080,000 tonnes per year. This is assumed to be a worst case situation as expected coal product output is 60,000,000 tonnes per year.

A1.18 Dust from Trains

Emissions from the wind erosion of coal from trains travelling along the railway were estimated using the following equation:

$$E_i = M \times D \times EF_i$$

where

E_i = emission rate of species i (g/y)

M = total amount of coal transported by train (tonnes) per year (tonne/y)

D = distance travelled by train (km)

EF_i = Uncontrolled emissions factor for species i (g/km/tonne)

The uncontrolled emission factor for TSP used the equation detailed in Connell-Hatch (2008).

$$EF_{TSP} = 0.0000378(V)^2 - 0.000126(V) + 0.000063 \quad \text{[g/km/tonne of coal]}$$

where

V = train speed (km/h).

The net load per train is 24,000 tonne (metric) of coal product.

A 25 percent spillage factor was applied to the emission factor EF_{TSP}. This represents fugitive coal and dust re-entrainment that is displaced from flat surfaces of the wagons and under-carriage that is deposited during the filling of coal wagons.

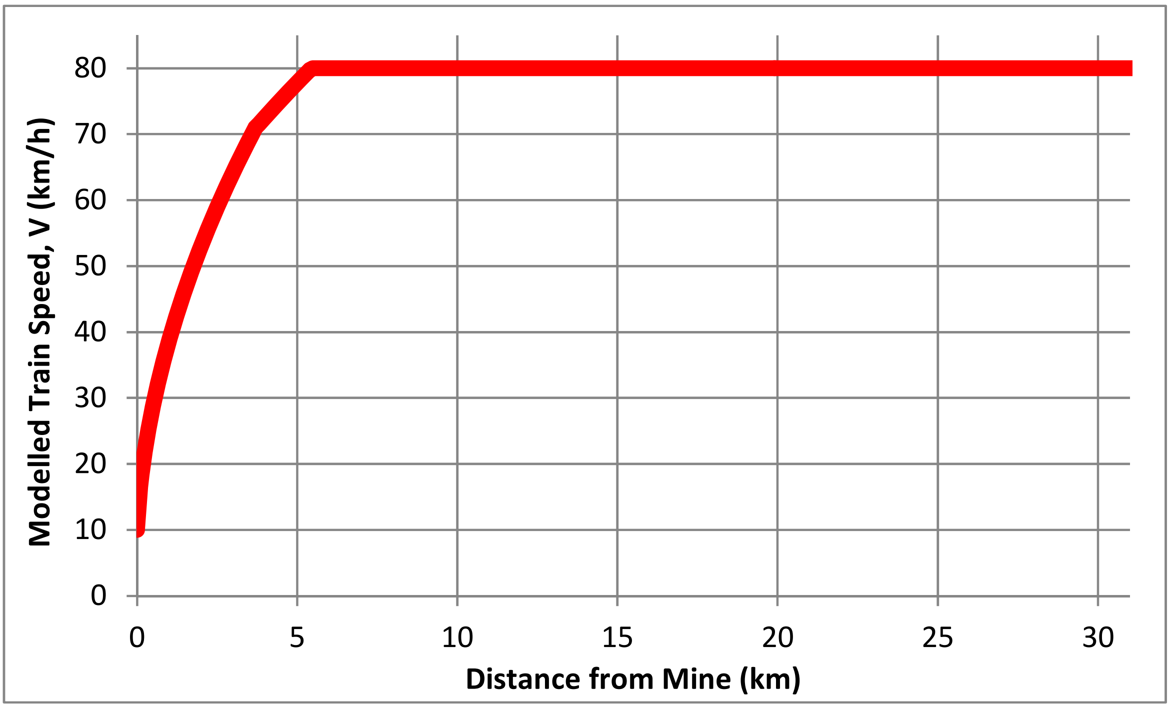
PM_{10} was assumed to be 50 percent of TSP.

$PM_{2.5}$ was assumed to be 18.3 percent of TSP.

The number of tonnes of coal transported by train from the Mine infrastructure area from the OCM pits and underground Mine was based on details in the Mine plan and project description. The coal extraction rate per year for the modelled year of 2025 is summarised below:

- Product coal: 60,120,000 tonne/y
- Railway operational days per year: 320 days/y
- Nominal trains per day: 7.83 trains/day

The railway line was modelled in CALPUFF as six (6) individual length segments representing the modelled 31 km path from the Mine towards the edge of the CALPUFF model domain. The train was modelled as accelerating away from the loading area at a rate of 0.05 m/s^2 (initially), easing to 0.03 m/s^2 at about 4 km from the mine site (Steimel, 2008, p.25), from a nominal starting speed of 10 km/h. This resulted in the maximum speed of 80 km/h being reached approximately 6 km from the rail loop at the mine site, as shown in the figure below. The dust emissions from the rail sections of the model were calculated based on the average speed along each of the individual sections.



The velocity profile was used to determine the EF for each of the railway line segments, which was then multiplied by the length of each segment, d_n, where the summation of segment lengths d_n equated to the total modelled railway length D.

A1.19 Wind Erosion

Emissions by wind erosion from exposed surfaces were estimated using the following equation:

$$E_i = A \times EF_i$$

where

E_i = emission rate of species i (kg/y)

A = total amount of exposed or disturbed surface area (plan) (ha)

EF_i = Uncontrolled emissions factor for species i (kg/ha/y)

Wind erosion was based on the AP-42 emissions estimation equation provided in NPI (2012, pp.59-60, equation 22). This equation relates the annual average wind erosion rate to the silt content (7.7 percent), the number of days per year when the rainfall is greater than 0.25 mm and the percentage of the time when the wind speed is greater than 5.4 m/s at the mean height of a stockpile.

$$EF_{TSP} = 1.9\left(\frac{s}{1.5}\right) \times 365 \times \left(\frac{365-p}{235}\right)\left(\frac{f}{15}\right) \text{ [kg/ha/y]}$$

where

s = silt content (%), assumed to be 7.7 percent.

p = number of days per year when rainfall is greater than 0.25 mm.

f = percentage of the time that wind speed is greater than 5.4 m/s at the mean height of the stockpile.

PM_{10} was assumed to be 50 percent of TSP.

$PM_{2.5}$ was assumed to be 18.3 percent of TSP, assuming half of the exposed areas consist of coal ($PM_{2.5}$:TSP = 25 percent) and the other half consists of overburden ($PM_{2.5}$:TSP = 11.6 percent).

BoM data for Clermont Post Office indicates that the mean number of rain days, p, for the region is 57.2.

Analysis of the CALMET data indicates that the wind speed is greater than 5.4 m/s (at a reference height of 10 m) 1.53 percent of the time. This 1.53 percent value is conservative since most wind erosion takes place at ground level, where the wind speed is lower.

Furthermore, wind erosion was modelled as wind speed dependent, based on a third order relationship with respect to wind speed. That is:

$$EF_{iTSP} = k\,U^3 \text{ (kg/ha/y)}$$

Where U is the wind speed at the reference height of 10 m and k is a proportional constant to maintain total annual emissions as a fixed total. In effect, the annualised emissions as determined by AP-42 are distributed throughout the year based on a wind dependent relationship. As CALPUFF does not allow a continuous function with respect to wind speed to be entered via the DEFAULT methods, a “binned” approached to the wind erosion EF’s was determined. The uncontrolled wind erosion EF’s are summarised below.

CALPUFF Wind Speed Upper Value (m/s)	Category Fraction	Emission Factor (kg/ha/h)		
		TSP	PM10	PM2.5
1.54	0.176	0.00071	0.00035	0.00013
3.09	0.500	0.0192	0.00961	0.00352
5.14	0.297	0.108	0.054	0.0198
8.23	0.027	0.463	0.232	0.0847
10.8	0.000	–	–	–
10.8+	0.000	–	–	–

The amount of exposed area modelled for the modelled year of 2025 is summarised below. No areas were assumed to be under rehabilitation during this phase of the Mine.

- OCM Pits exposed area: 4,517 ha
- WRD exposed area: 6,706 ha
- Top soil area: 1,352 ha

A1.20 Underground Mine Ventilation Emissions

The exhaust ventilation for the UGM was based on dust concentration measurements for an existing UGM operated by Illawarra Coal (PAE-Holmes, 2010). This information has been used in previous EIS air quality assessments (PAE-Holmes, 2011) and is considered as a reasonable estimate for UGM ventilation emissions, which consist mostly of dust.

The calculated dust mass emissions rates for the Illawarra Coal mine were scaled pro-rata with the extracted coal capacity difference of the Mine and that estimated for the Carmichael UGM. This assumes that for any given UGM, a doubling of the size of the Mine requires twice the ventilation requirements, and therefore twice the mass emission of dust. In-lieu of detailed ventilation specifications for the Project UGM, this is considered as a reasonable approach for the estimation of ventilation emissions.

A summary of the UGM ventilation emissions rates is provided in the table below. The ventilation emissions rates of dust were evenly distributed across five assumed exhaust ventilation structures.

PM_{10} was assumed to be 68.8 percent of TSP, which was based on matching TSP and PM_{10} measurements from Illawarra Coal.

$PM_{2.5}$ was assumed to be 100 percent of PM_{10}, which was based on matching $PM_{2.5}$ and PM_{10} measurements from Illawarra Coal.

Nominal OH&S requirements for Time Weighted Average (8 hour) exposure concentration limit for PM_{10} dust levels is 10 mg/m³. Therefore, applying an average exhaust concentration of 5.35 mg/m³ appears reasonable.

Emissions from the different UGM infrastructure sources were scaled proportionally to the amount of coal extracted from each of the UGM – north, central or south.

The exhaust ventilation emissions were modelled as volume sources as details regarding stack configurations have not been determined as at the time of this assessment. This is considered a conservative approach as model emissions are released near ground level.

Mine	UGM Coal Capacity (tonne/y)	PM_{10} Ventilation Exhaust Concentration (mg/m³)	Ventilation Exhaust Flow Rate (m³/s)	PM10 Emission Rate (g/s)
Illawarra Coal	5,800a	5.35b	600b	3.21
Carmichael – 2025	20,160	5.35	2088	11.17

a http://www.argusmedia.com/pages/NewsBody.aspx?id=774760&menu=yes

b Average of two on-site measurements.

Appendix B – CALPUFF Model Source Inputs

CALPUFF Model Source Inputs

The source input details to the CALPUFF model are provided in the following table. Note that the specified height information refers to height above the local ground level. Base elevation data has not been provided here.

Initial vertical dispersion values, Sigma-z, are provided for all area sources. The values of Sigma-z for the volume sources are given for initial vertical and lateral dispersion, Sigma-y.

Wind erosion sources from the OCM pits and WRD were modelled as area sources. Wind erosion from the top soil areas and active stockpiles (raw and product coal) were modelled as volume sources with an appropriate initial lateral spread parameter applied.

Pits and waste dumps were modelled, as close as possible, as a single quadrilateral in shape.

ID	Description	Source Type	Height (m)	Initial Horizontal Spread (Sigma Y) (m)	Initial Vertical Spread (Sigma Z) (m)	Easting (km)				Northing (km)			
						P1	P2	P3	P4	P1	P2	P3	P4
ROM-N	North ROM	Volume	5	10	2.5	433.117	-	-	-	7570.399	-	-	-
ROM-M	Central ROM	Volume	5	10	2.5	439.345	-	-	-	7562.363	-	-	-
ROM-S	South ROM	Volume	5	10	2.5	439.147	-	-	-	7548.580	-	-	-
Tr-Lo	Train Loadout	Volume	5	10	2.5	439.738	-	-	-	7565.100	-	-	-
CPP	Coal Processing Plant	Volume	10	120	5	437.828	-	-	-	7565.179	-	-	-
Pit-B	OCM Pit B	Volume	1	368	0.5	428.468	-	-	-	7570.199	-	-	-
Pit-C	OCM Pit C	Volume	1	445	0.5	431.772	-	-	-	7566.226	-	-	-
Pit-D	OCM Pit D	Volume	1	405	0.5	434.889	-	-	-	7561.644	-	-	-
Pit-E	OCM Pit E	Volume	1	556	0.5	437.551	-	-	-	7558.158	-	-	-
Pit-F	OCM Pit F	Volume	1	275	0.5	440.848	-	-	-	7552.868	-	-	-
Pit-G	OCM Pit G	Volume	1	351	0.5	441.890	-	-	-	7548.365	-	-	-
WRD-B	Waste Rock Dump B	Volume	20	553	10	429.955	-	-	-	7571.470	-	-	-
WRD-C	Waste Rock Dump C	Volume	20	592	10	433.055	-	-	-	7567.886	-	-	-
WRD-D	Waste Rock Dump D	Volume	20	649	10	436.481	-	-	-	7563.174	-	-	-
WRD-E	Waste Rock Dump E	Volume	20	456	10	439.396	-	-	-	7559.392	-	-	-
WRD-F	Waste Rock Dump F	Volume	20	586	10	442.717	-	-	-	7552.893	-	-	-
WRD-G	Waste Rock Dump G	Volume	20	458	10	443.677	-	-	-	7547.511	-	-	-

ID	Description	Source Type	Height (m)	Initial Horizontal Spread (Sigma Y) (m)	Initial Vertical Spread (Sigma Z) (m)	Easting (km)				Northing (km)			
						P1	P2	P3	P4	P1	P2	P3	P4
ST-RC1	Raw Coal Stockpile 1	Volume	15	15	7.5	437.596	-	-	-	7565.361	-	-	-
ST-RC2	Raw Coal Stockpile 2	Volume	15	15	7.5	437.673	-	-	-	7565.421	-	-	-
ST-ReC	Product Stockpile	Volume	15	258	7.5	438.312	-	-	-	7564.937	-	-	-
Vent1	UGM Exhaust Vent 1	Volume	5	3	2.5	439.835	-	-	-	7544.350	-	-	-
Vent2	UGM Exhaust Vent 2	Volume	5	3	2.5	435.566	-	-	-	7553.397	-	-	-
Vent3	UGM Exhaust Vent 3	Volume	5	3	2.5	433.256	-	-	-	7558.200	-	-	-
Vent4	UGM Exhaust Vent 4	Volume	5	3	2.5	430.208	-	-	-	7563.225	-	-	-
Vent5	UGM Exhaust Vent 5	Volume	5	3	2.5	422.906	-	-	-	7572.530	-	-	-
WE-PB	Pit B Wind Erosion	Area	0	N/A	0.5	425.686	426.958	431.182	430.047	7571.863	7572.836	7568.516	7567.581
WE-PC	Pit C Wind Erosion	Area	0	N/A	0.5	429.672	431.005	434.138	432.275	7567.093	7568.275	7565.110	7564.429
WE-PD	Pit D Wind Erosion	Area	0	N/A	0.5	432.448	434.304	437.007	435.796	7562.868	7563.961	7560.412	7559.336
WE-PE	Pit E Wind Erosion	Area	0	N/A	0.5	435.418	437.226	439.793	437.768	7558.821	7560.422	7557.152	7556.237

ID	Description	Source Type	Height (m)	Initial Horizontal Spread (Sigma Y) (m)	Initial Vertical Spread (Sigma Z) (m)	Easting (km)				Northing (km)			
						P1	P2	P3	P4	P1	P2	P3	P4
WE-PF	Pit F Wind Erosion	Area	0	N/A	0.5	439.512	440.706	442.087	441.087	7554.947	7554.603	7551.188	7550.732
WE-PG	Pit G Wind Erosion	Area	0	N/A	0.5	440.718	442.092	443.003	441.749	7550.443	7551.063	7546.291	7545.662
WE-DB	WRD B Wind Erosion	Area	20	N/A	10	426.958	429.181	432.499	431.182	7572.836	7574.231	7570.296	7568.516
WE-DC	WRD C Wind Erosion	Area	20	N/A	10	431.005	432.799	434.277	434.138	7568.275	7570.006	7568.155	7565.110
WE-DD	WRD D Wind Erosion	Area	20	N/A	10	434.304	435.486	439.125	437.007	7563.961	7566.270	7562.055	7560.412
WE-DE	WRD E Wind Erosion	Area	20	N/A	10	437.226	439.125	441.438	439.793	7560.422	7562.055	7557.940	7557.152
WE-DF	WRD F Wind Erosion	Area	20	N/A	10	440.706	443.046	445.028	442.087	7554.603	7554.440	7551.341	7551.188
WE-DG	WRD G Wind Erosion	Area	20	N/A	10	442.092	444.385	445.032	443.201	7551.063	7551.237	7543.873	7543.873
WE-TB1	Top Soil B1	Volume	10	188	5	426.934	Area (ha) =	113		7573.795			
WE-TB2	Top Soil B2	Volume	10	88	5	425.884	Area (ha) =	144		7568.251			
WE-TC	Top Soil C	Volume	10	125	5	429.847	Area (ha) =	166		7564.929			
WE-D1	Top Soil D1	Volume	10	100	5	432.599	Area (ha) =	100		7560.099			
WE-D2	Top Soil D2	Volume	10	100	5	433.041	Area (ha) =	77		7563.629			
WE-D3	Top Soil D3	Volume	10	149	5	436.308	Area (ha) =	44		7567.630			
WE-D4	Top Soil D4	Volume	10	50	5	435.056	Area (ha) =	46		7566.235			

ID	Description	Source Type	Height (m)	Initial Horizontal Spread (Sigma Y) (m)	Initial Vertical Spread (Sigma Z) (m)	Easting (km)				Northing (km)			
						P1	P2	P3	P4	P1	P2	P3	P4
WE-E	Top Soil E	Volume	10	125	5	433.675	Area (ha) =	123		7556.805			
WE-F	Top Soil F	Volume	10	188	5	436.569	Area (ha) =	228		7551.476			
WE-G1	Top Soil G1	Volume	10	125	5	441.263	Area (ha) =	188		7542.815			
WE-G2	Top Soil G2	Volume	10	188	5	441.425	Area (ha) =	123		7544.565			
Rail01	Coal Train 1	Area	2	N/A	1	439.738	439.511	439.541	439.768	7565.100	7566.111	7566.111	7565.100
Rail02	Coal Train 2	Area	2	N/A	1	439.511	439.901	439.931	439.541	7566.111	7567.229	7567.229	7566.111
Rail03	Coal Train 3	Area	2	N/A	1	439.901	440.464	440.494	439.931	7567.229	7568.687	7568.687	7567.229
Rail04	Coal Train 4	Area	2	N/A	1	440.464	446.078	446.108	440.494	7568.687	7571.834	7571.834	7568.687
Rail05	Coal Train 5	Area	2	N/A	1	446.078	451.381	451.411	446.108	7571.834	7575.933	7575.933	7571.834
Rail06	Coal Train 6	Area	2	N/A	1	451.381	451.381	465.818	465.818	7575.933	7575.963	7574.582	7574.552

ID	Description	Source Type	Height (m)	Initial Horizontal Spread (Sigma Y) (m)	Initial Vertical Spread (Sigma Z) (m)	Controlled Modelled Emission Rate			Emission Rate Units
						TSP	PM10	PM2.5	
ROM-N	North ROM	Volume	5	10	2.5	5.97	2.43	0.90	g/s
ROM-M	Central ROM	Volume	5	10	2.5	5.97	2.43	0.90	g/s
ROM-S	South ROM	Volume	5	10	2.5	5.97	2.43	0.90	g/s
Tr-Lo	Train Loadout	Volume	5	10	2.5	0.28	0.12	0.04	g/s
CPP	Coal Processing Plant	Volume	10	120	5	27.84	17.94	4.18	g/s
Pit-B	OCM Pit B	Volume	1	368	0.5	21.36	14.68	6.09	g/s
Pit-C	OCM Pit C	Volume	1	445	0.5	21.36	14.68	6.09	g/s
Pit-D	OCM Pit D	Volume	1	405	0.5	21.36	14.68	6.09	g/s
Pit-E	OCM Pit E	Volume	1	556	0.5	21.36	14.68	6.09	g/s
Pit-F	OCM Pit F	Volume	1	275	0.5	21.36	14.68	6.09	g/s
Pit-G	OCM Pit G	Volume	1	351	0.5	21.36	14.68	6.09	g/s
WRD-B	Waste Rock Dump B	Volume	20	553	10	28.18	8.76	1.96	g/s
WRD-C	Waste Rock Dump C	Volume	20	592	10	28.18	8.76	1.96	g/s
WRD-D	Waste Rock Dump D	Volume	20	649	10	28.18	8.76	1.96	g/s
WRD-E	Waste Rock Dump E	Volume	20	456	10	28.18	8.76	1.96	g/s
WRD-F	Waste Rock Dump F	Volume	20	586	10	28.18	8.76	1.96	g/s
WRD-G	Waste Rock Dump G	Volume	20	458	10	28.18	8.76	1.96	g/s
ST-RC1	Raw Coal Stockpile 1	Volume	15	15	7.5	1.24	0.58	0.18	g/s
ST-RC2	Raw Coal Stockpile 2	Volume	15	15	7.5	1.24	0.58	0.18	g/s
ST-ReC	Product Stockpile	Volume	15	258	7.5	7.93	3.10	1.06	g/s
Vent1	UGM Exhaust Vent 1	Volume	5	3	2.5	3.25	1.12	2.23	g/s
Vent2	UGM Exhaust Vent 2	Volume	5	3	2.5	3.25	2.23	2.23	g/s
Vent3	UGM Exhaust Vent 3	Volume	5	3	2.5	3.25	2.23	2.23	g/s
Vent4	UGM Exhaust Vent 4	Volume	5	3	2.5	3.25	2.23	2.23	g/s
Vent5	UGM Exhaust Vent 5	Volume	5	3	2.5	3.25	2.23	2.23	g/s
WE-PB	Pit B Wind Erosion	Area	0	N/A	0.5	Table 2	Table 2	Table 2	g/s/m²

ID	Description	Source Type	Height (m)	Initial Horizontal Spread (Sigma Y) (m)	Initial Vertical Spread (Sigma Z) (m)	Controlled Modelled Emission Rate			Emission Rate Units
						TSP	PM10	PM2.5	
WE-PC	Pit C Wind Erosion	Area	0	N/A	0.5	Table 2	Table 2	Table 2	g/s/m^2
WE-PD	Pit D Wind Erosion	Area	0	N/A	0.5	Table 2	Table 2	Table 2	g/s/m^2
WE-PE	Pit E Wind Erosion	Area	0	N/A	0.5	Table 2	Table 2	Table 2	g/s/m^2
WE-PF	Pit F Wind Erosion	Area	0	N/A	0.5	Table 2	Table 2	Table 2	g/s/m^2
WE-PG	Pit G Wind Erosion	Area	0	N/A	0.5	Table 2	Table 2	Table 2	g/s/m^2
WE-DB	WRD B Wind Erosion	Area	20	N/A	10	Table 2	Table 2	Table 2	g/s/m^2
WE-DC	WRD C Wind Erosion	Area	20	N/A	10	Table 2	Table 2	Table 2	g/s/m^2
WE-DD	WRD D Wind Erosion	Area	20	N/A	10	Table 2	Table 2	Table 2	g/s/m^2
WE-DE	WRD E Wind Erosion	Area	20	N/A	10	Table 2	Table 2	Table 2	g/s/m^2
WE-DF	WRD F Wind Erosion	Area	20	N/A	10	Table 2	Table 2	Table 2	g/s/m^2
WE-DG	WRD G Wind Erosion	Area	20	N/A	10	Table 2	Table 2	Table 2	g/s/m^2
WE-TB1	Top Soil B1	Volume	10	188	5	0.9(Table 2)	0.9(Table 2)	0.9(Table 2)	g/s
WE-TB2	Top Soil B2	Volume	10	88	5	0.9(Table 2)	0.9(Table 2)	0.9(Table 2)	g/s
WE-TC	Top Soil C	Volume	10	125	5	0.9(Table 2)	0.9(Table 2)	0.9(Table 2)	g/s
WE-D1	Top Soil D1	Volume	10	100	5	0.9(Table 2)	0.9(Table 2)	0.9(Table 2)	g/s
WE-D2	Top Soil D2	Volume	10	100	5	0.9(Table 2)	0.9(Table 2)	0.9(Table 2)	g/s
WE-D3	Top Soil D3	Volume	10	149	5	0.9(Table 2)	0.9(Table 2)	0.9(Table 2)	g/s
WE-D4	Top Soil D4	Volume	10	50	5	0.9(Table 2)	0.9(Table 2)	0.9(Table 2)	g/s
WE-E	Top Soil E	Volume	10	125	5	0.9(Table 2)	0.9(Table 2)	0.9(Table 2)	g/s
WE-F	Top Soil F	Volume	10	188	5	0.9(Table 2)	0.9(Table 2)	0.9(Table 2)	g/s
WE-G1	Top Soil G1	Volume	10	125	5	0.9(Table 2)	0.9(Table 2)	0.9(Table 2)	g/s
WE-G2	Top Soil G2	Volume	10	188	5	0.9(Table 2)	0.9(Table 2)	0.9(Table 2)	g/s
Rail01	Coal Train 1	Area	2	N/A	1	0.0060	0.0030	0.0010	g/s/m^2
Rail02	Coal Train 2	Area	2	N/A	1	0.0070	0.0040	0.0010	g/s/m^2
Rail03	Coal Train 3	Area	2	N/A	1	0.010	0.0050	0.0020	g/s/m^2
Rail04	Coal Train 4	Area	2	N/A	1	1.09	0.544	0.197	g/s/m^2

ID	Description	Source Type	Height (m)	Initial Horizontal Spread (Sigma Y) (m)	Initial Vertical Spread (Sigma Z) (m)	Controlled Modelled Emission Rate			Emission Rate Units
						TSP	PM10	PM2.5	
Rail05	Coal Train 5	Area	2	N/A	1	3.70	1.85	0.653	g/s/m²
Rail06	Coal Train 6	Area	2	N/A	1	8.02	4.00	1.35	g/s/m²

GHD

145 Ann Street Brisbane QLD 4000
GPO Box 668 Brisbane QLD 4001
T: (07) 3316 3000   F: (07) 3316 3333   E: bnemail@ghd.com

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
A	D Featherston	B Cook	DRAFT	J Keane	DRAFT	18/07/2013
B	B Cook	J Keane	DRAFT	J Keane	DRAFT	28/07/2013
0	B Cook	J Keane		J Keane		29/07/2013
1	M Goodall	J Keane		J Keane		17/10/2013

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