Appendix K

Air Quality and Greenhouse Gas Assessment Report

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HUME COAL PROJECT
APPENDIX K
AIR QUALITY IMPACT AND GREENHOUSE GAS ASSESSMENT

RAMBOLL ENVIRON

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FINAL	14/02/2017	S. Fishwick	R. Kellaghan	S. Fishwick	

Ref AS121538

Ramboll Environ
Level 3
100 Pacific Highway
PO Box 560
North Sydney
NSW 2060
Australia
T +61 2 9954 8100

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EXECUTIVE SUMMARY

Introduction

Hume Coal Pty Limited (Hume Coal) proposes to develop and operate the Hume Coal Project, an underground coal mine and associated mine infrastructure (the 'project') in the Southern Coalfield of New South Wales (NSW).

Ramboll Environ Australia Pty Ltd (Ramboll Environ) was commissioned by EMM Consulting Pty Limited (EMM) to conduct an air quality and greenhouse gas assessment of the project.

The project involves the development and operation of an underground coal mine and associated mine infrastructure. Over a 19-year period, the mine would extract approximately 50 million tonnes (Mt) of run-of-mine (ROM) coal from the Wongawilli Seam, at a rate of up to 3.5 million tonnes per annum (Mtpa).

Input Meteorology

Meteorological conditions are recorded in the project area by two onsite meteorological stations. Beyond the project area, meteorological monitoring resources in the surrounding area include stations at the Berrima Cement Works and in Moss Vale (Bureau of Meteorology operated). The review of data from all these resources has highlighted that the region experiences winds which are predominantly from the westerly, north-easterly and south-easterly quadrants.

Due to the variability in the recorded wind speeds across the region, two complete years of meteorological conditions recorded during 2013 (the BoM Moss Vale and southern Hume 1 onsite monitoring station datasets) were utilised for the dispersion modelling study. The likely reasons for the differences between the datasets and associated impact on the modelling are discussed later in this report.

Hourly average, and peak gust wind conditions from these two sites (which showed wind speeds ranging from calm (less than 2 km/hour) to 100 km/hour for the 2013 calendar year) were incorporated into the emission calculation and dispersion modelling process.

Existing air quality

A number of existing industrial operations are located in the surrounding area, including Boral's Berrima Cement Works, Ingham's Berrima Feed Mill and Omya's Southern Limestone facility. Emissions from neighbouring industrial facilities were quantified and modelled to predict spatially-varying impacts in the surrounding environment.

Additionally, air quality monitoring data from onsite, local and regional monitoring equipment was analysed to quantify baseline air quality conditions.

Air pollutant emissions and impacts

Particulate matter (PM), diesel combustion and odour emission inventories have been developed for peak construction and operational phases of the project. For operational phase, two scenarios have been assessed, involving the control of wind-blown dust emissions from the product coal stockpiles by watering alone and a combination of watering and surface veneering.

The results of the modelling show that for both construction and operational phases, the predicted particulate matter (TSP, PM_{10}, $PM_{2.5}$) and gaseous pollutant (NO_2 and VOCs) concentrations and dust deposition levels associated with project emissions are well below the applicable impact assessment criterion at neighbouring sensitive receptors.

The application of a combination of surface veneering and watering achieves a greater level of impact reduction on peak wind days relative to watering alone, however predicted impacts from both scenarios are considered low relative to impact assessment criteria.

Cumulative impacts were assessed by combining modelled project impacts with predicted impacts from neighbouring industrial emission sources and ambient background levels adopted from local and regional air quality monitoring stations. The results of the cumulative impact analysis highlight that the likelihood of the project resulting in an exceedance of the applicable cumulative impact assessment criterion is very low.

The design of the project incorporates a range of dust mitigation and management measures. A best practice dust control measures review was undertaken for the proposed mitigation and management measures. The review identified that proposed mitigation and management measures are in accordance with or above accepted industry best practice dust control measures.

Greenhouse gas emissions

A greenhouse gas quantification assessment was undertaken for the project. The annual Scope 1, Scope 2 and Scope 3 emissions (excluding the end use of product coal) represent approximately 0.068% of total GHG emissions for NSW and 0.017% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2014.

1. INTRODUCTION

Hume Coal Pty Limited (Hume Coal) proposes to develop and operate the Hume Coal Project, an underground coal mine and associated mine infrastructure (the 'project') in the Southern Coalfield of New South Wales (NSW). Hume Coal holds exploration Authorisation 349 (A349) to the west of Moss Vale, in the Wingecarribee local government area (LGA). The underground mine will be developed within A349 and associated surface infrastructure facilities will be developed within and north of A349. The project area and its regional and local setting are shown in **Figure 1-1** and **Figure 1-2** respectively.

Approval for the project is being sought under Part 4, Division 4.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). An environmental impact statement (EIS) is a requirement of the approval processes. This air quality impact and greenhouse gas assessment report forms part of the EIS. It documents the air quality impact assessment methods and results, greenhouse gas quantification study and the initiatives built into the project design to avoid and minimise air quality impacts.

1.1 Study Objective

1.1.1 Assessment guidelines and requirements

This assessment has been prepared following the appropriate guidelines, policies and industry requirements.

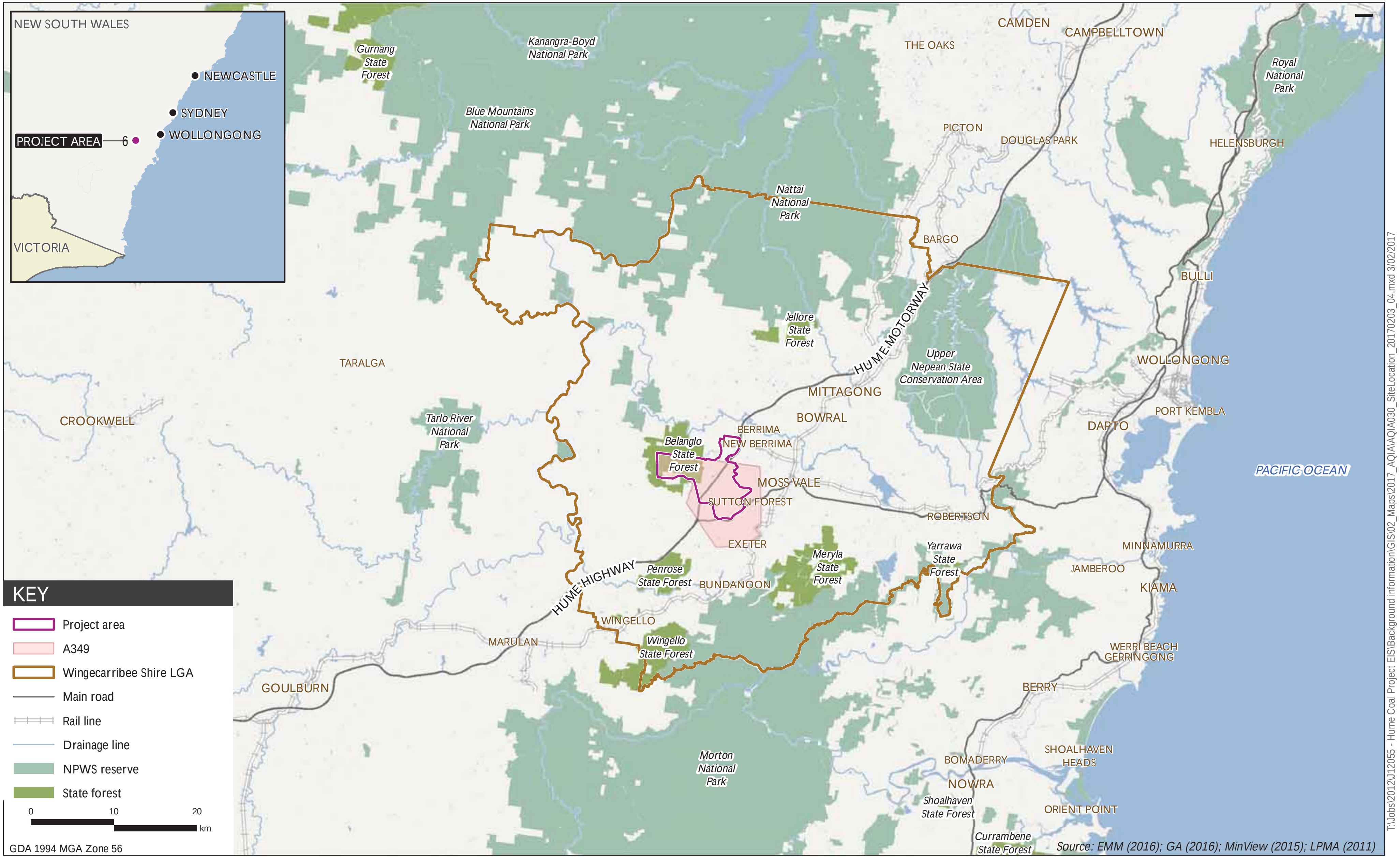
Guidelines and policies referenced are as follows:

- Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (EPA, 2016);
- Coal Mine Particulate Matter Control Best Practice – Site Specific Determination Guideline (EPA, 2011); and
- National Greenhouse Accounts Factors (DoE, 2015).

This assessment has been prepared in accordance with requirements of the Commonwealth Department of the Environment (DoE) and NSW Department of Planning and Environment (DP&E). These were set out in the Secretary's Environmental Assessment Requirements (SEARs) for the project, issued on 20 August 2015, supplementary SEARs issued on 18 January 2016 and Diesel Emissions Modelling requirement issued on 25 May 2016. The SEARs identify matters which must be addressed in the EIS and essentially form its terms of reference. A copy of the SEARs is attached to the EIS as Appendix B, while **Table 1-1** lists individual requirements relevant to this air quality impact and greenhouse gas assessment and where they are addressed in this report.

Table 1-1: Air Quality-related SEARs

Requirement	Section Addressed
An assessment of the likely air quality impacts of the development in accordance with the Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW	Sections 3, 4, 5, 6, 7, 8, 9 and 10
Quantitative analysis of diesel combustion emissions	Sections 6, 8, 9 and 10
Roads and Maritime Services: • The impact of dust pollution on the travelling public • The impact of dust pollution or the deposition of fines on the functioning of reflective signs, pavement markers and pavement line marking	Section 9
An assessment of the likely greenhouse gas impacts of the development	Section 11



Regional context
Hume Coal Project
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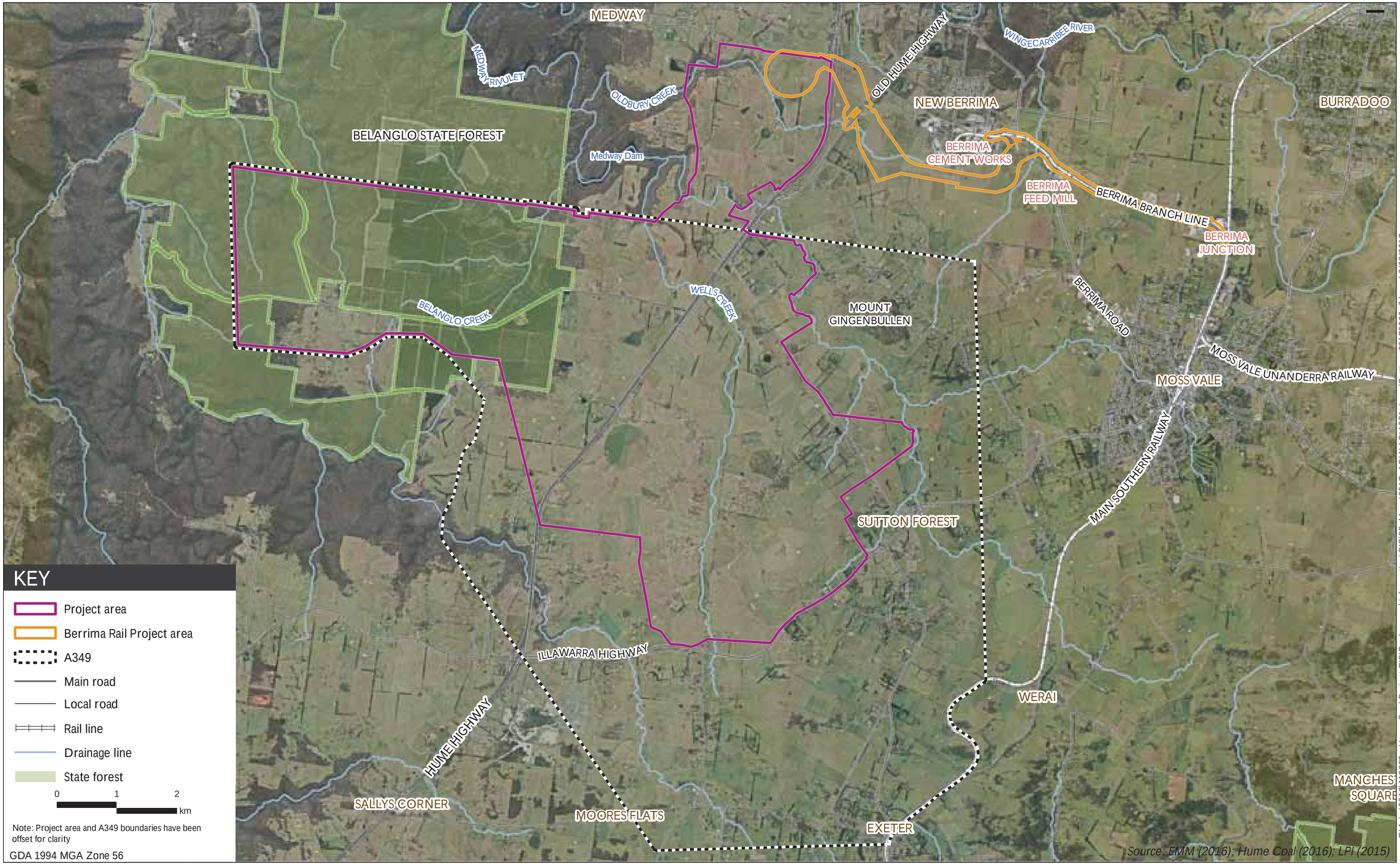
Figure 1.1



Local context

Hume Coal Project

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Figure 1.2

2. PROJECT OVERVIEW AND SETTING

2.1 Project description

The project involves developing and operating an underground coal mine and associated infrastructure over a total estimated project life of 23 years. Indicative mine and surface infrastructure plans are provided in **Figure 2-1** and **Figure 2-2** respectively. A full description of the project, as assessed in this report, is provided in Chapter 2 of the main EIS report (EMM 2016).

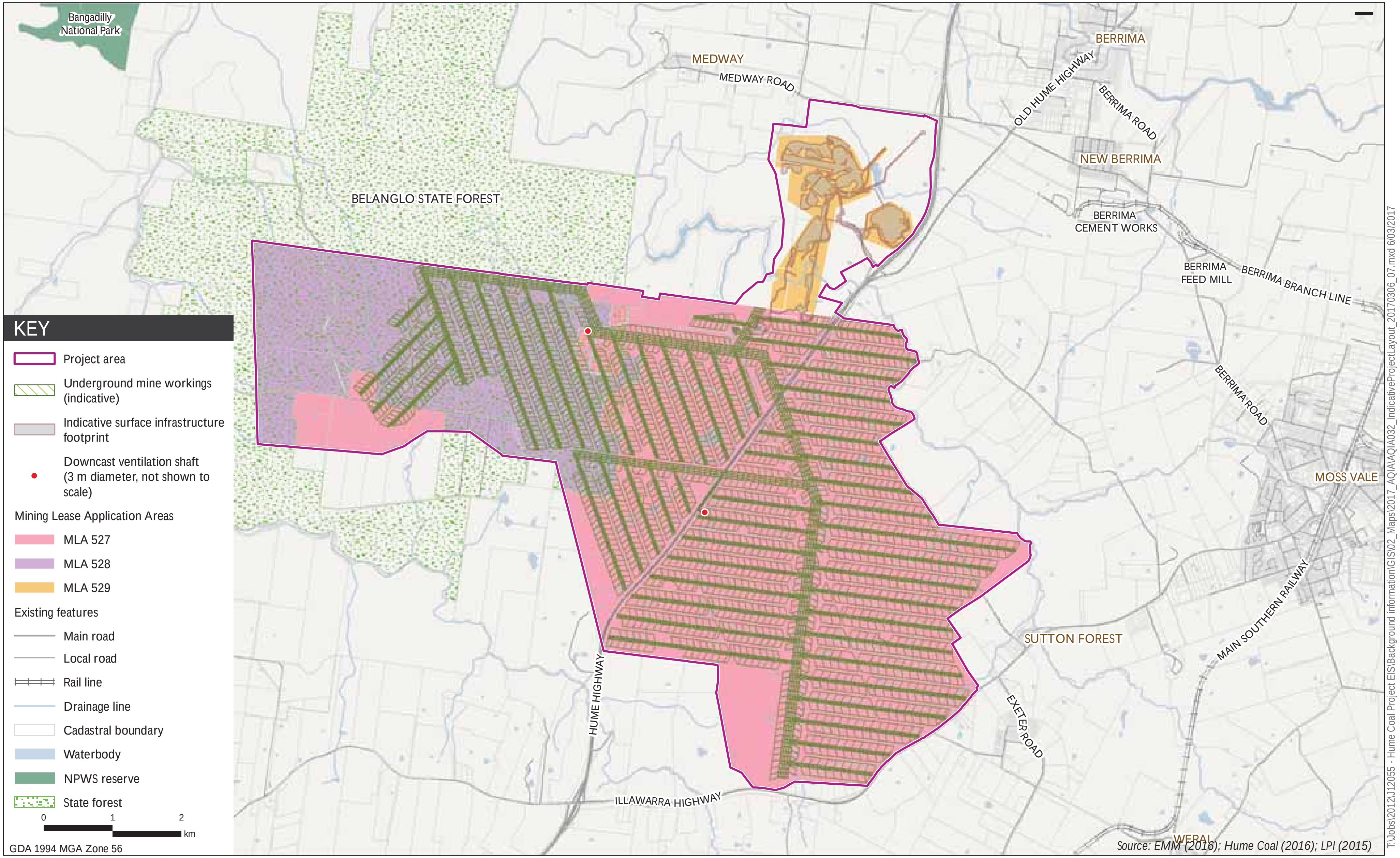
In summary it involves:

- Ongoing resource definition activities, along with geotechnical and engineering testing, and other low impact fieldwork to facilitate detailed design.
- Establishment of a temporary construction accommodation village.
- Development and operation of an underground coal mine, comprising of approximately two years of construction and 19 years of mining, followed by a closure and rehabilitation phase of up to two years, leading to a total project life of 23 years. Some coal extraction will commence during the second year of construction during installation of the drifts, and hence there will be some overlap between the construction and operational phases.
- Extraction of approximately 50 million tonnes (Mt) of run-of-mine (ROM) coal from the Wongawilli Seam, at a rate of up to 3.5 million tonnes per annum (Mtpa). Low impact mining methods will be used, which will have negligible subsidence impacts.
- Following processing of ROM coal in the coal preparation plant (CPP), production of up to 3 Mtpa of metallurgical and thermal coal for sale to international and domestic markets.
- Construction and operation of associated mine infrastructure, mostly on cleared land, including:
  - one personnel and materials drift access and one conveyor drift access from the surface to the coal seam;
  - ventilation shafts, comprising one upcast ventilation shaft and fans, and up to two downcast shafts installed over the life of the mine, depending on ventilation requirements as the mine progresses;
  - a surface infrastructure area, including administration, bathhouse, washdown and workshop facilities, fuel and lubrication storage, warehouses, laydown areas, and other facilities. The surface infrastructure area will also comprise the CPP and ROM coal, product coal and emergency reject stockpiles;
  - surface and groundwater management and treatment facilities, including storages, pipelines, pumps and associated infrastructure;
  - overland conveyors;
  - rail load-out facilities;
  - explosives magazine;
  - ancillary facilities, including fences, access roads, car parking areas, helipad and communications infrastructure; and
  - environmental management and monitoring equipment.
- Establishment of site access from Mereworth Road, and minor internal road modifications and relocation of some existing utilities.
- Coal reject emplacement underground, in the mined-out voids.
- Peak workforces of approximately 414 full-time equivalent employees during construction and approximately 300 full-time equivalent employees during operations.
- Decommissioning of mine infrastructure and rehabilitating the area once mining is complete, so that it can support land uses similar to current land uses.

The project area, shown in **Figure 1-2**, is approximately 5,051 hectares (ha). Surface disturbance will mainly be restricted to the surface infrastructure areas shown indicatively on **Figure 2-2**, though will include some other areas above the underground mine, such as drill pads and access tracks. The project area generally comprises direct surface disturbance areas of up to approximately 117 ha, and an underground mining area of approximately 3,472 ha, where negligible subsidence impacts are anticipated.

A construction buffer zone will be provided around the direct disturbance areas. The buffer zone will provide an area for construction vehicle and equipment movements, minor stockpiling and equipment laydown, as well as allowing for minor realignments of surface infrastructure. Ground disturbance will generally be minor and associated with temporary vehicle tracks and sediment controls as well as minor works such as backfilled trenches associated with realignment of existing services. Notwithstanding, environmental features identified in the relevant technical assessments will be marked as avoidance zones so that activities in this area do not have an environmental impact.

Product coal will be transported by rail, primarily to Port Kembla terminal for the international market, and possibly to the domestic market depending on market demand. Rail works and use are the subject of a separate EIS and State significant development application for the Berrima Rail Project.

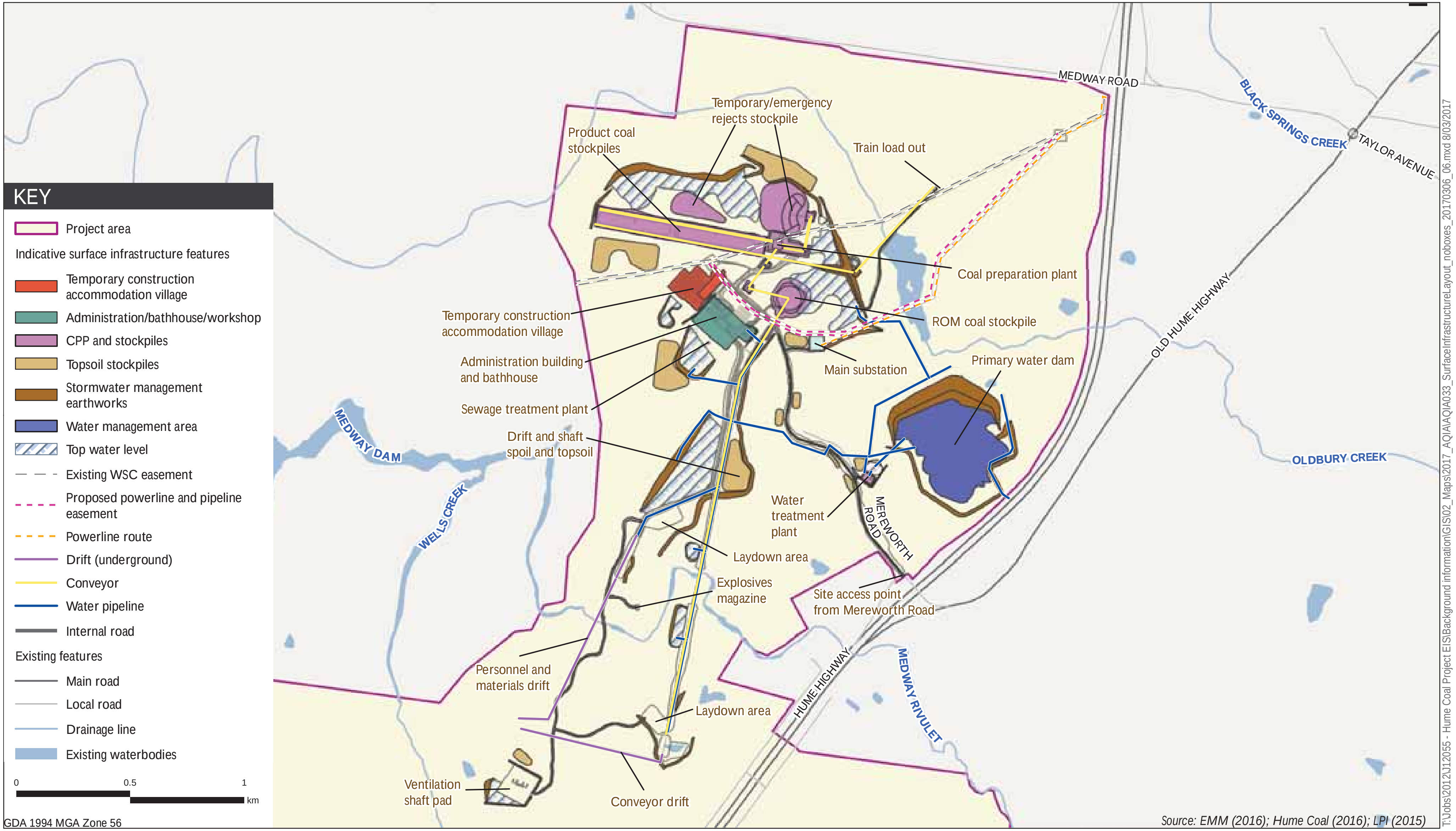


Indicative project layout

Hume Coal Project

Air Quality Impact and Greenhouse Gas Assessment

Figure 2.1



Indicative surface infrastructure layout

Hume Coal Project
Air Quality Impact and Greenhouse Gas Assessment

Figure 2.2

EMM HUMECOAL

2.2 Project setting

The project area is approximately 100 km south-west of Sydney and 4.5 km west of Moss Vale in the Wingecarribee LGA (**Figure 1-1** and **Figure 1-2**). The nearest area of surface disturbance will be associated with the surface infrastructure area, which will be 7.2 km north-west of the Moss Vale town centre. It is in the Southern Highlands region of NSW and the Sydney Basin Biogeographic Region.

The project area is in a semi-rural setting, with the wider region characterised by grazing properties, small-scale farm businesses, natural areas, forestry, scattered rural residences, villages and towns, industrial activities such as the Berrima Cement Works and Berrima Feed Mill, and some extractive industry and major transport infrastructure such as the Hume Highway.

Surface infrastructure is proposed to be developed on predominately cleared land owned by Hume Coal or affiliated entities, or for which there are appropriate access agreements in place with the landowner. Over half of the remainder of the project area (principally land above the underground mining area) comprises cleared land that is, and will continue to be, used for livestock grazing and small-scale farm businesses. Belanglo State Forest covers the north-western portion of the project area and contains introduced pine forest plantations, areas of native vegetation and several creeks that flow through deep sandstone gorges. Native vegetation within the project area is largely restricted to parts of Belanglo State Forest and riparian corridors along some watercourses.

The project area is traversed by several drainage lines including Oldbury Creek, Medway Rivulet, Wells Creek, Wells Creek Tributary, Belanglo Creek and Longacre Creek, all of which ultimately discharge to the Wingecarribee River, at least 5 km downstream of the project area (**Figure 1-2**). The Wingecarribee River's catchment forms part of the broader Warragamba Dam and Hawkesbury-Nepean catchments. Medway Dam is also adjacent to the northern portion of the project area (**Figure 1-2**).

Most of the central and eastern parts of the project area have very low rolling hills with occasional elevated ridge lines. However, there are steeper slopes and deep gorges in the west in Belanglo State Forest. A three-dimensional representation of the region surrounding the project area is presented in **Figure 2-3**.

Existing built features across the project area include scattered rural residences and farm improvements such as outbuildings, dams, access tracks, fences, yards and gardens, as well as infrastructure and utilities including roads, electricity lines, communications cables and water and gas pipelines. Key roads that traverse the project area are the Hume Highway and Golden Vale Road. The Illawarra Highway borders the south-eastern section of the project area.

Industrial and manufacturing facilities adjacent to the project area include the Berrima Cement Works and Berrima Feed Mill on the fringe of New Berrima. Berrima Colliery's mining lease (CCL 748) also adjoins the project area's northern boundary. Berrima colliery is currently not operating with production having ceased in 2013 after almost 100 years of operation. The mine is currently undergoing closure. Further consideration of neighbouring industrial facilities is documented in **Section 6**.

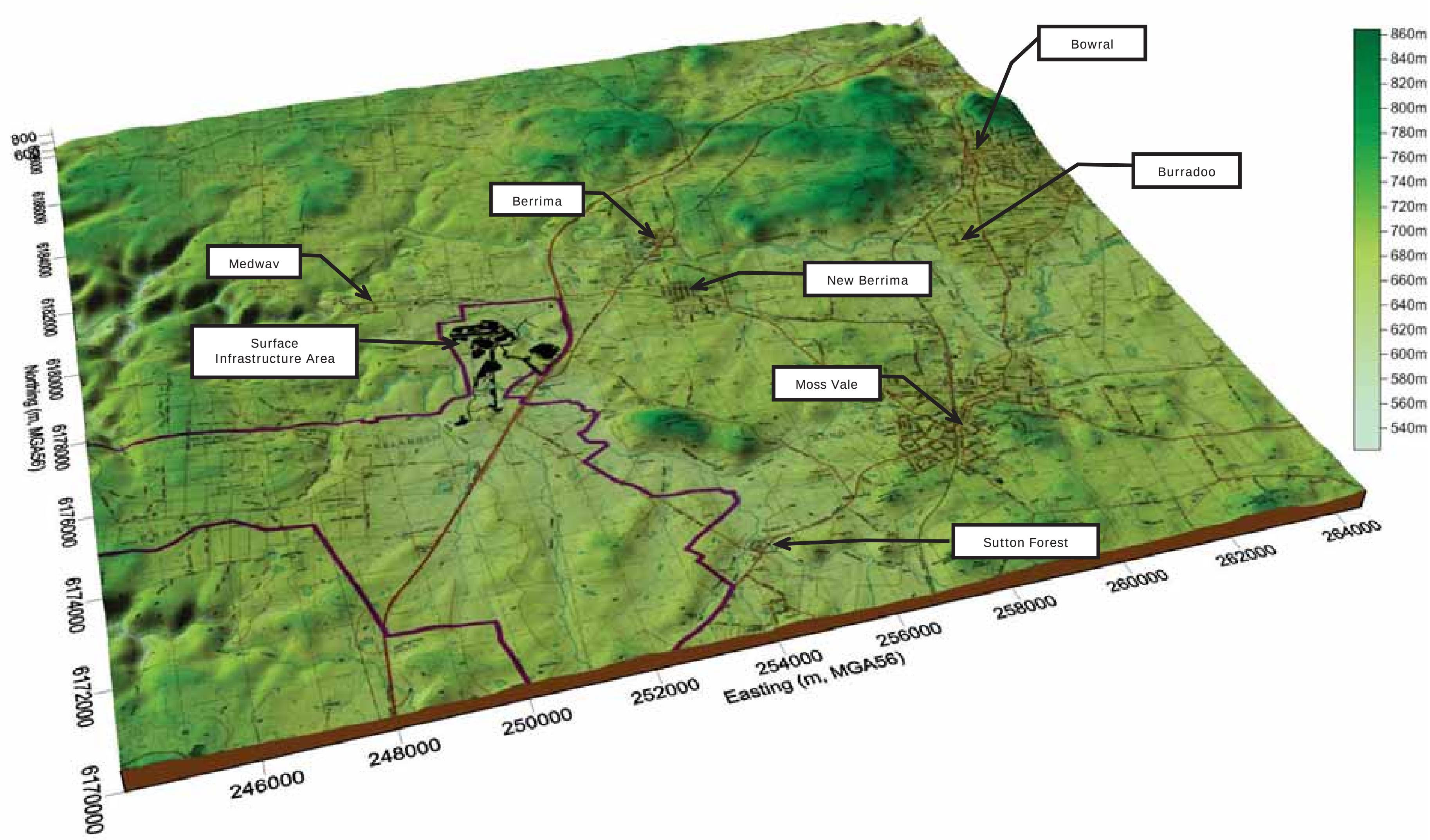


Figure 2-3:-Dimensional perspective of regional topographical features

Note: Vertical exaggeration of 2 applied

2.3 Surrounding sensitive receptors

The project is surrounded by a mixture of regional villages, scattered rural residential properties, industrial facilities and agricultural land. In order to assess potential air quality impacts across the surrounding area, a sub-set of surrounding residences has been selected, considered to be representative of sensitive receptor locations in all directions from the project area. Additionally, single village representative receptors have been included for the following:

- Medway (receptor 1);
- Berrima (receptor 23);
- New Berrima (receptor 22);
- Bowral (receptor 31);
- Burradoo (receptor 30);
- Sutton Forest (receptor 33); and
- Moss Vale (receptor 32).

While not all residence locations in the surrounding area have explicitly been included in this assessment, the modelling has been conducted for a 15km by 11km model domain with predictions made at 300m intervals. Therefore, air quality impact predictions have effectively been made for any location within the surrounding area of 165km^2. The selected receptor locations are presented in **Table 2-1** and illustrated in **Figure 2-4**.

Table 2-1: Selected Sensitive Receptor Locations Surrounding the project

Receptor ID	Location (m, MGA56S)		Elevation (m, AHD)
	Easting	Northing	
1	249331	6180137	662
2	249437	6179316	631
3	249778	6179270	641
4	250179	6179619	660
5	250325	6179786	659
6	250411	6179920	660
7	250453	6180020	662
8	250691	6180085	663
10	250899	6179919	655
12	251130	6179599	660
13	251208	6179744	659
14a	251498	6180116	674
14b	251457	6180109	674
15	251961	6180040	675
16	252354	6179922	663
17	252944	6179582	661
18	253254	6180054	665
19	253868	6179400	671
20	254482	6179446	671
21	254600	6179219	684
22	254975	6178785	686
23	255316	6180322	662
24	254072	6180006	695
25	257161	6176673	687
26	257713	6177294	701
27	257854	6176648	713
28	259028	6176937	668
29	259248	6176172	678
30	260449	6179342	669
31	262512	6181117	672
32	258925	6173965	681
33	254309	6171667	655
34	248854	6177002	661
35	248589	6176305	674
36	249040	6175659	657
37	249239	6175753	654
38	249775	6175047	668
39	250105	6175232	647
40	250002	6174979	645
41	250860	6175067	651
42	251015	6175282	642
43	251889	6174874	649
44	251806	6175425	646
45	251721	6175576	647
46	251658	6175678	646
47	251644	6175801	646
48	251523	6175857	647
49	251349	6175937	653
50	251590	6176084	643
51	251712	6176412	641
52	251719	6176510	640
53	251747	6176878	638
54	251942	6176680	636
55	251855	6177038	635
56	252060	6175654	641

Table 2-1: Selected Sensitive Receptor Locations Surrounding the project

Receptor ID	Location (m, MGA56S)		Elevation (m, AHD)
	Easting	Northing	
57	252144	6175446	640
58	253004	6175706	650
59	252990	6176040	649
60	253327	6176403	684
61	253141	6176981	677
62	253520	6177082	672
63	252992	6177520	677
64	249668	6179892	674
65	249372	6180036	660
66	249870	6180074	672
67	249105	6180133	662
68	249561	6180167	668
69	254321	6180310	680
70	254816	6179911	656
71	254641	6180129	663
72	254939	6180279	654
73	255094	6179859	675
74	254548	6179564	669
75	254720	6176633	688
76	255026	6176571	696

Surrounding local receptors

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Figure 2.4

3. AIR QUALITY ASSESSMENT CRITERIA

The Project must demonstrate compliance with the impact assessment criteria outlined in the Approved Methods for Modelling and Assessment of Air Pollutants in NSW (EPA, 2016 – hereafter the Approved Methods for Modelling). The impact assessment criteria are designed to maintain ambient air quality that allows for the adequate protection of human health and well-being.

Relevant ambient air quality criteria applicable to the project are presented in the following sections.

3.1 Airborne particulate matter

When first regulated, airborne PM was assessed based on concentrations of "total suspended particulate matter" (TSP). In practice, this typically referred to PM smaller than about 30-50 micrometres (µm) in diameter. As air sampling technology improved and the importance of particle size and chemical composition become more apparent, ambient air quality standards have been revised to focus on the smaller particle sizes, thought to be most dangerous to human health. Contemporary air quality assessment typically focuses on "fine" and "coarse" inhalable PM, based on health-based ambient air quality standards set for PM_{10} and $PM_{2.5}$[1].

Air quality criteria for PM in Australia are given for particle size metrics including TSP, PM_{10} and $PM_{2.5}$. The 2016 update to the Approved Methods for Modelling, gazetted on 20 January 2017, includes particle assessment criteria that are consistent with revised National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) national reporting standards (National Environment Protection Council [NEPC], 1998; NEPC, 2015).

For the purpose of this report, predicted ground level concentrations (GLCs) are assessed against the NSW EPA's impact assessment criteria presented in **Table 3-1**.

The revised AAQ NEPM also establishes long-term goals for $PM_{2.5}$ to be achieved by 2025 (NEPC, 2015). It is noted that the purpose of the AAQ NEPM is to attain '*ambient air quality that allows for the adequate protection of human health and wellbeing*', and compliance with the AAQ NEPM is assessed through air quality monitoring data collected and reported by each state and territory. The long-term goals for $PM_{2.5}$ are therefore not applicable to the assessment of impacts of emissions sources on individual sensitive receptors, and are shown in **Table 3-1** for information only.

Table 3-1: Impact assessment criteria for PM

PM Metric	Averaging Period	Concentration (µg/m³)	Purpose of goal
TSP	Annual	90	NSW EPA impact assessment criteria
PM_{10}	24 hours	50	
	Annual	25	
$PM_{2.5}$	24 hours	25	
	Annual	8	
	24 hours	20	AAQ NEPM long term goal for 2025
	Annual	7	

[1] Particulate matter with an aerodynamic diameter of less than 10 µm and 2.5 µm respectively.

The Approved Methods for Modelling specifies that the impact assessment criteria for PM are applied at the nearest existing or likely future off-site sensitive receptor and compared against the 100th percentile (i.e. the highest) dispersion modelling prediction. Both the incremental and cumulative impacts need to be considered (consideration of existing ambient background concentration is required).

3.2 Dust deposition criteria

Nuisance dust deposition is regulated through the stipulation of maximum permissible dust deposition rates. The NSW EPA impact assessment criteria for dust deposition are given in **Table 3-2** illustrating the allowable increment in dust deposition rates above ambient (background) dust deposition rates which would be acceptable so that dust nuisance could be avoided.

Table 3-2: Impact assessment criteria for dust deposition

Averaging Period	Maximum Increase in Deposited Dust Level	Maximum Total Deposited Dust Level
Annual	2 $g/m^2/month$	4 $g/m^2/month$

Source: Approved Methods for Modelling (EPA, 2016)

3.3 Gaseous air pollutants

Emissions of gaseous pollutants will occur as a result of fuel combustion by the underground mining fleet and surface based vehicles.

For this assessment, the key combustion-related pollutants of interest are nitrogen dioxide (NO_2) and Volatile organic compounds (VOCs). While numerous VOC species are emitted during the combustion of diesel fuel, this assessment has focused primarily on benzene, ethylbenzene, toluene and total xylenes to assess the potential health impact of individual organic species. These species are quantifiable based on available emission factors, and may be used as markers of the relative toxicity of organic compounds from combustion.

Air quality impact assessment criteria issued by the NSW EPA applicable to these gaseous emissions are summarised in **Table 3-3**.

The air quality impact assessment criteria for NO_2 are applicable at the nearest existing or likely future off-site dwellings or establishments. In assessing compliance against the applicable criteria, the maximum total concentration (incremental plus background concentration) at each receptor must be reported as the 100th percentile concentration (i.e. maximum concentration).

The criteria specified for benzene and ethylbenzene is applicable at and beyond the boundary of the facility. For a Level 2 assessment, as is undertaken in the current study, the incremental concentration (predicted concentration due to the pollutant source alone) must be reported as the 99.9th percentile 1-hour average (EPA, 2016).

The impact assessment criteria given for toluene and xylenes are applicable at any existing or likely future off-site dwellings or establishments. The incremental concentration (predicted concentration due to the pollutant source alone) must be reported as the 99.9th percentile 1-hour average (EPA, 2016).

Table 3-3: Impact assessment criteria for Combustion Pollutants

Pollutant	Averaging Period	Concentration		Reference
		µg/m³	pphm[5]	
NO_2	1-hour	246	12	NSW EPA(1)
	Annual	62	3	NSW EPA(1)
Benzene	1-hour	29	9	NSW EPA(1)(2)(3)
Toluene	1-hour	360	90	NSW EPA(1)(2)(4)
Xylenes	1-hour	190	40	NSW EPA(1)(2)(4)
Ethylbenzene	1-hour	8,000	1,800	NSW EPA(1)(2)(3)

(1): Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (EPA, 2016)

(2): For a Level 2 Assessment (defined within the Approved Methods for Modelling), expressed as the 99.9th percentile value. The current assessment constitutes a Level 2 Assessment

(3): Assessment criteria specified for toxic air pollutant

(4): Assessment criteria summarised for odorous air pollutants

(5): pphm: Parts per hundred million

3.4 Odour

The odour performance criteria are expressed in terms of odour units. The detectability of an odour is defined as a sensory property that refers to the theoretical minimum concentration that produces an olfactory response or sensation. This point is called the odour threshold and defines one odour unit (OU). An odour criterion of less than 1 OU would theoretically result in no odour impact being experienced.

A concentration of 7 OU means that the sample requires a 7-times dilution with clean air to become odour free; thus an odour concentration expressed as 7 OU coincides with a dilution-to-threshold (D/T) ratio of 7, and 2 OU equates to a D/T ratio of 2 (and so on).

The NSW Technical Framework - Assessment and Management of Odour from Stationary Sources recommends, as a design goal, that no individual be exposed to ambient odour levels of greater than 7 OU (NSW DEC, 2006). Although the level at which an odour is perceived to be a nuisance can range from 2 OU to 10 OU, experience gained through odour assessments from proposed and existing facilities in NSW indicates that an odour performance goal of 7 OU is likely to represent the level below which “offensive” odours should not occur (for an individual with a ‘standard sensitivity’ to odours) (NSW DEC, 2006).

Odour performance criteria are designed to take into account the range in sensitivities to odours within the community, and provide additional protection for individuals with a heightened response to odours, using a statistical approach which depends on the size of the affected population.

As the affected population size increases, the number of sensitive individuals is also likely to increase, which suggests that more stringent criteria are necessary in these situations. In addition, the potential for cumulative odour impacts in relatively sparsely populated areas can be more easily defined and assessed than in highly populated urban areas.

Where a number of factors simultaneously contribute to making an odour “offensive”, an odour goal of 2 OU at the nearest residence (existing or any likely future residences) is appropriate, which generally occurs for affected populations equal or above 2000 people. The EPA odour performance criteria are therefore based on considerations of risk of odour impact rather than on differences in odour acceptability between urban and rural areas.

Odour performance goals for various population densities are outlined in **Table 7.5** of the Approved Methods for Modelling (EPA, 2016), and summarised in **Table 3-4**. They are expressed as the 99th percentile value, nose response time average (approximately one second).

Table 3-4: OEH Odour Performance Criteria vs. Population Density

Population of Affected Community	**Odour Performance Criteria - OU(1)**
Urban area (> 2000)	2.0
500 – 2000	3.0
125 – 500	4.0
30 – 125	5.0
10-30	6.0
Single residence (< 2)	7.0

(1) Odour concentration over a nose response time averaging period (1 second), with permissible frequencies of occurrence at 99th percentile for Level 2 assessments

For this assessment, a conservative odour performance criterion of 2 OU has been adopted.

3.5 POEO (Clean Air) Regulation

The statutory framework for managing air emissions in NSW is provided in the Protection of the Environment Operations (POEO) Act[2] 1997 and the primary regulations for air quality made under the POEO Act are:

- Protection of the Environment Operations (Clean Air) Regulation 2010[3].
- Protection of the Environment Operations (General) Regulation 2009[4].

The project will comply with the POEO regulations as follows:

- As a scheduled activity under the POEO regulations, the project will operate under an environment protection licence (EPL) issued by the NSW EPA and will comply with requirements including emission limits, monitoring and pollution reduction programmes (PRPs);
- Best management practice (BMP) is a guiding principle in the POEO Act, and requires that all necessary practicable means are used to prevent or minimise air pollution in NSW. A BMP determination has been undertaken for emissions from the project and is outlined in **Section 7.3.3**, an demonstrates that the emission control measures designed for the project meet or exceed accepted best practice;
- Hume Coal will manage all aspects of its proposed operations so that offensive odour does not cause ‘harm to’ or involve ‘interfering unreasonably’ with the comfort or repose of any person outside the premises. Odour management measures will be outlined in the Air Quality Management Plan, with reference to ventilation shaft emissions and spontaneous combustion management; and
- No open burning will be performed onsite.

[2] http://www.legislation.nsw.gov.au/maintop/view/inforce/act+156+1997+cd+0+N
[3] http://www.legislation.nsw.gov.au/maintop/view/inforce/subordleg+428+2010+cd+0+N
[4] http://www.legislation.nsw.gov.au/maintop/view/inforce/subordleg+211+2009+cd+0+N

4. CLIMATE AND METEOROLOGY

Meteorological mechanisms affect the generation, dispersion, transformation and eventual removal of pollutants from the atmosphere. Dust generation rates are particularly dependent on wind energy, the moisture budget, which is a function of rainfall and evaporation rates, material movement, and activity.

The extent to which pollution will accumulate or disperse in the atmosphere is dependent on the degree of thermal and mechanical turbulence within the boundary layer (the general term for the layer of the atmosphere adjacent to the earth's surface) and other factors such as wind speed and direction.

Thermal turbulence is driven by incoming solar radiation and surface heating during the daylight hours. Mechanical turbulence is associated with wind speed, in combination with the surface roughness of the surrounding area. The stability of the atmosphere increases with a decrease in thermal and mechanical turbulence.

Air pollutant dispersion consists of vertical and horizontal components of motion. Vertical motion is defined by the stability of the atmosphere (e.g. a stable atmosphere has low vertical dispersion potential) and the depth of the surface-mixing layer (typically defined as the vertical distance between the earth's surface and a temperature inversion during the day).

The horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field (i.e. wind speed and direction). The wind speed determines both the distance of downwind transport and the rate of dilution as a result of plume 'stretching'. The wind direction, and the variability in wind direction, determines the general path pollutants will follow and the horizontal spread of the plume.

Airborne particulate concentration levels, therefore, fluctuate in response to changes in atmospheric stability, mixing depth and winds (Oke, 2003; Sturman and Tapper, 2006; Seinfeld and Pandis, 2006).

In order to characterise the dispersion meteorology of the project region, long-term climate records, time-resolved meteorological monitoring data and meteorological modelling for the region was drawn upon, as documented in the following sections.

4.1 Climate Records and Meteorological Data

This air quality impact assessment represents a Level 2 assessment in accordance with the NSW EPA Approved Methods for Modelling. The NSW EPA specifies in Section 4.1 of the Approved Methods for Modelling that for Level 2 assessments, meteorological data representative of a site should be used in the absence of actual onsite observations. The data should cover a period of at least one year with a percentage completeness of at least 90%. Site representative data can be obtained from either a nearby meteorological monitoring station or synthetically generated using the CSIRO prognostic meteorological model The Air Pollution Model (TAPM).

The installation of a meteorological monitoring station was commissioned by Hume Coal in March 2012 at a site in the south of the project area, approximately 8.1km south of the surface infrastructure area. At the time of commencement of dispersion modelling and data analysis for this assessment, the most complete continuous 12-month period of monitoring data was the 2013 calendar year. Data capture for 2014 in the dataset is below the 90% requirement of the NSW EPA due to instrumentation issues between June and September 2014, while 2015 was not yet a complete calendar year. Placement of this weather station was undertaken prior to the location of the surface infrastructure area being determined and the relevant properties acquired.

In addition to Hume Coal's meteorological station, monitoring data was also collated from the following monitoring stations:

- Bureau of Meteorology (BoM) automatic weather station (AWS) at Moss Vale, approximately 11.5km east-southeast of the surface infrastructure area;

- BoM long-term climate station at Moss Vale (Hoskins Street), approximately 8.3km southeast of the surface infrastructure area; and
- Boral-owned meteorological station at the Berrima Cement Works, approximately 4.5km east-southeast of the surface infrastructure area.

Finally, a second weather station was commissioned by Hume Coal and installed in the vicinity of the proposed product coal stockpiling area in October 2015 (Hume 2). Data from the Hume 2 station was compared to data recorded by the southern Hume Coal meteorological station (Hume 1) to illustrate similarities across the two locations. Concurrent data recorded between October 2015 and July 2016 from the Hume 1, Hume 2, Boral's Berrima Cement Works and BoM Moss Vale weather stations was collated, with period wind roses generated (**Figure 4-1**).

The following points are noted from **Figure 4-1**:

- The general wind direction profile recorded at all four monitoring stations is similar, with dominant air flow from the northeast, southeast and west evident;
- The Hume 1 station typically records higher wind speeds than the concurrent wind speed recorded at the Hume 2 station;
- The BoM Moss Vale station records higher wind speeds than all other analysed sites.

It is considered that the comparison of concurrent wind speed and direction observations from the Hume 1, Hume 2, Berrima Cement Works and BoM Moss Vale AWS monitoring stations indicates that data from the Hume 1 weather station is representative of the conditions likely to be experienced in the northern area of the project area. Further discussion on the selection of meteorological data for modelling purposes is presented in **Section 4.3.3**.

The monitoring stations from which the data has been obtained in relation to the surface infrastructure area are illustrated in **Figure 4-2.**

A summary of meteorological parameters recorded at the four continuous monitoring stations is presented in **Table 4-1**. The BoM Moss Vale climate station only records measurements at 9am and 3pm and will be used to detail long term trends in climatic conditions.

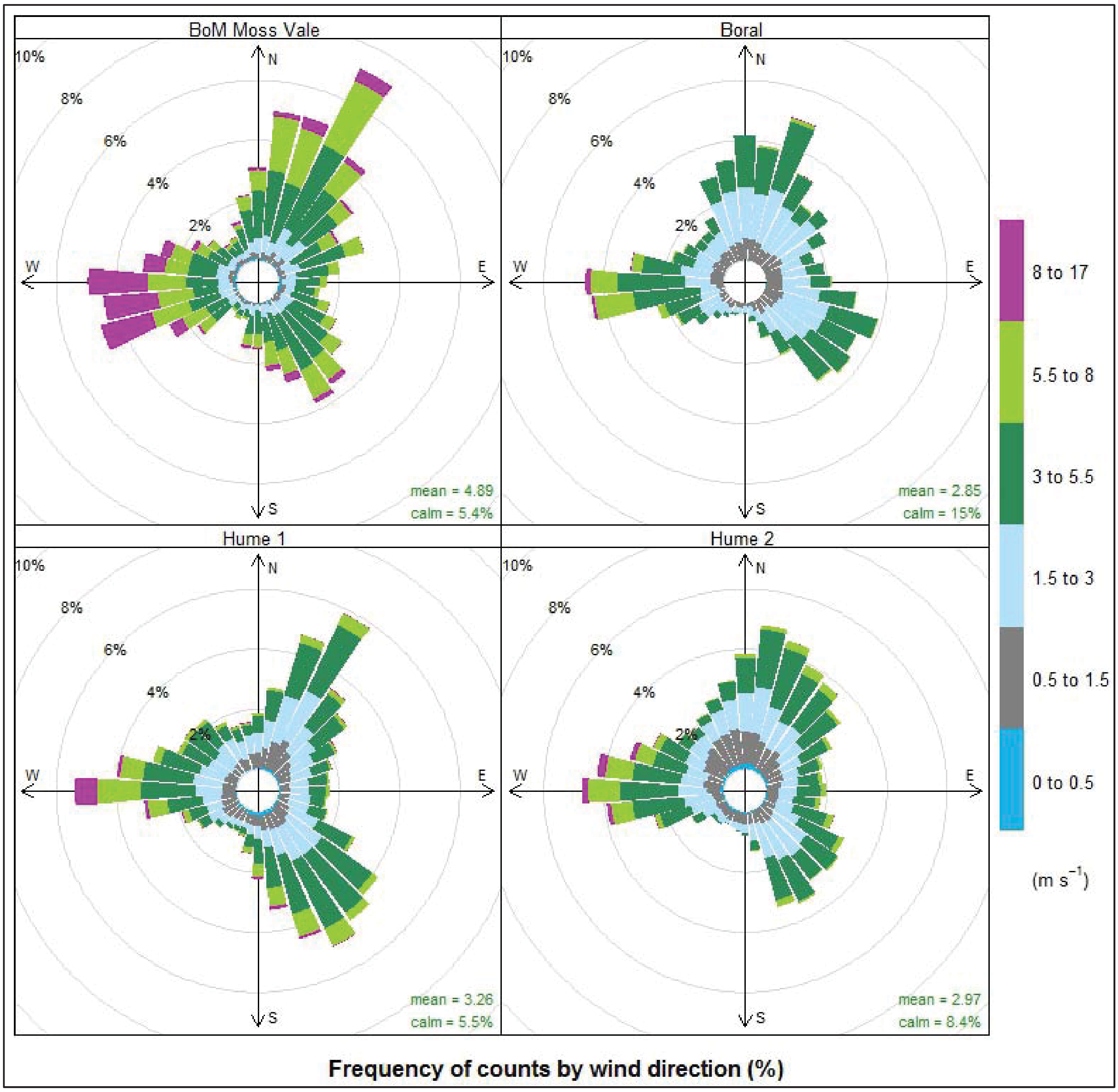


Figure 4-1: Comparison of concurrent wind data – October 2015 to July 2016

Location of local meteorological and air quality stations

Hume Coal Project

Air Quality Impact And Greenhouse Gas Assessment

Figure 4.2

Table 4-1: Meteorological parameters by monitoring station

Parameter	Hume Station 1	Hume Station 2	BoM Moss Vale	Boral Berrima Cement
Wind Speed and Direction	✓	✓	✓	✓
Air Temperature (2m above ground)	✓	✓		✓
Air Temperature (10m above ground)	✓	✓	✓	✓
Relative Humidity	✓	✓	✓	✓
Solar Radiation				✓
Rainfall	✓	✓	✓	✓
Cloud Cover			✓	

Of the reviewed monitoring locations, the BoM Moss Vale AWS returns the longest period of continuous monitoring data. Wind roses of wind speed and direction have been generated from recorded wind speed and direction data at the BoM Moss Vale AWS for the five year period between 2010 and 2014 inclusive. Wind rose diagrams illustrate the distribution of wind direction and speed, with the presented direction referring to the direction the wind is blowing from. These figures are presented within **Appendix 1** and indicate that minimal inter-annual variation in winds occurred across this period at Moss Vale.

As detailed above, the most complete 12-month period of monitoring data from the Hume 1 station at the commencement of the modelling assessment was the 2013 calendar year. On the basis of illustrated inter-annual consistency in recorded wind speed and direction at the BoM Moss Vale AWS, data recorded during the 2013 calendar year is the focus of this assessment.

4.2 Meteorological Modelling

To supplement the above meteorological observation datasets, the CSIRO meteorological model TAPM was used to generate parameters not routinely measured, specifically the vertical temperature and wind profile, and to substitute any data gaps in the monitoring datasets.

TAPM was configured for each monitoring station and run in accordance with Section 4.5 of the Approved Methods for Modelling (EPA, 2016), with the following refinements:

- Modelling to 300 m grid cell resolution (beyond 1 km resolution specified).
- Inclusion of high resolution (90 m) regional topography (improvement over default 250 m resolution data).

The TAPM-generated vertical temperature profile at each monitoring station for every hour was adjusted by first substituting the predicted 10 m above ground temperature with hourly recorded temperature at 10 m. The vertical layer temperature difference predicted by TAPM was then adjusted relative to the 10 m observation temperature for each hour. This modified vertical profile was used in combination with the ambient air temperature throughout the day to calculate convective mixing heights between sunrise and sunset (see **Section 4.7**).

4.3 Wind Speed and Direction

4.3.1 Prevailing Annual Wind Regime

Wind rose diagrams showing wind speed and direction data recorded at the Hume 1, BoM Moss Vale AWS and Boral's Berrima Cement Works monitoring stations during 2013 is presented in **Figure 4-3**. The following points are noted with regard to the presented wind profiles:

- The dominant wind is westerly which is evident at all three monitoring stations;

- Air flow from the north to east quadrant also occurs at all three stations, however the alignment is closer north-northeast at the Hume 1 and BoM Moss Vale AWS locations and north at Boral's Berrima Cement Works station;
- Less defined air flow from the southeast is also evident across all three locations;
- Wind speeds are greater at the BoM Moss Vale AWS than the Hume 1 and Boral stations;
- Highest wind speeds are greatest from the westerly quadrant at all three locations.

A time series plot of hourly-varying 1-hour average wind speed is illustrated in **Figure 4-4**.

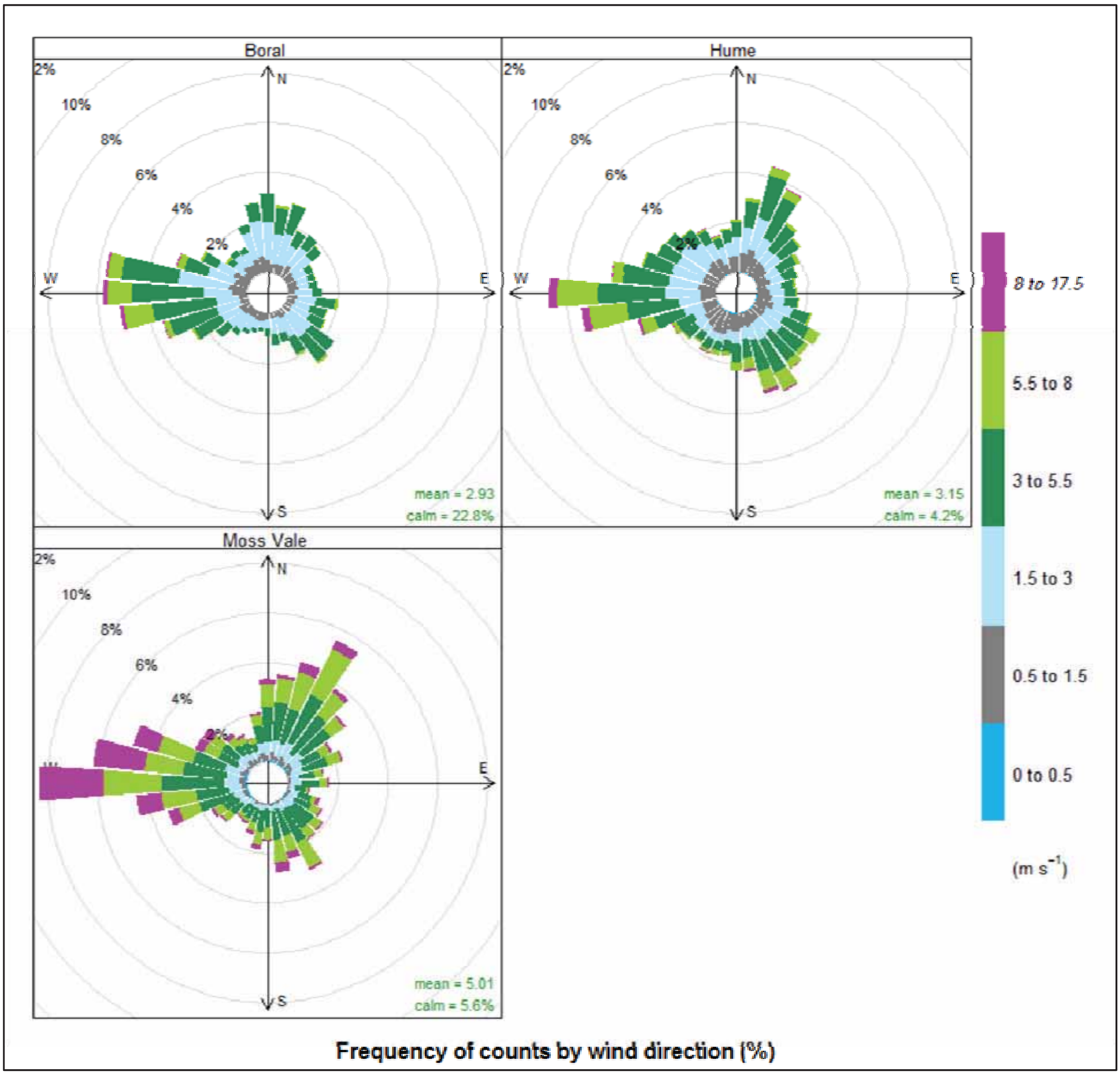


Figure 4-3: Annual wind rose – 2013 – Hume 1, BoM Moss Vale AWS and Boral Berrima monitoring stations

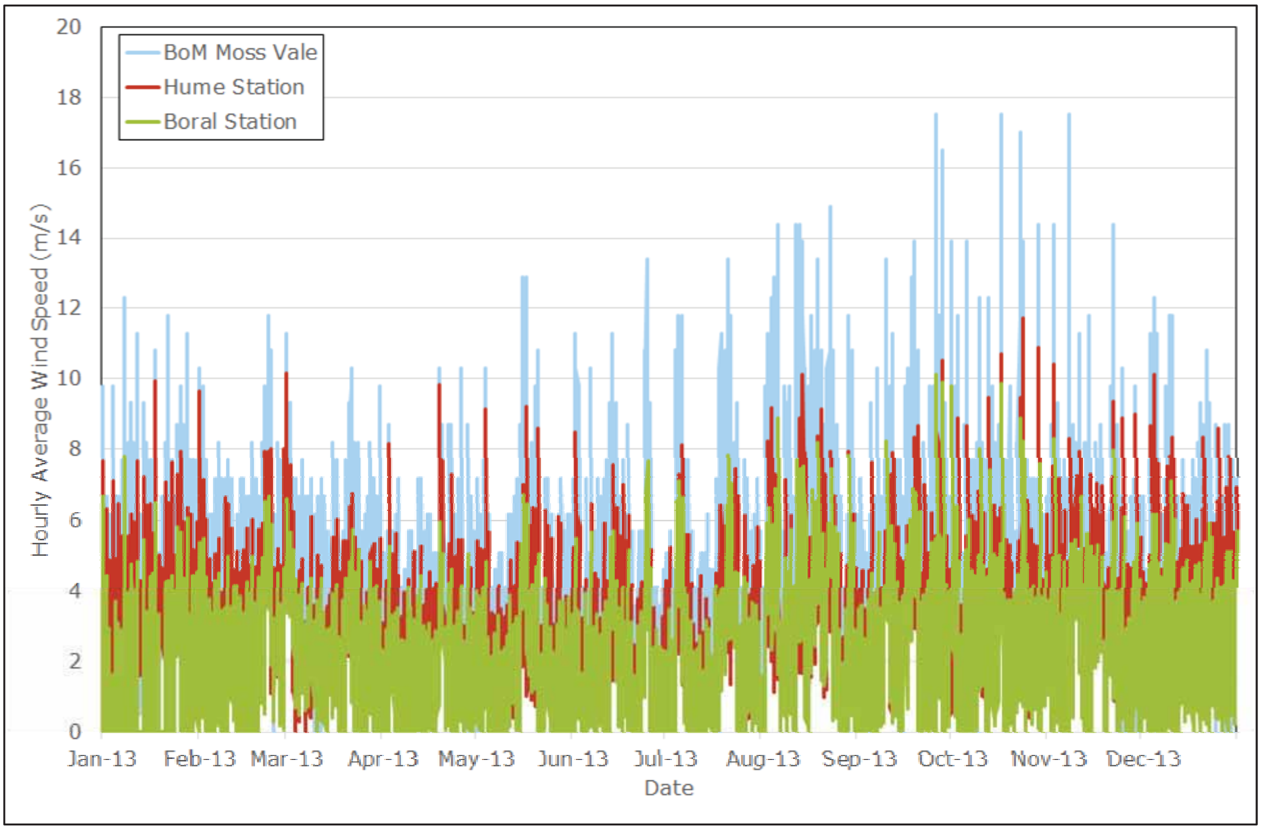


Figure 4-4: Time series of hourly average wind speed at local monitoring locations - 2013

Each 2013 meteorological monitoring dataset contains 12 months of 1-hour average observations derived from sub-hourly monitoring observations (10-minute data at Hume 1 and BoM Moss Vale AWS, 15-minute data at Boral's Berrima Cement Works).

A summary of hourly average and peak hourly gust wind speed conditions from the three monitoring stations is presented in **Table 4-2**. It is noted that during 2013, the data logger at the Hume 1 monitoring station was not configured to return peak gusts per 10-minute monitoring period. As a surrogate, the relationship between hourly average and peak gust at the Boral Berrima site was analysed, with the following linear relationship equation derived:

$$\textit{hourly gust} = 1.574 * \textit{hourly average wind speed} + 0.6722$$

To derive hourly peak gust data for the Hume 1 2013 dataset, the above equation was applied to each hourly average wind speed. Gust conditions for each hour of the Hume 1 and BoM Moss Vale datasets were used in the estimation of wind erosion from stockpiles (see **Section 7**).

Table 4-2: Summary of average and peak wind speed conditions by monitoring station - 2013

Parameter	Hume 1		BoM Moss Vale AWS		Boral Berrima Cement	
	m/s	km/h	m/s	km/h	m/s	km/h
Average Wind Speed	3.2	11.5	5.0	18.0	2.9	10.4
Maximum 1-hour Average Wind Speed	11.7	42.1	17.5	63.0	10.1	36.4
Average Gust	5.5	19.8	6.7	24.1	4.1	14.8
Maximum Gust	19.1	68.8	27.3	98.3	18.2	65.7
Frequency of Calm Conditions (%)	4.2		5.6		22.8	

4.3.2 Seasonal and Diurnal Wind Regime

Seasonal and diurnal (dividing the day into night and day) wind roses for the three meteorological monitoring datasets are presented within **Appendix 1**.

Seasonal variation in wind speed and direction is evident in the recorded data at all three monitoring stations. Wind speeds are greatest during the winter and spring months. The westerly air flow evident at all three sites is most dominant between autumn and spring, while north-easterly air flow is most common during the summer months.

Diurnal variation is most notable in recorded wind speed within all three monitoring datasets. The recorded wind speeds at each site are notably higher during the daylight hours. The westerly component is most dominant during the daylight hours, however is still evident during the night.

4.3.3 Data selection for modelling

This air quality impact assessment involves the prediction of ground level concentrations of particulate matter and gaseous pollutants emitted by the proposed project through the use of an appropriate atmospheric dispersion model. The AMS/US-EPA regulatory model (AERMOD) has been adopted for this assessment (further discussion in **Section 8.1**).

Many of the particulate matter emission sources associated with the project are wind-dependant, including coal stockpiles, coal handling and transfer points. Emissions from such sources increase with wind speed. Consequently, the selection of meteorological input conditions for the dispersion modelling process is a key component of this study.

As demonstrated in the preceding sections, the wind direction experienced in the local area is relatively uniform based on the three meteorological monitoring stations analysed (BoM Moss Vale AWS, Hume 1 and Boral Berrima). However, there is spatial variance with regard to wind speed, in particular high wind speeds. This variance in wind speed will result in a variation in both particulate matter emission calculations and the dispersion predictions ground level concentrations in the surrounding environment depending on the input dataset applied.

To understand the implications of different wind speed data, emission calculations and atmospheric dispersion modelling has been undertaken using two meteorological monitoring datasets (i.e. two complete years of modelling):

- the 2013 Hume 1 monitoring dataset; and
- the 2013 BoM Moss Vale AWS monitoring dataset.

Justification for this approach is as follows:

- Data recorded at the BoM Moss Vale AWS is reflective of elevated wind conditions in the region due to a very exposed station siting (situated in an open paddock area with minimal surrounding trees or structures in the surrounding 500m). The BoM Moss Vale station provides a conservative monitoring dataset for the calculation of wind-dependant emissions from the project (e.g. stockpile wind erosion, material handling activities);
- As demonstrated in **Section 4.1**, the comparison of data recorded at the recently installed Hume 2 meteorological monitoring station (located at the proposed surface infrastructure area) with concurrent measurements at the Hume 1 station (located in the southern extent of project area) demonstrates that the Hume 1 station is representative of conditions in the northern section of the project area. The Hume 1 2013 meteorological dataset is therefore adopted as a more realistic (relative to the BoM Moss Vale dataset) representation of meteorological conditions at the project; and
- The use of two complete meteorological monitoring datasets in the dispersion modelling (rather than a single year as per the requirements of the Approved Methods for Modelling) widens the range of dispersion meteorological conditions against which to assess potential air quality impacts in the surrounding environment.

Detailed analysis of ambient temperature, atmospheric stability and mixing depth, within the 2013 Hume 1 and BoM Moss Vale AWS monitoring datasets is presented in the following sections.

4.4 Ambient Temperature

A time series plot of hourly average recorded temperature during 2013 at the three monitoring stations is illustrated in **Figure 4-5**. It can be seen that the recorded temperature is similar at all three stations throughout 2013.

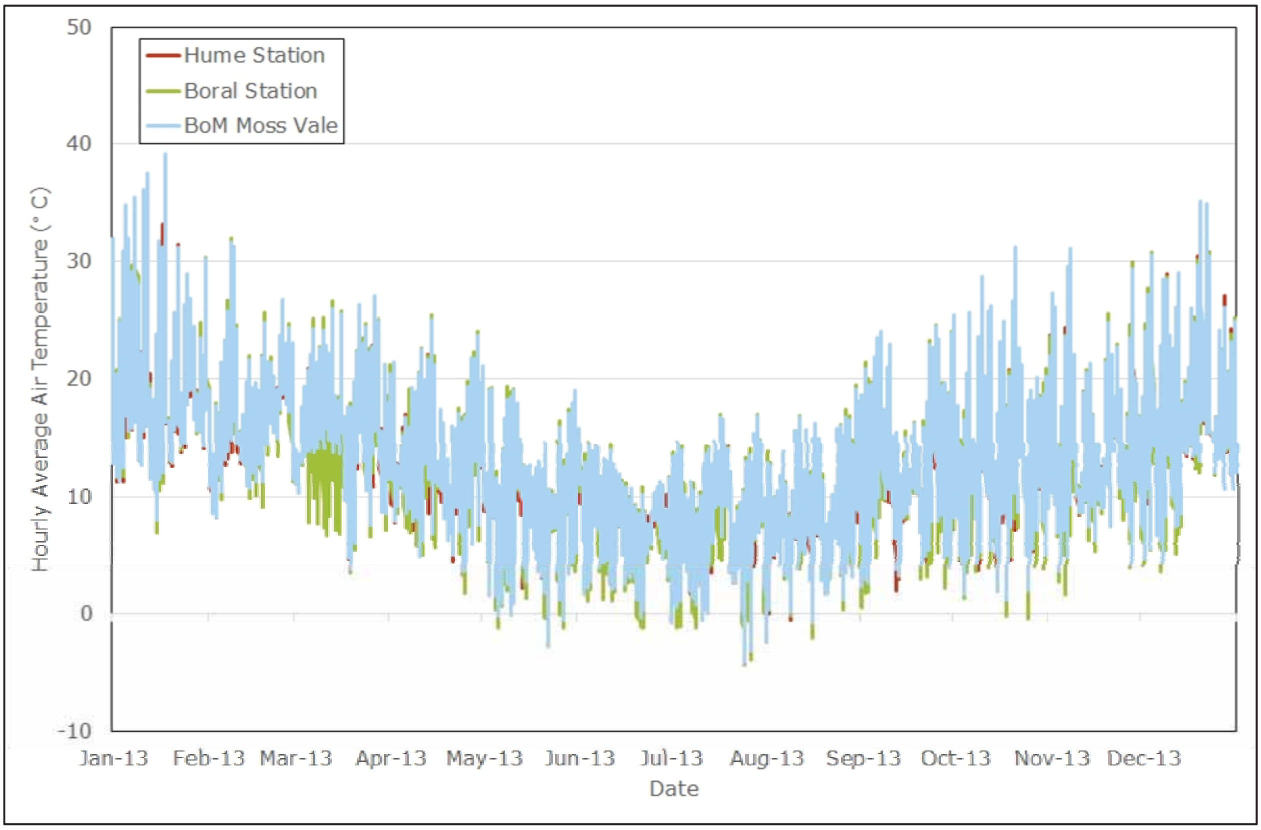
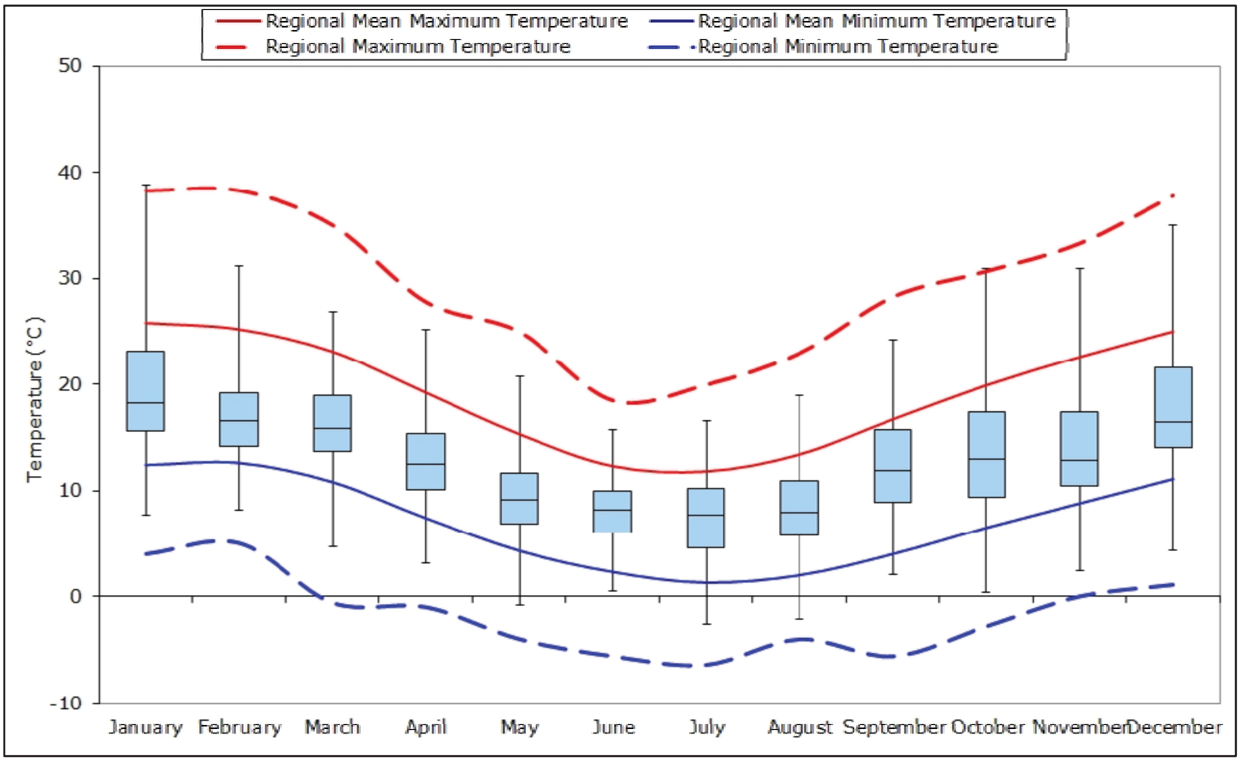


Figure 4-5: Time series plot of hourly average temperature – 2013 – Hume 1, BoM Moss Vale AWS and Boral Berrima stations

Based on the long term climate records from the BoM Moss Vale AWS climate station, monthly mean minimum temperatures are in the range of 1°C to 13°C, with mean maxima of 12°C to 26°C. Peaks occur during summer months with the highest temperatures typically being recorded between November and February. The lowest temperatures are usually experienced between June and August.

The 2013 Hume 1 and BoM Moss Vale AWS temperature datasets have been compared with the long-term trends recorded at the BoM Moss Vale climate station to determine the representativeness of these datasets. **Figure 4-6** presents the monthly variation in recorded temperature during 2013 compared with the recorded long-term climate station mean, minimum and maximum temperatures. There is good agreement between temperatures recorded during 2013 and the recorded historical trends, indicating that both datasets are representative of conditions likely to be experienced in the region.

Hume 1 Station



BoM Moss Vale

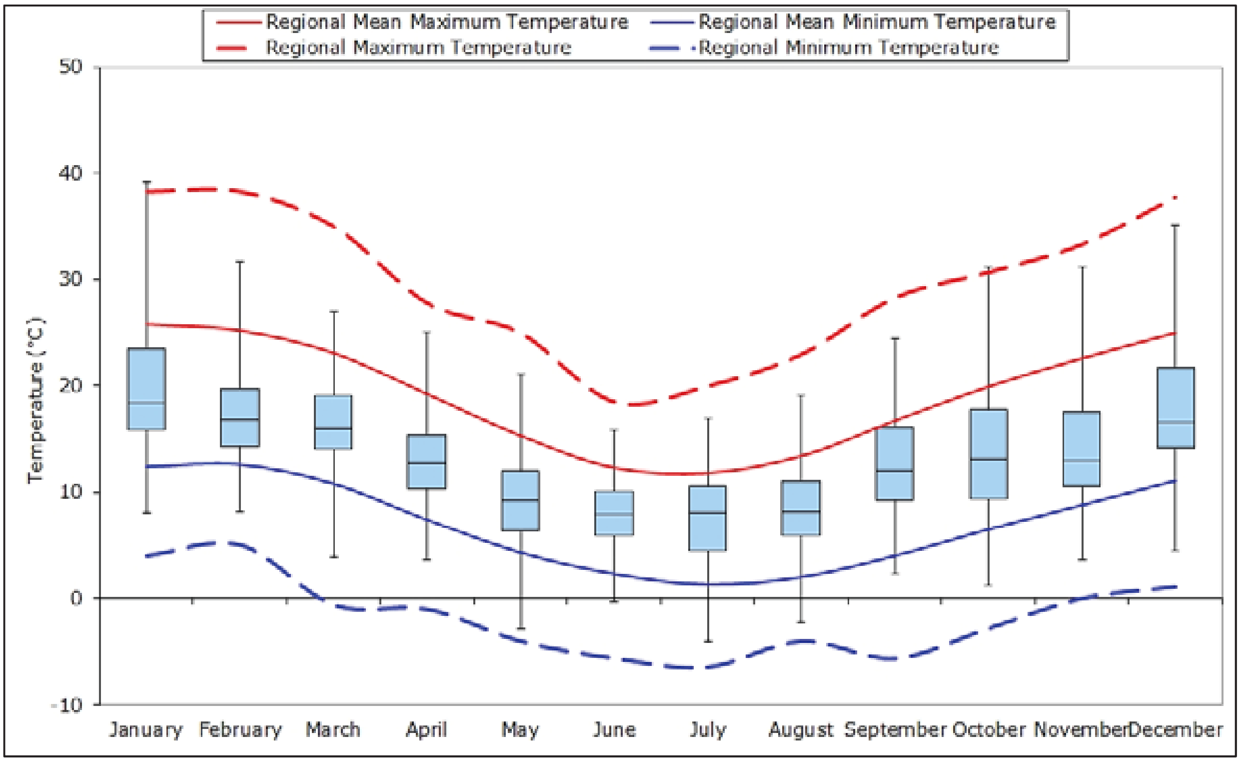


Figure 4-6: Temperature comparison between BoM Moss Vale (Hoskins Street) long term records and 2013 temperature monitoring datasets – Hume 1 Station (top) and BoM Moss Vale (bottom)

Note: 2013 data is illustrated by the 'box and whisker' indicators. Boxes indicate 25th, median and 75th percentile temperature values while upper and lower whiskers indicate maximum and minimum values. Maximum and minimum temperatures from long-term measurements at BoM Moss Vale climate station are depicted as line graphs.

4.5 Rainfall

Precipitation is important to air pollution studies since it impacts on dust generation potential and represents a removal mechanism for atmospheric pollutants.

Based on historical data recorded at the BoM Moss Vale climate station, the area is characterised by moderate to high rainfall, with a mean annual rainfall of approximately 970mm, and an annual rainfall range between 370mm and 1,850mm. Rainfall is quite evenly distributed throughout the year, with monthly average rainfall totals varying from slightly lower rainfall experienced between August and December than the remainder of the year. According to the long term records, an average of 120 rain days occurs per year.

To provide a conservative (upper bound) estimate of the airborne particulate matter concentrations occurring due to the project, wet deposition (removal of particles from the air by rainfall) was excluded from the dispersion modelling simulations undertaken in this study.

4.6 Atmospheric Stability

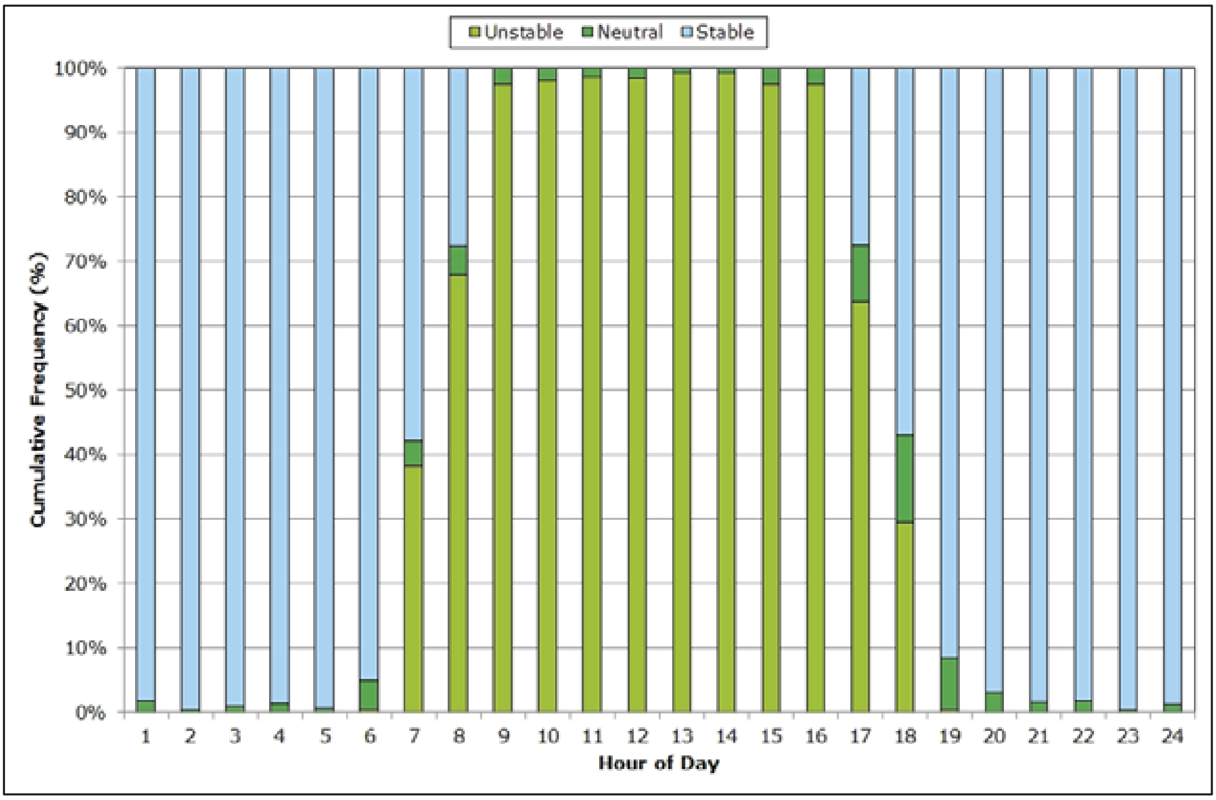
Atmospheric stability refers to the degree of turbulence or mixing that occurs in the atmosphere and is a controlling factor in the rate of atmospheric dispersion of pollutants.

The Monin-Obukhov length (L) provides a measure of the stability of the surface layer (i.e. the layer above the ground in which vertical variation of heat and momentum flux is negligible; typically about 10 % of the mixing height). Negative L values correspond to unstable atmospheric conditions, while positive L values correspond to stable atmospheric conditions. Very large positive or negative L values correspond to neutral atmospheric conditions.

Figure 4-7 illustrates the seasonal variation of atmospheric stability derived from the Monin-Obukhov length calculated by AERMET for both the Hume 1 and BoM Moss Vale AWS monitoring stations. Each diurnal profile presented illustrates that atmospheric instability increases during daylight hours as convective energy increases, whereas stable atmospheric conditions prevail during the night-time. Both profiles indicate that the potential for atmospheric dispersion of emissions would be greatest during day time hours and lowest during evening through to early morning hours.

It is noted that there is a higher amount of stable conditions within the Hume 1 monitoring station dataset relative to the BoM Moss Vale AWS monitoring station dataset due to the lower wind speeds (i.e. turbulence) in the Hume 1 dataset. While the higher wind speeds in the BoM Moss Vale AWS dataset has higher potential for wind-generated emissions (e.g erosion from stockpiles), the Hume 1 station dataset has a lower potential for pollution dispersion.

Hume 1 Station



BoM Moss Vale

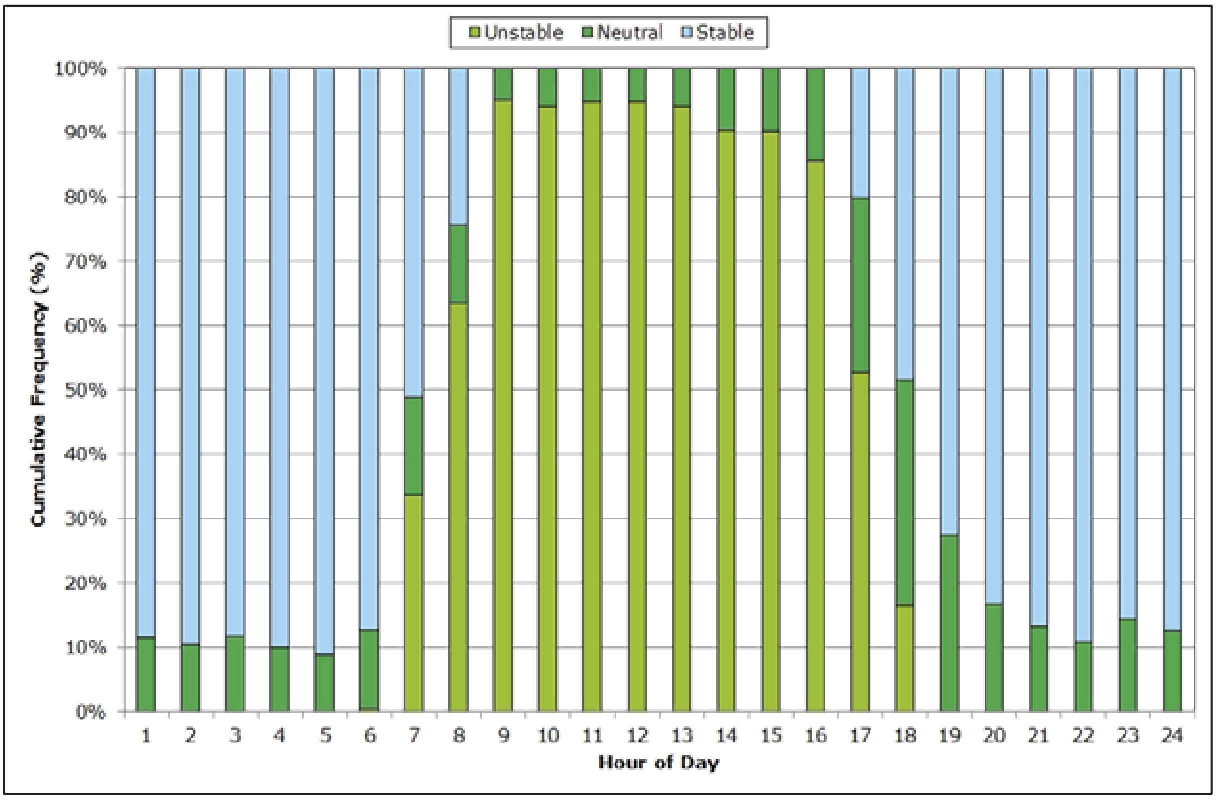


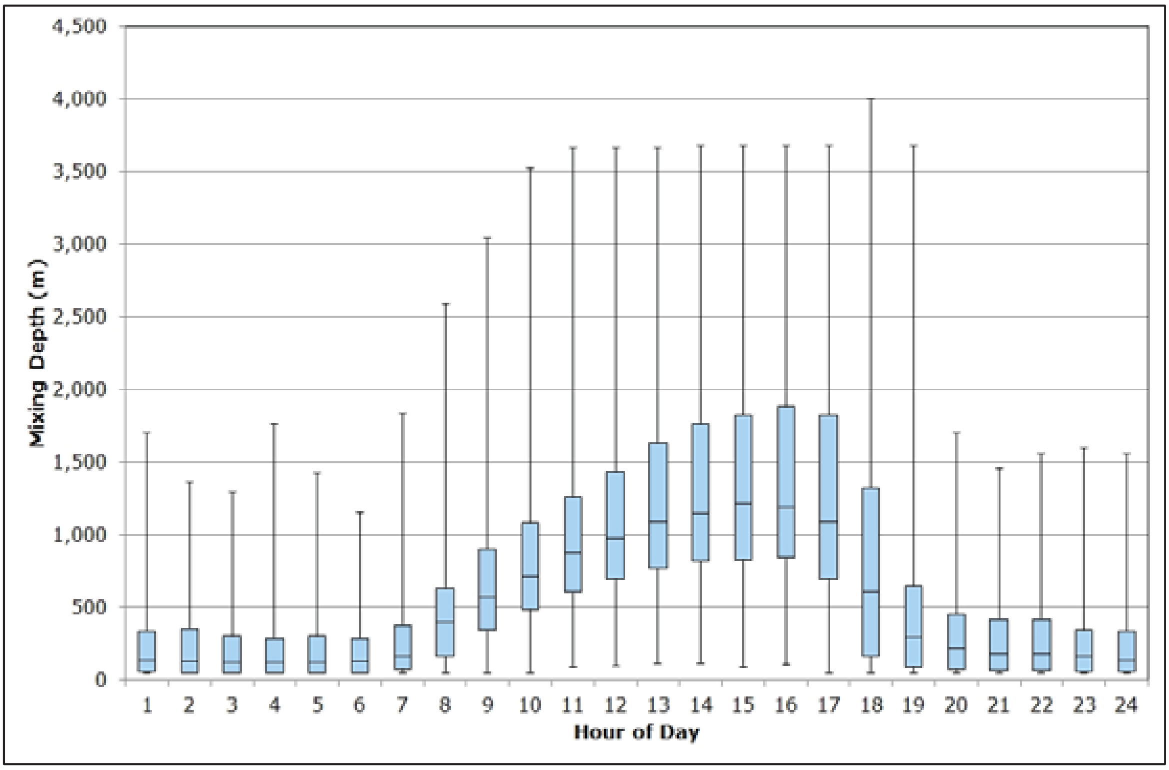
Figure 4-7: AERMET-Calculated Diurnal Variation in Atmospheric Stability– Hume 1 Station (top) and BoM Moss Vale AWS (bottom)

4.7 Mixing Depth

Hourly-varying atmospheric boundary layer depths were generated for each monitoring dataset by AERMET, the meteorological processor for the AERMOD dispersion model (see **Section 8.1** for further information), using a combination of surface observations from each station, sunrise and sunset times and adjusted TAPM-predicted upper air temperature profile.

The variation in average boundary layer depth by hour of the day for the Hume 1 and BoM Moss Vale AWS monitoring locations is illustrated in **Figure 4-8**. It can be seen that greater boundary layer depths are experienced during the day time hours, peaking in the mid to late afternoon. Higher day-time wind velocities and the onset of incoming solar radiation increase the amount of mechanical and convective turbulence in the atmosphere. As turbulence increases so too does the depth of the boundary layer, generally contributing to higher mixing depths and greater potential for atmospheric dispersion of pollutants.

Hume 1 Station



BoM Moss Vale

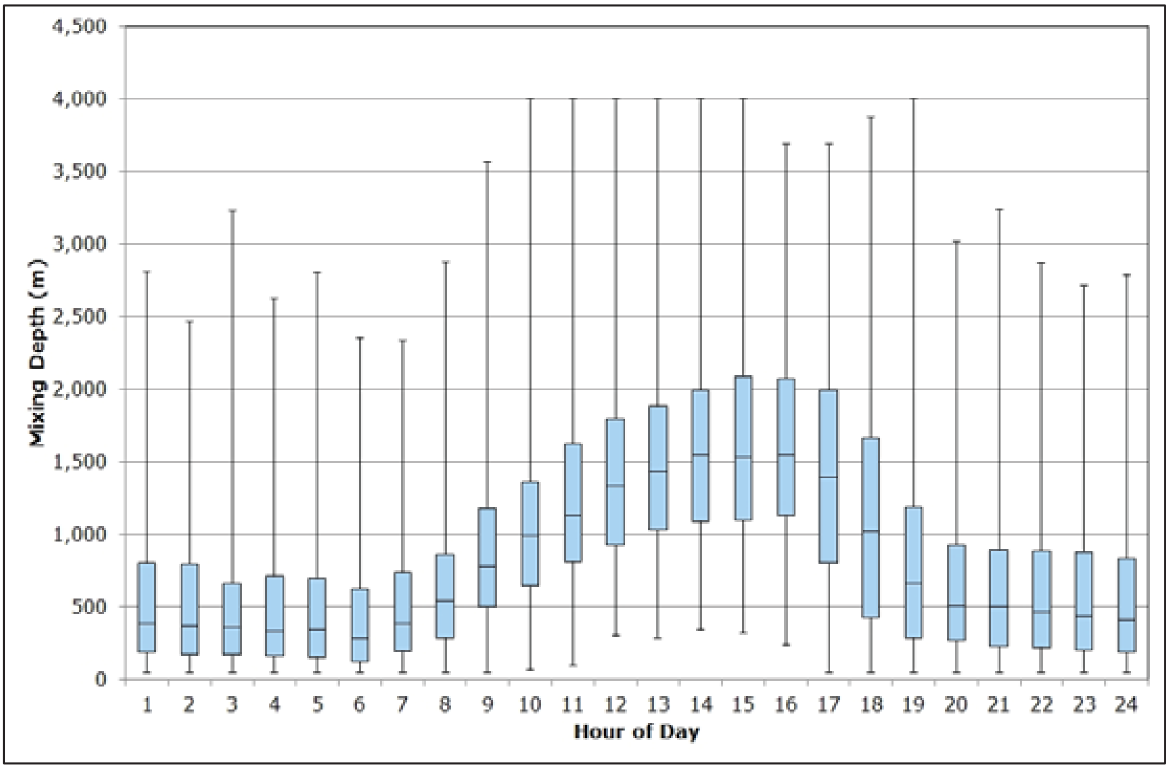


Figure 4-8: AERMET-Calculated Diurnal Variation in Mixing Depth– Hume 1 Station (top) and BoM Moss Vale AWS (bottom)

Note: Boxes indicate 25th, Median and 75th percentile of AERMET-calculated mixing height data while upper and lower whiskers indicate maximum and minimum values.

5. BASELINE AIR QUALITY ENVIRONMENT

5.1 Existing sources of air emissions

The quantification of the cumulative air pollution concentrations and the assessment of compliance with ambient air quality criteria necessitate the characterisation of baseline air quality. It is therefore pertinent to review existing sources of air pollutants in the local environment to be considered for cumulative assessment.

The National Pollutant Inventory (NPI) database lists the following sources of air pollution emissions in the surrounding 10km from the project:

- Berrima Cement Plant, New Berrima – clinker and cement manufacture;
- Inghams Feed Mill, Berrima – stock feed manufacture;
- Dux Manufacturing, Moss Vale – manufacture of gas, electric, heat pump and solar hot water heaters;
- Rail Corporation NSW Refuelling Facility, Moss Vale – rolling stock refuelling;
- Moss Vale Sewage Treatment Plant - sewage treatment, intermittent extended aeration; and
- Bowral Sewage Treatment Plant - sewage treatment utilising intermittent extended aeration and pasveer channel aeration systems.

The NSW EPA Environment Protection Licence (EPL) register lists the following activities within the surrounding 10km from the project:

- Berrima Colliery – underground coal mine (not currently operational, scheduled for closure)
- Omya Southern Limestone, Moss Vale – material processing facility;
- Southern regional livestock exchange, Moss Vale - Animal accommodation;
- Resource Recovery Centre, Moss Vale - waste recycling, collection and transfer facility; and
- Berrima Sewage Treatment Plant, New Berrima - Sewage treatment processing by small plants.

Finally, it is noted that a proposed shale quarry at New Berrima has received planning approval for development. It is understood that initial site preparation and exploration activities for this quarry are underway, however operational activities are yet to commence. In addition to the above existing and approved operations, it is considered that the following sources contribute to particulate matter emissions in the vicinity of the project:

- Dust entrainment due to vehicle movements along unsealed and sealed public roads;
- Petrol and diesel emission from vehicle movements along public roads;
- Wind generated dust from exposed areas within the surrounding region;
- Episodic emissions from local vegetation burning (e.g. grass and bushfires);
- Seasonal emissions from household wood burning fires.

More remote sources which contribute episodically to suspended particulates in the region include dust storms and bushfires. Whereas dust storms predominately contribute primary particulates from mechanical attrition, bushfires are a source of fine particulates including both primary particulates and secondary particulates formed by atmospheric gas to particle conversion processes.

In order to account for these existing sources of air pollution emissions in the cumulative assessment of project impacts, a combination of air quality monitoring datasets (**Section 5.2**) and publicly available air emissions data (see **Section** 6) have been utilised.

5.2 Monitoring Data Available for Baseline Air Quality Characterisation

5.2.1 Monitoring Stations

The following monitoring resources have been collated for this study:

- Hume-owned Tapered Element Oscillating Microbalance (TEOM), located approximately 8km south of the surface infrastructure area – referred to as TEOM1. Continuous concentrations of particulate matter (PM_{10} and $PM_{2.5}$) recorded;

- Boral's Berrima Cement Works Air Quality Monitoring station – one-in-six day 24-hour average concentrations of TSP and PM_{10}, located approximately 4.5km east of the surface infrastructure area;
- NSW OEH air quality monitoring stations, located at Bargo and Camden, approximately 33km and 62km to the northeast of the surface infrastructure area respectively. Continuous concentrations of particulate matter and gaseous pollutants recorded; and
- ACT Government air quality monitoring station at Monash, approximately 150km southwest of the surface infrastructure area. Continuous concentrations of particulate matter and gaseous pollutants recorded.

While spatially distant from the project area, the inclusion of data from the ACT Government Monash air quality monitoring station is considered useful to assist with understanding particulate matter concentrations beyond the influence of the Greater Sydney Metropolitan area and identify any regional elevated events.

The location of the Hume Coal and Boral-owned monitoring stations are illustrated in **Figure 4-2**.

5.2.2 TSP (Total Suspended Particulates)

Concentrations of TSP are recorded by Boral at the air quality monitoring station to the immediate east of the Berrima Cement Works on a one-in-six day basis via high volume air sampler (HVAS), in accordance with applicable environmental licence conditions. TSP data recorded since 2010 by Boral has been collated for use in this assessment in the absence of TSP monitoring at the project area. Annual average TSP concentrations recorded between 2010 and 2014 are presented in **Figure 5-1**.

It can be seen from the presented annual average TSP concentrations that all years are lower than the applicable NSW EPA assessment criterion of 90µg/m^3. The average TSP concentration is 37.6µg/m^3.

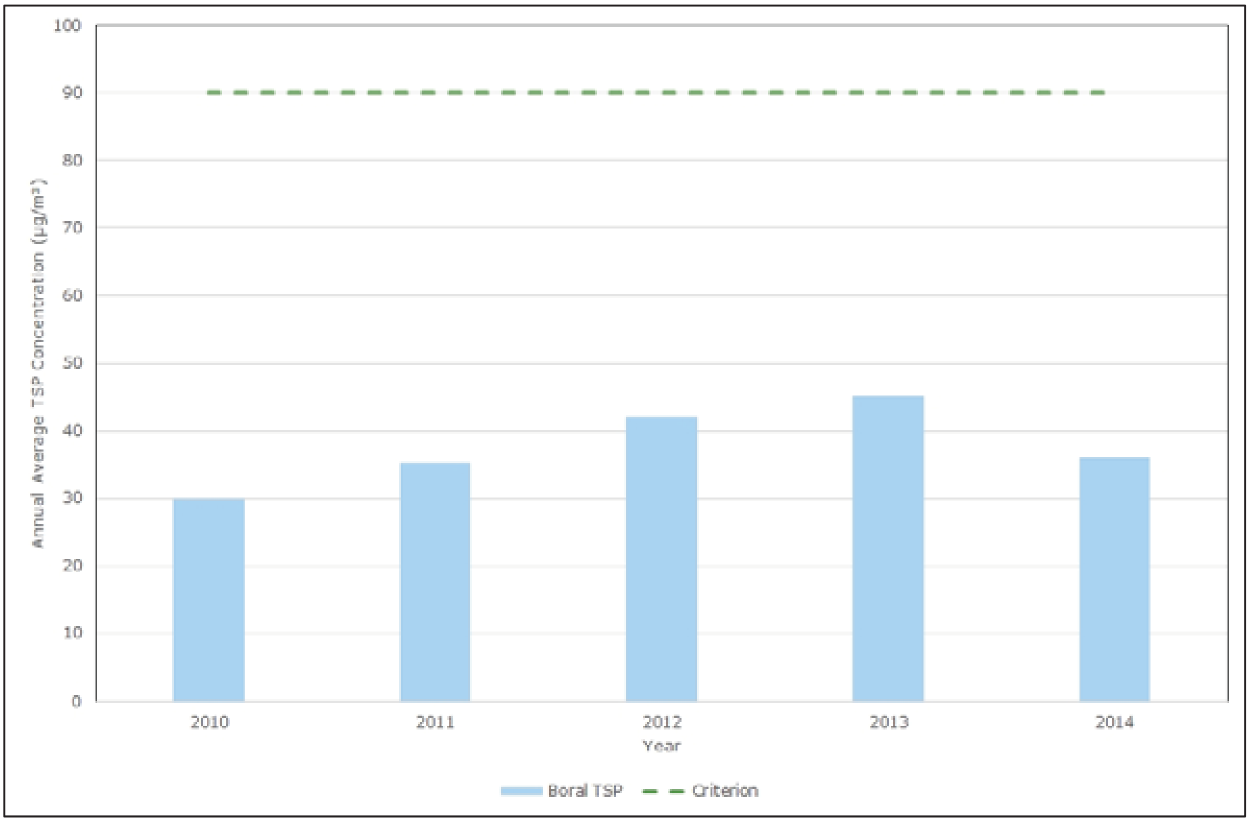


Figure 5-1: Annual average TSP concentrations – Boral's Berrima Cement Works monitoring station - 2010 to 2014

5.2.3 PM_{10}

Concentrations of PM_{10} are recorded by a number of sources both on a local and regional scale surrounding the project. A daily-varying time series plot of 24-hour average PM_{10} concentrations at the Hume TEOM1 station, Boral Berrima station, NSW OEH Camden and Bargo stations and ACT Government Monash station is illustrated in **Figure 5-2**.

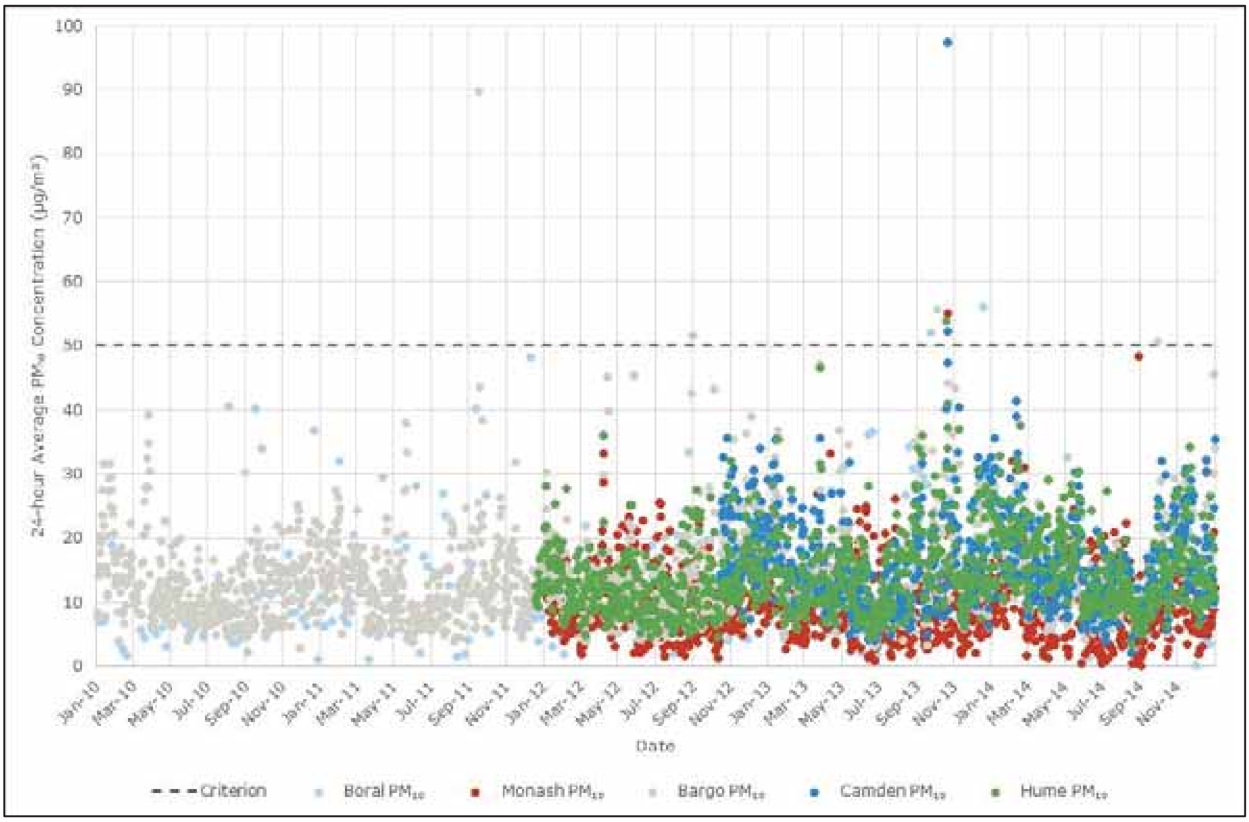


Figure 5-2: Time series plot of daily varying 24-hour average PM_{10} concentrations – January 2010 to December 2014

It can be seen that the recorded 24-hour average PM_{10} concentrations at all locations fluctuate throughout the period presented. Exceedances of the 24-hour average NSW EPA assessment criterion (50µg/m³) occur at all monitoring locations. The most notable grouping of recorded criteria exceedance is evident in late October/early November 2013, which was a period of extensive bushfires across NSW.

There is good agreement between the local stations (Hume TEOM1 and Boral Berrima) with stations located further afield (Bargo, Camden and Monash), indicating that the Hume TEOM1 PM_{10} dataset is appropriate for the representation of ambient concentrations in the local area and regional influences are notable to ambient particulate matter concentrations.

The frequency distribution of derived and recorded PM_{10} concentrations between January 2010 and December 2014 are illustrated in **Figure 5-3**. It can be seen that the majority of PM_{10} concentrations recorded at the Hume TEOM1 station are below 20µg/m³. The Boral Berrima station shows a higher occurrence of elevated PM_{10} concentrations (>30µg/m³) and is considered reflective of the localised influence of emissions from the cement works.

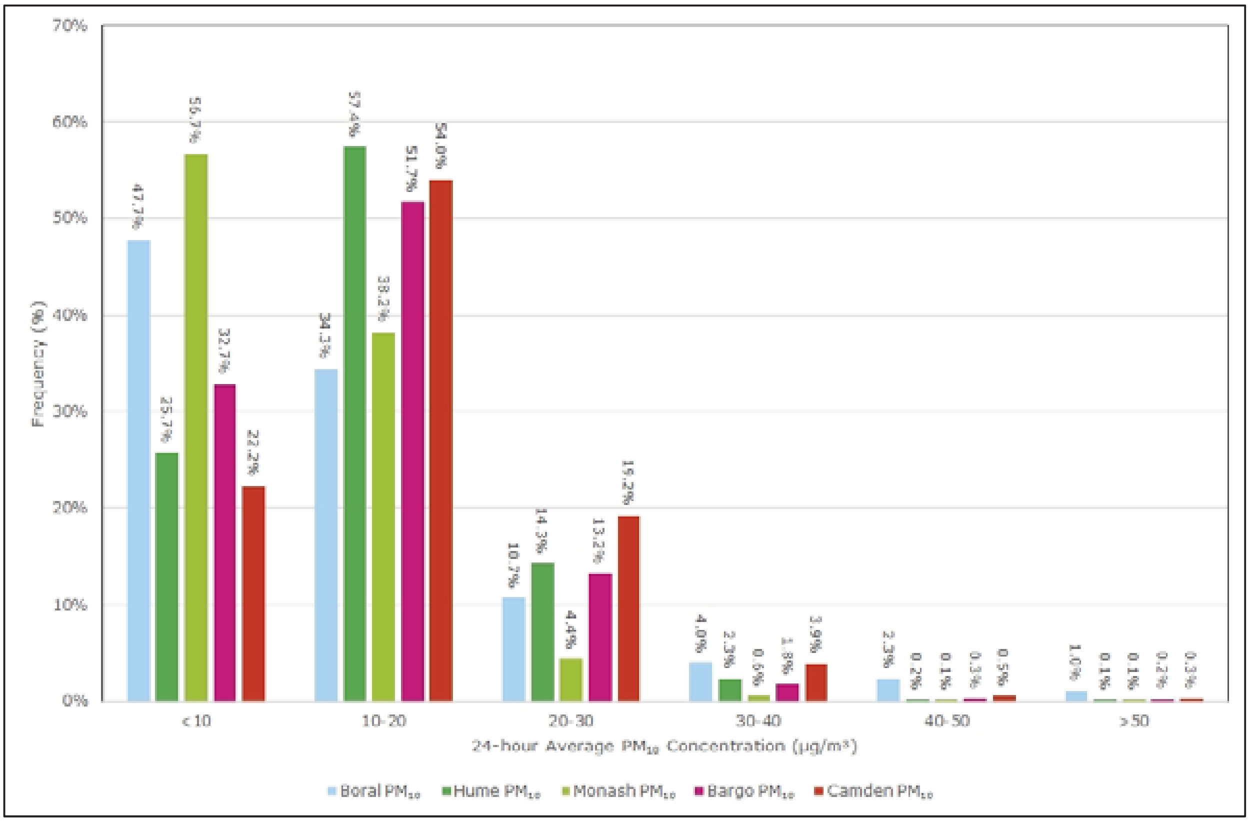


Figure 5-3: Frequency distribution of 24-hour average PM_{10} concentrations – January 2010 to December 2014

Annual average PM_{10} concentrations for 2010 through to 2014 are presented in **Figure 5-4**. For each year of data, it can be seen that the annual average PM_{10} concentrations at the Hume TEOM1 station are comparable with the concentrations recorded by the Boral Berrima, Bargo and Camden monitoring stations. The average concentrations for all years at all locations are below the NSW EPA assessment criterion of 25µg/m³. The average PM_{10} concentration across the Hume TEOM1 PM_{10} dataset is 14.3µg/m³.

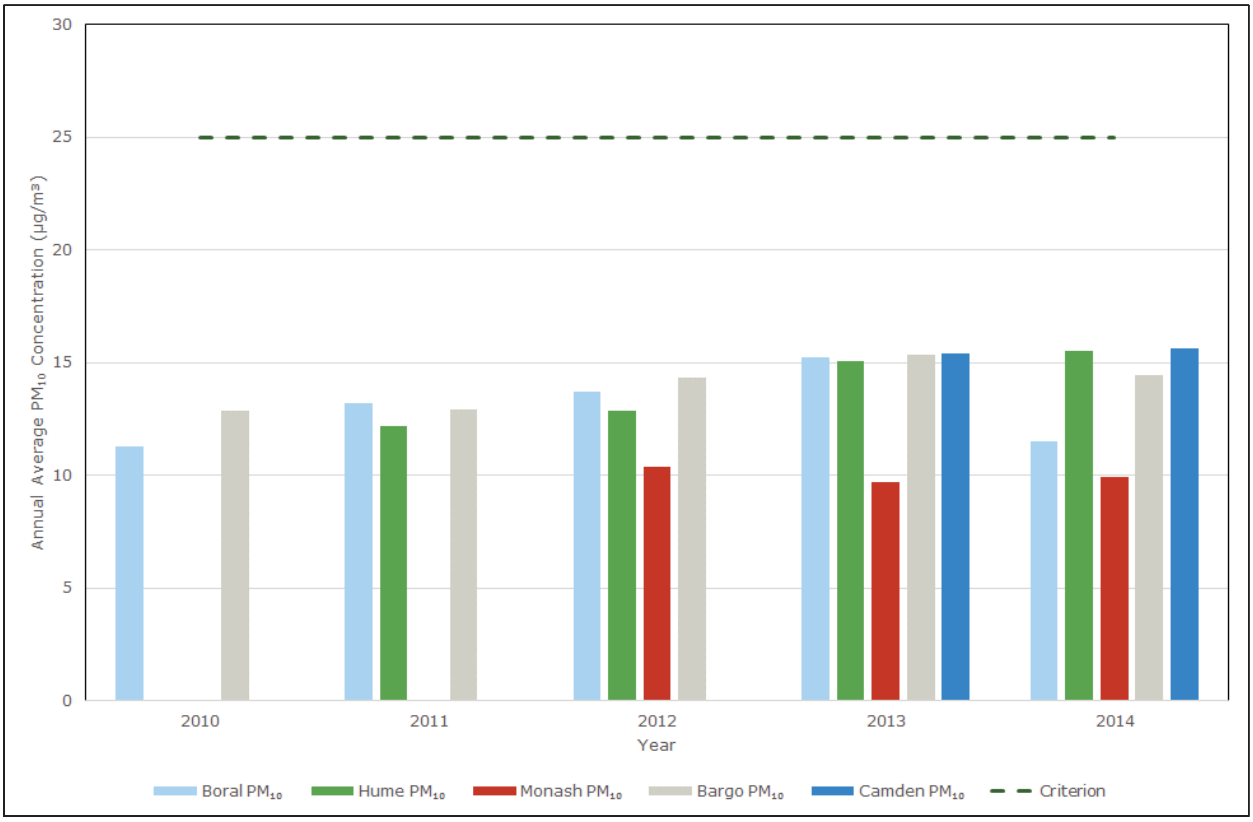


Figure 5-4: Annual average PM_{10} concentrations – local and regional monitoring locations - 2010 to 2014

5.2.4 $PM_{2.5}$

As stated previously, the Hume-owned TEOM1 records continuous concentrations of PM_{10} and $PM_{2.5}$. In analysing the $PM_{2.5}$ monitoring data, the average ratio of recorded $PM_{2.5}$ to corresponding PM_{10} concentrations by the TEOM1 station was calculated to be approximately 0.8. For the same period of time, the average ratio of $PM_{2.5}$ to PM_{10} across all NSW OEH monitoring stations where PM_{10} and $PM_{2.5}$ concentrations are co-recorded (including stations across the Sydney Metropolitan, Illawarra and Hunter Valley regions) ranged from 0.3 to 0.5. The Hume TEOM1 $PM_{2.5}/PM_{10}$ ratio is considered questionable for the following reasons:

- A high $PM_{2.5}/PM_{10}$ ratio is reflective of the influence of combustion sources to the monitoring station. While the Hume TEOM 1 station is located in proximity of some scattered rural residential properties, analysis of concurrent wind direction data from the Hume 1 station with recorded concentrations did not return any directional footprint of recorded concentrations (i.e. recorded concentrations were evenly distributed across all directions); and
- The ratio at the Hume TEOM1 station is much higher than the ratio recorded by NSW OEH monitoring stations in significantly more urbanised (Sydney Metropolitan) and mining-intensive (Hunter Valley) regions – locations with an abundance of combustion emission sources.

The issue of the elevated $PM_{2.5}/PM_{10}$ ratio for the Hume TEOM1 station was raised with the monitoring consultant and Hume Coal. In response, a second TEOM (TEOM2) was commissioned by Hume Coal and installed in the vicinity of the surface infrastructure area in July 2015. Analysis of data from TEOM2 showed agreement for both PM_{10} (across all stations) and $PM_{2.5}$ (for regional stations only, indicating that the original Hume TEOM1 $PM_{2.5}$ station concentrations are indeed erroneously high).

A range of further investigation studies on concurrent data recorded at TEOM1 and TEOM2 was conducted by Hume Coal and Ramboll Environ, including physically swapping the TEOM1 and TEOM2 stations to either location. These investigation studies highlighted the following:

- PM_{10} concentrations recorded by TEOM1 were comparable with concurrent TEOM2 and regional monitoring station data, indicating that the total incoming less than 10 micron sample was reliable; and
- The ratio of less than 2.5 micron to less than 10 micron sample was much higher at TEOM1 in comparison with concurrent TEOM2 and regional monitoring station data. This indicates that TEOM1 was apportioning too high of a percentage of the less than 10 micron total sample to the less than 2.5 micron internal recording channel.

Due to the uncertainty with the $PM_{2.5}/PM_{10}$ ratio recorded at the Hume TEOM1 station, the $PM_{2.5}/PM_{10}$ ratio of the closest NSW OEH $PM_{2.5}/PM_{10}$ monitoring station (Camden) has been adopted. The referencing of the $PM_{2.5}/PM_{10}$ ratio from the Camden dataset is considered appropriate and consistent with Section 4.2 of the Approved Methods for Modelling to conservatively derive existing $PM_{2.5}$ concentrations in the project area in the absence of a reliable onsite dataset.

The average $PM_{2.5}/PM_{10}$ ratio recorded at Camden between October 2012 (commencement of monitoring at station) and December 2014 was 0.41. The daily varying $PM_{2.5}/PM_{10}$ ratio was applied to the corresponding 24-hour average PM_{10} concentrations recorded at the Hume TEOM1 station to derive a background $PM_{2.5}$ dataset for the study area. A daily-varying time series plot of 24-hour average $PM_{2.5}$ concentrations at the Hume TEOM1 station (derived), NSW OEH and ACT Government Monash station is illustrated in **Figure 5-5**.

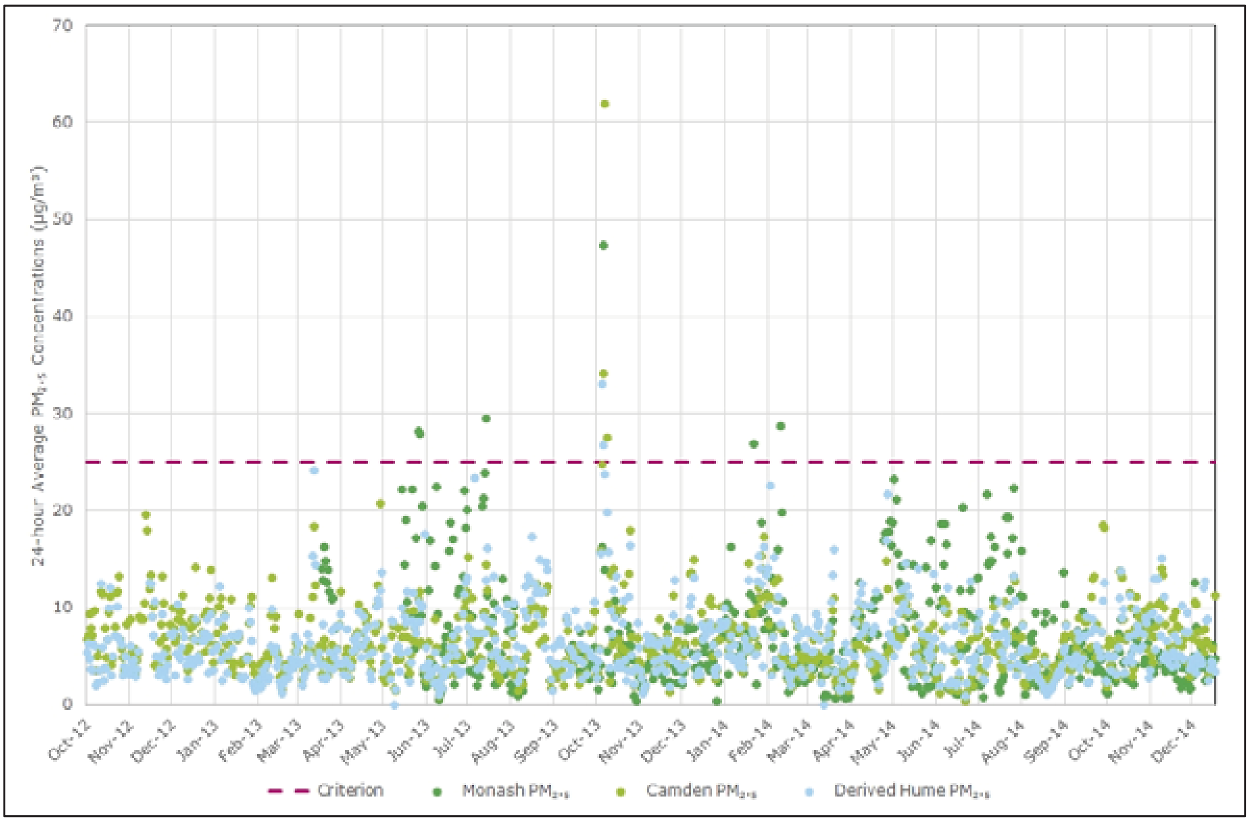


Figure 5-5: Time series plot of daily varying 24-hour average $PM_{2.5}$ concentrations – October 2012 to December 2014

Like the PM_{10} concentrations, it can be seen that the recorded 24-hour average $PM_{2.5}$ concentrations at all locations fluctuate throughout the period presented. Exceedances of the 24-hour average NSW EPA assessment criterion (25µg/m³) occur in all three datasets, with the most notable coinciding with the widespread October/November 2013 bushfire event that affected NSW.

The frequency distribution of derived and recorded $PM_{2.5}$ concentrations between December 2012 and December 2014 are illustrated in **Figure 5-6**. It can be seen that the majority of $PM_{2.5}$ concentrations at all locations are below 10µg/m³. It is noted that the Monash dataset experiences a higher frequency of greater than 12.5µg/m³ concentrations due to the proximity of that monitoring station to residential wood fire heater emission sources.

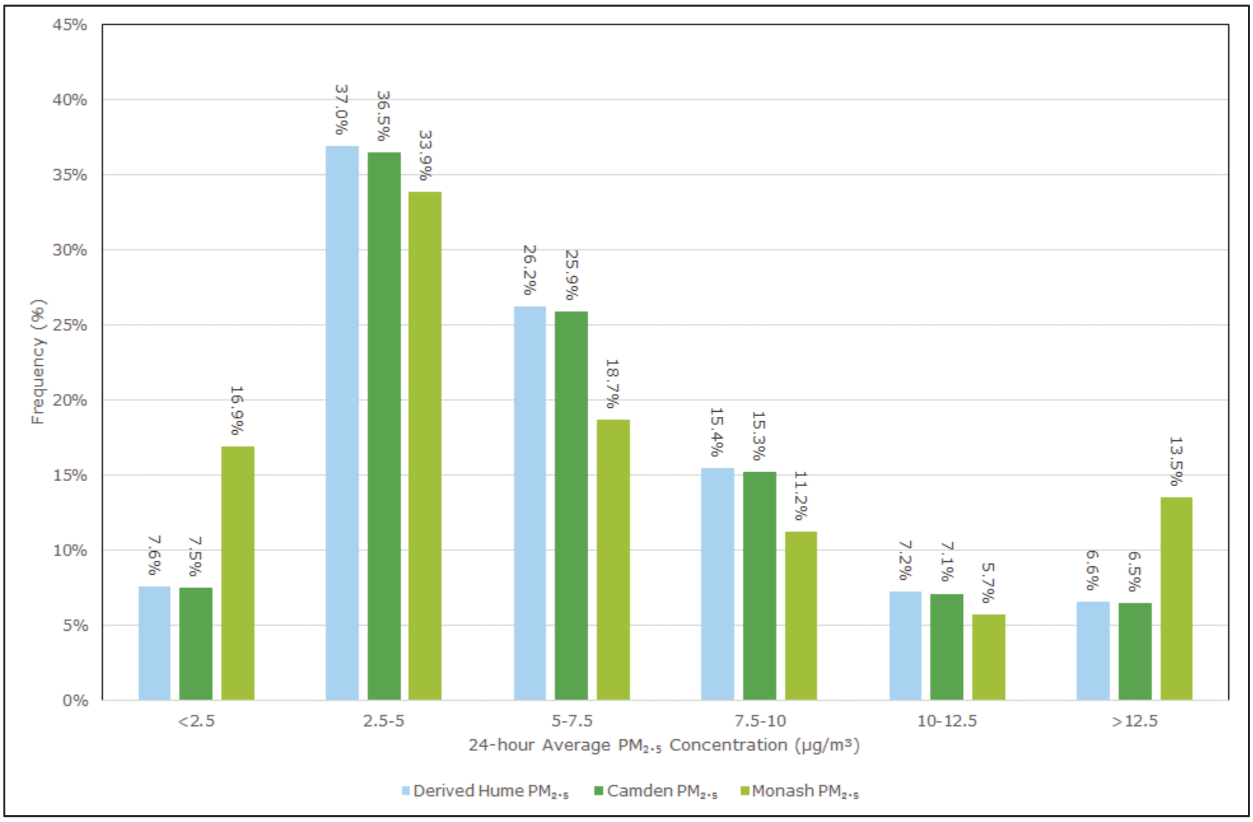


Figure 5-6: Frequency distribution of 24-hour average $PM_{2.5}$ concentrations – October 2012 to December 2014

Annual average $PM_{2.5}$ concentrations for 2013 and 2014 are presented in **Figure 5-7**. The 2013 datasets are higher than the 2014 datasets at all three locations, attributable to the extensive bushfire events that occurred in that year. The average concentrations for both years at all locations are below the NSW EPA assessment criterion of 8µg/m³. The average $PM_{2.5}$ concentration across the derived Hume $PM_{2.5}$ dataset is 6.3µg/m³.

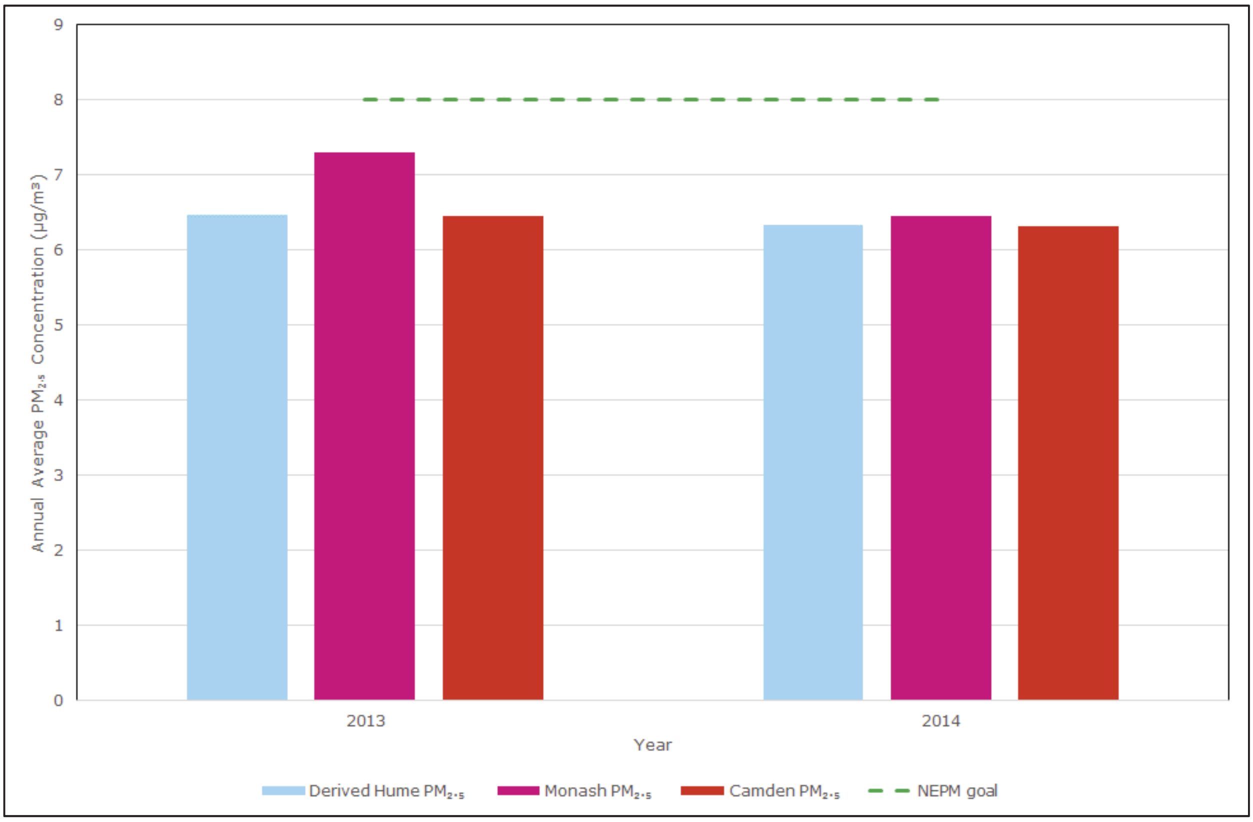


Figure 5-7: Annual average $PM_{2.5}$ concentrations – local and regional monitoring locations - 2013 to 2014

5.2.5 Dust Deposition

A network of dust deposition gauges were deployed in 2012 in the vicinity of the project area, progressively increasing from an initial four locations to ten locations. Annual average dust deposition levels are presented in **Figure 5-8**. Across all locations and years of monitoring, the recorded dust deposition levels are below the applicable NSW EPA criterion of 4g/m^2/month. The average across all sites between 2012 and 2015 is 0.8g/m^2/month.

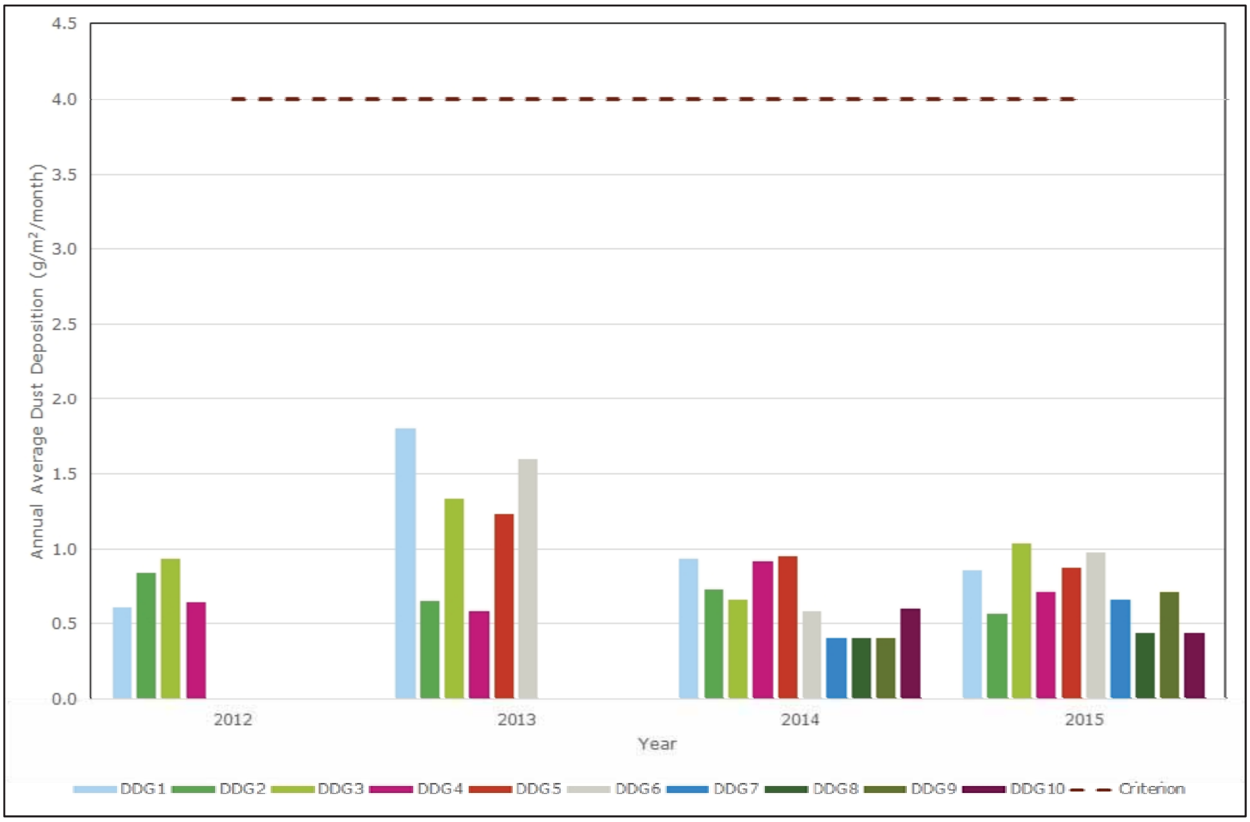


Figure 5-8: Annual average dust deposition levels - Project area - 2012 to 2015

5.2.6 Gaseous Air Pollutants

This assessment will quantify and assess impacts from nitrogen dioxide and individual VOC species benzene, ethylbenzene, toluene and xylenes.

Of the above pollutants, only NO_2 has a cumulative impact assessment criterion, with individual VOC species assessed as increment only. To convert predicted concentrations of oxides of nitrogen (NO_x) to NO_2, the ozone limiting method (OLM) prescribed in Section 8.1.2 of the NSW EPA Approved Methods for Modelling (EPA, 2016) has been applied. While further detail relating to this approach is presented in **Section 8**, the OLM requires background concentrations of NO_2 and ozone (O_3).

No monitoring of ambient gaseous pollutants is conducted in the immediate vicinity of the project. The closest available resource of such monitoring data is the NSW OEH Bargo station. A summary of maximum and average concentrations recorded since 2010 is presented in **Table 5-1**. Hourly varying NO_2 and O_3 concentrations, concurrent with the meteorological datasets (2013), have been adopted for this assessment.

Table 5-1: Summary of NO_2 and O_3 concentrations – NSW OEH Bargo monitoring station – 2010 to 2015

Year	NO_2 (µg/m³)		O_3 (µg/m³)	
	Max 1-hr	Average	Max 1-hr	Average
2010	111	9	216	41
2011	86	9	247	37
2012	83	9	178	37
2013	128	9	186	39
2014	68	9	206	41
2015	90	9	163	37
Average	**94**	**9**	**199**	**39**
Criterion	**246**	**62**	**214**	**-**

5.2.7 Ambient baseline air quality for cumulative impact assessment

Drawing on the information presented in the preceding sections, the ambient baseline air quality for cumulative impacts for the project comprise of the following:

- Annual average TSP - 37.6µg/m^3;
- 24-hour PM_{10} – the frequency distribution profile of all 24-hour average PM_{10} monitoring measurements from Hume, Boral, NSW OEH Bargo and Camden stations and ACT EPA Monash station;
- Annual average PM_{10} – 14.3µg/m^3;
- 24-hour $PM_{2.5}$ – the frequency distribution profile of all 24-hour average $PM_{2.5}$ monitoring measurements from Hume (derived), NSW OEH Camden station and ACT EPA Monash station;
- Annual average $PM_{2.5}$ – 6.3µg/m^3;
- Annual dust deposition – 0.8g/m^2/month;
- NO_2 – hourly varying concentrations recorded at NSW OEH Bargo station during 2013 for contemporaneous OLM analysis with modelling period predictions; and
- O_3 – hourly varying concentrations recorded at NSW OEH Bargo station during 2013 for contemporaneous OLM analysis with modelling period predictions.

6. NEIGHBOURING EMISSION SOURCES

As discussed in **Section 5.1**, a number of existing and approved industrial sources of air pollution emissions are located in the area surrounding the project. The location of these sources in relation to the project is illustrated in **Figure 6-1**.

Due to the spatial distribution of these industrial operations, the potential for cumulative impact at individual receptors may vary. The following sections detail emissions from neighbouring industrial operations and resultant predicted ground level concentrations in the surrounding environment.

6.1 Annual emissions

Emissions from the neighbouring industrial emission sources have been quantified based on the following resources:

- Boral's Berrima Cement Works - *Boral Cement Berrima Works Use of Solid Waste Derived Fuels in Kiln 6 - Air Quality Impact Assessment* (Air Quality Professionals, 2015) – point and fugitive emission sources;
- New Berrima Shale Quarry – *New Berrima Shale Quarry, S75W Modification, Air Quality Impact Assessment* (SLR, 2015) – fugitive emission sources;
- Dux Manufacturing Moss Vale – NPI annual reporting totals, 2013-2014 – fugitive emission sources;
- Ingham's Berrima Feed Mill – NPI annual reporting totals, 2013-2014 – fugitive emission sources;
- Omya Southern Limestone, Moss Vale – emission calculations based on EPL limit of processing of 500,000tpa – fugitive emission sources;
- Southern Regional Livestock Exchange – emission calculations based on EPL limit of cattle accommodation of 25,000 heads of cattle – fugitive emission sources; and
- Wingecarribee Resource Recovery Centre – emissions derived based on air quality impact assessment conducted by Ramboll Environ for the Widemere Recycling Facility a similar operation in Western Sydney (Environ, 2015) – fugitive emission sources.

Additionally, locomotive movements currently occur along the Berrima Branch Line associated with Boral's Berrima Cement Works, Inghams Berrima Feed Mill and Omya's Southern Limestone facilities. Once approved, the project would add additional rail movements along the Berrima Branch Line. While locomotive emissions along the Berrima Branch Line are the focus of the Berrima Rail Project air quality impact assessment (Ramboll Environ, 2016), the particulate matter and NO_x emissions along the Berrima Branch Line have been included in the cumulative analysis of impacts in the surrounding environment for this report.

Annual emission totals for neighbouring emission sources are presented in **Table 6-1**. A detailed breakdown of emission calculations and assumptions for the above emission sources is presented in **Appendix 2**.

Table 6-1: Summary of annual average emissions from neighbouring emission sources

Emissions Source	Annual Emissions (kg/annum)			
	TSP	PM_{10}	$PM_{2.5}$	NO_x
Berrima Cement Works	706,974	455,607	187,024	4,975,750
New Berrima Shale Quarry	136,674	40,555	4,947	n/a
Dux Manufacturing Moss Vale	356	237	100	3,400
Ingham Berrima Feed Mill	10,125	6,750	148	3,441
Omya Southern Limestone	11,642	3,578	471	n/a
Southern Regional Livestock Exchange	66,477	43,875	6,581	n/a
Wingecarribee Resource Recovery Centre	21,708	5,175	668	n/a
Berrima Branch Line – movements associated with existing users	1,960	1,672	1,429	56,234
Berrima Branch Line– Hume Coal-related movements	764	764	741	25,580

Note: n/a – no emissions data available. Assumed to be minor

Surrounding emission sources

Hume Coal Project

Air Quality Impact And Greenhouse Gas Assessment

Figure 6.1

6.2 Predicted impacts

The maximum predicted concentrations and dust deposition rates resulting from neighbouring industrial emission sources and the Berrima Branch Line (existing and proposed Hume Coal movements) emissions are presented in **Table 6-2**. The results presented are the maximum predicted concentrations and deposition rates across all selected representative receptor locations and the two meteorological dataset years. The concentrations exclude existing ambient concentrations.

Predicted concentrations and deposition rates for each individual selected assessment location are presented in **Appendix 2**.

Table 6-2: Maximum predicted concentrations and deposition rates – neighbouring emission sources and Berrima Branch Line emissions

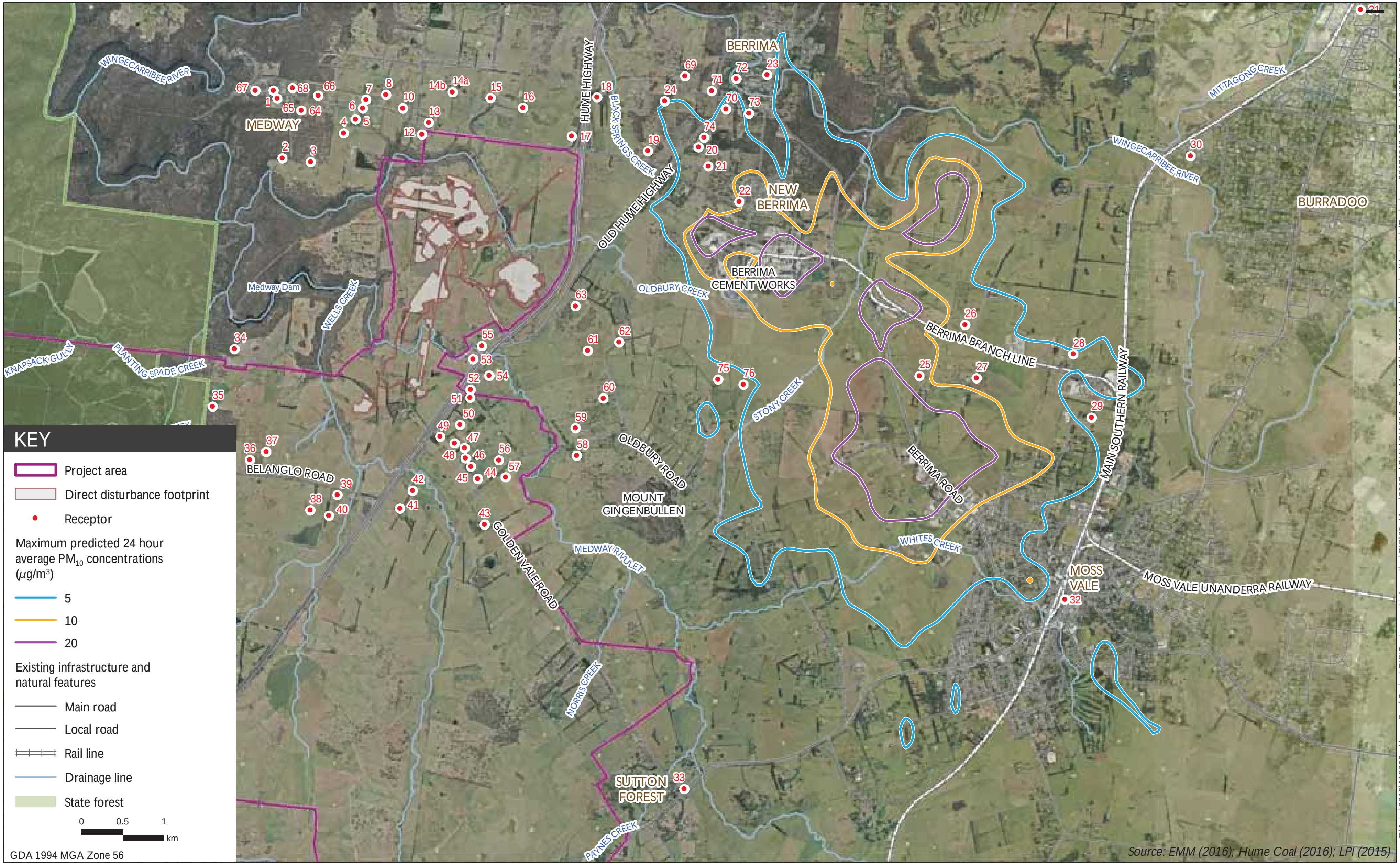
	Maximum Predicted Concentration (µg/m³)							Dust Deposition (g/m²/month)
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	1-hour NO_2	Annual NO_2	
Neighbouring sources and Berrima Branch Line	4.9	13.5	3.1	4.0	0.6	84.5	3.2	0.2

The following points are noted from the results presented:

- Concentrations generated by the neighbouring emission sources in combination are low for all pollutants relative to the applicable assessment criterion; and
- Highest impacts are experienced at the receptors located in the vicinity of the industrial emission sources (receptors 21, 22, 25, 26, 27, 28, 29, 75 and 76), with concentrations reducing notably at the receptors further afield.

The particulate matter and NO_2 concentrations from neighbouring industrial emission sources will be paired with contemporaneous project concentrations and ambient background concentrations to determine cumulative impacts in the surrounding environment (**Section 9**).

Concentration isopleth plots of maximum predicted neighbouring industrial emission sources-only and incremental 24-hour average PM_{10} and $PM_{2.5}$ are presented in **Figure 6-2** and **Figure 6-3**.



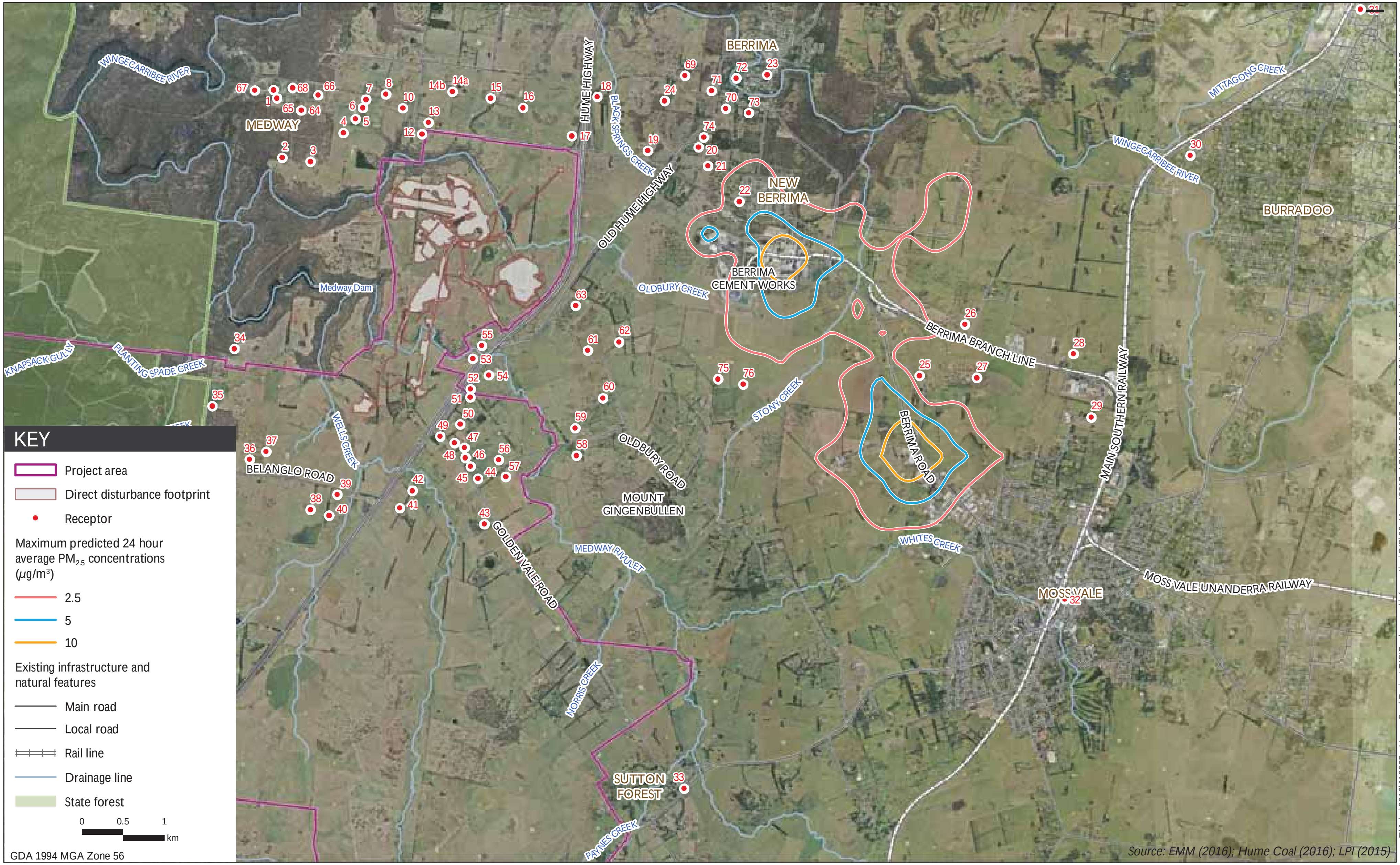
Maximum predicted 24 hour average PM_{10} concentrations ($\mu g/m^3$) - neighbouring industrial emission sources

Hume Coal Project

Air Quality Impact And Greenhouse Gas Assessment

Figure 6.2

EMM HUMECOAL



T:\Jobs\2012\J12055 - Hume Coal Project EIS\Background information\GIS\02_Maps\2017_AQ\IAA\QIA005_6_3_Max24hrPM2_5_NeighbouringIndustrialEmissions_20170313_06.mxd 13/02/2017

Maximum predicted 24 hour average $PM_{2.5}$ concentrations ($\mu g/m^3$) - neighbouring industrial emission sources

Hume Coal Project

Air Quality Impact And Greenhouse Gas Assessment

Figure 6.3

7. AIR QUALITY EMISSIONS INVENTORY

7.1 Introduction

Emissions to air associated with the construction and operation of the project would primarily comprise fugitive dust in each of the particle size metrics described in **Section 3.1** (TSP, PM_{10} and $PM_{2.5}$). Emissions of particulate matter, NO_x and individual VOC species benzene, ethylbenzene, toluene and xylenes generated by the combustion of diesel fuel by plant and equipment has also been accounted for in this assessment. Other pollutants, including SO_2 and CO, would also be generated by the combustion of diesel fuel; however Ramboll Environ's experience with such emissions indicates that related impacts would be negligible relative to ambient concentrations and assessment criterion. Consequently, only emissions of NO_x and the above listed VOC species have been assessed in this report.

Emission factors and equations published by the US EPA and NPI have been combined with project specific operational details to estimate the amount of particulate matter and gaseous pollutants produced by the project. In the case of particulate matter, emissions were quantified for each particle size fraction, with the TSP size fraction also used to predict dust deposition rates.

Two emission scenarios have been developed; corresponding to the peak year of construction based on material handled (construction) and ROM coal extracted (operations). To account for the range of meteorological conditions experienced in the local environment, annual emissions have been quantified based on meteorological monitoring data from both the Hume Coal onsite station and the BoM Moss Vale AWS locations (see **Section 4** for further details on meteorological datasets).

Detailed emission calculation assumptions and equations are presented in **Appendix 3**.

7.2 Construction phase emissions

The construction phase of the project is broadly divided into the following segments:

- Early works;
- Construction of surface infrastructure; and
- Underground drifts and associated infrastructure.

Peak air pollution emissions potential from the construction phase of the project is associated with surface infrastructure construction and the establishment of the drift portals. Surface construction areas are broadly classified as surface infrastructure area, drift portal, rail and primary dam areas.

Based on information provided by Hume Coal, the peak year of construction activities would involve the movement and handling of the following indicative quantities of material:

- Hume Coal Project – 635,000m^3; and
- Berrima Rail Project – 290,000m^3.

From these figures, approximately 140,000m^3 and 21,000m^3 is estimated to be transported from the rail and surface infrastructure area construction areas respectively to the primary dam area. While the Berrima Rail Project emissions are not part of the project and subject to a separate approval, related construction emissions have been incorporated into this assessment due to the amount of material transported from the rail construction area to the primary dam area.

Material handled for the construction phase of both projects is predominately cut/fill material, with smaller amounts of topsoil, gravel, capping and ballast handling. For the purpose of this assessment, it is conservatively assumed that all handled material is soil and weathered rock from on-site excavation (i.e. material with higher dust generating potential than gravel, ballast etc.), with the units of material in bank cubic meters (bcm). This assessment should therefore be viewed as conservative.

Construction activities are assumed to occur concurrently in the areas of the drift portal, surface infrastructure area, rail balloon and primary storage dam. This is conservative as construction activities at all areas are unlikely to occur at the same time. Construction emissions from the Berrima Rail Project have been quantified and incorporated into this assessment for cumulative purposes.

As the largest amount of excavation will be associated with the establishment of the drift portal, it is assumed that 60% of the project construction material is handled at the drift portal areas, with the remaining 40% of material at the SIA area. To conservatively account for cumulative emissions with the project construction activities, 100% of the Berrima Rail Project material is assumed to be handled at the rail balloon only.

For the estimation of construction emissions, the indicative construction fleet at each area is assumed to include a dozer, a grader, an excavator and dump trucks for transporting material. Unpaved road movements related to the transport of material from the drift portal and rail areas to the primary dam area have also been included. Diesel particulate emissions from the construction fleet have been calculated.

A summary of peak annual construction emissions by source type is presented in **Table 7-1** and **Table 7-2** for the Hume 1 and BoM Moss Vale AWS meteorological datasets respectively.

The contribution of various source groups to construction particulate matter emissions is presented in **Figure 7-1** and **Figure 7-2** for the Hume 1 and BoM Moss Vale AWS dataset calculations respectively. Emissions from truck movements along unpaved roads are most dominant sources of coarser particulate matter fractions, while diesel combustion is more dominant for finer fractions (PM_{10} and $PM_{2.5}$). It is noted that annual emission totals are similar between the two meteorological datasets due to the dominance of non-wind dependant emission sources (unpaved roads and diesel combustion).

Table 7-1: Annual emissions by source for peak construction – Hume 1 meteorological dataset

Emissions Source	Calculated Emissions (kg/annum) by Source		
	TSP	PM_{10}	$PM_{2.5}$
Drift Portal Area Construction - material excavation	209	99	15
Drift Portal Area Construction - Loading to trucks	209	99	15
Drift Portal Area Construction - Dozer operations	1,186	224	125
Drift Portal Area Construction - Grader operations	502	370	16
Drift Portal Area Construction - Material haulage	12,175	3,479	348
Drift Portal Area Construction - Truck unloading	209	99	15
SIA Construction - material excavation	139	66	10
SIA Construction - Loading to trucks	139	66	10
SIA Construction - Dozer operations	1,898	358	199
SIA Construction - Grader operations	803	591	25
SIA Construction - Material haulage	8,116	2,319	232
SIA Construction - Truck unloading	139	66	10
SIA Construction - Haulage to Primary Dam	3,195	913	91
Rail Construction - material excavation	159	75	11
Rail Construction - Loading to trucks	159	75	11
Rail Construction - Dozer operations	1,898	358	199
Rail Construction - Grader operations	803	591	25
Rail Construction - Material haulage	9,267	2,648	265
Rail Construction - Truck unloading	159	75	11
Rail Construction - Haulage to Primary Dam	13,581	3,880	388
Dam Construction - Truck unloading	139	66	10
Dam Construction - Dozer operations	2,610	492	492
Dam Construction - Grader operations	1,104	813	34
Wind Erosion - Wind Erosion - drift portal area	1,495	747	112
Wind Erosion - Wind Erosion - SIA area	4,783	2,392	359
Wind Erosion - Wind Erosion - Rail area	3,074	1,537	231
Wind Erosion - Wind Erosion - Primary Dam	1,366	683	102
All activities - Diesel combustion	13,026	13,026	11,941
Total	**82,542**	**36,207**	**15,302**

Table 7-2: Annual emissions by source for peak construction – BoM Moss Vale AWS meteorological dataset

Emissions Source	Calculated Emissions (kg/annum) by Source		
	TSP	PM_{10}	$PM_{2.5}$
Drift Portal Area Construction - material excavation	375	177	27
Drift Portal Area Construction - Loading to trucks	375	177	27
Drift Portal Area Construction - Dozer operations	1,186	224	125
Drift Portal Area Construction - Grader operations	502	370	16
Drift Portal Area Construction - Material haulage	12,175	3,479	348
Drift Portal Area Construction - Truck unloading	375	177	27
SIA Construction - material excavation	250	118	18
SIA Construction - Loading to trucks	250	118	18
SIA Construction - Dozer operations	1,898	358	199
SIA Construction - Grader operations	803	591	25
SIA Construction - Material haulage	8,116	2,319	232
SIA Construction - Truck unloading	250	118	18
SIA Construction - Haulage to Primary Dam	3,195	913	91
Rail Construction - material excavation	285	135	20
Rail Construction - Loading to trucks	285	135	20
Rail Construction - Dozer operations	1,898	358	199
Rail Construction - Grader operations	803	591	25
Rail Construction - Material haulage	9,267	2,648	265
Rail Construction - Truck unloading	285	135	20
Rail Construction - Haulage to Primary Dam	13,581	3,880	388
Dam Construction - Truck unloading	250	118	18
Dam Construction - Dozer operations	2,610	492	274
Dam Construction - Grader operations	1,104	813	34
Wind Erosion - Wind Erosion - drift portal area	1,495	747	112
Wind Erosion - Wind Erosion - SIA area	4,783	2,392	359
Wind Erosion - Wind Erosion - Rail area	3,074	1,537	231
Wind Erosion - Wind Erosion - Primary Dam	1,366	683	102
All activities - Diesel combustion	13,026	13,026	11,941
Total	**83,862**	**36,829**	**15,179**

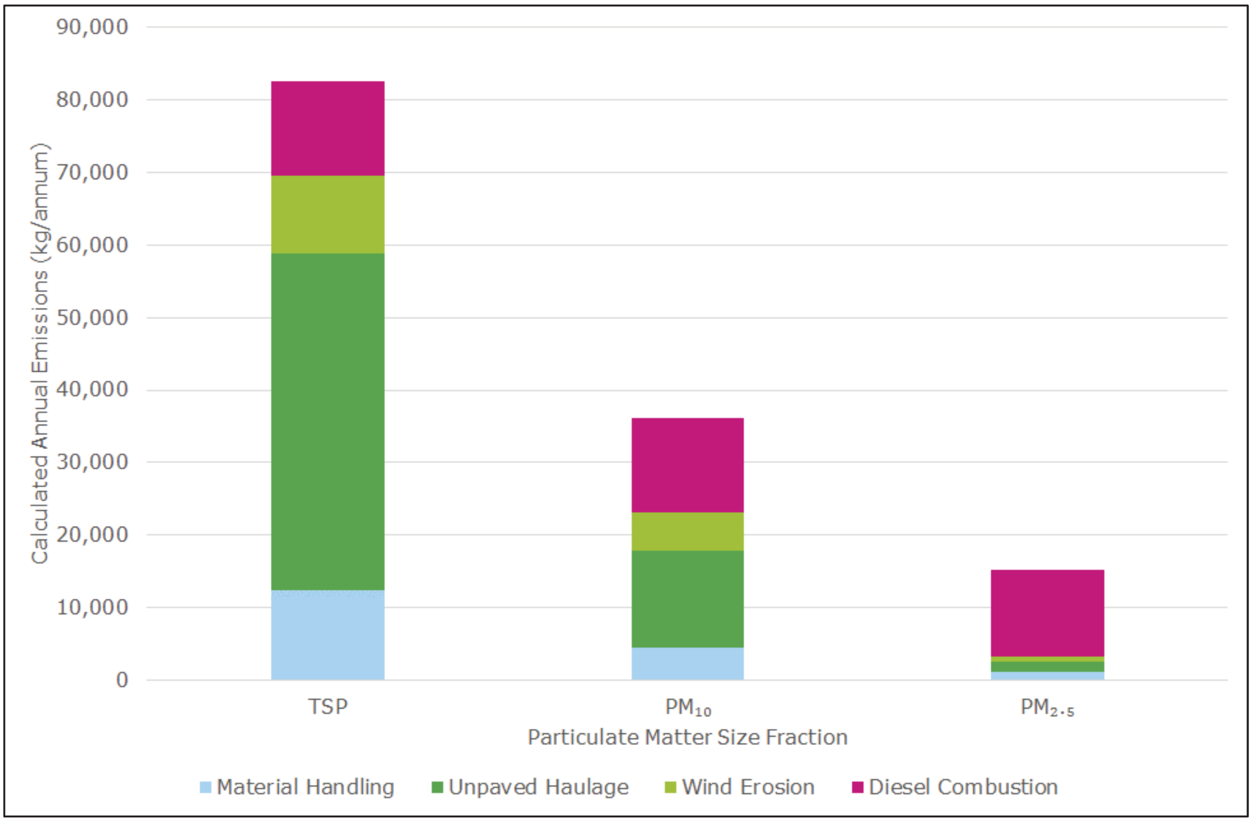


Figure 7-1: Source contribution to peak construction particulate matter emissions – Hume 1 dataset

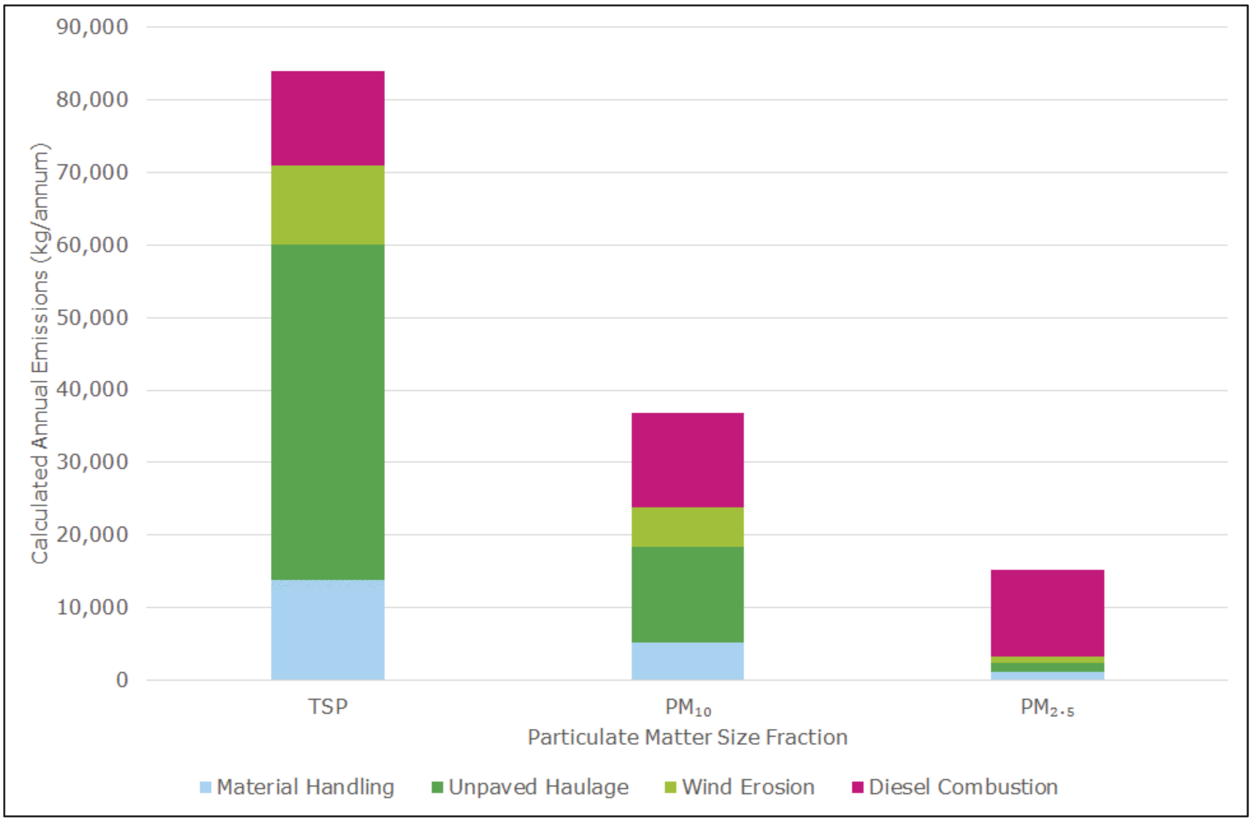


Figure 7-2: Source contribution to peak construction particulate matter emissions – BoM Moss Vale AWS dataset

7.2.1 Proposed particulate matter control measures

For the construction emissions scenario, particulate matter emissions would largely be controlled by the application of water. The particulate matter control measures to be implemented during the construction phase of the project are presented in **Table 7-3**. These reduction factors have been incorporated into the emission calculations for the construction phase (summarised in **Section 7.2**).

Table 7-3: Particulate matter control measures – construction scenario

Emissions Source	Control Measure	Emission Reduction Factor (%)
Dozer operations	Water added to travel routes	50
Grader operations	Water added to travel routes	50
Material haulage	Watering of unsealed roads	75
Wind erosion	Watering of exposed areas	50

Source: *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining* (Katestone, 2011)

7.3 Operational phase emissions

7.3.1 Particulate matter emissions

Sources of particulate matter emissions from the operation of the project are as follows:

- Conveying and transfer of coal and coal rejects;
- Stacker/Reclaimer at ROM and product coal stockpiles;
- ROM coal sizing and screening stations;
- Coal preparation plant (CPP)
- Loading of product coal to rail wagons for dispatch to market;
- Transfer and loading of coal rejects to temporary storage area;
- Bulldozer operations on coal rejects temporary storage area;
- Handling of coal rejects by front end loader (FEL) and transfer to paste plant hopper;
- Wind erosion of stockpiles, temporary storage area and conveyor belts; and
- Ventilation shaft emissions from underground operations, including diesel combustion.

It is noted that emissions have been calculated for peak ROM extraction and processing (3.5 Mtpa ROM). By the time peak ROM extraction is reached, it is unlikely that the surface storage of coal rejects material will be occurring, rather coal rejects would be pumped in slurry form to the underground void. This assessment has conservatively assumed that emissions related to the surface storage of reject material (bulldozer, FEL handling and transportation, conveyor transfer and wind erosion) will coincide with peak operations.

Dust mitigation measures are incorporated into the design of the project, with further discussion provided in **Section 7.3.2**.

A key source of emissions from the project is wind erosion from the product coal stockpiles. At the time of reporting, Hume Coal are investigating several control methods for effective dust mitigation from the product stockpiles, including automated water sprays and veneering which would be undertaken using biodegradable starch-based or polymer-based veneering solutions, of which there are a wide range currently available on the market. The veneer acts by forming a crust on the surface of the stockpile and preventing wind lift-off of fine particles.

The emission scenarios are as follows:

- Operations with product stockpiles controlled by watering only – a nominal 50% emission reduction factor is applied to product stockpile emissions to account for control by water sprays (Katestone, 2011). This factor is considered lower bound, as supported by Katestone (2011) in the following statement:
  For storage pile wind erosion, the estimated control efficiency for water sprays is reported at 50% to 80%. Modern automated sprays may be capable of better performance than this.
- Operations with product stockpiles controlled by watering and veneering – while the actual veneering solution has not been chosen at the time of reporting, a nominal 95% emission reduction factor is applied to product stockpile emissions to account for the application of a surface veneer (Katestone, 2011). For this scenario it is assumed that at any given time, 20% of the total product coal stockpile area is actively disturbed by stacker/reclaimer activity and controlled by water sprays only (50% reduction), with the remaining 80% area is stabilised by a veneer (95% reduction).

This report assesses four separate emission scenarios for proposed peak operations of the project:

- Hume 1 dataset – watering only at product stockpiles;
- Moss Vale BoM dataset – watering only at product stockpiles;
- Hume 1 dataset – combination of veneering (80%) and watering (20%) at product stockpiles; and
- Moss Vale BoM dataset – combination of veneering (80%) and watering (20%) at product stockpiles.

In the absence of ventilation shaft emissions data for the project, emissions of particulate matter have been quantified by referencing monitoring data from a number of operational underground coal mines located in the Illawarra, Western and Central Coast coal mining areas. Details of ventilation shaft particulate matter emission calculations are provided in **Appendix 3**.

A summary of annual emissions by source type for each scenario is presented in **Table 7-4**.

The contribution of various source groups to annual particulate matter emissions is presented in **Figure 7-3**, **Figure 7-4**, **Figure 7-5** and **Figure 7-6** for the above listed emission scenarios. Across all emission scenarios it can be seen that emissions from stockpile wind erosion (ROM and product combined) and the ventilation shafts are the most dominant sources of particulate matter. It is noted that wind erosion emissions are higher for the BoM Moss Vale dataset emission calculations, which is directly attributable to the higher wind speeds in that dataset relative to the Hume 1 dataset. As stated previously in **Section 4.3**, this is overly-conservative as evidenced by the high degree of similarity between the Hume 2 weather station wind speeds (at the stockpile location), and the Hume 1 weather station wind speeds over the period for which comparative data exists.

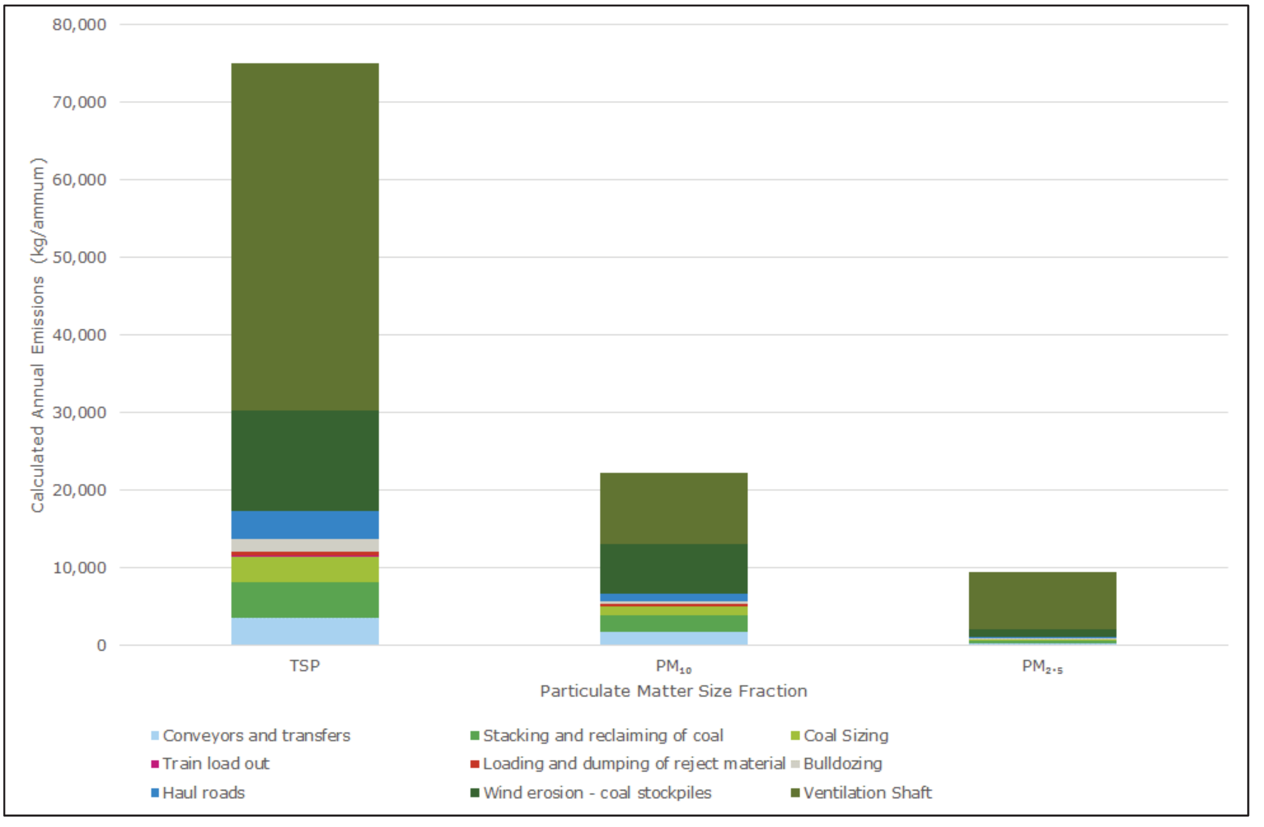


Figure 7-3: Source contribution to annual particulate matter emissions – Hume 1 dataset – Product stockpiles watering only

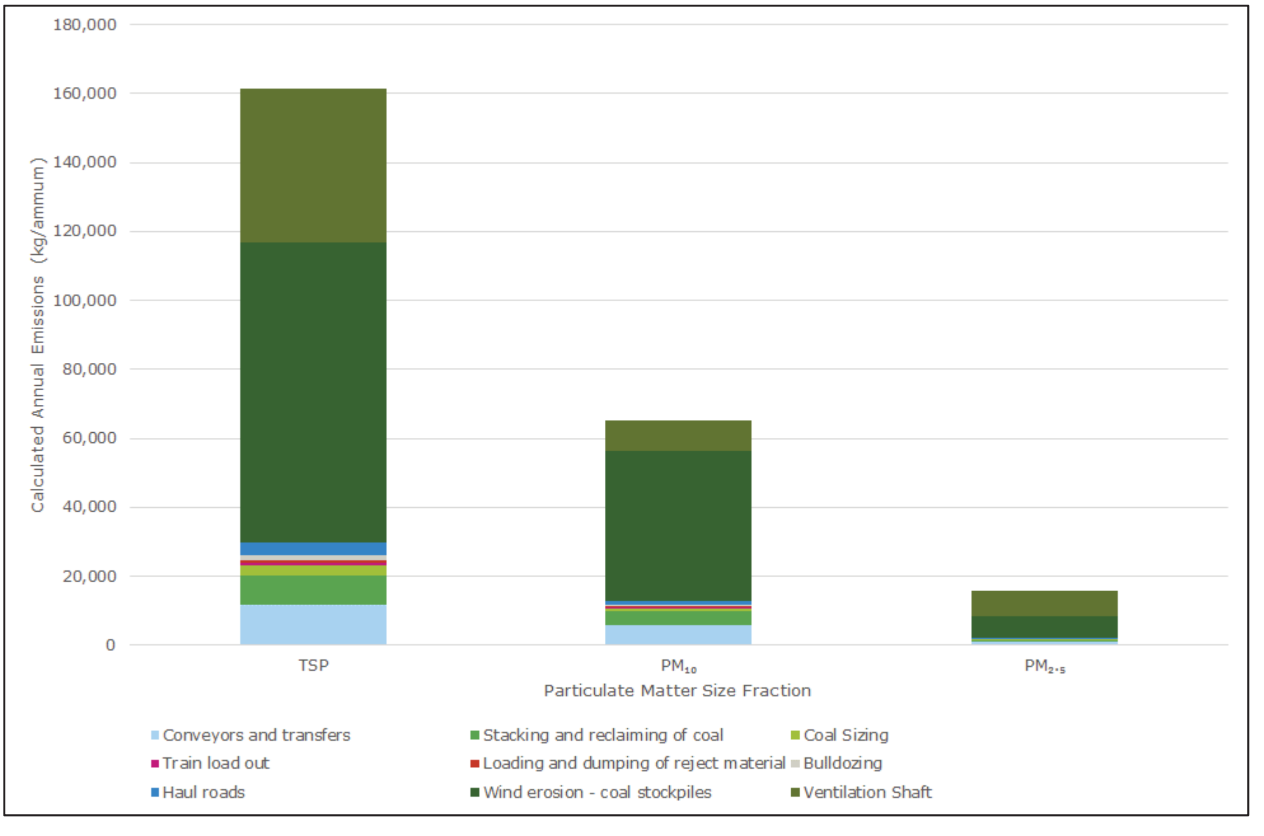


Figure 7-4: Source contribution to annual particulate matter emissions – BoM Moss Vale AWS dataset – Product stockpiles watering only

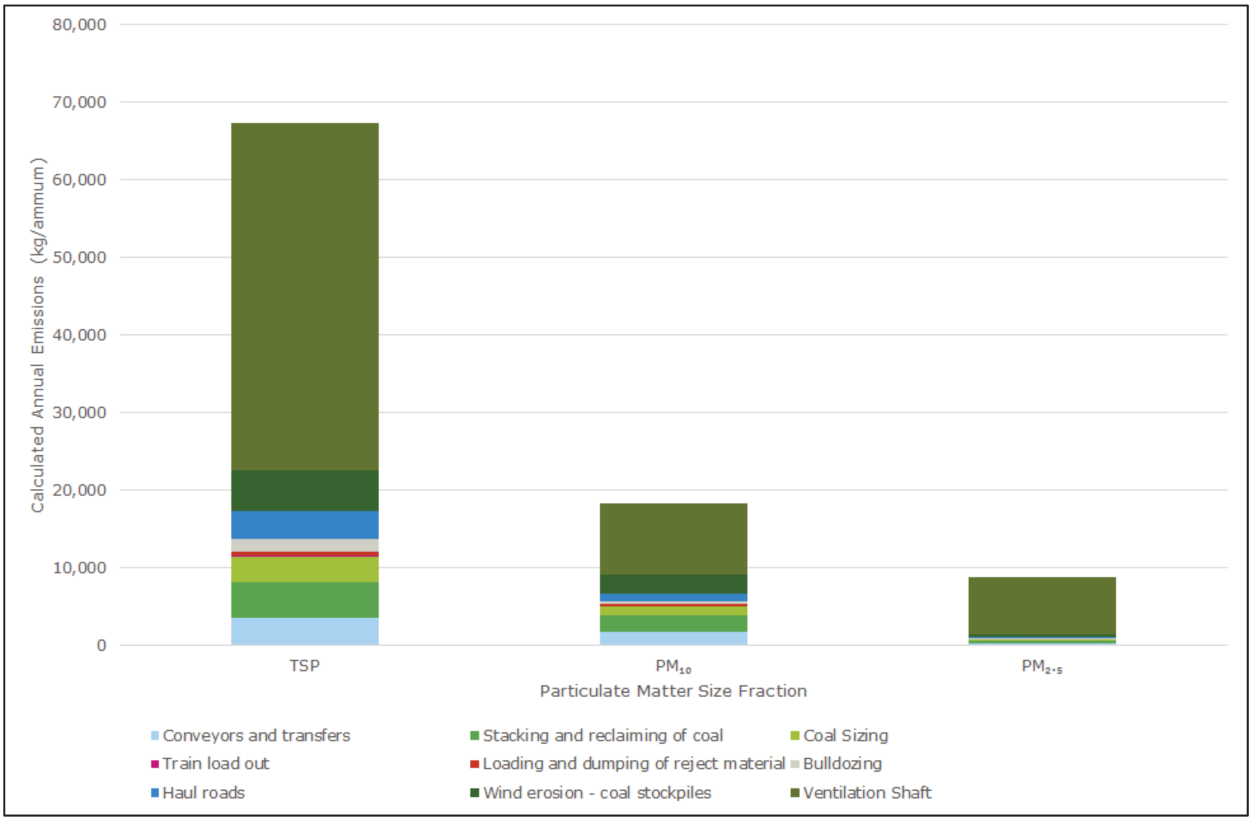


Figure 7-5: Source contribution to annual particulate matter emissions – Hume 1 dataset – Product stockpiles watering and veneering

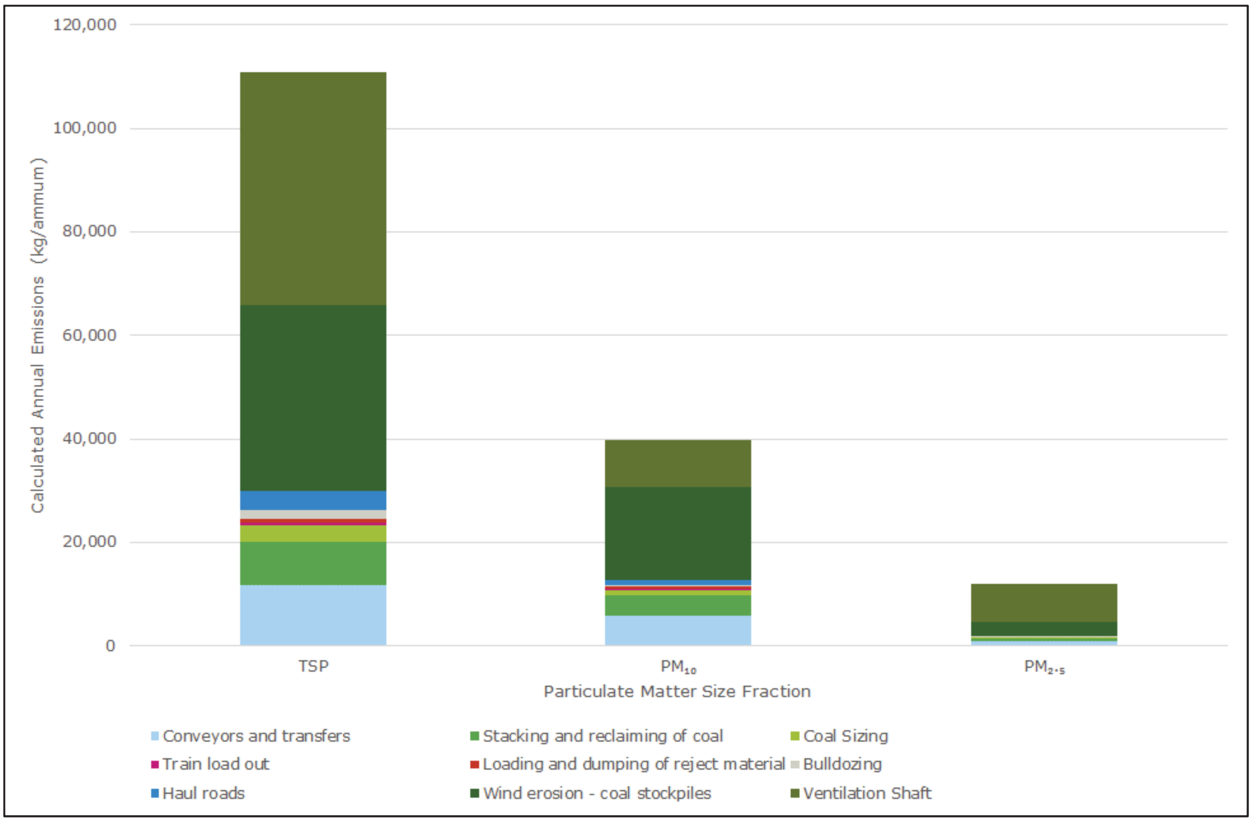


Figure 7-6: Source contribution to annual particulate matter emissions – BoM Moss Vale AWS dataset – Product stockpiles watering and veneering

Table 7-4: Annual emissions by source for peak operations – Hume 1 meteorological dataset

Emissions Source	Calculated Emissions (kg/annum) by Source		
	TSP	PM_{10}	$PM_{2.5}$
Overland conveyor to stacker transfer	234	111	17
Stacker to ROM stockpile	1,561	738	112
Reclaimer - ROM stockpile	1,561	738	112
Tertiary sizing station	1,575	525	79
Screening station	1,575	525	79
CPP (four internal transfer points)	937	443	67
CPP to product conveyor transfer	238	113	17
Product conveyor to stacker transfer	238	113	17
Stacker to product stockpiles	795	376	57
Reclaimer - product stockpiles	795	376	57
Product reclaimer to rail loader conveyor transfer	238	113	17
Rail bin transfer	238	113	17
Loading trains	238	113	17
Rejects conveyer transfer 1	59	28	4
Rejects conveyer transfer 2	59	28	4
Loading temporary rejects storage area	197	93	14
FEL handling Rejects	99	47	7
Dozer on temporary storage area	1,657	368	174
FEL travel from storage area to hopper	3,581	924	92
FEL Rejects to paste plant hopper loading	197	93	14
Paste plant conveyer transfer 1	59	28	4
Paste plant conveyer transfer 2	59	28	4
Conveyor wind erosion - enclosed sections	453	227	34
Conveyor wind erosion - open sections	674	337	51
Wind erosion - ROM stockpile	1,718	859	129
Wind erosion - Product stockpiles – watering only	10,712	5,356	803
Wind erosion - Product stockpiles – watering and veneering	2,999	1,500	225
Wind erosion - Reject temporary storage	476	238	36
Ventilation shaft	44,776	9,132	7,412
Total with Product stockpile watering only	**74,999**	**22,183**	**9,447**
Total with Product stockpile watering and veneering	**67,286**	**18,327**	**8,869**

Table 7-5: Annual emissions by source for peak operations – BoM Moss Vale AWS meteorological dataset

Emissions Source	Calculated Emissions (kg/annum) by Source		
	TSP	PM_{10}	$PM_{2.5}$
Overland conveyor to stacker transfer	420	199	30
Stacker to ROM stockpile	2,801	1,325	201
Reclaimer ROM stockpile	2,801	1,325	201
Tertiary sizing station	1,575	525	79
Screening station	1,575	525	79
CPP (four internal transfer points)	1,681	795	120
CPP to product conveyor transfer	428	202	31
Product conveyor to stacker transfer	428	202	31
Stacker to product stockpiles	1,426	675	102
Reclaimer - product stockpiles	1,426	675	102
Product reclaimer to rail loader conveyor transfer	428	202	31
Rail bin transfer	428	202	31
Loading trains	428	202	31
Rejects conveyer transfer 1	106	50	8
Rejects conveyer transfer 2	106	50	8
Loading temporary rejects storage area	354	167	25
FEL handling Rejects	177	84	13
Dozer on temporary storage area	1,657	368	174
FEL travel from storage area to hopper	3,581	924	92
FEL Rejects to paste plant hopper loading	354	167	25
Paste plant conveyer transfer 1	106	50	8
Paste plant conveyer transfer 2	106	50	8
Conveyor wind erosion - enclosed sections	2,985	1,492	224
Conveyor wind erosion - open sections	4,443	2,221	333
Wind erosion - ROM stockpile	11,321	5,660	849
Wind erosion - Product stockpiles – watering only	70,575	35,287	5,293
Wind erosion - Product stockpiles – watering and veneering	19,761	9,881	1,482
Wind erosion - Reject temporary storage	5,040	2,520	378
Ventilation shaft	44,776	9,132	7,412
Total with Product stockpile watering only	**161,532**	**65,276**	**15,919**
Total with Product stockpile watering and veneering	**110,718**	**39,870**	**12,108**

7.3.2 Proposed particulate matter control measures

Laboratory analysis of the dust extinction moisture (DEM) content of the project coking coal samples was undertaken for two project samples by TUNRA Bulk Solids Handling Research

Associates. DEM content is the level of material moisture content above which dust emissions can be controlled.

The results of the DEM content analysis undertaken showed that the coking coal samples possessed a DEM content between 4% and 5%. The application of water to coal stockpiles and transfer points to maintain a moisture content above the analysed DEM content will assist with the management of fugitive particulate matter emissions from the project.

The particulate matter control measures proposed for implementation during the operation of the project are presented in **Table 7-6**.

Table 7-6: Particulate matter control measures – operational scenario

Emission Sources	**Control Measures**	**Emission Reduction Factors (%)[1]**
ROM coal conveyor transfer points, sizing and screening stations, CPP internal processes	Water sprays / wet process Full enclosure **Combined emission reduction**	50 70 85
Product coal, coal rejects and paste plant conveyor transfer points	Full enclosure	70
FEL handling coal rejects	Watering	50
Dozer on temporary storage area	High moisture in travel routes / watering	50
FEL travel from storage area to hopper	Route watering	75
Conveyor belt wind erosion - enclosed sections	Enclosure	70
ROM stockpile	Water sprays	50
Product stockpiles	Water sprays	50
Product stockpiles	Surface veneering	95
Reject temporary storage	Water sprays	50
Wind erosion of coal dust from rail wagons	Full enclosure	100

Note 1: All control reduction factors adopted from *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining* (Katestone, 2011). Where multiple controls are in place (e.g. sizing station), the multiplicative control factor has been applied as per NPI (2012).

7.3.3 Best management practice review

In November 2011, the NSW OEH published the guideline *Coal Mine Particulate Matter Control Best Practice Site-specific determination* (OEH, 2011). This guideline document provides detail of the process to follow when conducting a site-specific determination of best practice measures to reduce emissions of particulate matter from coal mining activities.

The NSW OEH 2011 guidance for best practice review identifies that the top four controlled emission sources should be identified, with the proposed control measures compared with best practice dust management techniques as identified within *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining* (Katestone, 2011).

The contribution of each dust emission source category to annual TSP, PM_{10} and $PM_{2.5}$ emissions have been ranked by emissions magnitude. The results are presented in **Table 7-7**.

Table 7-7: Ranking of emission source categories by particulate matter size fraction

Emissions Source	Rank of emissions source by pollutant		
	TSP	**PM_{10}**	**$PM_{2.5}$**
Stacking and reclaiming of coal	**4**	**4**	**4**
Coal sizing	6	5	6
Train load out	9	9	9
Bulldozing	7	7	5
Haul roads	5	6	7
Loading and dumping of reject material	8	8	8
Conveyors and transfers	**3**	**3**	**3**
Wind erosion - coal stockpiles	**1**	**1**	**2**
Ventilation shaft	**2**	**2**	**1**

Note: 1 = highest ranked emission source category, 9 = lowest ranked emission source category

Based on the results presented in **Table 7-7**, the highest ranking sources of TSP, PM_{10} and $PM_{2.5}$ emissions from the project are:

- Wind erosion from coal stockpiles;
- Ventilation shaft emissions from underground operations, incorporating both fugitive emissions from coal extraction and transportation and diesel fuel combustion;
- Conveyor belt and transfer stations, from both wind erosion and coal transfer emissions; and
- Stacking and reclaiming of coal.

A comparison of the controls proposed for the project against best practice control measures (Katestone, 2011), is presented in **Table 7-8**.

On the basis of the information presented within **Table 7-8**, the control measures proposed for the project for the top-ranked sources of particulate matter emissions are comparable to current best practise control measures wherever practicable.

Table 7-8: Best practice particulate matter control measures review

Emissions source category	Best practice control measures (Katestone, 2011)	Proposed for implementation at Project	Comments
Wind erosion - coal stockpiles	Stockpile watering on continuous cycle with modification of cycle depending on prevailing weather conditions to allow greater or lesser watering intensity	Yes	Water sprays will be fitted to the ROM and product stockpiles and the temporary reject storage area to maintain surface moisture levels. Water spray intensity will be adjusted in real-time based on meteorological observations (wind speed and temperature)
	Shaping and orientation to minimise emissions of particulate matter	Yes	Product stockpiles to be aligned with dominant westerly air flow (**Section 4.3**) to reduce erodible surface area during peak wind events
Conveyors and transfers	Application of watering at transfer points	Yes	Watering will be implemented at ROM conveyor transfer station. Further, watering would be applied to the ROM and product stockpiles and tertiary sizing station, ensuring carry over moisture through the conveying and transfer process
	Enclosure of transfer points	Yes	Conveyor transfer stations will be fitted with full enclosure
	Wind shielding of conveyor belts – roof and/or side wall	Yes	With the exception of the product stockpile stacking and reclaim conveyors, conveyors will be fitted with either a side wall wind break or side wall and roof. The extent of all conveyor shielding will be designed with functional considerations accommodated.
	Belt cleaning and spillage minimisation	Yes	While not quantified in the emission calculations for this assessment, a belt washing station has been incorporated into the design of the project.

Table 7-8: Best practice particulate matter control measures review

Emissions source category	Best practice control measures (Katestone, 2011)	Proposed for implementation at Project	Comments
Stacking and reclaiming of coal	Avoidance – bypass stockpiles	No	Measure not practicable to the project. Stockpiling of ROM and product coal is an essential element of the project.
	Stacking coal – Variable height luffing stacker to allow drop height to be minimised and stacking to occur without dozer push	Yes	Stacker design has been implemented at the project to avoid bulldozer operations at the stockpiles.
	Stacking coal– Use of chutes or wind shields to shroud falling coal from static trippers	Yes	Wind guards to be fitted to stockpile stackers.
	Stacking coal – water application through boom tip sprays	Yes	Water will be added to coal prior to stockpile loading and direct to stockpile surface to maintain surface moisture content.
	Reclaiming coal – use of bucket-wheel, portal or bridge reclaimer	Yes	Reclaimer design has been implemented at the project to avoid bulldozer operations at the stockpiles.
	Reclaiming coal – coal moisture management through water application	Yes	Water will be added to coal stockpile surface to maintain surface moisture content.
	Reclaiming coal – reclaim tunnel with minimal mechanical disturbance	Yes	Central reclaim tunnel designed for ROM pile
	Reclaiming coal – minimise residence time in stockpiles	Yes	Coal from stockpiles will be reclaimed and replenished on a continuous basis.

Table 7-8: Best practice particulate matter control measures review

Emissions source category	Best practice control measures (Katestone, 2011)	Proposed for implementation at Project	Comments
Ventilation Shaft emissions	Not considered in Katestone, 2011	-	Emissions from underground ventilation discharge will be managed through a combination of underground operation dust mitigation practices (water sprays at coal extraction and handling points and dust suppression along underground roads) and maintenance of underground mining fleet to maintain manufacturer's engine emissions specifications.

7.4 Project-related gaseous emissions

As stated in **Section 7.1**, the combustion of diesel fuel by underground mining equipment, surface plant and locomotive engines will generate emissions of various gaseous pollutants. For this assessment, focus is given to emissions of NO_x and individual VOC species benzene, ethylbenzene, toluene and xylenes.

Annual non-particulate matter diesel combustion emissions from the project fleet have been estimated using peak projected annual diesel consumption (1,323,734 L) and emission factors for diesel industrial vehicles (kg/kL) (NPI, 2008). Speciation of individual VOCs has been estimated from US-EPA Speciate profile 8775 - *Diesel Exhaust Emissions from 2007 Model Year Heavy-Duty Diesel Engines with Controls*. Due to the limited and infrequent amount of surface based plant and equipment, it is assumed that 100% of project diesel consumption occurs underground, with emissions released from the ventilation shaft outlets.

Locomotive related diesel combustion emissions have been quantified for idling and moving phases within the air quality impact assessment for the Berrima Rail Project (Ramboll Environ, 2016). Resultant concentrations from Hume Coal-related train movements as assessed in the Berrima Rail Project are incorporated into the cumulative analysis completed in this assessment (**Section** 9).

Calculated annual diesel combustion emissions from the project are presented in **Table 7-9**.

Table 7-9: Summary of annual combustion emissions – peak operations

Pollutant	Annual Emissions (kg/annum) from mining operations
NO_x	12,906.4
Benzene	105.4
Ethylbenzene	54.4
Toluene	214.2
Xylenes	292.9

Detailed emission calculations and assumptions are presented in **Appendix 3**. It is noted that due to the fact that the construction phase will have significantly lower fuel consumption and no locomotive operations, combustion emissions from the construction phase have not been quantified in this assessment.

7.5 Project-related odour emissions

In addition to emissions of particulate matter and diesel combustion pollutants, this assessment has considered the potential for the project to release odorous emissions into the ambient air shed. Similar to particulate matter emissions, in the absence of ventilation shaft emissions data for the project, emissions of odour have been quantified by referencing monitoring data from a number of operational underground coal mines located in the Illawarra, Western and Central Coast coal mining areas. Details of ventilation shaft odour emission calculations are provided in **Appendix 3**.

8. AIR QUALITY MODELLING METHODOLOGY

8.1 Dispersion model selection and application

The atmospheric dispersion modelling completed within this assessment used the AMS/US-EPA regulatory model (AERMOD) (US-EPA, 2004). AERMOD is designed to handle a variety of pollutant source types, including surface and buoyant elevated sources, in a wide variety of settings such as rural and urban as well as flat and complex terrain. AERMOD replaced the Industrial Source Complex (ISC) model for regulatory purposes in the US in December 2006 as it is considered to provide more realistic results with concentrations that are generally lower and more representative of actual concentrations compared to the ISC model. Compared to ISC, AERMOD represents an advanced new-generation model which requires additional meteorological and land-use inputs to provide more refined predictions.

Predicted concentrations were calculated at three levels:

- An outer Cartesian receptor grid covering a 15km by 11km computational domain covering the project and surrounding area, with a grid resolution of 300m applied; and
- The 75 representative sensitive receptor locations listed in **Table 2-1**.

Atmospheric dispersion simulations were undertaken for two 12 month periods of meteorological modelling data. These datasets (Hume 1 and BoM Moss Vale) are described in detail in **Section 4**.

8.2 Source and emissions data

The methodology and results of the emissions inventory developed for this study are presented in **Section 7** and **Appendix 3**. The spatial allocation of emissions for each scenario is presented in **Appendix 3**. Material handling and wind erosion emissions were varied by wind speed, with higher emissions occurring during periods of higher wind speed.

8.3 Presentation of model results

This air quality impact assessment represents a Level 2 assessment as specified within the Approved Methods for Modelling.

Dispersion simulations were undertaken to predict the concentrations of TSP, PM_{10}, $PM_{2.5}$, NO_x, VOCs and dust deposition. Incremental project-related concentrations and deposition rates occurring due to the proposed construction and operations were modelled. Model results are expressed as the maximum predicted concentration for each averaging period at the selected assessment locations over the two meteorological modelling datasets (Hume 1 and BoM Moss Vale). For operational emissions, two variations of the operations phase have been assessed; product coal stockpiles controlled by watering only and product coal stockpiles controlled by watering and veneering (as per **Section 7.3**)

The results are presented in the following formats:

- Maximum predicted concentrations and dust deposition rates attributable to the project only (**Section 9**);
- Maximum predicted concentrations and dust deposition rates attributable to the combination of the project and neighbouring emission sources (**Section 9**);
- Cumulative predicted concentrations and dust deposition rates attributable to the combination of the project and neighbouring emission sources with ambient background levels (**Section 9**);
- Tabulated results of predictions at all receptors is provided in **Appendix 4**; and

- Isopleth plots, illustrating spatial variations in project-related incremental TSP, PM_{10} and $PM_{2.5}$ concentrations and dust deposition rates are provided in **Appendix 5**. Isopleth plots of the maximum 24-hour average concentrations presented in **Appendix 5** do not represent the dispersion pattern on any individual day, but rather illustrate the maximum daily concentration that was predicted to occur at each model calculation point given the range of meteorological conditions occurring over the modelling period.

8.4 Cumulative impacts assessment

Cumulative impacts in the environment surrounding the project have been assessed in the following way:

- For each hour of the modelling period, predicted incremental concentrations from the project and neighbouring emission sources have been paired in time at each sensitive receptor location;
- For hourly NO_2, a contemporaneous OLM analysis has been conducted using hourly predicted concentrations and hourly NO_2 and O_3 concentrations from the NSW OEH Bargo monitoring station (further discussion in **Section 8.5**);
- For 24-hour average PM_{10} and $PM_{2.5}$, each cumulative predicted concentration has been paired with every individual 24-hour average recorded PM_{10} and $PM_{2.5}$ concentration in the analysed monitoring datasets (**Section 5.2**). A frequency analysis of potential cumulative PM_{10} and $PM_{2.5}$ was derived and compared with ambient background to determine potential frequency of any criterion exceedance (further discussion in **Section 9.1.3**).
- For annual average pollutants, the annual average cumulative concentration/dust deposition level is paired with the applicable ambient annual average background concentration/deposition level.

Combining neighbouring emission source models predicted with local and regional ambient monitoring data, a degree of double counting of existing air quality will occur. By combining model-predicted project-only increment with the modelled neighbouring emissions source increment and ambient background, it is considered that cumulative impacts in the surrounding environment have been conservatively assessed.

8.5 Modelling of NO_x emissions

NO_x emissions associated with fuel combustion are primarily emitted as NO with some NO_2. The transformation in the atmosphere of NO to NO_2 was accounted for using the US-EPA's Ozone Limiting Method (OLM) which requires ambient ozone data, as per the Approved Methods for Modelling.

Reference has been made to the hourly-varying O_3 concentrations recorded at the NSW OEH Bargo station.

The equation used to calculate NO_2 concentrations from predicted NO_X concentrations is as follows:

$$[NO_2]_{TOTAL} = \{0.1 \times [NO_x]_{PRED}\} + MIN\{(0.9) \times [NO_x]_{PRED} \text{ or } (46/48) \times [O_3]_{BKGD}\} + [NO_2]_{BKGD}$$

Where:

$[NO_2]_{TOTAL}$ = The predicted concentration of NO_2 as µg/m^3.

$[NO_x]_{PRED}$ = The AERMOD prediction of ground level NO_X concentrations as µg/m^3.

MIN = The minimum of the two quantities within the braces

$[O_3]_{BKGD}$ = The background ambient O_3 concentration – Hourly Varying OEH Bargo as µg/m^3.

46/48 = the molecular weight of NO_2 divided by the molecular weight of O_3.

$[NO_2]_{BKGD}$ = The background ambient NO_2 concentration – Hourly Varying OEH Bargo as µg/m^3.

The US-EPA's OLM assumes that all of the available O_3 in the atmosphere will react with NO until either all of the O_3, or all of the NO has reacted. A major assumption of this method is that the reaction is instantaneous. In reality, this reaction takes place over a number of hours and over distance. Furthermore, the method assumes that the complete mixing of the emitted NO and ambient ozone, down to the level of molecular contact, will have occurred by the time the emissions reach the ground level receiver of the maximum ground level NO_X concentration.

Finally, the use of NO_2 and O_3 air quality monitoring data from the NSW OEH Bargo air quality monitoring station, located in the southwest of the Sydney basin, is considered conservative for representing ambient concentrations at the project.

Consequently, concentrations of the NO_2 reported within this assessment should be viewed as highly conservative, providing an upper bound estimate of NO_2 concentrations.

8.6 Odour impacts

Odour impacts are expressed as a maximum 1-second (nose response) concentration for comparison with the NSW EPA odour performance criterion of 2 OU. Predicted 1-hour average concentrations were converted using the peak-to-mean ratio of 2.3, as per Table 6.1 of the NSW EPA Approved Methods for Modelling.

9. AIR QUALITY ASSESSMENT

9.1 Assessment of Particulate Matter

9.1.1 Project-only incremental results

The maximum predicted project-only incremental particulate matter concentrations and dust deposition rates across all selected sensitive receptor locations for the peak construction and peak operations scenarios are presented in **Table 9-1**.

Table 9-1: Maximum predicted concentrations and deposition rates summary – Hume Coal Project Only Increment

Scenario	Maximum Predicted Concentration (µg/m³) – all receptors					Dust Deposition (g/m²/month)
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	
Criterion[1]	**90**	**50**	**25**	**25**	**8**	**2**
Construction	2.0	4.6	0.9	1.9	0.3	0.2
Operations – Product stockpile watering only	1.1	4.7	0.3	1.6	0.2	0.1
Operations – Product stockpile veneering and watering	1.1	2.1	0.3	1.6	0.2	0.1

Note: 1 – listed criterion for TSP, PM_{10} and $PM_{2.5}$ are applicable to cumulative concentrations only

The following key points are noted from the results presented in **Table 9-1**:

- All project-only incremental concentrations and deposition rates are below the applicable impact assessment criteria;
- Predicted maximum particulate matter concentrations are higher during the construction phase than the operations phase due to the high amount of surface-based activities (material excavation and handling, unpaved road haulage of materials) associated with the establishment of the project;
- The application of veneering (assumed control efficiency of 95% in accordance with literature) in combination with water spraying at the product stockpiles is effective at reducing worst case 24-hour average PM_{10} concentrations (occurring on days with high wind conditions) relative to the implementation of water spraying alone. There is little change between the watering only and veneering and watering product stockpile scenarios for annual average PM_{10} concentrations at receptors;
- Highest $PM_{2.5}$ concentrations in the area are associated with emissions from the ventilation outlets, with $PM_{2.5}$ impacts associated with diesel combustion; and
- For both operational emission scenario options (watering only or watering and veneering at the product stockpiles), the predicted impacts are well below applicable impact assessment criteria at all surrounding receptors.

It is noted however that the criteria for TSP, PM_{10} and $PM_{2.5}$ is applicable to cumulative concentrations (project + neighbouring sources + ambient background). Cumulative impacts are addressed in **Section 9.1.3** and **Section 9.1.4**.

Concentration isopleth plots of maximum predicted project-only incremental 24-hour average PM_{10} and $PM_{2.5}$ concentrations for construction and operations are presented in **Figure 9-1** to **Figure 9-6**.

Maximum predicted 24 hour average PM_{10} concentrations ($\mu g/m^3$) - project only - construction scenario

Hume Coal Project

Air Quality Impact And Greenhouse Gas Assessment

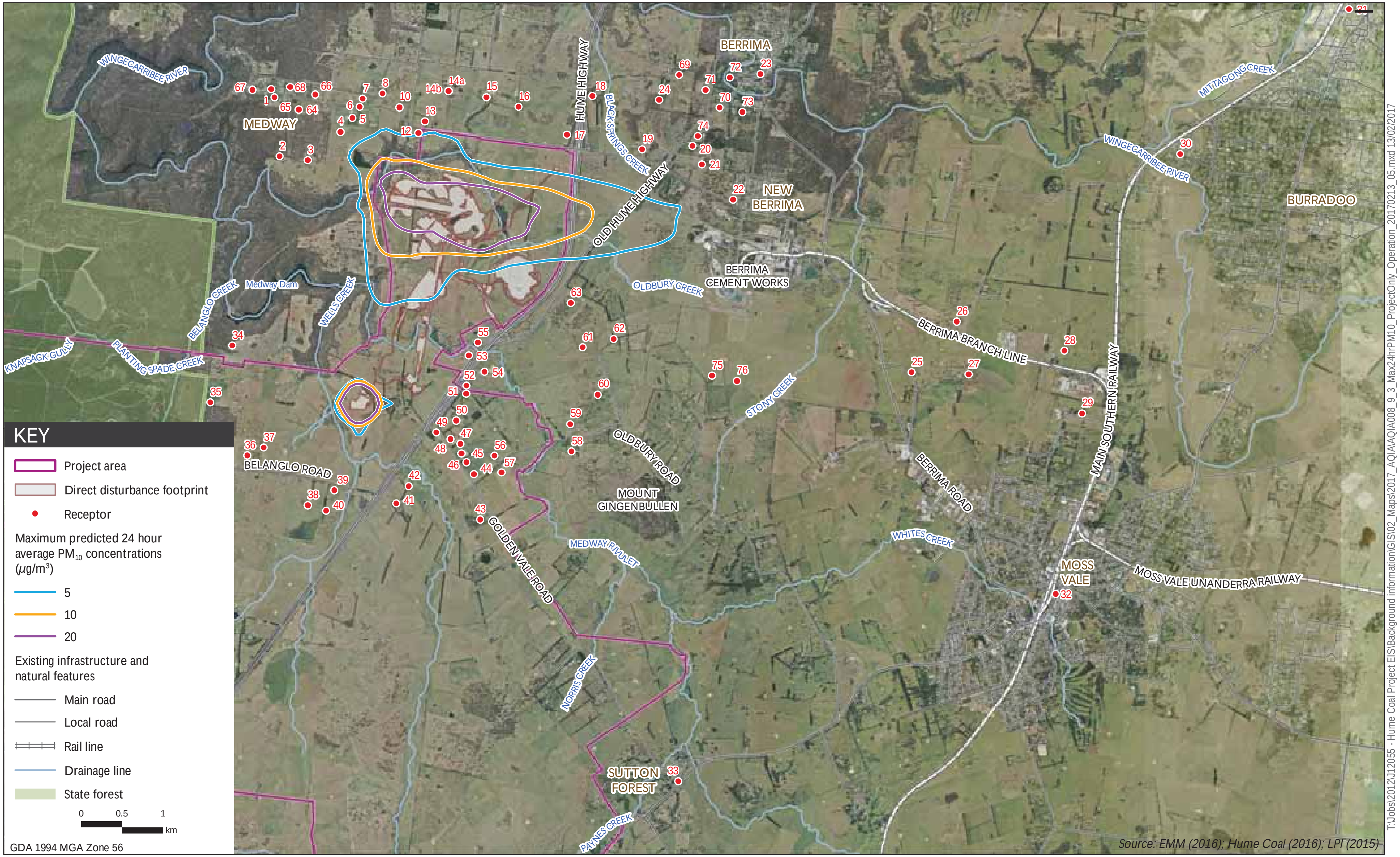
Figure 9.1

Maximum predicted 24 hour average $PM_{2.5}$ concentrations ($\mu g/m^3$) - project only - construction scenario

Hume Coal Project

Air Quality Impact And Greenhouse Gas Assessment

Figure 9.2

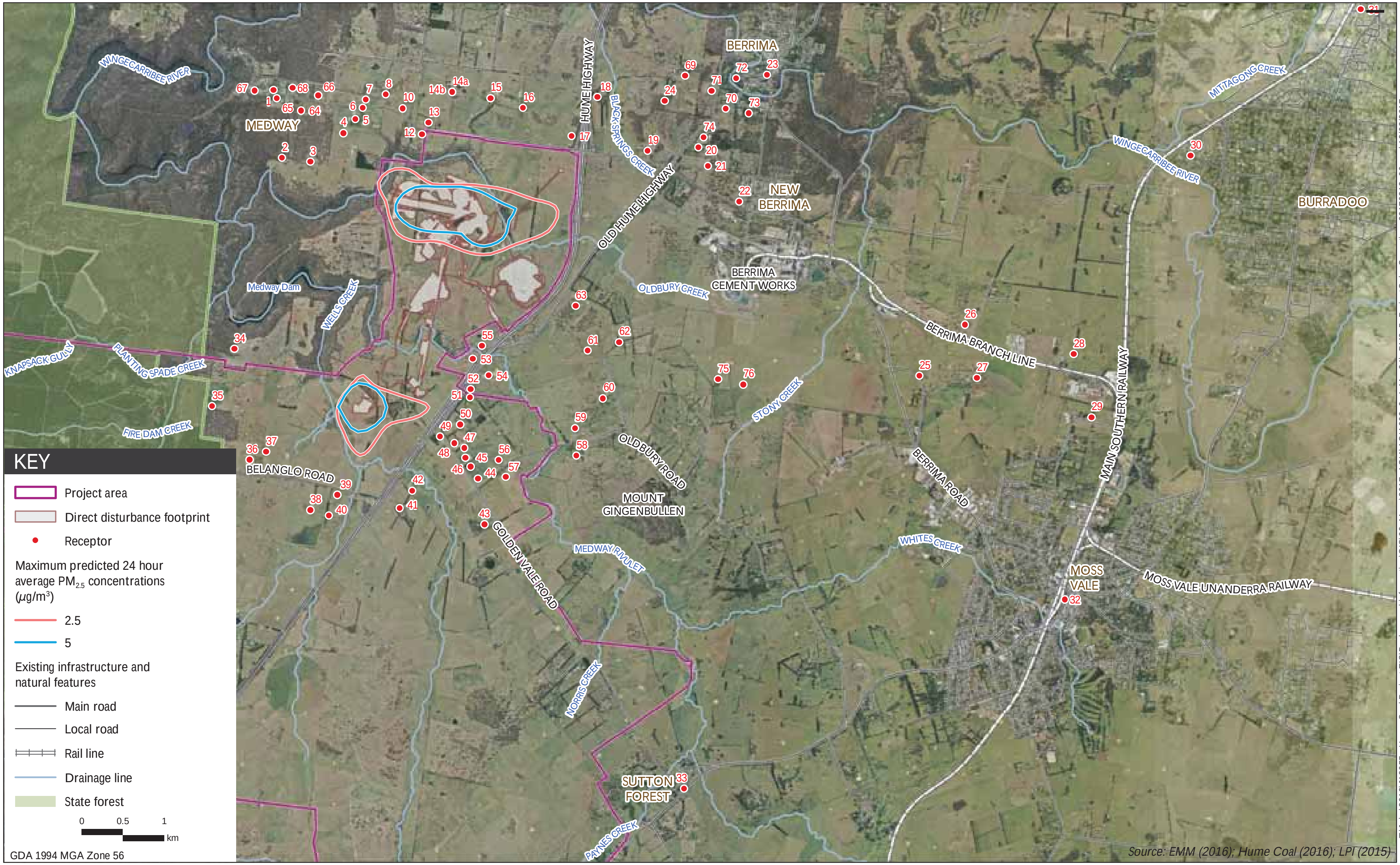


Maximum predicted 24 hour average PM_{10} concentrations ($\mu g/m^3$) - project only - operation scenario - watering only at product stockpiles

Hume Coal Project

Air Quality Impact And Greenhouse Gas Assessment

Figure 9.3



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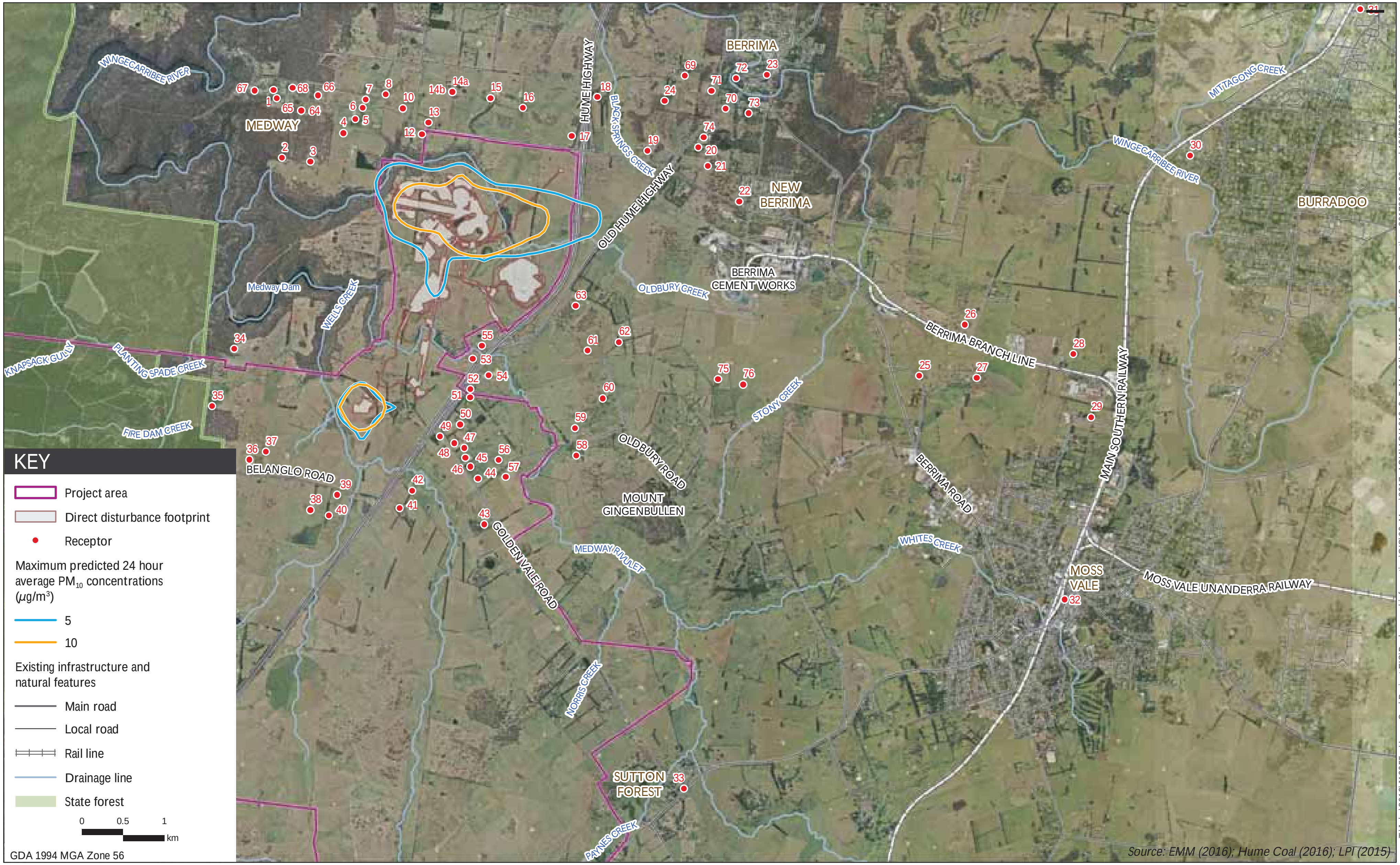
Maximum predicted 24 hour average $PM_{2.5}$ concentrations ($\mu g/m^3$) - project only - operation scenario - watering only at product stockpiles

Hume Coal Project

Air Quality Impact And Greenhouse Gas Assessment

Figure 9.4



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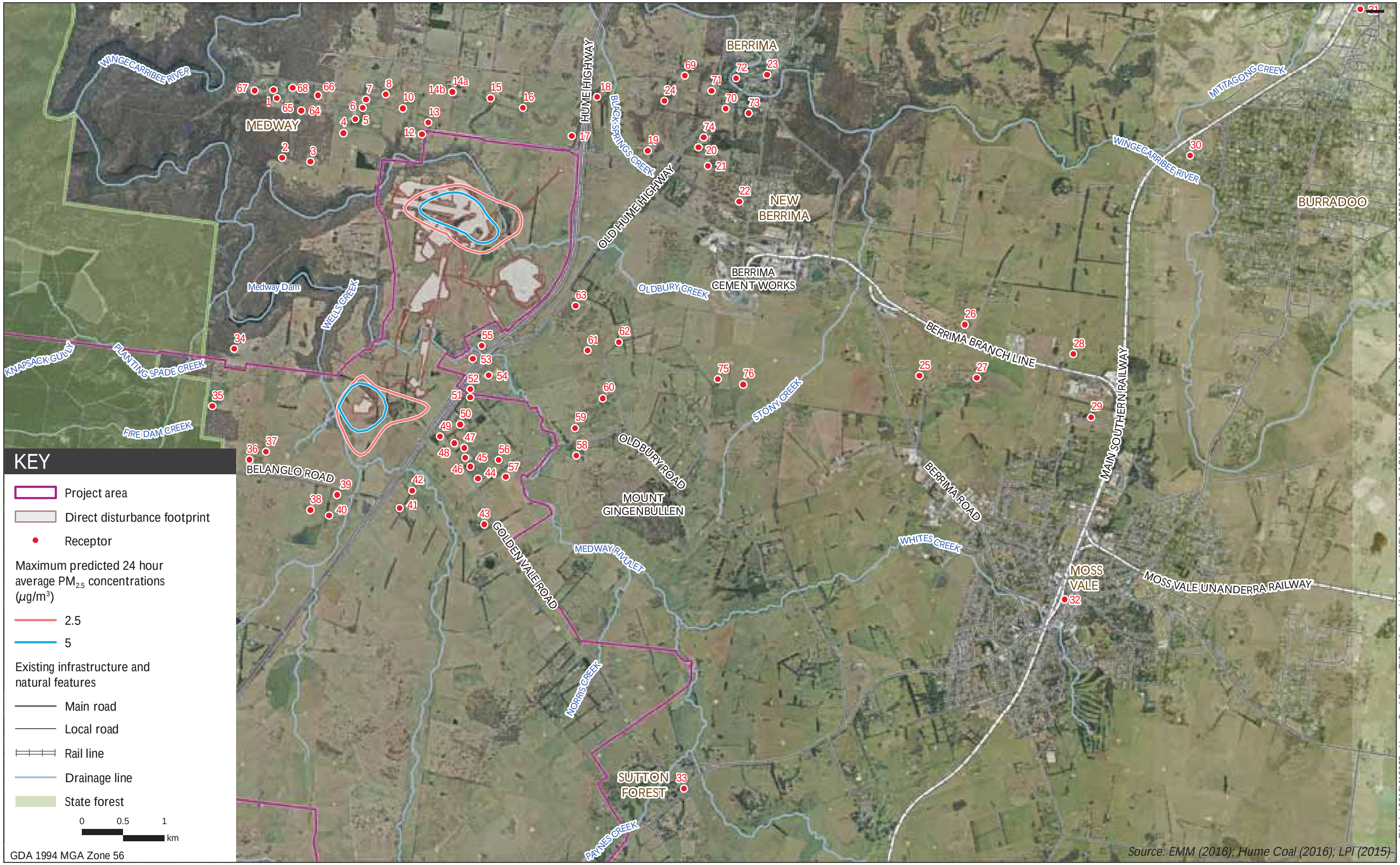
Maximum predicted 24 hour average PM_{10} concentrations ($\mu g/m^3$) - project only - operation scenario - veneering and watering at product stockpiles

Hume Coal Project

Air Quality Impact And Greenhouse Gas Assessment

Figure 9.5



Maximum predicted 24 hour average $PM_{2.5}$ concentrations ($\mu g/m^3$) - project only - operation scenario - veneering and watering at product stockpiles

Hume Coal Project

Air Quality Impact And Greenhouse Gas Assessment

Figure 9.6

9.1.2 Project and neighbouring industrial operations incremental results

The combined maximum predicted project-only and neighbouring industrial emission source incremental particulate matter concentrations and dust deposition rates across all selected sensitive receptor locations for the peak construction and peak operations scenarios (watering only and veneering and watering at the product stockpiles) are presented in **Table 9-2**. It is noted that the cumulative construction predictions include emissions from existing rail movements along the Berrima Branch Line, while the operational scenarios also include rail movements associated with the project.

All concentrations and deposition rates are below the applicable impact assessment criteria. Concentrations are similar between the three assessed modelling scenarios, indicating that existing sources of particulate matter are a significant influencing factor to concentrations in the local area, without causing exceedance of criteria.

It is noted however that the criteria for TSP, PM_{10} and $PM_{2.5}$ are applicable to cumulative concentrations, accounting for ambient particulate matter levels. Total cumulative impacts are addressed in **Section 9.1.3** and **Section 9.1.4**.

Table 9-2: Maximum predicted concentrations and deposition rates summary – Hume Coal Project Only Increment plus Neighbouring Industrial Sources Increment

Scenario	Maximum Predicted Concentration (µg/m³) – all receptors					Dust Deposition (g/m²/month)
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	
Criterion[1]	90	50	25	25	8	2
Construction	4.9	13.5	3.1	4.0	0.6	0.2
Operations – Product stockpile watering only	5.0	13.5	3.2	4.0	0.6	0.3
Operations – Product stockpile veneering and watering	5.0	13.5	3.2	4.0	0.6	0.2

Note: 1 – listed criterion for TSP, PM_{10} and $PM_{2.5}$ are applicable to cumulative concentrations only

9.1.3 Cumulative 24-hour average concentrations

As illustrated in **Section 9.1.2**, maximum predicted 24-hour average concentrations combining project and neighbouring industrial sources occur during the peak operations scenarios (detailed in **Section 7.3**). In order to assess worst case cumulative impacts (project + neighbouring industrial emission sources + ambient air quality levels) at surrounding receptors, model predictions for the peak operation emissions scenario (i.e. watering only at product stockpiles) will be drawn upon.

Cumulative impacts for 24-hour PM_{10} and $PM_{2.5}$ have been evaluated using a statistical approach which presents the likelihood of the project causing additional exceedances of the 24-hour average assessment criterion of 50µg/m^3 and 25µg/m^3 for PM_{10} and $PM_{2.5}$ respectively. To provide an analysis of the likelihood of compliance with the NSW EPA assessment criterion for 24-hour average PM_{10} (50 µg/m^3) and $PM_{2.5}$ (25 µg/m^3), every predicted 24-hour average concentration (365 individual concentrations) has been paired with every recorded 24-hour average concentration detailed in **Section 5.2** (5,084 for PM_{10}, 2,151 for $PM_{2.5}$). Due to the large number of assessment locations, the top ten highest receptor locations for 24-hour PM_{10} and $PM_{2.5}$ have been selected for detailed cumulative analysis. These receptors are:

- 24-hour PM_{10} – Receptors 20, 21, 22, 24, 25, 26, 27, 28, 70 and 74; and

- 24-hour $PM_{2.5}$ – Receptors 20, 21, 22, 25, 26, 50, 70, 74, 75 and 76.

Each combination of model prediction and recorded concentration (1,855,660 potential combinations for PM_{10}; 785,115 potential combinations for $PM_{2.5}$) has been collated. The process assumes that any background value from the dataset could occur on any given day during the project operation. In using all available background values from the analysed monitoring stations (with monitoring stations located locally, in southwest Sydney and in Canberra), an extensive range of potential background conditions are assessed.

For each of the top ten receptor locations a frequency distribution of cumulative concentrations has been derived. Frequency histogram plots for cumulative 24-hour average PM_{10} and $PM_{2.5}$ concentrations are presented in **Figure 9-7** and **Figure 9-8** respectively.

The frequency histogram profiles presented in **Figure 9-7** and **Figure 9-8** demonstrate that the most notable change from the "ambient background" frequency occurs in the lower concentration bands (less than 20µg/m^3 for PM_{10} and less than 10µg/m^3 for $PM_{2.5}$).

The frequency analysis of the combined ambient background dataset, comprising of data from local and regional monitoring sources, indicates that the region has a 0.2% likelihood (or 0.7 days per year) of experiencing a 24-hour average PM_{10} concentration greater than 50µg/m^3 and a 0.5% likelihood (or 1.9 days per year) of experiencing a 24-hour average $PM_{2.5}$ concentration greater than 25µg/m^3. As discussed in **Section 5.2**, infrequent exceedances of applicable particulate matter criteria are generally associated with large-scale natural events, such as bushfires and dust storms.

For 24-hour average PM_{10} concentrations , the frequency of potential cumulative concentrations greater than 50µg/m^3 across all top ten receptors is between 0.2% and 0.3%, representing a minor change from the ambient background PM_{10} dataset. Similarly, for 24-hour average for $PM_{2.5}$ concentrations the frequency of potential cumulative concentrations greater than 25µg/m^3 across all top ten receptors is between 0.5% and 0.6%. For both PM_{10} and $PM_{2.5}$ concentrations, the increase in exceedance days relative to the background dataset is minor. Consequently, the frequency analysis demonstrates that the likelihood of an additional exceedance day occurring as a result of emissions from the project is negligible for both 24-hour average PM_{10} and $PM_{2.5}$ concentrations.

On the basis of this cumulative analysis, it is considered unlikely that worst case emissions from the project (operational phase, watering only at product stockpiles), combined with emissions from neighbouring emission sources and ambient background concentrations, will result in additional exceedances of the 24-hour average PM_{10} or $PM_{2.5}$ criteria at surrounding receptors, beyond those that would occur in the absence of the project (i.e. days influenced by bushfires, dust storms, etc.).

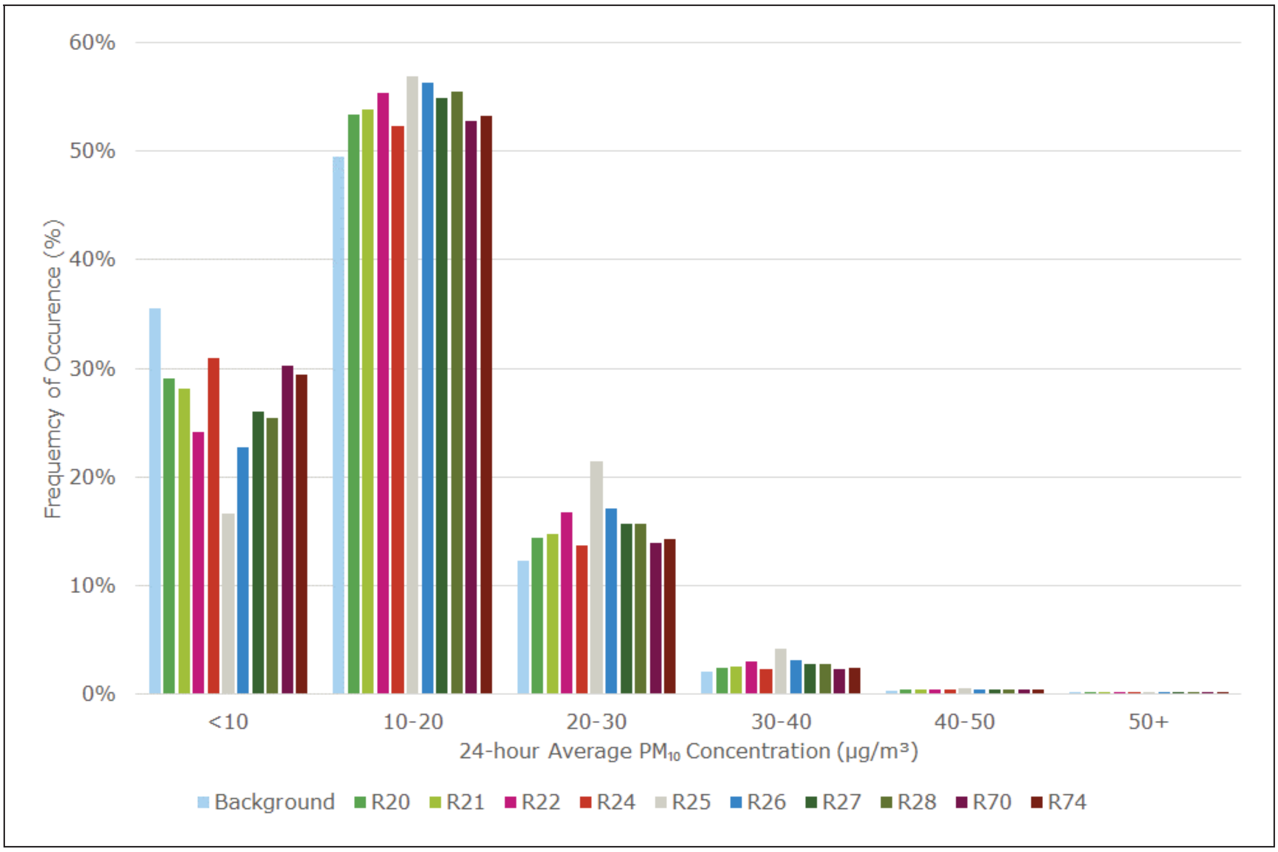


Figure 9-7: Frequency histogram of cumulative 24-hour average PM_{10} concentrations – operational scenario – watering only at product stockpiles

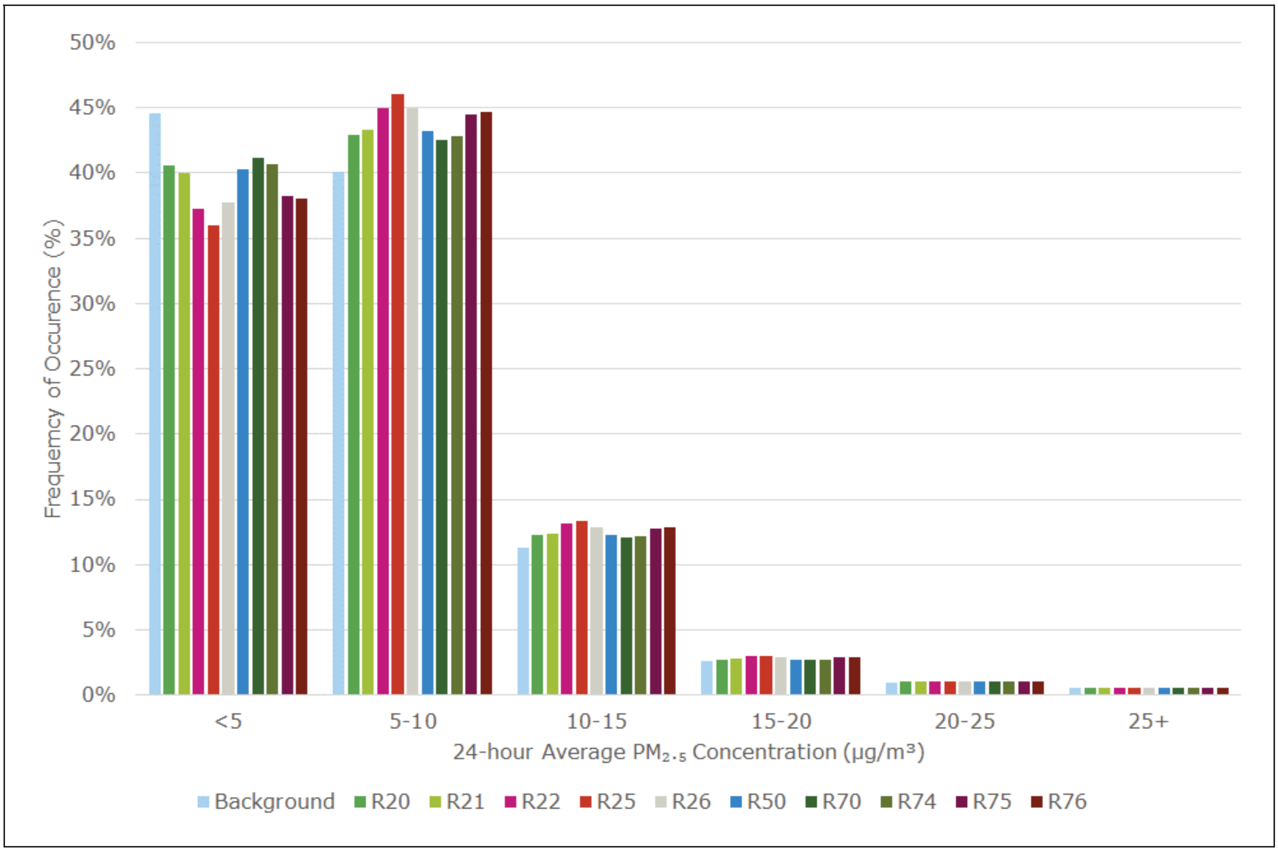


Figure 9-8: Frequency histogram of cumulative 24-hour average $PM_{2.5}$ concentrations – operational scenario – watering only at product stockpiles

9.1.4 Cumulative annual average concentrations and deposition rates

The predicted annual average concentrations from project emissions, neighbouring industrial operations plus ambient background are presented in **Table 9-3**. The results show that all cumulative annual average concentrations and dust deposition levels are below the applicable impact assessment criteria for all modelling scenarios across all sensitive receptor location.

Table 9-3: Annual cumulative concentrations and deposition rates summary – Hume Coal Project Only Increment plus Neighbouring Industrial Sources Increment plus ambient background levels

Scenario	Maximum Predicted Concentration (µg/m³) – all receptors			Dust Deposition (g/m²/month)
	Annual TSP	Annual PM_{10}	Annual $PM_{2.5}$	
Criterion	**90**	**25**	**8**	**2**
Construction	42.5	17.4	6.8	1.0
Operations – Product stockpile watering only	42.6	17.5	6.9	1.1
Operations – Product stockpile veneering and watering	42.6	17.5	6.9	1.0

The contribution to cumulative annual PM_{10} and $PM_{2.5}$ concentrations of the construction and operational phases of the project, relative to neighbouring sources and ambient background levels at each selected receptor location is illustrated in **Figure 9-9** to **Figure 9-11** for PM_{10} and **Figure 9-12** to **Figure 9-14** for $PM_{2.5}$ respectively.

On an annual average basis, it is noted that the predicted PM_{10} and $PM_{2.5}$ concentrations from the project are low relative to the combination of existing neighbouring emission sources and ambient baseline levels at all selected receptor locations. It is also noted that for the operational emission scenarios, the inclusion of veneering as a dust mitigation measure at the product stockpiles does not significantly reduce annual average concentrations. The benefit of this additional control measure is observed in reducing peak short term (24-hour average) concentrations under elevated wind speed conditions (i.e. veneering is most effective at reducing emissions on high wind days).

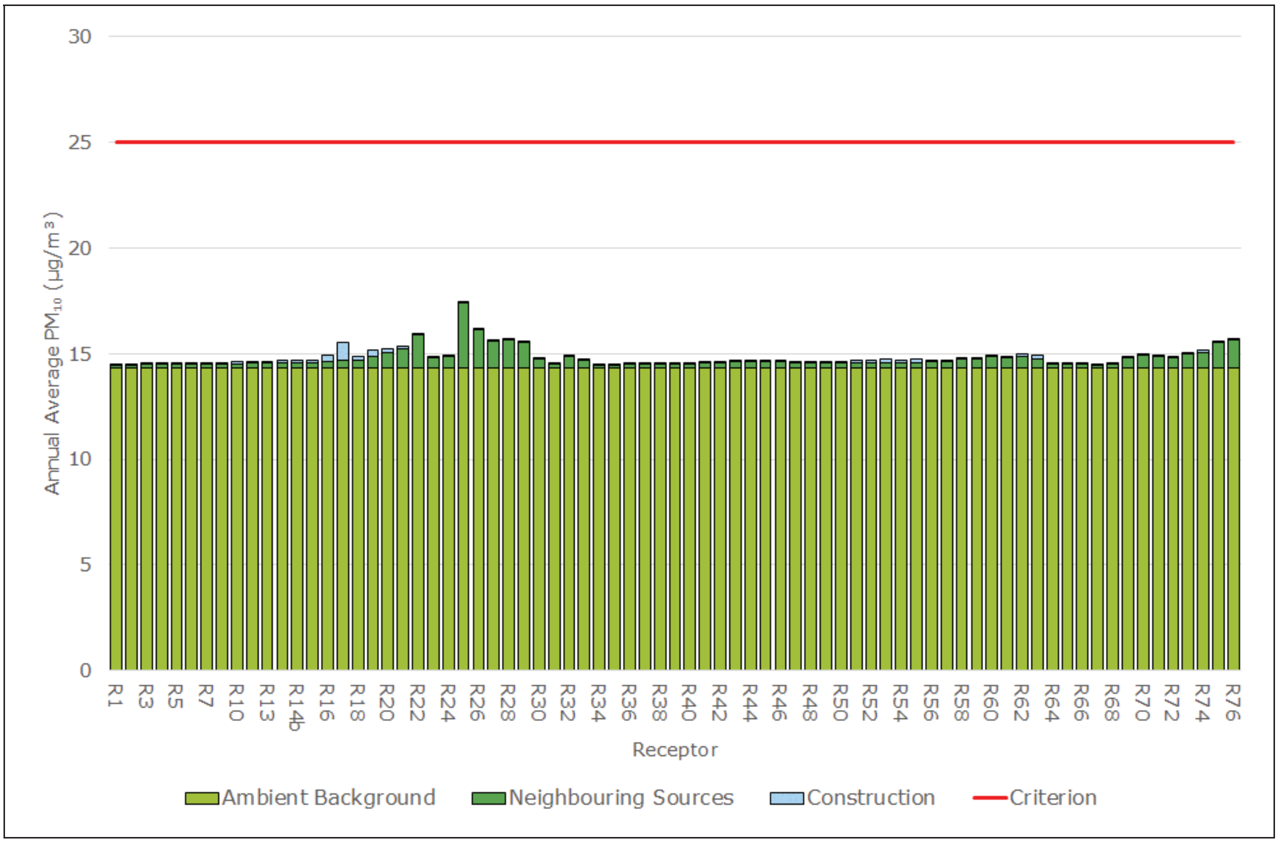


Figure 9-9: Contribution to cumulative annual average PM_{10} concentration by receptor location - construction scenario

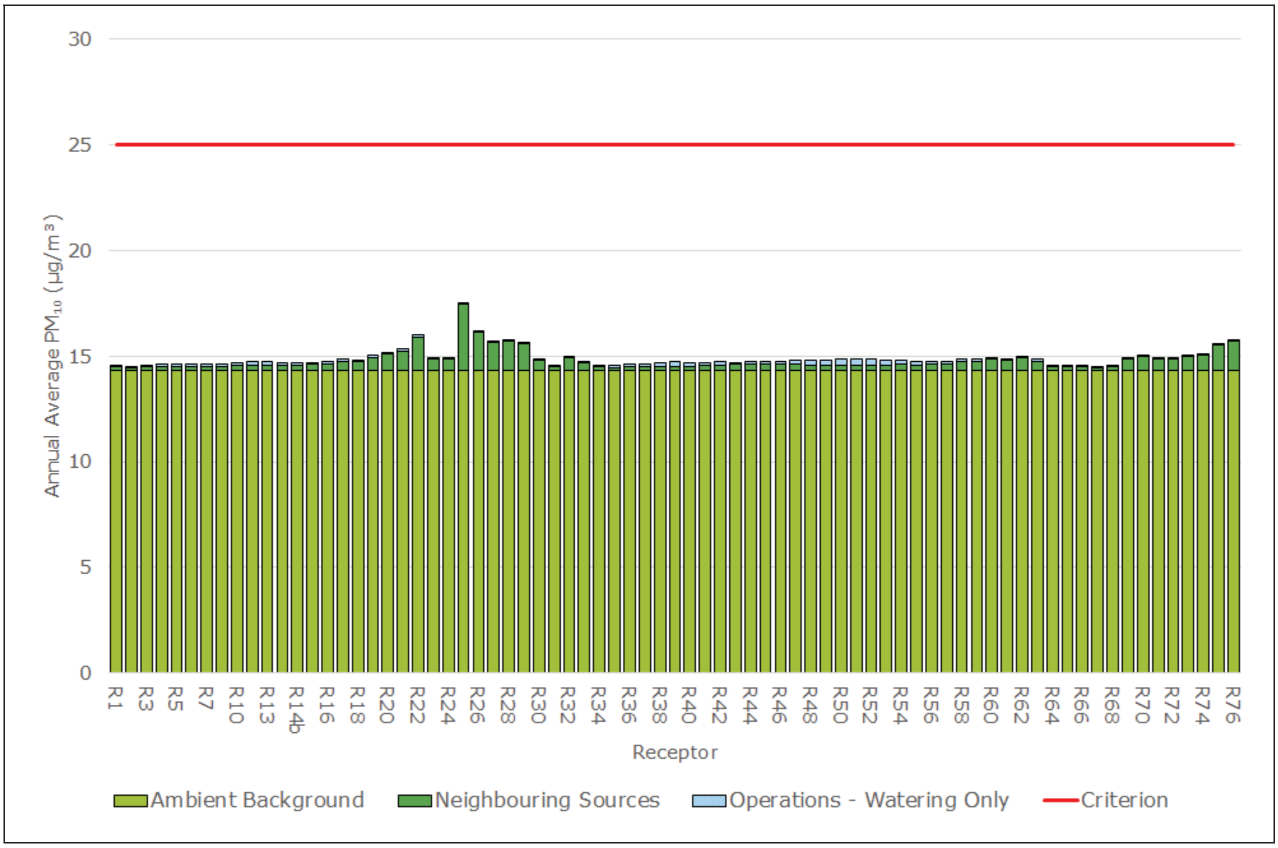


Figure 9-10: Contribution to cumulative annual average PM_{10} concentration by receptor location - operational scenario – watering only at product stockpiles

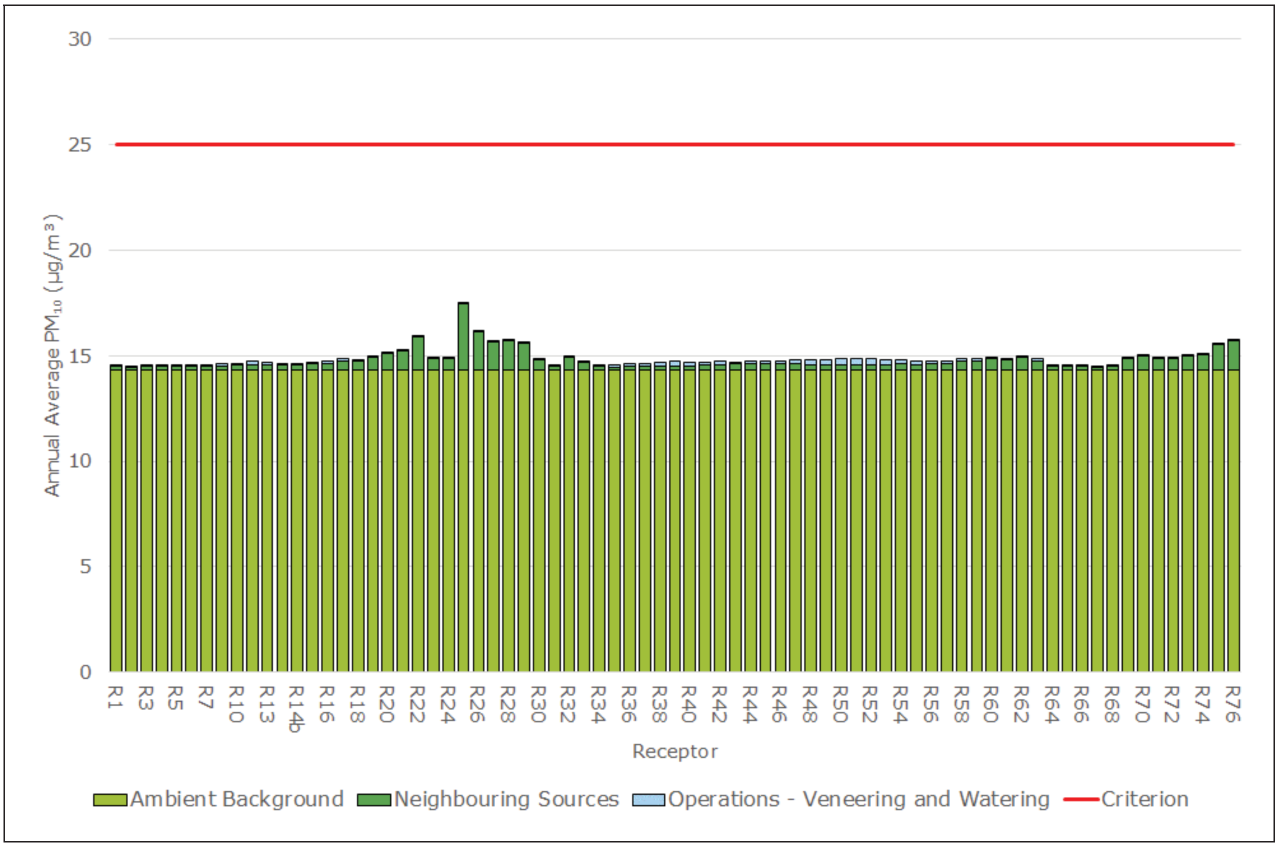


Figure 9-11: Contribution to cumulative annual average PM_{10} concentration by receptor location - operational scenario – veneering and watering at product stockpiles

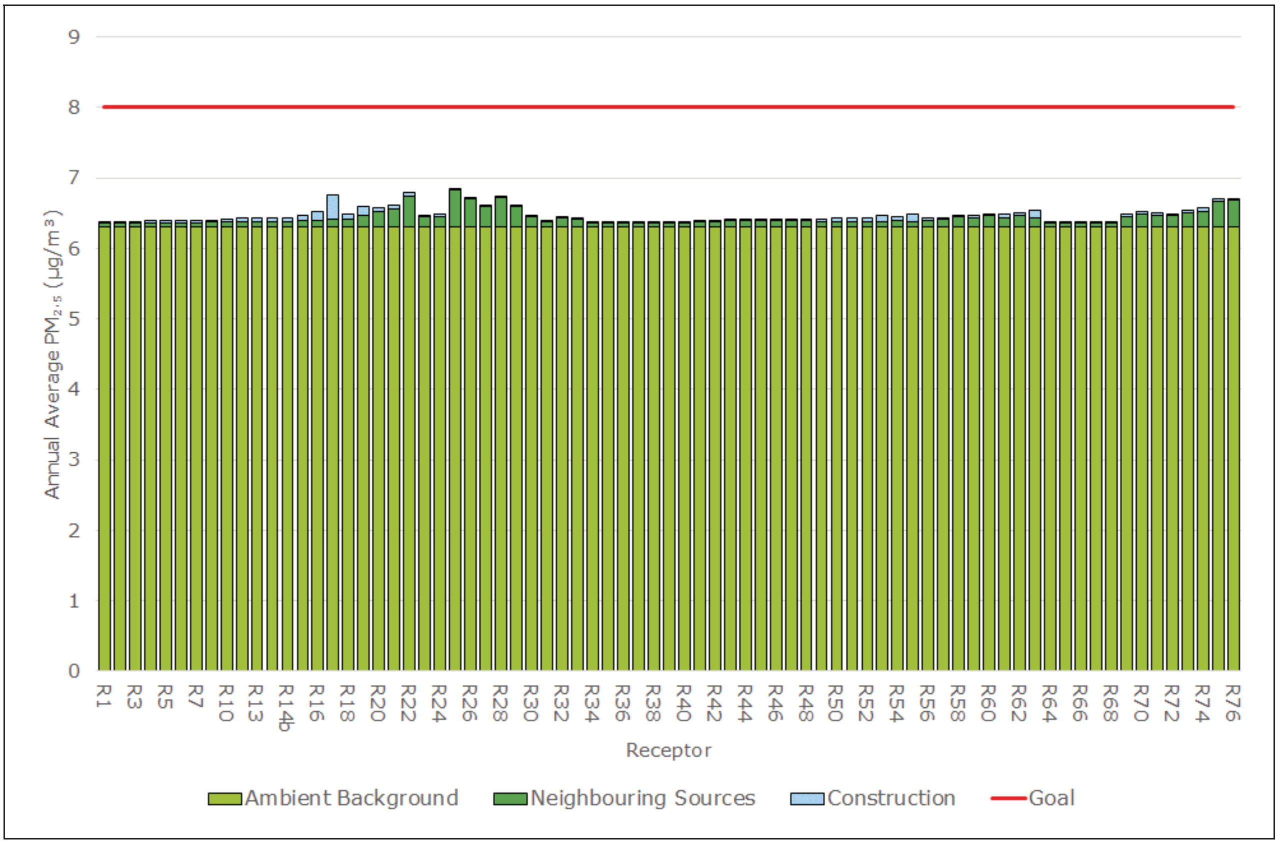


Figure 9-12: Contribution to cumulative annual average $PM_{2.5}$ concentration by receptor location - construction scenario

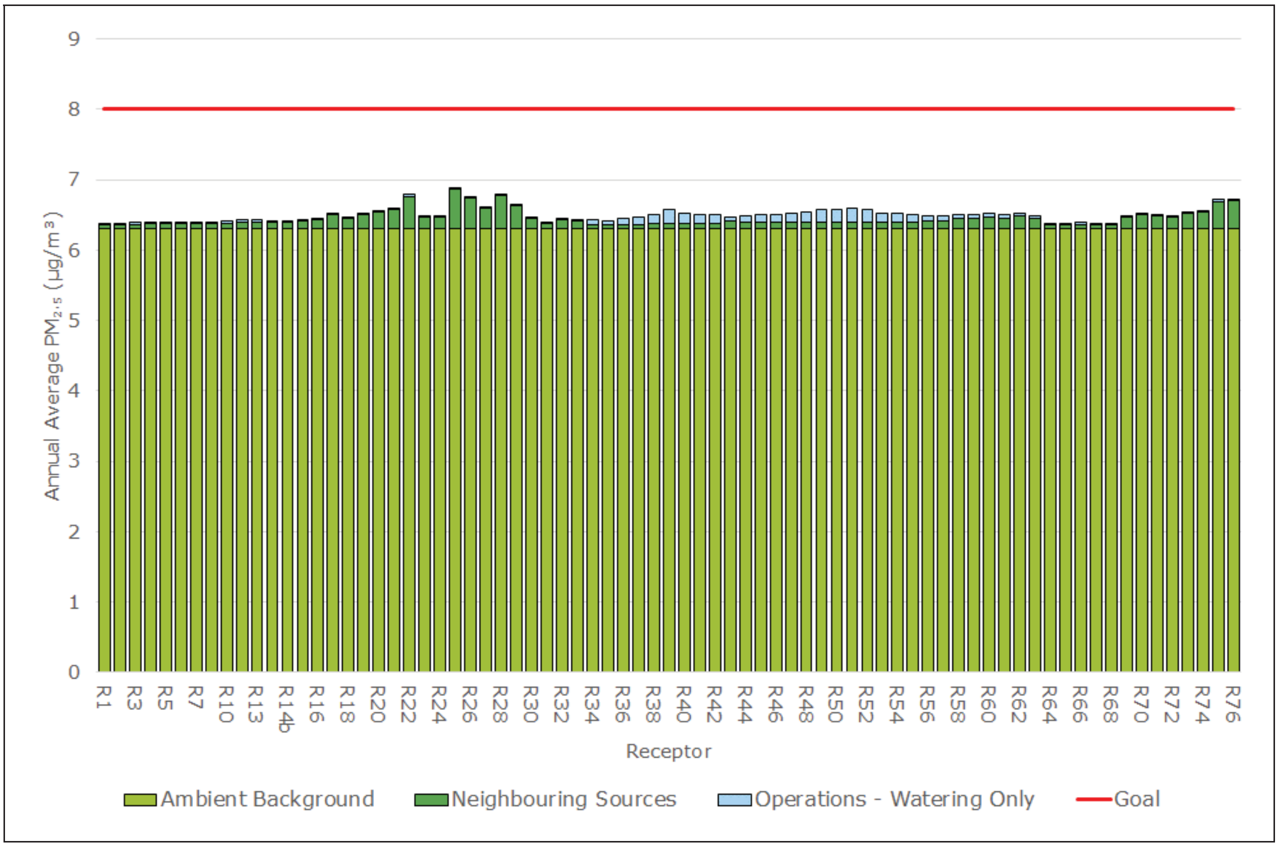


Figure 9-13: Contribution to cumulative annual average $PM_{2.5}$ concentration by receptor location - operational scenario – watering only at product stockpiles

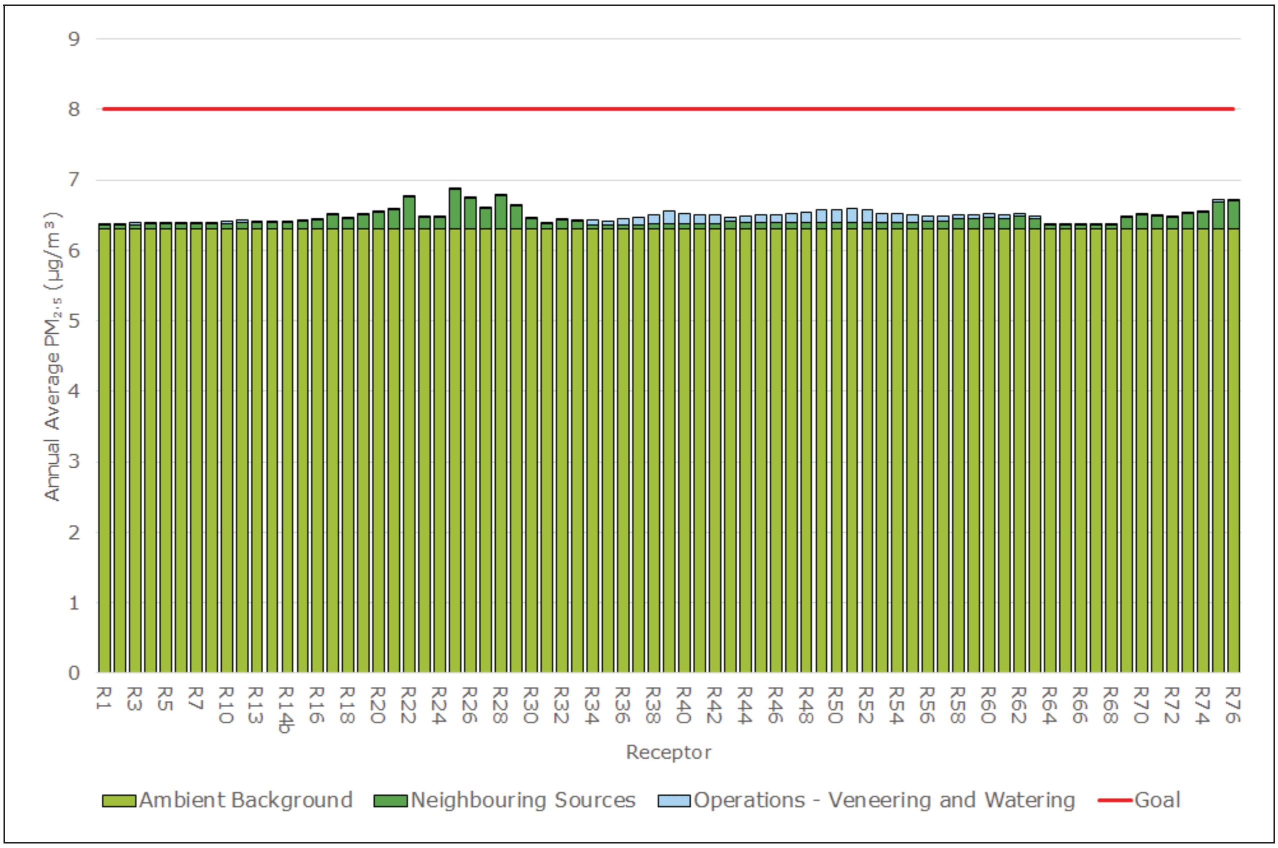


Figure 9-14: Contribution to cumulative annual average $PM_{2.5}$ concentration by receptor location - operational scenario – veneering and watering at product stockpiles

9.2 Assessment of Gaseous Pollutants

The maximum predicted concentrations of NO_2 and VOCs are detailed in **Table 9-4**, with results presented for project-only incremental and cumulative (Hume Coal + neighbouring emissions sources + ambient background) across all selected sensitive receptor locations for the peak operations scenarios.

It can be seen from the results presented in **Table 9-4** that all predicted concentrations are below applicable air quality impact assessment criteria. Therefore, adverse impacts to the surrounding environment associated with the combustion of diesel fuel by project operations are unlikely.

It is reiterated that the methodology for deriving NO_2 concentrations from predicted NO_x concentrations is highly conservative on the following basis (as per **Section 8.5**):

- 1-hour average concentrations predicted based on the peak hourly rail movements occurring continuously throughout the 12 month dispersion modelling period;
- Application of the OLM NO_x to NO_2 conversion
- Adoption of NO_2 and O_3 concentrations from the NSW OEH Bargo monitoring station.

Table 9-4: Maximum predicted incremental and cumulative NO_2 and VOC concentrations – Hume Coal Project peak operations

	Maximum Predicted Concentration (µg/m³) – all receptors		99.9th Percentile 1-hour concentration (µg/m³) – all receptors			
	1-hour NO_2	Annual NO_2	Benzene	Ethylbenzene	Toluene	Xylenes
Criterion	**246**	**62**	**29**	**8,000**	**360**	**190**
Hume Coal Project Only	16.7	0.3	0.1	0.1	0.2	0.3
Hume Coal Project + Neighbouring Emissions Sources + Ambient Background	201.7	23.0	-	-	-	-

Note: Criterion for benzene, ethylbenzene, toluene and xylenes is applicable to incremental concentrations.

9.3 Assessment of odour impacts

Modelling has been conducted for potential odour emissions from the ventilation shaft outlet, drawing on odour monitoring results obtained from other underground coal mining operations in NSW (as per **Section 7.5**).

The predicted 99th percentile 1-second (nose response) odour concentrations across all surrounding receptors is below the conservative odour assessment criterion of 2 OU. Therefore, adverse odour impacts from project emissions are unlikely in the surrounding environment.

9.4 Impact of emissions to road users and road infrastructure

To inform the preparation of the SEARs, DP&E invited other government agencies to recommend matters toaddress in the EIS. NSW Roads and Maritime services requested an assessment of the following matters in the air quality assessment:

- The impact of dust pollution on the travelling public
- The impact of dust pollution or the deposition of fines on the functioning of reflective signs, pavement markers and pavement line marking

The results of the dispersion modelling presented in the preceding sections highlight that the potential for adverse air quality impacts at any location beyond the site boundary arising from construction or operational emissions from the project is unlikely. Therefore, the impacts of dust pollution to road users are considered negligible.

Impact of dust pollution or deposition of fines to road infrastructure is considered unlikely considering the very low predicted dust deposition rates relative to measured existing dust deposition levels in the project area.

9.5 Summary of air quality impact assessment results

The results of the dispersion modelling conducted for the construction and operational phases of the project presented in the preceding sections highlight the following:

- Predicted concentrations and deposition rates of particulate matter, diesel combustion and odour air pollutants related to the project-only are well below applicable air quality impact assessment criteria, and minor relative to existing ambient background conditions;
- The construction phase of the project will generate higher impacts in the immediate surrounding environment relative to the operational phase of the project due to a greater proportion of surface based material handling, and truck transportation;
- When project incremental concentrations are combined with concentrations from neighbouring emission sources, the combined concentrations are well below applicable impact assessment criteria;
- Analysis of cumulative impacts, accounting for the combination of project and neighbouring emission sources with ambient background levels, highlights that exceedance of applicable NSW EPA impact assessment criteria would be unlikely to occur as a result of the project, beyond those that would occur in the absence of the project (i.e. days influenced by bushfires, dust storms, etc.).

10. MITIGATION AND MONITORING

10.1 Particulate matter emissions

Section 7.3.2 lists the mitigation measures and management practices proposed for the project to manage particulate matter emissions during peak operations. These controls were incorporated into the modelling wherever an appropriate emission reduction factor was available. A best practice management analysis was undertaken for the top ranking particulate matter emission sources, with proposed mitigation measures in compliance with accepted best practice dust control measures.

10.2 Diesel combustion emissions

The following management practices will be implemented at the project to minimise emissions from the combustion of diesel:

- Acquisition of best available emissions technology locomotives at the time of initial development consent, to minimise emissions from diesel combustion;
- All equipment will be routinely serviced to maintain manufacturers' emission specifications;
- Idling of diesel equipment will be minimised wherever practicable;
- Use of electric powered underground mining equipment where practicable, such as continuous miners, shuttle cars, flexible conveyors etc.; and
- Use of diesel exhaust scrubbers and diesel particulate filters on all underground diesel equipment.

10.3 Management and Monitoring of Spontaneous Combustion

The spontaneous combustion potential of the coal has been assessed using a number of coal samples from the seam including roof and floor samples, and using the SponComSIM test conducted by CB3 Mine Services Pty Ltd (CB3, 2014). These tests have demonstrated that the coal is typical of the Wongawilli Seam and South Coast coals and has a low potential for spontaneous combustion.

Hume Coal intends to manage any potential risk of spontaneous combustion for the project through the implementation of the following measures, as appropriate:

- Undertake a spontaneous combustion risk assessment for coal and coal rejects and develop and implement a Spontaneous Combustion Management Plan. This will include a "Trigger and Response Plan";
- Undertake continuous real-time monitoring of ventilation air;
- Seal mined out panels progressively as the mine is worked; and
- Stockpile management in accordance with good practice.

10.4 Air quality monitoring

As documented in **Section** 4 and **Section** 5, an extensive network of air quality and meteorological monitoring equipment is already in place at the project area. This network includes real-time measurements of meteorological conditions and particulate matter concentrations (PM_{10} and $PM_{2.5}$) and dust deposition levels.

The equipment would form the basis for any future air quality monitoring to be conducted during the life of the project. Daily and annual average PM_{10} and $PM_{2.5}$ concentrations and monthly average dust deposition results would be recorded and reported in annual environmental management reports.

During operations, the Hume 1 weather station and TEOM 1 will be decommissioned and monitoring will be undertaken by Hume 2 weather station and TEOM 2, both of which are adjacent to the majority of the surface infrastructure.

An air quality monitoring plan will be developed for the project, documenting monitoring locations, monitoring methods and reporting responsibilities.

11. GREENHOUSE GAS ASSESSMENT

11.1 Introduction

The estimation of greenhouse gas (GHG) emissions for the project is based on the Australian Government Department of the Environment (DoE) National Greenhouse Accounts Factors (NGAF) workbook (DoE, 2016). The methodologies in the NGAF workbook follow a simplified approach, equivalent to the "Method 1" approach outlined in the National Greenhouse and Energy Reporting (Measurement) Technical Guidelines (DoE 2014). The Technical Guidelines are used for the purpose of reporting under the National Greenhouse and Energy Reporting Act 2007 (the NGER Act).

For accounting and reporting purposes, GHG emissions are defined as 'direct' and 'indirect' emissions. Direct emissions (also referred to as Scope 1 emissions) occur within the boundary of an organisation and as a result of that organisation's activities. Indirect emissions are generated as a consequence of an organisation's activities but are physically produced by the activities of another organisation (DoE, 2016). Indirect emissions are further defined as Scope 2 and Scope 3 emissions. Scope 2 emissions occur from the generation of the electricity purchased and consumed by an organisation. Scope 3 emissions occur from all other upstream and downstream activities, for example the downstream extraction and production of raw materials or the upstream use of products and services.

Scope 3 is an optional reporting category (Bhatia et al, 2010) and should not be used to make comparisons between organisations, for example in benchmarking GHG intensity of products or services. Typically, only major sources of Scope 3 emissions are accounted and reported by organisations. Specific Scope 3 emission factors are provided in the NGAF workbook for the consumption of fossil fuels and purchased electricity, making it straightforward for these sources to be included in a GHG inventory, even though they are a relatively minor source.

11.2 Emission sources

The GHG emission sources included in this assessment are listed in **Table 11-1**, representing the most significant sources associated with the project.

Emissions of GHG have been quantified on an annual basis accounting for the construction and operational phases of the project. In the absence of detailed fuel and energy consumption details for the rehabilitation phase at the time of reporting, the year one construction phase fuel and energy consumption have been adopted for the calculation of annual rehabilitation GHG emissions.

GHG emissions from the project are estimated using the methodologies outlined in the NGAF workbook, using fuel energy contents and scope 1, 2 and 3 emission factors for coal, diesel, and electricity use in NSW.

Table 11-1: Scope 1, 2 and 3 emission sources

Scope 1	Scope 2	Scope 3
Direct emissions from fuel combustion (diesel) by onsite plant and equipment.	Indirect emissions associated with the consumption of purchased electricity	Indirect upstream emissions from the extraction, production and transport of diesel and petrol
Direct emissions from fuel combustion (diesel) for transport of coal in company owned locomotives.		Indirect upstream emissions from electricity lost in delivery in the transmission and distribution network.
Fugitive emissions of gas from mine ventilation.		Downstream emissions generated from the end use of product coal.

11.3 Excluded emissions

There are a number of GHG emissions that are considered minor relative to the emission sources listed in **Section 11.2** and have therefore not been incorporated into this GHG assessment. These include:

- Consumption of fuels other than diesel and petrol (e.g. LPG) (Scope 1);
- fugitive leaks from high voltage switch gear and refrigeration (Scope 1);
- waste water handling (Scope 1);
- land use change and land clearing (Scope 1);
- disposal of solid waste at landfill (Scope 3);
- travel of employees to and from the project (Scope 3).

In the case of land use change, it is considered that the GHG emissions generated by the changes to the land use in the establishment of the project will be offset by the rehabilitation of the site at the completion of the project.

11.4 Activity data

Estimates of annual energy consumption associated with the construction and operational phases have been provided by Hume Coal. Annual estimates for ROM coal extraction, diesel fuel consumption by mobile mining equipment, stationary combustion sources (e.g. emergency generators) and Hume Coal-owned locomotives transporting product coal to Port Kembla, petrol and purchased electricity consumption are summarised in **Table 11-2**.

As stated previously, in the absence of energy consumption requirements for the rehabilitation phase, consumption rates from the first year of construction have been adopted to estimate annual rehabilitation GHG emissions.

Table 11-2: Annual ROM coal production schedule and activity data

Year	ROM production (Mt)	Product coal (Mt)	Diesel (on site, mobile equipment) (kL)	Diesel (on-site, stationary equipment) (kL)	Diesel (Hume owned locomotives) (kL)	Petrol consumption (kL)	Electricity (kWh)
Construction Y1	-	-	4,205	-	-	128	3,756,225
Construction Y2	0.033	0.030	4,536	2	15	132	30,710,745
Operations Y1	1.03	0.85	662	5	430	7	53,909,040
Operations Y2	2.42	1.99	993	5	1,008	11	80,863,560
Operations Y3	3.08	2.62	1,324	6	1,327	14	107,818,080
Operations Y4	2.17	1.79	1,324	7	906	14	107,818,080
Operations Y5	3.10	2.51	1,324	8	1,271	14	107,818,080
Operations Y6	3.10	2.44	1,324	9	1,236	14	107,818,080
Operations Y7	3.18	2.40	1,324	10	1,215	14	107,818,080
Operations Y8	3.22	2.49	1,324	10	1,261	14	107,818,080
Operations Y9	3.28	2.68	1,324	10	1,357	14	107,818,080
Operations Y10	2.32	1.92	1,324	10	972	14	107,818,080
Operations Y11	3.02	2.48	1,324	10	1,256	14	107,818,080
Operations Y12	3.14	2.56	1,324	10	1,296	14	107,818,080
Operations Y13	3.40	2.60	1,324	10	1,317	14	107,818,080
Operations Y14	3.11	2.04	1,324	10	1,033	14	107,818,080
Operations Y15	2.56	1.72	1,324	10	871	14	107,818,080
Operations Y16	3.20	2.63	1,324	10	1,332	14	107,818,080
Operations Y17	2.73	2.28	1,324	10	1,155	14	107,818,080
Operations Y18	2.19	1.80	1,059	10	912	12	86,254,464
Operations Y19	0.20	0.16	265	10	81	3	21,563,616
Rehabilitation Y1	-	-	4,205	-	-	128	3,756,225
Rehabilitation Y2	-	-	4,205	-	-	128	3,756,225

11.5 Emission estimates

The following emission factors have been adopted in estimating GHG emissions from the project:

- Diesel consumption on-site (Scope 1) – Diesel oil factors from Table 3 of the NGAF Workbook (2016);
- Diesel consumption; locomotive engines (Scope 1) – Post-2004 Diesel oil factors from Table 4 of the NGAF Workbook (2016)
- Petrol consumption (Scope 1) - Petrol factors from Table 3 of the NGAF Workbook (2016);
- Fugitive methane emissions (Scope 1) – site specific emission factor based on coal seam gas content monitoring results – 0.00068 t CO_2-e/t ROM coal;
- Electricity consumption (Scope 2) – NSW Scope 2 emission factor from Table 41 of the NGAF Workbook (2016);
- Diesel consumption on-site and locomotives (Scope 3) – Diesel oil factor from Table 40 of the NGAF Workbook (2016);
- Petrol consumption on-site (Scope 3) – Petrol factor from Table 40 of the NGAF Workbook (2016);
- Electricity consumption (Scope 3) - NSW Scope 3 emission factor from Table 41 of the NGAF Workbook (2016);
- End use of product coking coal (Scope 3) – Coking coal factor from Table 37 of the NGAF Workbook (2016); and
- End use of product thermal coal (Scope 3) – Bituminous coal factor from Table 37 of the NGAF Workbook (2016).

The estimated annual GHG emissions for each emission source are presented in **Table 11-3**, with annual total and annual average Scope 1, Scope 2 and Scope 3 emissions presented in **Table 11-4**.

The significance of project GHG emissions relative to state and national GHG emissions is made by comparing annual average Scope 1, 2 and 3 emissions (excluding the end use of product coal) against the most recent available total GHG emissions inventories (calendar year 2014[5]) for NSW (130,115.7 kt CO_2-e) and Australia (523,309.8 kt CO_2-e). Scope 3 emissions are not included in the comparison with NSW and Australian inventories, for reasons stated in **Section 11.1**.

Annual average GHG emissions generated by the project represent approximately 0.068% of total GHG emissions for NSW and 0.017% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2014[6].

[6] http://ageis.climatechange.gov.au/

Table 11-3: Estimated GHG emissions (tonnes CO_2-e) by emissions source

Year	ROM (Mt)	Scope 1					Scope 2	Scope 3				
		Diesel (on-site, mobile equipment)	Diesel (on-site, stationary equipment)	Diesel (Hume owned locomotives)	Petrol	Mine ventilation gas	Electricity	Diesel fuel	Electricity	Petrol	End use of Coking Coal	End use of Thermal Coal
Construction Y1	-	11,281	-	-	306	-	3,155	584	451	16	-	-
Construction Y2	0.033	12,169	5	41	315	23	25,797	46,573	3,685	16	3,456	972
Operations Y1	1.0	1,776	14	1,155	17	703	45,284	92,033	6,469	1	97,920	27,540
Operations Y2	2.4	2,663	14	2,703	26	1,656	67,925	138,099	9,704	1	229,248	64,476
Operations Y3	3.1	3,551	16	3,559	33	2,108	90,567	184,130	12,938	2	301,824	84,888
Operations Y4	2.2	3,551	19	2,432	33	1,482	90,567	184,072	12,938	2	206,208	57,996
Operations Y5	3.1	3,551	22	3,410	33	2,125	90,567	184,122	12,938	2	289,152	81,324
Operations Y6	3.1	3,551	24	3,315	33	2,119	90,567	184,118	12,938	2	281,088	79,056
Operations Y7	3.2	3,551	27	3,260	33	2,175	90,567	184,115	12,938	2	276,480	77,760
Operations Y8	3.2	3,551	27	3,383	33	2,206	90,567	184,121	12,938	2	286,848	80,676
Operations Y9	3.3	3,551	27	3,641	33	2,244	90,567	184,135	12,938	2	308,736	86,832
Operations Y10	2.3	3,551	27	2,608	33	1,589	90,567	184,081	12,938	2	221,184	62,208
Operations Y11	3.0	3,551	27	3,369	33	2,066	90,567	184,121	12,938	2	285,696	80,352
Operations Y12	3.1	3,551	27	3,478	33	2,151	90,567	184,126	12,938	2	294,912	82,944
Operations Y13	3.4	3,551	27	3,532	33	2,324	90,567	184,129	12,938	2	299,520	84,240
Operations Y14	3.1	3,551	27	2,771	33	2,129	90,567	184,090	12,938	2	235,008	66,096
Operations Y15	2.6	3,551	27	2,337	33	1,752	90,567	184,067	12,938	2	198,144	55,728
Operations Y16	3.2	3,551	27	3,573	33	2,190	90,567	184,131	12,938	2	302,976	85,212
Operations Y17	2.7	3,551	27	3,097	33	1,871	90,567	184,107	12,938	2	262,656	73,872
Operations Y18	2.2	2,841	27	2,445	29	1,501	72,454	147,284	10,351	1	207,360	58,320
Operations Y19	0.2	710	27	217	7	137	18,113	36,802	2,588	0	18,409	5,178
Rehabilitation Y1	-	11,281	-	-	306	-	3,155	584	451	16	-	-
Rehabilitation Y2	-	11,281	-	-	306	-	3,155	584	451	16	-	-
Project Total		**107,268**	**468**	**54,327**	**1,812**	**34,550**	**1,597,547**	**8,394**	**228,221**	**94**	**4,606,825**	**1,295,670**
Annual average		**4,664**	**20**	**2,362**	**79**	**1,502**	**69,459**	**365**	**9,923**	**4**	**200,297**	**56,333**

Table 11-4: Scope 1, 2 and 3 emission sources

Project Year	Scope 1	Scope 2	Scope 3
Construction Y1	11,586	3,155	1,051
Construction Y2	12,553	25,797	8,762
Operations Y1	3,664	45,284	132,082
Operations Y2	7,062	67,925	303,708
Operations Y3	9,268	90,567	400,021
Operations Y4	7,517	90,567	277,455
Operations Y5	9,141	90,567	383,778
Operations Y6	9,043	90,567	373,441
Operations Y7	9,047	90,567	367,534
Operations Y8	9,200	90,567	380,824
Operations Y9	9,496	90,567	408,882
Operations Y10	7,809	90,567	296,652
Operations Y11	9,046	90,567	379,348
Operations Y12	9,241	90,567	391,161
Operations Y13	9,468	90,567	397,068
Operations Y14	8,512	90,567	314,373
Operations Y15	7,700	90,567	267,118
Operations Y16	9,375	90,567	401,498
Operations Y17	8,581	90,567	349,814
Operations Y18	6,843	72,454	276,307
Operations Y19	1,098	18,113	26,224
Rehabilitation Y1	11,586	3,155	1,051
Rehabilitation Y2	11,586	3,155	1,051
Project Total	**198,422**	**1,597,543**	**6,139,204**
Annual average	**8,627**	**69,458**	**266,922**

12. CONCLUSIONS

Dispersion modelling was undertaken for the peak construction and peak operational phases of the proposed project. Atmospheric dispersion modelling was undertaken using the US-EPA regulatory model, AERMOD. Hourly meteorological observations from 2013, collected by an onsite meteorological station and the nearby BoM Moss Vale AWS, were used as inputs into the dispersion modelling process.

The results of the modelling show that for both construction and operational phases, the predicted particulate matter (TSP, PM_{10}, $PM_{2.5}$) and gaseous pollutant (NO_2 and VOCs) concentrations and dust deposition levels associated with project emissions are well below applicable impact assessment criteria at neighbouring sensitive receptors.

Cumulative impacts were assessed by combining modelled project impacts with predicted impacts from neighbouring industrial emission sources and ambient background levels adopted from local and regional air quality monitoring stations. The results of the cumulative analysis highlight that the likelihood of the project resulting in an exceedance of applicable cumulative assessment criteria is very low.

The design of the project incorporates a range of dust mitigation measures. A best practice dust control measures review was undertaken for the proposed mitigation measures. The review identified that proposed measures are in accordance with or above accepted industry best practice dust control measures.

On the basis of the modelling conducted, the proposed mitigation measures effectively control emissions to minimise impacts on the surrounding environment. The modelling identified that the integration of a surface crusting veneer product to the product coal stockpiles in addition to water sprays would achieve a higher emission and impact reduction than watering alone, however it is noted that impacts from either control configuration are low relative to impact assessment criteria.

A greenhouse gas quantification assessment was undertaken for the project. The annual Scope 1 and Scope 3 emissions (excluding the end use of product coal) represent approximately 0.068% of total GHG emissions for NSW and 0.017% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2014.

13. GLOSSARY OF KEY ACRONYMS AND SYMBOLS

AHD	Australian Height Datum
Approved Methods for Modelling	Approved Methods for the Modelling and Assessment of Air Pollutants in NSW
AWS	Automatic Weather Station
BoM	Australian Bureau of Meteorology
CO_2	Carbon dioxide
CO_2-e	CO_2 equivalent
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCCEE	Department of Climate Change and Energy Efficiency
DEC	NSW Department of the Environment and Conservation
DoE	Department of Environment
EMM	EMM Consulting
EPL	Environmental Protection Licence
GHG	Greenhouse Gas
LGA	Local government area
µg	Microgram (g x 10-6)
µm	Micrometre or micron (metre x 10-6)
m^3	Cubic metre
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NGAF	National Greenhouse Accounts Factors
NPI	National Pollutant Inventory
PM_{10}	Particulate matter less than 10 microns in aerodynamic diameter
$PM_{2.5}$	Particulate matter less than 2.5 microns in aerodynamic diameter
OEH	Office of Environment and Heritage
Ramboll Environ	Ramboll Environ Australia Pty Ltd
SEARs	Secretary's Environmental Assessment Requirements
TAPM	The Air Pollution Model
tpa	Tonnes per annum
TSP	Total Suspended Particulate
US-EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds
VKT	Vehicle Kilometres Travelled

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APPENDIX 1
SEASONAL AND DIURNAL WIND ROSES

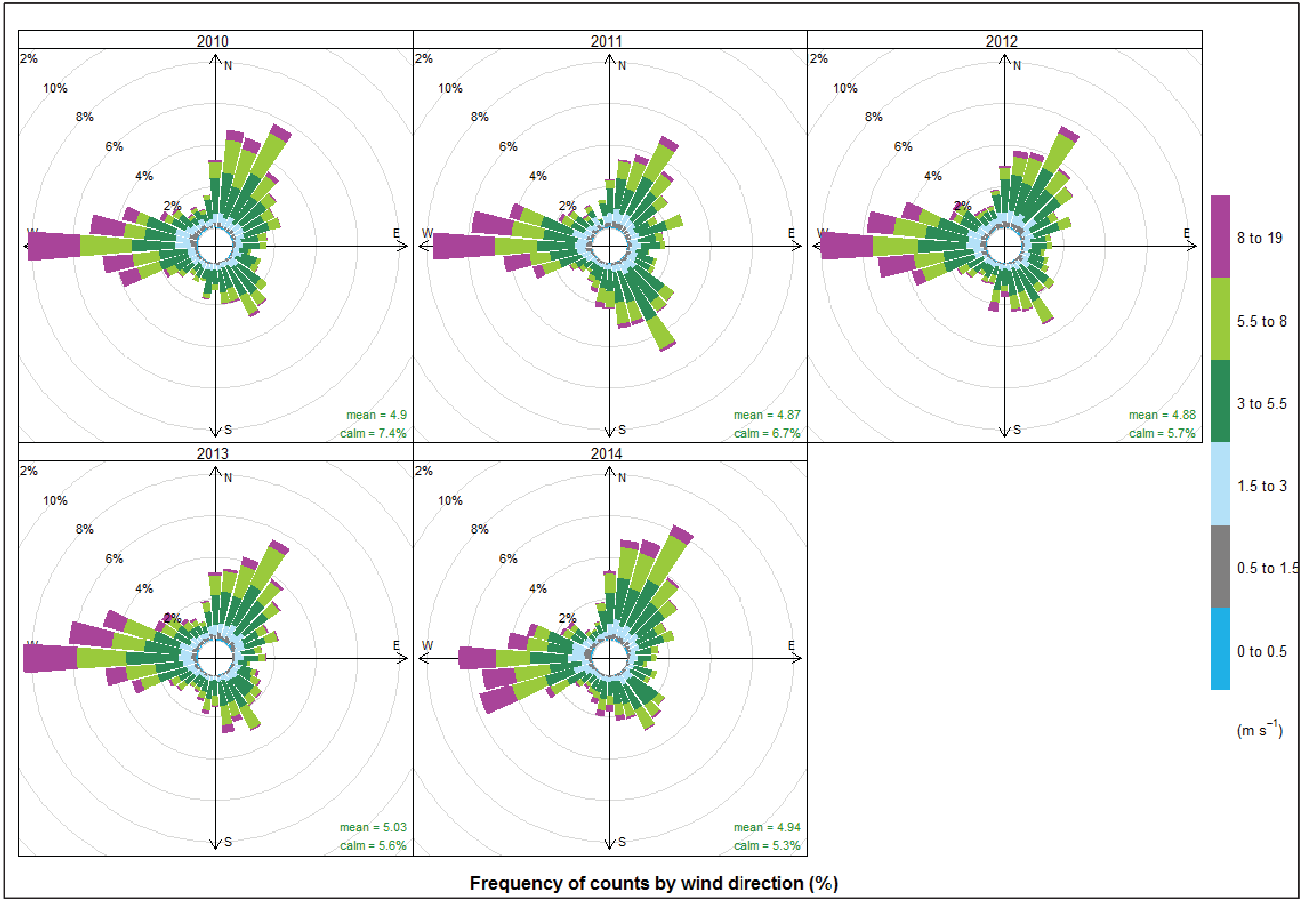


Figure A1-1: Annual wind roses – BoM Moss Vale – 2010 to 2014

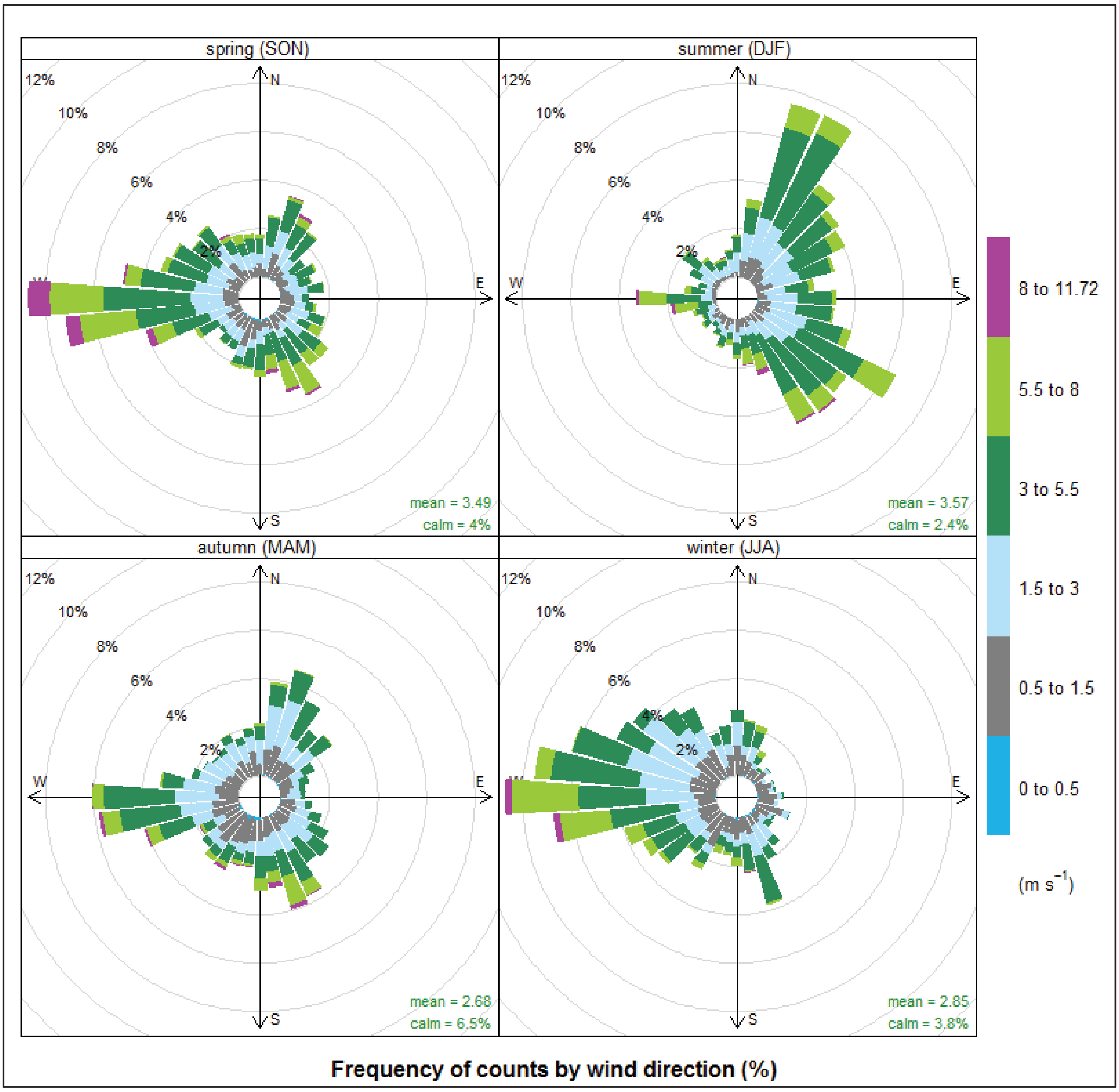


Figure A1-2: Seasonal wind roses – Hume 1 - 2013

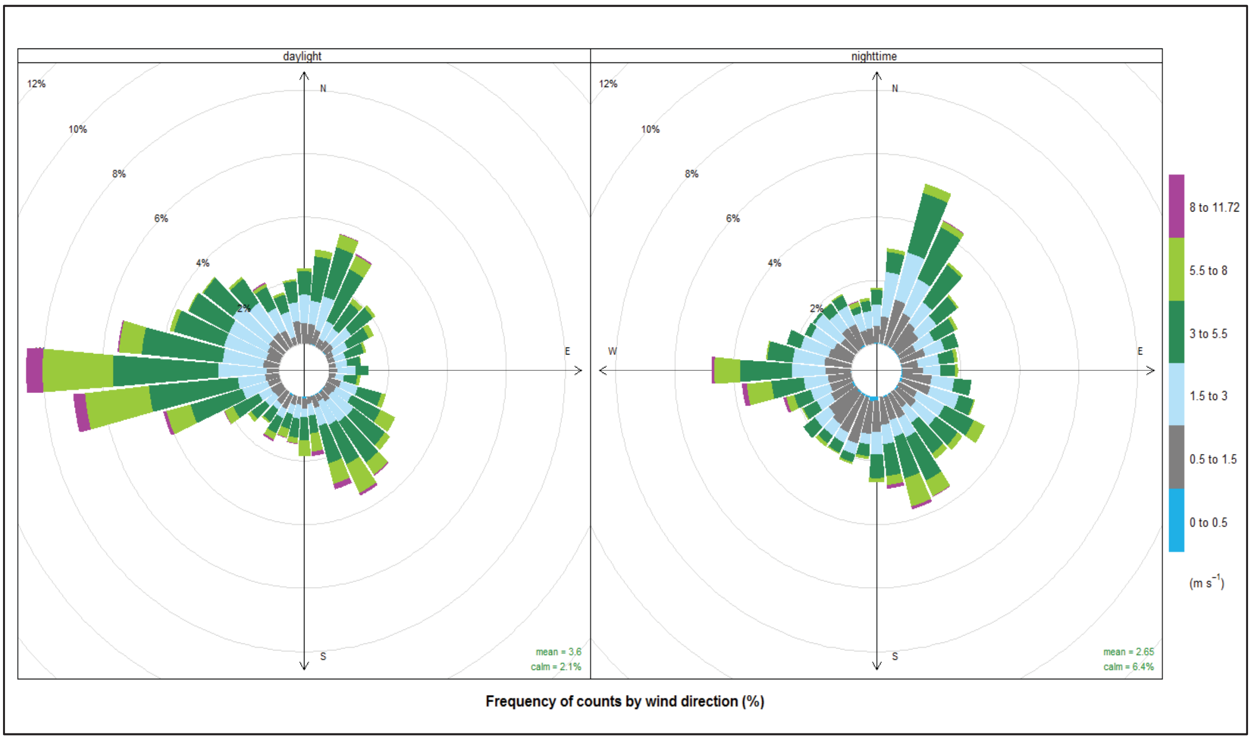


Figure A1-3: Diurnal wind roses – Hume 1 - 2013

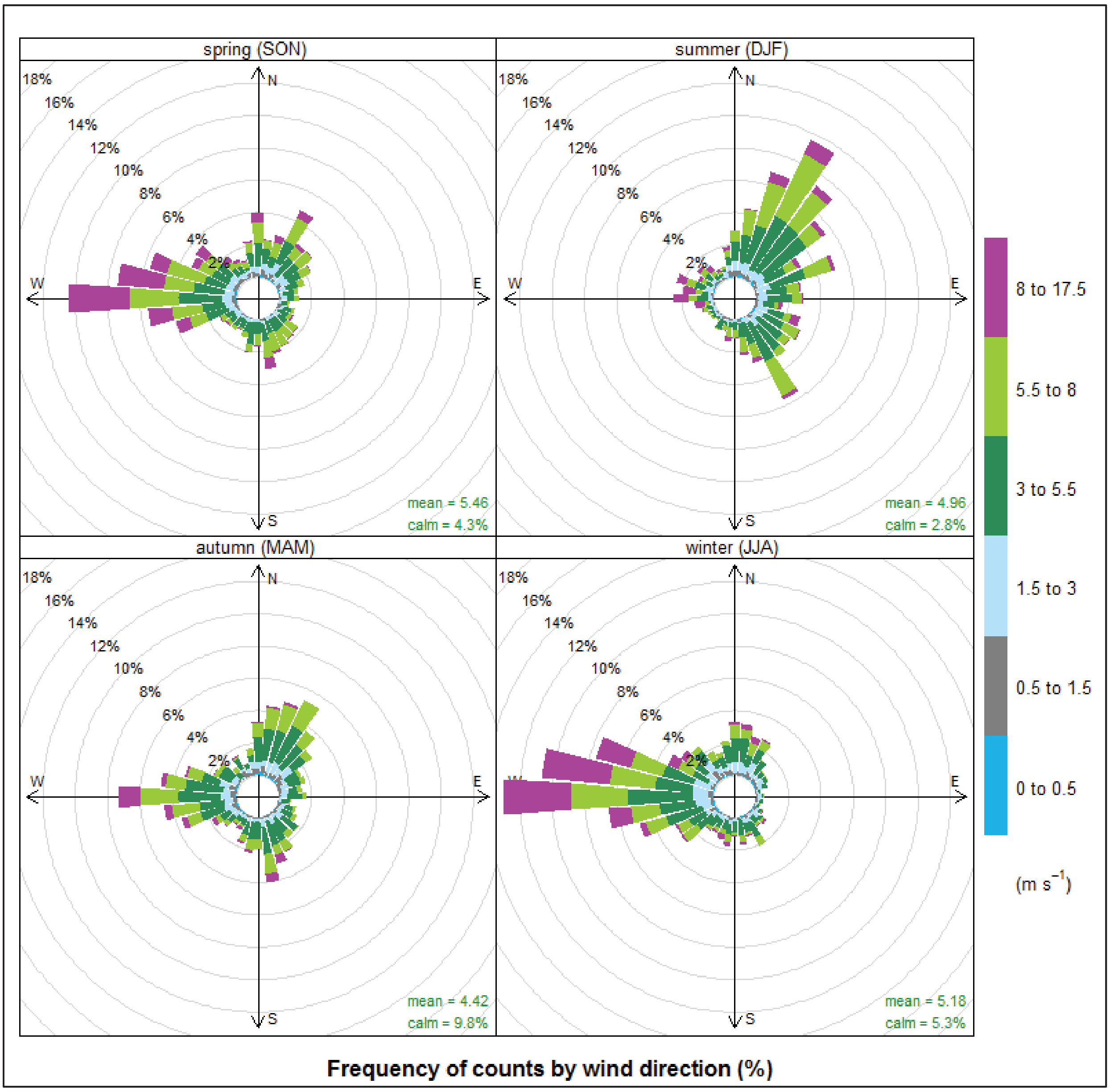


Figure A1-4: Seasonal wind roses – BoM Moss Vale - 2013

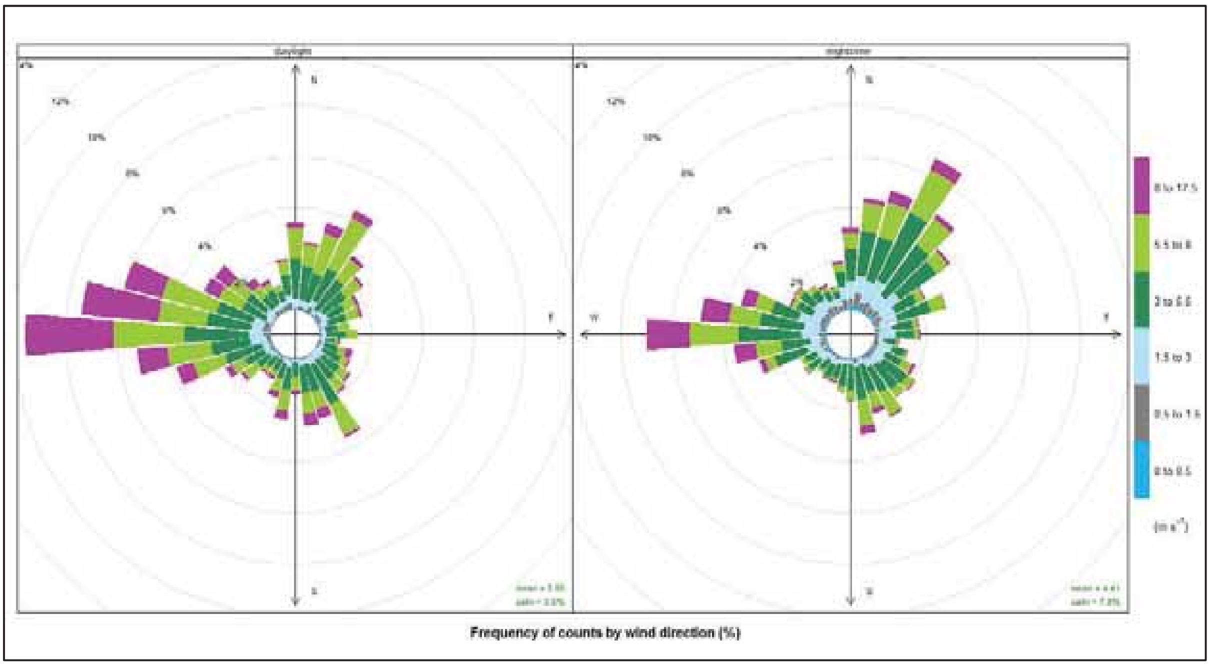


Figure A1-5: Diurnal wind roses – BoM Moss Vale - 2013

APPENDIX 2
NEIGHBOURING EMISSION SOURCE EMISSION CALCULATIONS AND IMPACTS

Emission Calculations

Air pollution emissions from neighbouring industrial operations have been quantified through a combination of publicly available air quality impact assessment reports, NPI annual reporting totals, EPL maximum authorised production rates and emission estimation manuals. The following sections provide a discussion of emission calculations by source.

Boral Berrima Cement Works

The primary resource for emission estimation from the Boral Berrima Cement Works facility was the air quality impact assessment *Boral Cement Berrima Works Use of Solid Waste Derived Fuels in Kiln 6 –Air Quality Impact Assessment* (Air Quality Professionals, 2015).

Emission rates presented in Section 4.8 of the Boral Berrima Cement air quality assessment were adopted in this assessment. Fugitive wind-dependant emissions (e.g. wind erosion) were varied by wind speed, with higher emissions from such sources coinciding with higher wind speeds. Emission source parameters presented in Section 5 of the Boral Berrima Cement air quality assessment were adopted in the modelling conducted for this assessment.

New Berrima Shale Quarry

The primary resource for emission estimation from the approved New Berrima Shale Quarry was the air quality impact assessment *Modified New Berrima Clay/Shale Quarry Appendix 5 Air Quality Impact Assessment* (SLR, 2015).

Annual emission rates presented in Section 2.1 of the New Berrima Shale Quarry air quality assessment were adopted in this assessment. Fugitive wind-dependant emissions (e.g. wind erosion) were varied by wind speed, with higher emissions from such sources coinciding with higher wind speeds. In the absence of source location details, emission sources were configured across the proposed site extraction and site access road areas.

Dux Manufacturing, Moss Vale

The primary resource for emission estimation from the Dux Manufacturing facility at Moss Vale was the NPI annual reporting totals of PM_{10}, $PM_{2.5}$, and NO_x for 2013/2014, as archived on the NPI website database. Emissions were released on a continuous basis in the absence of facility-specific operating details.

To estimate TSP, annual emissions of PM_{10} were up scaled by a factor of two.

Volume emission sources were configured across the Dux Manufacturing site in the absence of site emission parameters.

Ingham's Berrima Feed Mill

The primary resource for emission estimation from Ingham's Berrima Feed Mill facility was the NPI annual reporting totals of PM_{10}, $PM_{2.5}$, and NO_x for 2013/2014, as archived on the NPI website database. Emissions were released on a continuous basis in the absence of facility-specific operating details.

To estimate TSP, annual emissions of PM_{10} were up scaled by a factor of two.

Volume emission sources were configured across Ingham's Berrima Feed Mill site in the absence of site emission parameters.

Omya Southern Limestone, Moss Vale

There was no publicly available air quality impact assessment or NPI reporting totals for the Omya Southern Limestone facility. The EPL for the facility identifies that operation is approved to process up to 500,000tpa of limestone material.

Using US-EPA AP-42 equations and emission factors and a peak processing throughput of 500,000tpa, annual emissions of TSP, PM_{10} and $PM_{2.5}$ were estimated for the Omya Southern Limestone facility. Emission calculations are presented in **Table A2.1**.

Table A2-1 Emission Calculations and Assumptions – Omya Southern Limestone

Emissions Source	Number of Sources	Factor Source	Emission Factor			Unit	Emission Control	Reduction Factor	Annual Emission (kg/annum)		
			TSP	PM_{10}	$PM_{2.5}$				TSP	PM_{10}	$PM_{2.5}$
Unloading trains	1	AP-42 11.19.2 - Transfer Point	0.0015	0.00055	0.000155	kg/t	Enclosed	0.7	225.0	82.5	23.3
Stockpile Loading	1	AP-42 11.19.2 - Transfer Point	0.0015	0.00055	0.000155	kg/t	Watering	0.5	375.0	137.5	38.9
Crushing	4	AP-42 11.19.2 - Tertiary Crushing	0.0027	0.0012	0.000222	kg/t	Enclosed	0.7	405.0	180.0	33.3
Screening	4	AP-42 11.19.2 - Screening	0.0125	0.0043	0.000291	kg/t	Enclosed	0.7	1,875.0	645.0	43.6
Conveying transfer	6	AP-42 11.19.2 - Transfer Point	0.0015	0.00055	0.000155	kg/t	Enclosed	0.7	225.0	82.5	23.3
Truck Loading	1	AP-42 11.19.2 - Transfer Point	0.0015	0.00055	0.000155	kg/t	Enclosed	0.7	225.0	82.5	23.3
Material Handling Yard	1	AP-42 11.19.2 - Transfer Point	0.0015	0.00055	0.000155	kg/t	Watering	0.5	375.0	137.5	38.9
Unpaved Roads	1	AP-42 13.2.2 - Unpaved Roads equation	3.3808	0.9318	0.0932	kg/VKT	Watering	0.75	7,043.4	1,941.3	194.1
Paved Roads	1	AP-42 13.2.1 - Paved Roads equation	0.0613	0.0118	0.0028	kg/VKT			510.7	98.0	23.7
Wind Erosion	1	AP-42 11.9 - Wind erosion from exposed surfaces	850	425	63.75	kg/ha/year	Watering	0.5	382.5	191.3	28.7
								Total	**11,641.6**	**3,578.1**	**471.1**

Other assumptions: Paved and Unpaved road length – 500m return journey; Load in truck – 30t; Average truck weight – 45t – Unpaved road silt content – 7.1% (US-EPA default for sand and gravel processing); Paved road silt loading – 0.6g/m^2 (US-EPA default).

Southern Regional Livestock Exchange

There was no publicly available air quality impact assessment or NPI reporting totals for the Southern Regional Livestock Exchange at Moss Vale. The EPL for the facility identifies that operation is approved to accommodate 25,000 head of cattle.

The NPI *Emission Estimation Manual for Intensive livestock - beef cattle* (NPI, 2007) provides a PM_{10} emission estimation factor of 11.7t PM_{10}/1,000 standard cattle unit (SCU). A scaling factor of 0.15 was applied to the PM_{10} emission factor to derive a $PM_{2.5}$ emission factor (1.8t/1,000 SCU). Sweeton et al (1998) identify that 66% of TSP is in the form of PM_{10}, which was used to derive a TSP emission factor (17.7t/1,000 SCU).

Control factors of 50% for water application and 70% for wind breaks due to the facility shed structure, were applied. Using the NPI emission factor/derived emission factors and 25,000 cattle per year, the following annual emissions were calculated

- 66,477.3kg TSP;
- 43,875.0kg PM_{10}; and
- 6,581.3kg $PM_{2.5}$.

Volume emission sources were configured across the Southern Regional Livestock Exchange site in the absence of site emissions parameters.

Wingecarribee Resource Recovery Centre, Moss Vale

There was no publicly available air quality impact assessment or NPI reporting totals for the Wingecarribee Resource Recovery Centre at Moss Vale. The EPL for the facility identifies that operation is approved to compost up to 50,000 t of organics received, however this threshold is not appropriate to calculate annual emissions from all practices onsite.

In order to estimate potential annual emissions from this facility, a recent air quality impact assessment for an existing recycling facility in western Sydney undertaken by Ramboll Environ (*Widemere Recycling Facility - Air Quality Impact Assessment* - Environ 2015) has been referenced.

Based on the approximate land area of the Wingecarribee Resource Recovery Centre (6.2ha) and the Widemere facility (10ha), the annual particulate matter emissions for the Widemere facility have been scaled by 0.62. Annual emissions for the Wingecarribee Resource Recovery Centre are therefore derived as:

- 21,708.1kg TSP;
- 5,175.3kg PM_{10}; and
- 668.0kg $PM_{2.5}$.

Volume emission sources were configured across the Wingecarribee Resource Recovery Centre site.

Berrima Branch Line – existing and future operations

Emissions from the Berrima Branch Line (existing and future) are assessed in detail within Section 8 of the EIS for the Berrima Rail Project (EMM, 2016). Emissions were quantified based on the highest possible 24-hour emissions (for TSP, PM_{10} and $PM_{2.5}$) and hourly emissions (for NO_x) from rail movements using the assumptions listed below.

- In any 24-hour period, 26 train movements occur over a working weekday 24 hour period for existing Berrima Branch Line activity. The Hume Coal Project will add an additional eight train movements per day.
- A peak hourly rail movement scenario was configured to assess peak 1-hour average concentrations of NO_2 and VOCs. Based on information provided by Hume Coal, the estimated run time for the rail section between Berrima Junction and Boral's Berrima Cement Works is between 17 and 23 minutes. Consequently, the peak 1-hour traffic scenario assumed two train movements occur for existing Berrima Branch Line activity, with the Hume Coal Project adding a maximum of one additional train per hour.

- Existing Berrima Branch Line train movements involve trains with one or two locomotives of 81 Class. For conservative purposes, all trains are assumed to have two locomotives.
- Hume Coal trains will have two locomotives of C44aci Class or similar.
- Locomotive 81 Class has a gross power rating of 3,300 bhp, while C44aci Class has a gross power rating of 4,500 bhp.
- Based on information provided by Hume Coal, the average weighting of locomotive engine notch settings for the journey from Berrima Junction to Boral and Hume Coal is 2 and 3 respectively. Locomotive engines are assumed to be in notch 1 when idling. Based on Table 5-2 of US-EPA (1998), the power output for notch 1, 2 and 3 is 4.5%, 11.5% and 23.5% of gross power rating respectively. These values have been applied to the respective locomotive engines for existing and Hume Coal train movements;
- Locomotive emissions were estimated based on US-EPA uncontrolled emission factors for the existing Berrima Branch Line, and US-EPA Tier 1+ emission factors for the Hume Coal trains (US-EPA, 2009);
- Based on information provided by Hume Coal, the weighted average travel speed for trains moving to the Boral Berrima Cement Works and the Hume Coal Project are 16km/hr and 18km/hr respectively. The moving distance of trains along the Berrima Branch Line is 4.5 km, while the moving distance between the project site balloon loop and the Main Southern Railway Line is 9.5 km.
- Using the above speed and distances, the time for a single train movement between Berrima Junction and the Boral Berrima Cement Works is 21 minutes for all existing trains and 32 minutes for Hume Coal trains between Berrima Junction and the Hume Coal train load-out facility.
- All existing trains are assumed to spend one hour idling per trip, while Hume Coal trains are assumed to spend three hours idling per trip.
- Of the existing Berrima Branch Line movements, only limestone wagons are assumed to be uncovered. It has been assumed limestone trains account for approximately 35% of existing movements on the Berrima Branch Line based on ARTC timetable data, with on average 30 wagons per train. Using the findings of Ferrier et al (2003) for uncovered 60t coal wagons, fugitive TSP, PM_{10} and $PM_{2.5}$ emission factors were derived to estimate fugitive particulate matter emissions from uncovered wagons moving between the Boral Berrima Cement Works and the Main Southern Railway Line. While it is acknowledged that the emission factors are relevant to coal, in the absence of limestone-specific emission factors these values are considered appropriate for use in this assessment.
- Fugitive PM_{10} and $PM_{2.5}$ emissions from the loading of product coal to wagons at the project are included in the future Berrima Branch Line scenario. Emission calculations from this process are presented in the project AQIA.
- The US-EPA emission factor for locomotive engines is for PM_{10}. 97% of PM_{10} is assumed to be made up of much smaller $PM_{2.5}$ particles (US-EPA, 2009).
- Emissions of individual VOC species benzene, ethylbenzene, toluene and xylenes were estimated based on the hazardous air pollutant speciation profile presented by US-EPA (2011).

Calculated annual emissions from existing and future rail movements along the Berrima Branch Line are presented in **Table A2-2**.

Table A2-2: Annual Berrima Branch Line emissions – current and future

Pollutant	Annual Emissions (kg/annum)	
	Existing movements	Future movements
TSP	1,959.9	2,723.4
PM_{10}	1,672.0	2,435.6
$PM_{2.5}$	1,429.0	2,169.7
NO_x	56,233.6	81,813.5

Volume sources were allocated along the Berrima Branch Line between the project rail load point and the Main Southern Rail Line.

Model Prediction Tables

Maximum predicted TSP, PM_{10}, $PM_{2.5}$ and NO_2 concentrations and dust deposition levels based on the above emission calculations are presented in **Table A2-3**.

Table A2-3: Maximum predicted concentrations – Neighbouring Emissions Sources only

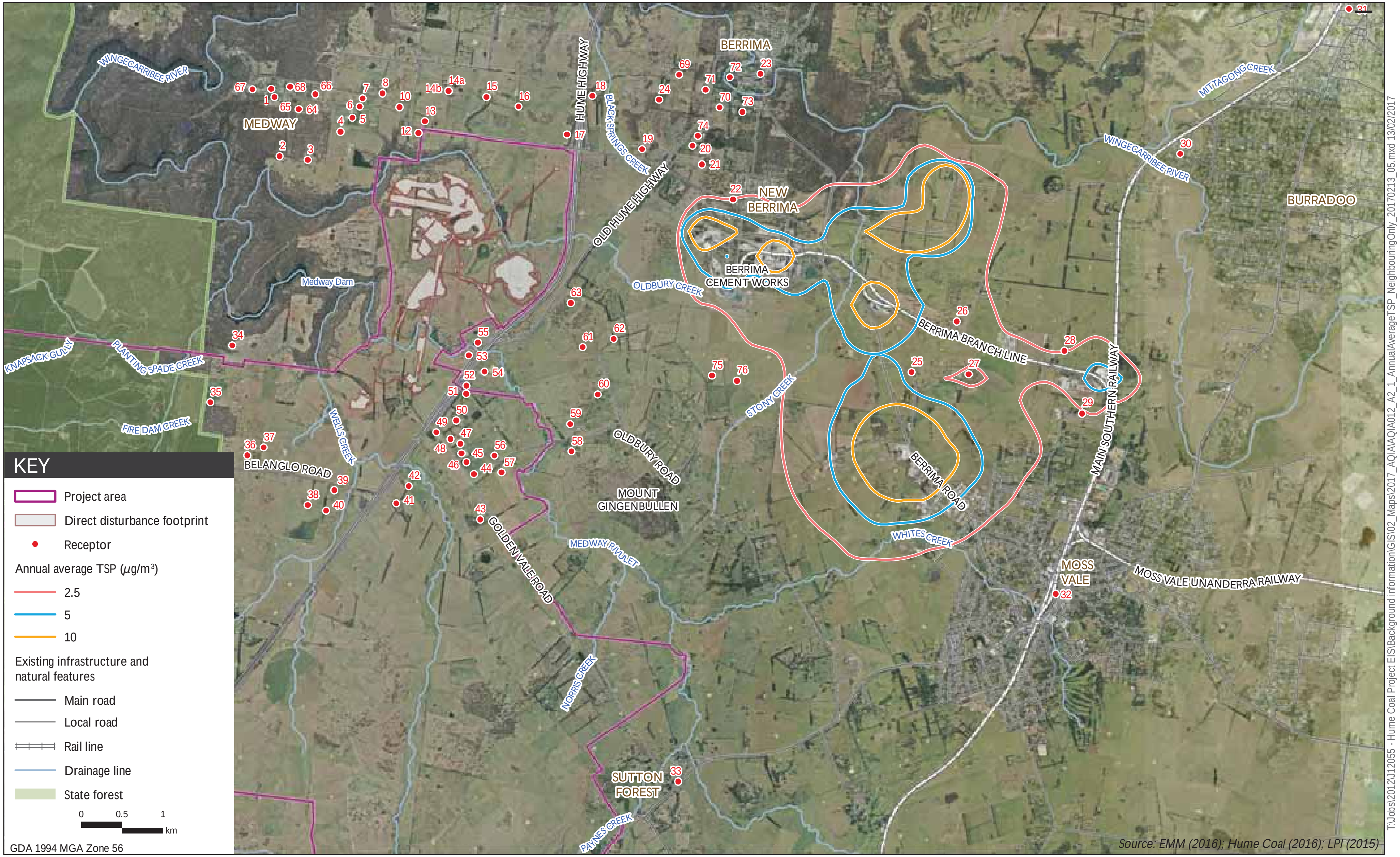
Receptor ID	Maximum Predicted Concentration (µg/m³)							Dust Deposition (g/m²/month)
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	1-hour NO_2	Annual NO_2	
Criterion	90	50	25	25	8	246	62	2
1	0.2	0.9	0.2	0.3	0.1	67.0	1.4	<0.1
2	0.2	0.9	0.2	0.4	0.1	43.6	1.3	<0.1
3	0.3	1.0	0.2	0.4	0.1	44.2	1.5	<0.1
4	0.3	1.0	0.2	0.4	0.1	62.2	1.7	<0.1
5	0.3	1.2	0.2	0.4	0.1	67.8	1.8	<0.1
6	0.3	1.2	0.2	0.4	0.1	67.9	1.8	<0.1
7	0.3	1.2	0.2	0.4	0.1	67.2	1.8	<0.1
8	0.3	1.3	0.2	0.5	0.1	62.5	1.9	<0.1
9	0.3	1.3	0.2	0.5	0.1	55.2	2.0	<0.1
10	0.3	1.3	0.2	0.5	0.1	52.9	2.1	<0.1
12	0.4	1.5	0.3	0.4	0.1	50.2	2.3	<0.1
13	0.4	1.5	0.3	0.5	0.1	50.1	2.4	<0.1
14	0.4	1.6	0.3	0.6	0.1	68.1	2.4	<0.1
15	0.4	1.7	0.3	0.6	0.1	72.3	2.9	<0.1
16	0.5	1.8	0.3	0.7	0.1	89.5	4.1	<0.1
17	0.7	2.2	0.5	0.8	0.2	112.6	7.0	<0.1
18	0.6	2.3	0.4	0.8	0.1	62.2	3.8	<0.1
19	1.0	3.3	0.6	1.1	0.2	87.3	5.1	<0.1
20	1.3	7.7	0.8	2.0	0.2	80.2	5.1	<0.1
21	1.5	9.3	0.9	2.4	0.3	70.9	5.3	0.1
22	2.6	13.4	1.6	4.0	0.5	89.6	6.6	0.2
23	0.8	4.6	0.5	0.9	0.2	63.6	3.5	<0.1
24	0.9	5.0	0.6	1.4	0.2	77.5	3.3	<0.1
25	4.9	13.5	3.1	2.1	0.6	85.1	6.9	0.2
26	2.7	9.5	1.9	1.7	0.4	112.2	10.7	0.2
27	2.0	8.1	1.3	1.2	0.3	94.6	5.0	0.1
28	2.4	6.0	1.4	1.3	0.5	140.1	13.0	0.1
29	2.2	3.9	1.3	1.4	0.3	120.8	6.9	0.2
30	0.8	2.2	0.5	0.8	0.1	73.6	3.2	<0.1
31	0.3	1.5	0.2	0.6	0.1	64.1	1.8	<0.1
32	0.9	3.1	0.6	1.0	0.1	67.4	2.1	<0.1
33	0.5	1.9	0.4	0.7	0.1	58.5	1.9	<0.1
34	0.2	1.5	0.2	0.6	0.1	57.8	1.3	<0.1
35	0.2	1.3	0.2	0.5	0.1	57.0	1.3	<0.1
36	0.2	1.3	0.2	0.5	0.1	50.8	1.3	<0.1
37	0.2	1.3	0.2	0.5	0.1	53.9	1.3	<0.1
38	0.3	1.6	0.2	0.6	0.1	60.0	1.5	<0.1
39	0.3	1.6	0.2	0.6	0.1	60.1	1.5	<0.1
40	0.3	1.5	0.2	0.6	0.1	63.1	1.5	<0.1
41	0.3	1.5	0.2	0.6	0.1	82.0	1.7	<0.1
42	0.4	1.7	0.3	0.6	0.1	81.7	1.8	<0.1
43	0.4	1.5	0.3	0.6	0.1	67.8	2.1	<0.1
44	0.4	1.8	0.3	0.6	0.1	68.3	2.0	<0.1
45	0.4	2.1	0.3	0.7	0.1	67.5	2.0	<0.1
46	0.4	2.2	0.3	0.7	0.1	66.7	2.0	<0.1
47	0.4	2.1	0.3	0.8	0.1	62.6	2.0	<0.1

Table A2-3: Maximum predicted concentrations – Neighbouring Emissions Sources only

Receptor ID	Maximum Predicted Concentration (µg/m³)							Dust Deposition (g/m²/month)
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	1-hour NO_2	Annual NO_2	
Criterion	90	50	25	25	8	246	62	2
48	0.4	2.0	0.3	0.7	0.1	54.8	1.9	<0.1
49	0.4	1.9	0.3	0.7	0.1	54.9	1.9	<0.1
50	0.4	1.8	0.3	0.7	0.1	54.9	1.9	<0.1
51	0.4	1.8	0.3	0.7	0.1	55.2	2.0	<0.1
52	0.4	1.8	0.3	0.6	0.1	55.0	2.0	<0.1
53	0.4	1.5	0.3	0.5	0.1	60.6	2.1	<0.1
54	0.4	1.7	0.3	0.6	0.1	50.5	2.1	<0.1
55	0.4	1.5	0.3	0.5	0.1	61.5	2.1	<0.1
56	0.5	2.1	0.3	0.6	0.1	67.0	2.1	<0.1
57	0.5	1.7	0.3	0.6	0.1	67.5	2.1	<0.1
58	0.7	2.1	0.5	0.8	0.2	57.4	2.7	<0.1
59	0.7	2.4	0.5	1.0	0.1	59.1	2.7	<0.1
60	0.8	3.3	0.6	1.4	0.2	67.7	3.2	<0.1
61	0.7	2.9	0.5	0.9	0.2	61.4	3.2	<0.1
62	0.9	2.9	0.6	0.9	0.2	56.4	3.9	<0.1
63	0.7	2.4	0.5	0.9	0.1	72.2	3.3	<0.1
64	0.3	1.0	0.2	0.3	0.1	70.8	1.5	<0.1
65	0.2	0.9	0.2	0.3	0.1	65.9	1.4	<0.1
66	0.3	1.1	0.2	0.4	0.1	79.2	1.6	<0.1
67	0.2	0.9	0.2	0.3	0.1	65.1	1.4	<0.1
68	0.3	1.0	0.2	0.4	0.1	72.7	1.5	<0.1
69	0.8	3.6	0.5	1.1	0.2	77.0	3.6	<0.1
70	1.0	5.8	0.7	1.8	0.2	76.8	4.3	<0.1
71	0.9	4.4	0.6	1.3	0.2	75.7	4.0	<0.1
72	0.8	3.5	0.5	1.2	0.2	72.0	3.6	<0.1
73	1.1	4.3	0.7	1.5	0.2	79.6	4.4	<0.1
74	1.2	6.9	0.8	1.8	0.2	82.2	4.9	<0.1
75	1.7	4.5	1.2	1.7	0.4	72.4	5.9	0.1
76	2.0	4.5	1.4	1.8	0.4	79.6	5.6	0.1

Contour Plots

The following figures present the predicted concentration isopleths from neighbouring sources for TSP, PM_{10}, $PM_{2.5}$ and dust deposition.



Annual average TSP concentrations ($\mu g/m^3$) - neighbouring emission sources only

Hume Coal Project

Air Quality Impact And Greenhouse Gas Assessment

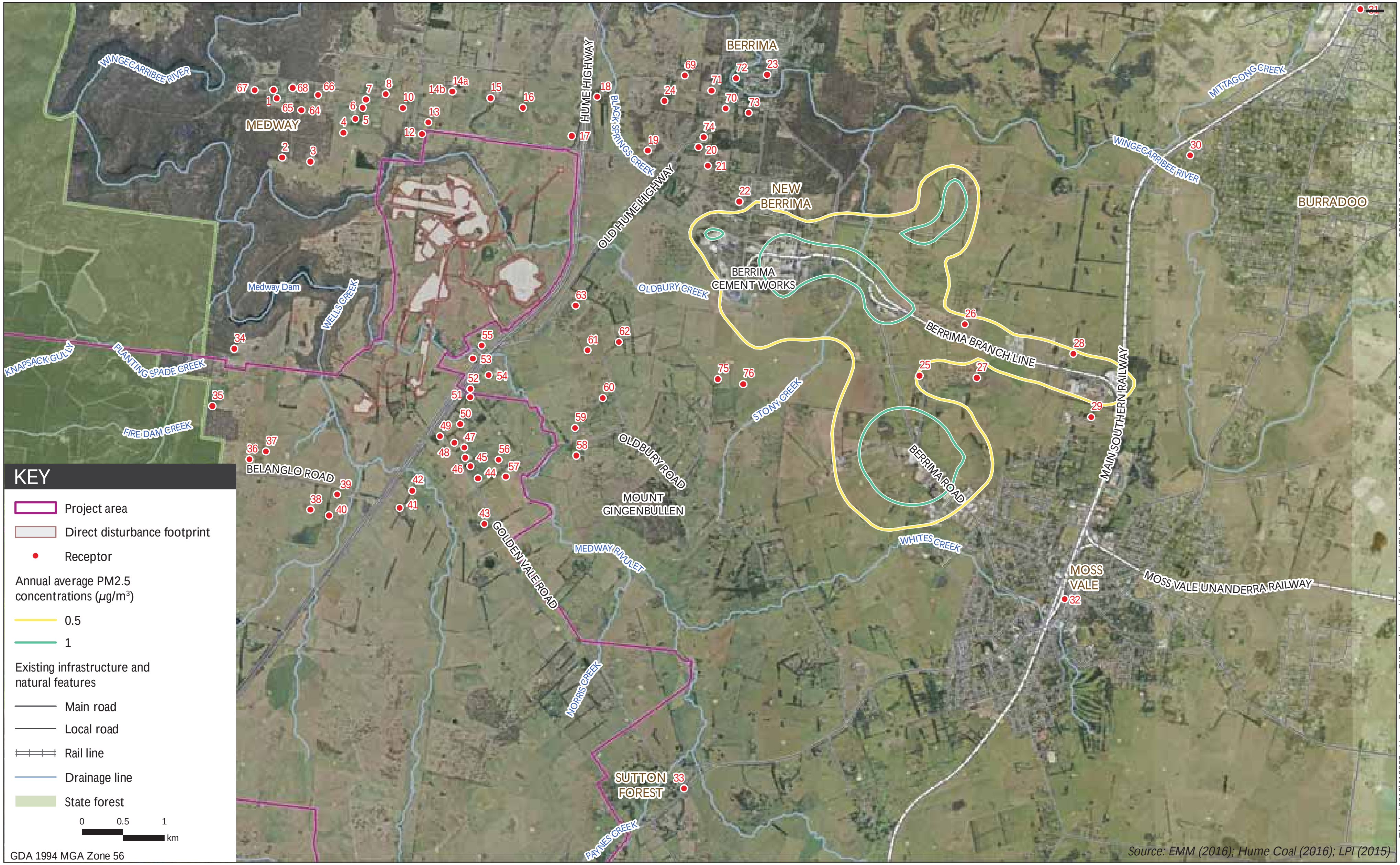
Figure A2.1

Annual average PM10 concentrations (µg/m³) - neighbouring emission sources only

Hume Coal Project

Air Quality Impact And Greenhouse Gas Assessment

Figure A2.2



Annual average PM2.5 concentrations (μg/m³) - neighbouring emission sources only

Hume Coal Project

Air Quality Impact And Greenhouse Gas Assessment

Figure A2.3

T:\Jobs\2012\J12055 - Hume Coal Project EIS\Background information\GIS\02_Maps\2017_AQ\AIAQIA015_A2_4_AnnualAverageDD_neighbours_20170213_05.mxd 13/02/2017

EMM HUMECOAL

Annual average dust deposition levels (g/m²/month) - neighbouring emission sources only

Hume Coal Project

Air Quality Impact And Greenhouse Gas Assessment

Figure A2.4

APPENDIX 3
EMISSIONS INVENTORY

Introduction

Dust emissions were estimated using United States Environmental Protection Authority (USEPA) AP-42 and National Pollution Inventory (NPI) emission factors and predictive equations listed below, taken from the following documents:

- NPI Emission Estimation Technique Manual for Mining (NPI, 2012);
- NPI Emission Estimation Manual for Combustion Engines (NPI, 2008);
- Chapter 11.9 Western Surface Coal Mining (US-EPA, 1998).
- Chapter 13.2.2 Unpaved Roads (US-EPA, 2006a).
- Chapter 13.2.4 Aggregate Handling and Storage Piles (US-EPA, 2006b)
- Chapter 13.2.5 Industrial Wind Erosion (US-EPA, 2006c).

Material parameters, emission estimation equations and factors and emission source activity rates for the construction and operational scenarios are presented in the following tables.

With regard to coal stockpile and coal rejects dump emissions, the US-EPA industrial wind erosion approach was implemented, with the following assumptions:

- Default threshold friction velocity values of 1.12m/s (uncrusted coal stockpile) and 1.33m/s (scoria) were adopted for the coal stockpiles and coal rejects storage area respectively;
- Emissions were calculated on an hourly basis. Peak gust wind speeds for each hour of the modelling period were applied to estimate an upper bound of wind erosion potential;
- The most conservative stockpile wind orientation profile from Table 13.2.5-3 (Profile B3) was applied to every hour, regardless of wind direction, to maximise wind erosion calculations;
- For coal stockpiles, it was assumed that the entire stockpile footprint area is actively disturbed and emitting for every hour of the modelling period.

This list of assumptions is considered to return a conservatively high estimation of wind erosion emissions from the operational project.

Emission source model locations are presented in Figure A3-1 and Figure A3-2 for the construction and operational emission scenarios respectively.

Table A3-1: Material properties – construction scenario

Properties	**Units**	**Value**	**Source of Information**
Silt Content of Unpaved Roads internal haul roads	%	8.5	US-EPA (2006a) mean value for “construction sites”
Silt Content of excavated material	%	6.9	US-EPA AP42 (1998) mean value for “overburden”
Moisture Content of excavated material	%	7.9	US-EPA AP42 (1998) mean value for “overburden”

Table A3-2: Construction emissions scenario emissions equations

Inventory activity	Units	TSP emission factor / equation	PM_{10} emission factor / equation	$PM_{2.5}$ emission factor / equation	Variables	EF source
Material handling (material extraction, loading trucks, unloading trucks)	kg/t	$0.74 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.35 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.053 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	U = mean wind speed (m/s) M = material moisture content (%)	AP42 13.2.4
Material handling (loading trucks with coal)	kg/t	$\frac{0.58}{M^{1.2}}$	$\frac{0.75 * 0.0596}{M^{0.9}}$	0.019 x TSP	U = mean wind speed (m/s) M = material moisture content (%)	AP42 11.9
Dozers on excavated material	kg/hr	$2.6 \times \frac{s^{1.2}}{M^{1.3}}$	$0.3375 \times \frac{s^{1.5}}{M^{1.4}}$	0.105 x TSP	s = material silt content (%) M = material moisture content (%)	AP42 11.9
Hauling on unsealed roads	kg/VKT	$\left(\frac{0.4536}{1.6093}\right) \times 4.9 * \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 1.5 * \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 0.15 * \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	s = surface material silt content (%) W = mean vehicle weight (tonnes)	AP42 13.2.2
Grader	kg/VKT	$0.0034 \times S^{2.5}$	$0.00336 \times S^{2.0}$	$0.0001054 \times S^{2.5}$	S = travel speed km/hr	AP42 11.9
Diesel Combustion	kg/L	0.0036	0.0012	0.0011		NPI Combustion Engines - Miscellaneous Industrial Vehicles

Table A3-3: Emission factors – construction scenario –Hume 1 database				
Emissions source	**TSP**	**PM_{10}**	**$PM_{2.5}$**	**Unit**
Drift portal Construction - material excavation	0.00026	0.00012	0.00002	kg/tonne
Drift portal Construction - Loading to trucks	0.00026	0.00012	0.00002	kg/tonne
Drift portal Construction - Dozer operations	1.798	0.339	0.189	kg/hour
Drift portal Construction - Grader operations	0.190	0.140	0.006	kg/Vehicle KM Travelled
Drift portal Construction - Material haulage	4.159	1.188	0.119	kg/Vehicle KM Travelled
Drift portal Construction - Truck unloading	0.00026	0.00012	0.00002	kg/tonne
SIA Construction - Haulage to Primary Dam	4.159	1.188	0.119	kg/Vehicle KM Travelled
SIA Construction - material excavation	0.00026	0.00012	0.00002	kg/tonne
SIA Construction - Loading to trucks	0.00026	0.00012	0.00002	kg/tonne
SIA Construction - Dozer operations	1.798	0.339	0.189	kg/hour
SIA Construction - Grader operations	0.190	0.140	0.006	kg/Vehicle KM Travelled
SIA Construction - Material haulage	4.159	1.188	0.119	kg/Vehicle KM Travelled
SIA Construction - Truck unloading	0.00026	0.00012	0.00002	kg/tonne
Rail Construction - material excavation	0.00026	0.00012	0.00002	kg/tonne
Rail Construction - Loading to trucks	0.00026	0.00012	0.00002	kg/tonne
Rail Construction - Dozer operations	1.798	0.339	0.189	kg/hour
Rail Construction - Grader operations	0.19007	0.14000	0.00589	kg/Vehicle KM Travelled
Rail Construction - Material haulage	4.159	1.188	0.119	kg/Vehicle KM Travelled
Rail Construction - Truck unloading	0.00026	0.00012	0.00002	kg/tonne
Rail Construction - Haulage to Primary Dam	4.159	1.188	0.119	kg/Vehicle KM Travelled
Dam Construction - Truck unloading	0.00026	0.00012	0.00002	kg/tonne
Dam Construction - Dozer operations	1.798	0.339	0.189	kg/hour
Dam Construction - Grader operations	0.190	0.140	0.006	kg/Vehicle KM Travelled
Wind Erosion - Wind Erosion - drift portal area	850	425	63.75	kg/ha/year
Wind Erosion - Wind Erosion - SIA area	850	425	63.75	kg/ha/year
Wind Erosion - Wind Erosion - Rail area	850	425	63.75	kg/ha/year
Wind Erosion - Wind Erosion - Primary Dam	850.0	425.0	63.75	kg/ha/year
All activities - Diesel combustion	0.0036	0.0036	0.0033	kg/L

Table A3-4: Emission factors – construction scenario –BoM Moss Vale database				
Emissions source	**TSP**	**PM_{10}**	**$PM_{2.5}$**	**Unit**
Drift portal Construction - material excavation	0.00026	0.00012	0.00002	kg/tonne
Drift portal Construction - Loading to trucks	0.00026	0.00012	0.00002	kg/tonne
Drift portal Construction - Dozer operations	1.798	0.339	0.189	kg/hour
Drift portal Construction - Grader operations	0.190	0.140	0.006	kg/Vehicle KM Travelled
Drift portal Construction - Material haulage	4.159	1.188	0.119	kg/Vehicle KM Travelled
Drift portal Construction - Truck unloading	0.00026	0.00012	0.00002	kg/tonne
SIA Construction - Haulage to Primary Dam	4.159	1.188	0.119	kg/Vehicle KM Travelled
SIA Construction - material excavation	0.00026	0.00012	0.00002	kg/tonne
SIA Construction - Loading to trucks	0.00026	0.00012	0.00002	kg/tonne
SIA Construction - Dozer operations	1.798	0.339	0.189	kg/hour
SIA Construction - Grader operations	0.190	0.140	0.006	kg/Vehicle KM Travelled
SIA Construction - Material haulage	4.159	1.188	0.119	kg/Vehicle KM Travelled
SIA Construction - Truck unloading	0.00026	0.00012	0.00002	kg/tonne
Rail Construction - material excavation	0.00026	0.00012	0.00002	kg/tonne
Rail Construction - Loading to trucks	0.00026	0.00012	0.00002	kg/tonne
Rail Construction - Dozer operations	1.798	0.339	0.189	kg/hour
Rail Construction - Grader operations	0.19007	0.14000	0.00589	kg/Vehicle KM Travelled
Rail Construction - Material haulage	4.159	1.188	0.119	kg/Vehicle KM Travelled
Rail Construction - Truck unloading	0.00026	0.00012	0.00002	kg/tonne
Rail Construction - Haulage to Primary Dam	4.159	1.188	0.119	kg/Vehicle KM Travelled
Dam Construction - Truck unloading	0.00026	0.00012	0.00002	kg/tonne
Dam Construction - Dozer operations	1.798	0.339	0.189	kg/hour
Dam Construction - Grader operations	0.190	0.140	0.006	kg/Vehicle KM Travelled
Wind Erosion - Wind Erosion - drift portal area	850	425	63.75	kg/ha/year
Wind Erosion - Wind Erosion - SIA area	850	425	63.75	kg/ha/year
Wind Erosion - Wind Erosion - Rail area	850	425	63.75	kg/ha/year
Wind Erosion - Wind Erosion - Primary Dam	850.0	425.0	63.75	kg/ha/year
All activities - Diesel combustion	0.0036	0.0036	0.0033	kg/L

Table A3-5: Activity rates – construction scenario		
Emissions source	**Activity Rate**	**Unit**
Drift portal Construction - material excavation	800,100	Tonnes of excavated material
Drift portal Construction - Loading to trucks	800,100	Tonnes of excavated material
Drift portal Construction - Dozer operations	1,320	Hours of operation
Drift portal Construction - Grader operations	5,280	Vehicle KM Travelled
Drift portal Construction - Material haulage	11,709	Vehicle KM Travelled
Drift portal Construction - Truck unloading	800,100	Tonnes of excavated material
SIA Construction - Haulage to Primary Dam	533,400	Tonnes of excavated material
SIA Construction - material excavation	533,400	Tonnes of excavated material
SIA Construction - Loading to trucks	2,112	Hours of operation
SIA Construction - Dozer operations	8,448	Vehicle KM Travelled
SIA Construction - Grader operations	7,806	Vehicle KM Travelled
SIA Construction - Material haulage	533,400	Tonnes of excavated material
SIA Construction - Truck unloading	3,073	Vehicle KM Travelled
Rail Construction - material excavation	609,000	Tonnes of excavated material
Rail Construction - Loading to trucks	609,000	Tonnes of excavated material
Rail Construction - Dozer operations	2,112	Hours of operation
Rail Construction - Grader operations	8,448	Vehicle KM Travelled
Rail Construction - Material haulage	8,912	Vehicle KM Travelled
Rail Construction - Truck unloading	609,000	Tonnes of excavated material
Rail Construction - Haulage to Primary Dam	13,061	Vehicle KM Travelled
Dam Construction - Truck unloading	210,000	Tonnes of excavated material
Dam Construction - Dozer operations	2,904	Hours of operation
Dam Construction - Grader operations	11,616	Vehicle KM Travelled
Wind Erosion - Wind Erosion - drift portal area	23	Area (ha)
Wind Erosion - Wind Erosion - SIA area	47	Area (ha)
Wind Erosion - Wind Erosion - Rail area	30	Area (ha)
Wind Erosion - Wind Erosion - Primary Dam	10	Area (ha)
All activities - Diesel combustion	7,236,808	Litres of diesel

Material parameters for ROM coal, product coal and coal rejects were collated from the following documents from operational underground mining operations in NSW:

- Oceanic Coal Australia Limited West Wallsend Colliery, Macquarie Coal Preparation Plant And Teralba Colliery - Coal Mine Particulate Matter Control Best Management Practice Determination – (Environ, 2012);
- Tahmoor Colliery - Coal Mine Particulate Matter Control Best Management Practice Determination (Environ, 2012);
- Dendrobium Particulate Matter Control Best Practice PRP (PAE Holmes, 2012a);
- Metropolitan Colliery Site Specific Particulate Matter Control Best Practice Assessment (SLR, 2012);
- Appin Mine And West Cliff Colliery Particulate Matter Control Best Practice Pollution Reduction Program (PAE Holmes, 2012b);
- NRE No. 1 Colliery Particulate Matter Control Best Practice Pollution Reduction Program (PAE Holmes, 2012c);
- Airly Coal Mine Site Specific Particulate Matter Control Best Practice Assessment (SLR, 2012b)
- Angus Place Colliery Mine Site Specific Particulate Matter Control Best Practice Assessment (SLR, 2012c); and
- Springvale Coal Services Site Specific Particulate Matter Control Best Practice Assessment (SLR, 2012d).

The average silt and moisture contents for ROM coal, product coal and coal rejects from these operational mines were calculated and adopted for the emissions inventory of the project.

Table A3-6: Material properties – operational scenario

Properties	Units	Value	Source of Information
Silt Content of Unpaved Roads FEL rejects transport route	%	5.1	US-EPA (2006a) mean value for "coal mine plant road"
Silt Content of ROM coal	%	6.6	Average of NSW underground mines
Moisture Content of ROM coal	%	5.4	Average of NSW underground mines
Silt Content of product coal	%	5.7	Average of NSW underground mines
Moisture Content of product coal	%	7.8	Average of NSW underground mines
Silt Content of rejects	%	10.9	Average of NSW underground mines
Moisture Content of rejects	%	5.9	Average of NSW underground mines

In order to estimate emissions of particulate matter and odour from the ventilation shaft outlets, monitoring data from the following operational NSW underground coal mines were collated:

- Dendrobium Particulate Matter Control Best Practice PRP (PAE Holmes, 2012a);
- Tahmoor Colliery - Coal Mine Particulate Matter Control Best Management Practice Determination (Environ, 2012);
- Oceanic Coal Australia Limited West Wallsend Colliery, Macquarie Coal Preparation Plant and Teralba Colliery - Coal Mine Particulate Matter Control Best Management Practice Determination (Environ, 2012);
- BHP Illawarra Coal - Ventilation Shaft No. 6 Project – Air Quality Impact Assessment (PAE Holmes, 2010); and
- Illawarra Coal Holdings - Bulli Seam Operations - Air Quality Impact Assessment (PAE Holmes, 2009).

The average particulate matter concentration, odour concentration and exit temperature were calculated and adopted for the emissions inventory of the project. The adopted values are presented in **Table A3-7**.

Table A3-7: Ventilation Shaft parameters			
Properties	**Units**	**Value**	**Source of Information**
TSP	mg/m^3	3.3	Average of reviewed NSW underground mines
PM_{10}	mg/m^3	0.7	Average of reviewed NSW underground mines
$PM_{2.5}$	mg/m^3	0.5	Average of reviewed NSW underground mines
Odour	OU	189	Average of reviewed NSW underground mines
Temperature	deg C	21.2	Average of reviewed NSW underground mines

Table A3-8: Operational emissions scenario emissions equations						
Inventory activity	**Units**	**TSP emission factor / equation**	**PM_{10} emission factor / equation**	**$PM_{2.5}$ emission factor / equation**	**Variables**	**EF source**
Material handling (conveyor transfer, stacker/reclaimer at stockpiles, rejects rehandle, loading trains)	kg/t	$0.74 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.35 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.053 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	U = mean wind speed (m/s) M = material moisture content (%)	AP42 13.2.4
Dozer on rejects	kg/hr	$2.6 \times \frac{s^{1.2}}{M^{1.3}}$	$0.3375 \times \frac{s^{1.5}}{M^{1.4}}$	0.105 x TSP	s = material silt content (%) M = material moisture content (%)	AP42 11.9
Wind erosion from coal stockpiles	kg/ha/h	$58(\mathrm{u}* - \mathrm{ut}*) + 25(\mathrm{u}* - \mathrm{ut}*)$	0.5 * TSP	0.075 * TSP	u* = friction velocity ut* = threshold friction velocity	AP42 13.2.5
Hauling on unsealed roads (FEL rejects transfer)	kg/VKT	$\left(\frac{0.4536}{1.6093}\right) \times 4.9 * \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 1.5 * \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 0.15 * \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	s = surface material silt content (%) W = mean vehicle weight (tonnes)	AP42 13.2.2

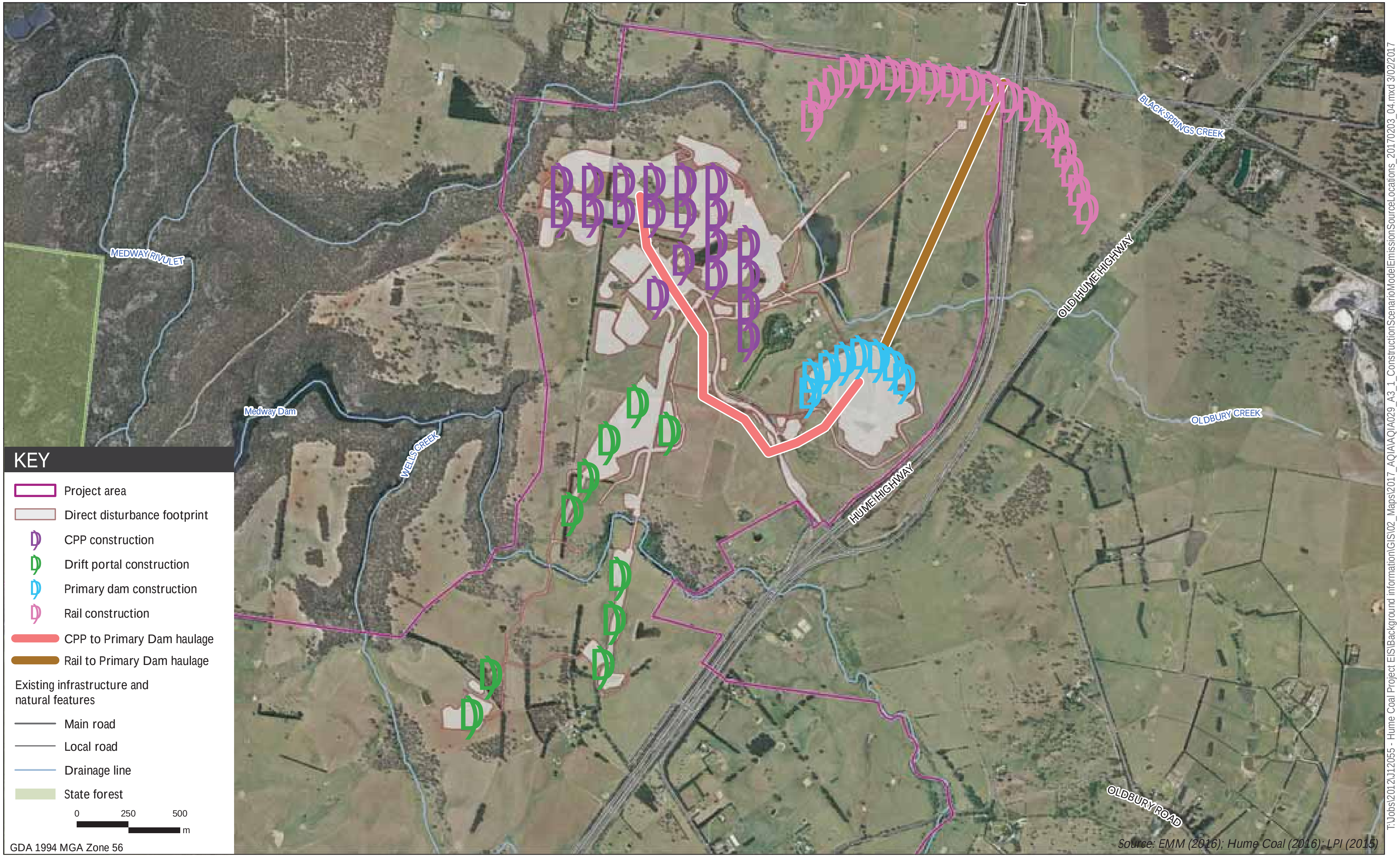
Table A3-9: Emission factors – operational scenario –Hume 1 database

Emissions source	TSP	PM_{10}	$PM_{2.5}$	Unit
Overland conveyor to stacker transfer	0.00045	0.00021	0.00003	kg/tonne
Stacker to ROM stockpile	0.00045	0.00021	0.00003	kg/tonne
Reclaimer ROM stockpile	0.00045	0.00021	0.00003	kg/tonne
Tertiary sizing station	0.003	0.001	0.00015	kg/tonne
Screening station	0.003	0.001	0.00015	kg/tonne
CPP	0.00045	0.00021	0.00003	kg/tonne
CPP to product conveyor transfer	0.00026	0.00013	0.00002	kg/tonne
Product conveyor to stacker transfer	0.00026	0.00013	0.00002	kg/tonne
Stacker to product stockpiles	0.00026	0.00013	0.00002	kg/tonne
Reclaimer - product stockpiles	0.00026	0.00013	0.00002	kg/tonne
Product reclaimer to rail loader conveyor transfer	0.00026	0.00013	0.00002	kg/tonne
Rail bin transfer	0.00026	0.00013	0.00002	kg/tonne
Loading trains	0.00026	0.00013	0.00002	kg/tonne
Rejects conveyer transfer 1	0.00039	0.00019	0.00003	kg/tonne
Rejects conveyer transfer 2	0.00039	0.00019	0.00003	kg/tonne
Loading temporary rejects storage area	0.00039	0.00019	0.00003	kg/tonne
FEL handling Rejects	0.00039	0.00019	0.00003	kg/tonne
Dozer on temporary storage area	4.54	1.01	0.48	kg/hour
FEL travel from storage area to hopper	1.86	0.48	0.05	kg/Vehicle KM Travelled
FEL Rejects to paste plant hopper loading	0.00039	0.00019	0.00003	kg/tonne
Paste plant conveyer transfer 1	0.00039	0.00019	0.00003	kg/tonne
Paste plant conveyer transfer 2	0.00039	0.00019	0.00003	kg/tonne
Conveyor wind erosion - enclosed sections	3,818.3	1,909.1	286.4	kg/ha/year
Conveyor wind erosion - open sections	3,818.3	1,909.1	286.4	kg/ha/year
ROM stockpile	3,818.3	1,909.1	286.4	kg/ha/year
Product stockpiles	3,818.3	1,909.1	286.4	kg/ha/year
Reject temporary storage	951.6	475.8	71.4	kg/ha/year
Ventilation shafts	3.3	0.7	0.5	mg/m^3

Table A3-10: Emission factors – operational scenario – BoM Moss Vale database				
Emissions source	**TSP**	**PM_{10}**	**$PM_{2.5}$**	**Unit**
Overland conveyor to stacker transfer	0.00080	0.00038	0.00006	kg/tonne
Stacker to ROM stockpile	0.00080	0.00038	0.00006	kg/tonne
Reclaimer ROM stockpile	0.00080	0.00038	0.00006	kg/tonne
Tertiary sizing station	0.003	0.001	0.00015	kg/tonne
Screening station	0.003	0.001	0.00015	kg/tonne
CPP	0.00080	0.00038	0.00006	kg/tonne
CPP to product conveyor transfer	0.00048	0.00022	0.00003	kg/tonne
Product conveyor to stacker transfer	0.00048	0.00022	0.00003	kg/tonne
Stacker to product stockpiles	0.00048	0.00022	0.00003	kg/tonne
Reclaimer - product stockpiles	0.00048	0.00022	0.00003	kg/tonne
Product reclaimer to rail loader conveyor transfer	0.00048	0.00022	0.00003	kg/tonne
Rail bin transfer	0.00048	0.00022	0.00003	kg/tonne
Loading trains	0.00048	0.00022	0.00003	kg/tonne
Rejects conveyer transfer 1	0.00071	0.00033	0.00005	kg/tonne
Rejects conveyer transfer 2	0.00071	0.00033	0.00005	kg/tonne
Loading temporary rejects storage area	0.00071	0.00033	0.00005	kg/tonne
FEL handling Rejects	0.00071	0.00033	0.00005	kg/tonne
Dozer on temporary storage area	4.54	1.01	0.48	kg/hour
FEL travel from storage area to hopper	1.86	0.48	0.05	kg/Vehicle KM Travelled
FEL Rejects to paste plant hopper loading	0.00071	0.00033	0.00005	kg/tonne
Paste plant conveyer transfer 1	0.00071	0.00033	0.00005	kg/tonne
Paste plant conveyer transfer 2	0.00071	0.00033	0.00005	kg/tonne
Conveyor wind erosion - enclosed sections	25,157.0	12,578.5	1,886.8	kg/ha/year
Conveyor wind erosion - open sections	25,157.0	12,578.5	1,886.8	kg/ha/year
ROM stockpile	25,157.0	12,578.5	1,886.8	kg/ha/year
Product stockpiles	25,157.0	12,578.5	1,886.8	kg/ha/year
Reject temporary storage	10,080.5	5,040.2	756.0	kg/ha/year
Ventilation shafts	3.3	0.7	0.5	mg/m^3

Table A3-11: Activity rates – operational scenario

Emissions source	Activity Rate	Unit
Overland conveyor to stacker transfer	3,500,000	Tonnes of ROM coal
Stacker to ROM stockpile	3,500,000	Tonnes of ROM coal
Reclaimer ROM stockpile	3,500,000	Tonnes of ROM coal
Tertiary sizing station	3,500,000	Tonnes of ROM coal
Screening station	3,500,000	Tonnes of ROM coal
CPP (four internal transfer points)	14,000,000	Tonnes of ROM coal
CPP to product conveyor transfer	3,000,000	Tonnes of product coal
Product conveyor to stacker transfer	3,000,000	Tonnes of product coal
Stacker to product stockpiles	3,000,000	Tonnes of product coal
Reclaimer - product stockpiles	3,000,000	Tonnes of product coal
Product reclaimer to rail loader conveyor transfer	3,000,000	Tonnes of product coal
Rail bin transfer	3,000,000	Tonnes of product coal
Loading trains	3,000,000	Tonnes of product coal
Rejects conveyer transfer 1	500,000	Tonnes of reject
Rejects conveyer transfer 2	500,000	Tonnes of reject
Loading temporary rejects storage area	500,000	Tonnes of reject
FEL handling Rejects	500,000	Tonnes of reject
Dozer on temporary storage area	730	Hours of operation
FEL travel from storage area to hopper	6,154	Vehicle KM Travelled
FEL Rejects to paste plant hopper loading	500,000	Tonnes of reject
Paste plant conveyer transfer 1	500,000	Tonnes of reject
Paste plant conveyer transfer 2	500,000	Tonnes of reject
Conveyor wind erosion - enclosed sections	0.4	Area (ha)
Conveyor wind erosion - open sections	0.2	Area (ha)
ROM stockpile	0.9	Area (ha)
Product stockpiles	5.6	Area (ha)
Reject temporary storage	1.0	Area (ha)
Ventilation shafts	435	m^3/second flow rate



Construction scenario model emission source locations

Hume Coal Project

Air Quality Impact And Greenhouse Gas Assessment

Figure A3.1

EMM HUMECOAL PROJECT

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Operational scenario model emission source locations

Hume Coal Project
Air Quality Impact And Greenhouse Gas Assessment

Figure A3.2

EMM HUMECOAL

APPENDIX 4
HUME COAL PROJECT PREDICTED IMPACTS

Table A4-1: Maximum predicted concentrations – peak construction scenario – Hume Coal Project Only Increment

Receptor ID	Maximum Predicted Concentration (µg/m³)					Dust Deposition (g/m²/month)
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	
1	0.1	0.6	<0.1	0.3	<0.1	<0.1
2	0.1	0.6	<0.1	0.3	<0.1	<0.1
3	0.1	0.8	<0.1	0.5	<0.1	<0.1
4	0.1	0.8	0.1	0.4	<0.1	<0.1
5	0.1	0.9	0.1	0.5	<0.1	<0.1
6	0.1	0.9	0.1	0.5	<0.1	<0.1
7	0.1	0.9	0.1	0.4	<0.1	<0.1
8	0.2	1.2	0.1	0.5	<0.1	<0.1
10	0.2	1.1	0.1	0.5	<0.1	<0.1
12	0.2	0.9	0.1	0.4	0.1	<0.1
13	0.2	1.3	0.1	0.6	0.1	<0.1
14a	0.3	2.3	0.1	1.0	0.1	<0.1
14b	0.3	2.3	0.1	1.0	0.1	<0.1
15	0.4	1.8	0.2	0.8	0.1	<0.1
16	0.7	2.2	0.3	1.0	0.1	0.1
17	2.0	4.6	0.9	1.9	0.3	0.2
18	0.4	1.3	0.2	0.6	0.1	<0.1
19	0.7	1.8	0.3	0.7	0.1	0.1
20	0.3	1.1	0.2	0.5	0.1	<0.1
21	0.3	1.1	0.2	0.5	0.1	<0.1
22	0.2	0.9	0.1	0.4	<0.1	<0.1
23	0.1	0.4	<0.1	0.2	<0.1	<0.1
24	0.2	1.0	0.1	0.4	<0.1	<0.1
25	0.1	0.3	<0.1	0.2	<0.1	<0.1
26	0.1	0.4	<0.1	0.2	<0.1	<0.1
27	<0.1	0.3	<0.1	0.1	<0.1	<0.1
28	<0.1	0.2	<0.1	0.1	<0.1	<0.1
29	<0.1	0.2	<0.1	0.1	<0.1	<0.1
30	<0.1	0.2	<0.1	0.1	<0.1	<0.1
31	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
32	<0.1	0.2	<0.1	0.1	<0.1	<0.1
33	<0.1	0.1	<0.1	0.1	<0.1	<0.1
34	0.1	0.2	<0.1	0.1	<0.1	<0.1
35	<0.1	0.3	<0.1	0.1	<0.1	<0.1
36	<0.1	0.3	<0.1	0.2	<0.1	<0.1
37	0.1	0.3	<0.1	0.2	<0.1	<0.1
38	0.1	0.3	<0.1	0.1	<0.1	<0.1
39	0.1	0.3	<0.1	0.2	<0.1	<0.1
40	0.1	0.3	<0.1	0.1	<0.1	<0.1
41	0.1	0.6	<0.1	0.3	<0.1	<0.1
42	0.1	0.6	<0.1	0.3	<0.1	<0.1
43	0.1	0.4	<0.1	0.2	<0.1	<0.1
44	0.1	0.4	<0.1	0.2	<0.1	<0.1
45	0.1	0.4	0.1	0.2	<0.1	<0.1
46	0.1	0.5	0.1	0.3	<0.1	<0.1
47	0.1	0.6	0.1	0.3	<0.1	<0.1
48	0.1	0.7	0.1	0.4	<0.1	<0.1
49	0.1	0.8	0.1	0.5	<0.1	<0.1
50	0.2	0.8	0.1	0.4	<0.1	<0.1
51	0.2	1.0	0.1	0.5	0.1	<0.1
52	0.2	1.1	0.1	0.6	0.1	<0.1
53	0.3	1.6	0.2	0.9	0.1	<0.1

Table A4-1: Maximum predicted concentrations – peak construction scenario – Hume Coal Project Only Increment

Receptor ID	Maximum Predicted Concentration (µg/m³)					Dust Deposition (g/m²/month)
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	
54	0.2	1.1	0.1	0.6	0.1	<0.1
55	0.4	1.8	0.2	1.0	0.1	<0.1
56	0.1	0.4	0.1	0.2	<0.1	<0.1
57	0.1	0.4	<0.1	0.2	<0.1	<0.1
58	0.1	0.5	<0.1	0.2	<0.1	<0.1
59	0.1	0.5	0.1	0.3	<0.1	<0.1
60	0.1	0.7	0.1	0.4	<0.1	<0.1
61	0.2	1.0	0.1	0.5	0.1	<0.1
62	0.2	0.7	0.1	0.4	<0.1	<0.1
63	0.4	1.5	0.2	0.9	0.1	<0.1
64	0.1	0.8	<0.1	0.4	<0.1	<0.1
65	0.1	0.6	<0.1	0.4	<0.1	<0.1
66	0.1	0.8	<0.1	0.5	<0.1	<0.1
67	0.1	0.6	<0.1	0.3	<0.1	<0.1
68	0.1	0.7	<0.1	0.4	<0.1	<0.1
69	0.1	0.8	0.1	0.4	<0.1	<0.1
70	0.2	0.5	0.1	0.3	<0.1	<0.1
71	0.1	0.6	0.1	0.2	<0.1	<0.1
72	0.1	0.5	0.1	0.2	<0.1	<0.1
73	0.2	0.7	0.1	0.4	<0.1	<0.1
74	0.3	1.1	0.1	0.5	0.1	<0.1
75	0.1	0.6	<0.1	0.3	<0.1	<0.1
76	0.1	0.6	<0.1	0.3	<0.1	<0.1

Table A4-2: Maximum predicted concentrations – peak operations scenario – watering only at product stockpiles – Hume Coal Project Only Increment – particulate matter

Receptor ID	Maximum Predicted Concentration (µg/m³)					Dust Deposition (g/m²/month)
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	
1	0.1	1.2	<0.1	0.3	<0.1	<0.1
2	0.2	0.8	0.1	0.3	<0.1	<0.1
3	0.2	1.1	0.1	0.2	<0.1	<0.1
4	0.2	3.5	0.1	0.5	<0.1	<0.1
5	0.3	2.9	0.1	0.4	<0.1	<0.1
6	0.3	2.4	0.1	0.4	<0.1	<0.1
7	0.2	2.2	0.1	0.3	<0.1	<0.1
8	0.3	2.6	0.1	0.4	<0.1	<0.1
10	0.3	3.1	0.1	0.5	<0.1	<0.1
12	0.5	4.5	0.2	0.8	<0.1	0.1
13	0.4	3.9	0.2	0.7	<0.1	0.1
14a	0.2	3.1	0.1	0.5	<0.1	<0.1
14b	0.2	3.1	0.1	0.5	<0.1	<0.1
15	0.2	2.4	0.1	0.4	<0.1	<0.1
16	0.2	0.8	0.1	0.2	<0.1	<0.1
17	0.2	1.2	0.1	0.2	<0.1	<0.1
18	0.1	0.5	<0.1	0.2	<0.1	<0.1
19	0.2	1.4	0.1	0.2	<0.1	<0.1
20	0.2	1.1	0.1	0.2	<0.1	<0.1
21	0.2	1.7	0.1	0.3	<0.1	<0.1

Table A4-2: Maximum predicted concentrations – peak operations scenario – watering only at product stockpiles – Hume Coal Project Only Increment – particulate matter

Receptor ID	Maximum Predicted Concentration (µg/m³)					Dust Deposition (g/m²/month)
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	
22	0.3	3.5	0.1	0.5	<0.1	0.1
23	0.1	0.5	<0.1	0.1	<0.1	<0.1
24	0.1	0.7	<0.1	0.1	<0.1	<0.1
25	0.1	0.5	<0.1	0.1	<0.1	<0.1
26	0.1	0.8	<0.1	0.1	<0.1	<0.1
27	0.1	0.5	<0.1	0.1	<0.1	<0.1
28	0.1	0.5	<0.1	0.1	<0.1	<0.1
29	<0.1	0.3	<0.1	<0.1	<0.1	<0.1
30	<0.1	0.5	<0.1	0.1	<0.1	<0.1
31	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
32	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
33	<0.1	0.1	<0.1	0.1	<0.1	<0.1
34	0.4	0.7	0.1	0.6	0.1	<0.1
35	0.3	0.5	0.1	0.4	0.1	<0.1
36	0.5	0.9	0.1	0.7	0.1	<0.1
37	0.6	1.0	0.2	0.8	0.1	0.1
38	0.7	1.3	0.2	0.7	0.1	0.1
39	1.0	2.0	0.3	1.6	0.2	0.1
40	0.8	1.4	0.2	1.1	0.1	0.1
41	0.6	1.4	0.2	1.1	0.1	0.1
42	0.7	1.3	0.2	1.0	0.1	0.1
43	0.3	1.4	0.1	1.1	0.1	<0.1
44	0.5	0.8	0.1	0.6	0.1	<0.1
45	0.6	0.8	0.1	0.6	0.1	<0.1
46	0.6	1.0	0.2	0.8	0.1	0.1
47	0.7	1.3	0.2	1.0	0.1	0.1
48	0.8	1.5	0.2	1.2	0.2	0.1
49	0.9	1.7	0.2	1.4	0.2	0.1
50	1.0	2.0	0.3	1.6	0.2	0.1
51	1.1	1.8	0.3	1.4	0.2	0.1
52	1.1	1.7	0.3	1.3	0.2	0.1
53	0.8	1.0	0.2	0.8	0.1	0.1
54	0.8	1.2	0.2	0.9	0.1	0.1
55	0.7	1.0	0.2	0.6	0.1	0.1
56	0.5	0.9	0.1	0.7	0.1	<0.1
57	0.4	0.6	0.1	0.4	0.1	<0.1
58	0.3	0.7	0.1	0.6	0.1	<0.1
59	0.4	0.8	0.1	0.6	0.1	<0.1
60	0.3	0.6	0.1	0.4	0.1	<0.1
61	0.3	1.0	0.1	0.3	<0.1	<0.1
62	0.2	1.0	0.1	0.3	<0.1	<0.1
63	0.3	1.8	0.1	0.3	<0.1	0.1
64	0.2	1.8	0.1	0.3	<0.1	<0.1
65	0.1	1.2	<0.1	0.3	<0.1	<0.1
66	0.2	2.0	0.1	0.3	<0.1	<0.1
67	0.1	0.9	<0.1	0.4	<0.1	<0.1
68	0.1	1.5	<0.1	0.2	<0.1	<0.1
69	0.1	0.4	<0.1	0.1	<0.1	<0.1
70	0.1	0.7	<0.1	0.1	<0.1	<0.1
71	0.1	0.6	<0.1	0.1	<0.1	<0.1
72	0.1	0.5	<0.1	0.1	<0.1	<0.1
73	0.1	0.7	<0.1	0.1	<0.1	<0.1

Table A4-2: Maximum predicted concentrations – peak operations scenario – watering only at product stockpiles – Hume Coal Project Only Increment – particulate matter

Receptor ID	Maximum Predicted Concentration (µg/m³)					Dust Deposition (g/m²/month)
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	
74	0.1	0.9	0.1	0.1	<0.1	<0.1
75	0.2	0.5	<0.1	0.2	<0.1	<0.1
76	<0.1	0.4	<0.1	0.2	<0.1	<0.1

Table A4-3: Maximum predicted concentrations – peak operations scenario – watering and veneering at product stockpiles – Hume Coal Project Only Increment – particulate matter

Receptor ID	Maximum Predicted Concentration (µg/m³)					Dust Deposition (g/m²/month)
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	
1	0.1	0.5	<0.1	0.3	<0.1	<0.1
2	0.2	0.4	0.1	0.3	<0.1	<0.1
3	0.2	0.5	0.1	0.2	<0.1	<0.1
4	0.2	1.5	0.1	0.2	<0.1	<0.1
5	0.2	1.3	0.1	0.2	<0.1	<0.1
6	0.2	1.1	0.1	0.2	<0.1	<0.1
7	0.2	1.0	0.1	0.2	<0.1	<0.1
8	0.2	1.1	0.1	0.2	<0.1	<0.1
10	0.3	1.3	0.1	0.2	<0.1	<0.1
12	0.5	1.9	0.2	0.4	<0.1	<0.1
13	0.4	1.7	0.1	0.3	<0.1	<0.1
14a	0.2	1.2	0.1	0.3	<0.1	<0.1
14b	0.2	1.2	0.1	0.3	<0.1	<0.1
15	0.2	1.6	0.1	0.3	<0.1	<0.1
16	0.2	0.7	0.1	0.2	<0.1	<0.1
17	0.2	0.7	0.1	0.2	<0.1	<0.1
18	0.1	0.4	<0.1	0.2	<0.1	<0.1
19	0.2	0.7	0.1	0.2	<0.1	<0.1
20	0.1	0.5	0.1	0.1	<0.1	<0.1
21	0.1	0.7	0.1	0.1	<0.1	<0.1
22	0.2	1.8	0.1	0.3	<0.1	<0.1
23	0.1	0.2	<0.1	0.1	<0.1	<0.1
24	0.1	0.3	<0.1	0.1	<0.1	<0.1
25	0.1	0.2	<0.1	0.1	<0.1	<0.1
26	0.1	0.4	<0.1	0.1	<0.1	<0.1
27	0.1	0.2	<0.1	0.1	<0.1	<0.1
28	<0.1	0.3	<0.1	<0.1	<0.1	<0.1
29	<0.1	0.2	<0.1	<0.1	<0.1	<0.1
30	<0.1	0.2	<0.1	<0.1	<0.1	<0.1
31	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
32	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
33	<0.1	0.1	<0.1	0.1	<0.1	<0.1
34	0.4	0.7	0.1	0.6	0.1	<0.1
35	0.3	0.5	0.1	0.4	0.1	<0.1
36	0.5	0.9	0.1	0.7	0.1	<0.1
37	0.6	1.0	0.1	0.8	0.1	0.1
38	0.7	1.0	0.2	0.7	0.1	0.1
39	1.0	2.0	0.3	1.6	0.2	0.1
40	0.8	1.4	0.2	1.1	0.1	0.1
41	0.6	1.4	0.2	1.1	0.1	0.1

Table A4-3: Maximum predicted concentrations – peak operations scenario – watering and veneering at product stockpiles – Hume Coal Project Only Increment – particulate matter

Receptor ID	Maximum Predicted Concentration (µg/m³)					Dust Deposition (g/m²/month)
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	
42	0.7	1.3	0.2	1.0	0.1	0.1
43	0.3	1.4	0.1	1.1	0.1	<0.1
44	0.5	0.8	0.1	0.6	0.1	<0.1
45	0.6	0.8	0.1	0.6	0.1	<0.1
46	0.6	1.0	0.2	0.8	0.1	0.1
47	0.7	1.3	0.2	1.0	0.1	0.1
48	0.8	1.5	0.2	1.2	0.2	0.1
49	0.9	1.7	0.2	1.4	0.2	0.1
50	1.0	2.0	0.3	1.6	0.2	0.1
51	1.1	1.8	0.3	1.4	0.2	0.1
52	1.1	1.7	0.3	1.3	0.2	0.1
53	0.8	1.0	0.2	0.8	0.1	0.1
54	0.8	1.2	0.2	0.9	0.1	0.1
55	0.7	0.8	0.2	0.6	0.1	0.1
56	0.5	0.9	0.1	0.7	0.1	<0.1
57	0.4	0.6	0.1	0.4	0.1	<0.1
58	0.3	0.7	0.1	0.6	0.1	<0.1
59	0.4	0.8	0.1	0.6	0.1	<0.1
60	0.3	0.6	0.1	0.4	0.1	<0.1
61	0.3	0.5	0.1	0.3	<0.1	<0.1
62	0.2	0.6	0.1	0.3	<0.1	<0.1
63	0.3	1.0	0.1	0.3	<0.1	<0.1
64	0.2	0.8	<0.1	0.2	<0.1	<0.1
65	0.1	0.5	<0.1	0.3	<0.1	<0.1
66	0.2	0.9	<0.1	0.1	<0.1	<0.1
67	0.1	0.5	<0.1	0.4	<0.1	<0.1
68	0.1	0.7	<0.1	0.2	<0.1	<0.1
69	0.1	0.3	<0.1	0.1	<0.1	<0.1
70	0.1	0.3	<0.1	0.1	<0.1	<0.1
71	0.1	0.3	<0.1	0.1	<0.1	<0.1
72	0.1	0.2	<0.1	0.1	<0.1	<0.1
73	0.1	0.4	<0.1	0.1	<0.1	<0.1
74	0.1	0.5	<0.1	0.1	<0.1	<0.1
75	0.2	0.3	<0.1	0.2	<0.1	<0.1
76	<0.1	0.2	<0.1	0.2	<0.1	<0.1

Table A4-4: Maximum predicted concentrations – peak operations scenario – Hume Coal Project Only Increment – combustion pollutants and odour

Receptor ID	Maximum Predicted Concentration (µg/m³)		99.9th Percentile 1-hour average Concentration (µg/m³)				99th Percentile 1-second Odour (OU)
	1-hour NO_2	Annual NO_2	Benzene	Ethylbenzene	Toluene	Xylenes	
1	1.6	<0.1	0.01	<0.01	0.02	0.03	<1
2	2.8	<0.1	0.02	<0.01	0.03	0.04	<1
3	2.9	<0.1	0.01	<0.01	0.03	0.04	<1
4	2.1	<0.1	0.01	<0.01	0.03	0.04	<1
5	2.1	<0.1	0.01	<0.01	0.03	0.04	<1

Table A4-4: Maximum predicted concentrations – peak operations scenario – Hume Coal Project Only Increment – combustion pollutants and odour

Receptor ID	Maximum Predicted Concentration (µg/m³)		99.9th Percentile 1-hour average Concentration (µg/m³)				99th Percentile 1-second Odour (OU)
	1-hour NO_2	Annual NO_2	Benzene	Ethylbenzene	Toluene	Xylenes	
6	2.0	<0.1	0.01	<0.01	0.02	0.03	<1
7	1.8	<0.1	0.01	<0.01	0.02	0.03	<1
8	1.9	<0.1	<0.01	<0.01	0.02	0.03	<1
10	1.5	<0.1	0.01	<0.01	0.02	0.03	<1
12	2.1	<0.1	0.01	<0.01	0.03	0.04	<1
13	1.9	<0.1	0.01	<0.01	0.02	0.03	<1
14a	1.5	<0.1	<0.01	<0.01	0.02	0.03	<1
14b	1.5	<0.1	<0.01	<0.01	0.02	0.03	<1
15	1.3	<0.1	<0.01	<0.01	0.02	0.02	<1
16	1.3	<0.1	<0.01	<0.01	0.02	0.03	<1
17	1.6	<0.1	<0.01	<0.01	0.02	0.03	<1
18	1.2	<0.1	<0.01	<0.01	0.02	0.02	<1
19	1.2	<0.1	<0.01	<0.01	0.02	0.02	<1
20	0.9	<0.1	<0.01	<0.01	0.01	0.02	<1
21	0.9	<0.1	<0.01	<0.01	0.01	0.02	<1
22	0.9	<0.1	<0.01	<0.01	0.01	0.02	<1
23	0.7	<0.1	<0.01	<0.01	<0.01	0.01	<1
24	0.8	<0.1	<0.01	<0.01	0.01	0.01	<1
25	0.6	<0.1	<0.01	<0.01	<0.01	<0.01	<1
26	0.4	<0.1	<0.01	<0.01	<0.01	<0.01	<1
27	0.5	<0.1	<0.01	<0.01	<0.01	<0.01	<1
28	0.4	<0.1	<0.01	<0.01	<0.01	<0.01	<1
29	0.4	<0.1	<0.01	<0.01	<0.01	<0.01	<1
30	0.2	<0.1	<0.01	<0.01	<0.01	<0.01	<1
31	0.2	<0.1	<0.01	<0.01	<0.01	<0.01	<1
32	0.4	<0.1	<0.01	<0.01	<0.01	<0.01	<1
33	0.7	<0.1	<0.01	<0.01	<0.01	0.01	<1
34	6.6	0.1	0.04	0.02	0.07	0.10	<1
35	6.4	<0.1	0.03	0.02	0.07	0.09	<1
36	8.4	0.1	0.05	0.03	0.10	0.14	<1
37	10.5	0.2	0.07	0.03	0.14	0.19	<1
38	7.4	0.2	0.06	0.03	0.12	0.16	<1
39	13.4	0.3	0.10	0.05	0.21	0.29	1
40	10.2	0.2	0.07	0.04	0.15	0.20	<1
41	9.0	0.2	0.08	0.04	0.16	0.22	<1
42	12.5	0.2	0.09	0.05	0.19	0.25	<1
43	4.3	<0.1	0.04	0.02	0.07	0.10	<1
44	7.0	0.1	0.04	0.02	0.08	0.11	<1
45	8.0	0.2	0.05	0.02	0.10	0.13	<1
46	9.4	0.2	0.06	0.03	0.12	0.16	<1
47	9.2	0.2	0.07	0.04	0.14	0.19	<1
48	11.3	0.2	0.08	0.04	0.17	0.23	<1
49	16.7	0.3	0.11	0.05	0.21	0.29	<1
50	12.6	0.3	0.08	0.04	0.16	0.22	<1
51	11.1	0.3	0.08	0.04	0.16	0.22	<1
52	10.8	0.3	0.08	0.04	0.16	0.21	<1
53	9.2	0.2	0.06	0.03	0.13	0.18	<1
54	9.0	0.2	0.06	0.03	0.12	0.16	<1
55	7.2	0.2	0.05	0.03	0.10	0.14	<1
56	5.9	0.1	0.05	0.02	0.09	0.13	<1

Table A4-4: Maximum predicted concentrations – peak operations scenario – Hume Coal Project Only Increment – combustion pollutants and odour

Receptor ID	Maximum Predicted Concentration (µg/m³)		99.9th Percentile 1-hour average Concentration (µg/m³)				99th Percentile 1-second Odour (OU)
	1-hour NO_2	Annual NO_2	Benzene	Ethylbenzene	Toluene	Xylenes	
57	4.7	0.1	0.03	0.02	0.07	0.09	<1
58	2.9	<0.1	0.02	0.01	0.04	0.06	<1
59	3.1	0.1	0.02	0.01	0.05	0.06	<1
60	2.5	<0.1	0.02	<0.01	0.03	0.04	<1
61	2.8	<0.1	0.02	<0.01	0.04	0.05	<1
62	2.4	<0.1	0.02	<0.01	0.03	0.04	<1
63	2.4	<0.1	0.02	<0.01	0.03	0.05	<1
64	1.7	<0.1	0.01	<0.01	0.02	0.03	<1
65	1.6	<0.1	0.01	<0.01	0.02	0.03	<1
66	1.6	<0.1	<0.01	<0.01	0.02	0.03	<1
67	1.7	<0.1	0.01	<0.01	0.02	0.03	<1
68	1.7	<0.1	<0.01	<0.01	0.02	0.03	<1
69	0.8	<0.1	<0.01	<0.01	0.01	0.01	<1
70	0.9	<0.1	<0.01	<0.01	0.01	0.02	<1
71	0.8	<0.1	<0.01	<0.01	0.01	0.01	<1
72	0.8	<0.1	<0.01	<0.01	0.01	0.01	<1
73	0.7	<0.1	<0.01	<0.01	0.01	0.01	<1
74	0.9	<0.1	<0.01	<0.01	0.01	0.02	<1
75	1.1	<0.1	<0.01	<0.01	0.02	0.02	<1
76	1.1	<0.1	<0.01	<0.01	0.01	0.02	<1

Table A4-5: Maximum predicted concentrations – peak construction scenario – Hume Coal Project Only Increment + Neighbouring Emissions Sources

Receptor ID	Maximum Predicted Concentration (µg/m³)					Dust Deposition (g/m²/month)
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	
1	0.3	1.4	0.2	0.3	0.1	<0.1
2	0.3	1.2	0.2	0.4	0.1	<0.1
3	0.3	1.5	0.2	0.4	0.1	<0.1
4	0.4	1.8	0.3	0.4	0.1	<0.1
5	0.4	1.8	0.3	0.4	0.1	<0.1
6	0.4	1.8	0.3	0.4	0.1	<0.1
7	0.4	1.9	0.3	0.4	0.1	<0.1
8	0.5	2.2	0.3	0.5	0.1	<0.1
10	0.5	2.2	0.3	0.5	0.1	<0.1
12	0.6	2.1	0.3	0.4	0.1	<0.1
13	0.6	2.4	0.3	0.5	0.1	<0.1
14a	0.6	3.2	0.4	0.6	0.1	<0.1
14b	0.6	3.2	0.4	0.6	0.1	<0.1
15	0.8	3.0	0.5	0.6	0.1	0.1
16	1.1	3.3	0.6	0.7	0.1	0.1
17	2.6	4.8	1.3	0.8	0.2	0.2
18	0.9	2.6	0.6	0.8	0.1	0.1
19	1.6	3.6	0.9	1.1	0.2	0.1
20	1.6	7.7	0.9	2.0	0.2	0.1
21	1.8	9.3	1.1	2.4	0.3	0.2
22	2.8	13.4	1.7	4.0	0.5	0.2
23	0.9	4.7	0.6	0.9	0.2	0.1

Table A4-5: Maximum predicted concentrations – peak construction scenario – Hume Coal Project Only Increment + Neighbouring Emissions Sources

Receptor ID	Maximum Predicted Concentration (µg/m³)					Dust Deposition (g/m²/month)
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	
24	1.0	5.0	0.6	1.4	0.2	0.1
25	4.9	13.5	3.1	2.1	0.6	0.2
26	2.8	9.6	1.9	1.7	0.4	0.2
27	2.1	8.1	1.3	1.2	0.3	0.1
28	2.4	6.0	1.4	1.3	0.5	0.1
29	2.2	3.8	1.3	1.4	0.3	0.2
30	0.8	2.3	0.5	0.8	0.1	0.1
31	0.4	1.5	0.2	0.6	0.1	<0.1
32	1.0	3.3	0.6	1.0	0.1	<0.1
33	0.5	1.9	0.4	0.7	0.1	<0.1
34	0.3	1.5	0.2	0.6	0.1	<0.1
35	0.3	1.3	0.2	0.5	0.1	<0.1
36	0.3	1.4	0.2	0.5	0.1	<0.1
37	0.3	1.4	0.2	0.5	0.1	<0.1
38	0.3	1.6	0.2	0.6	0.1	<0.1
39	0.4	1.7	0.2	0.6	0.1	<0.1
40	0.3	1.6	0.2	0.6	0.1	<0.1
41	0.4	1.6	0.3	0.6	0.1	<0.1
42	0.4	1.9	0.3	0.6	0.1	<0.1
43	0.5	1.9	0.4	0.6	0.1	<0.1
44	0.5	2.0	0.4	0.6	0.1	<0.1
45	0.5	2.3	0.4	0.7	0.1	<0.1
46	0.5	2.3	0.3	0.7	0.1	<0.1
47	0.5	2.3	0.3	0.8	0.1	<0.1
48	0.5	2.2	0.3	0.7	0.1	<0.1
49	0.5	2.1	0.3	0.7	0.1	<0.1
50	0.6	2.0	0.3	0.7	0.1	<0.1
51	0.6	2.1	0.4	0.7	0.1	<0.1
52	0.6	2.1	0.4	0.6	0.1	<0.1
53	0.7	1.9	0.4	0.5	0.1	0.1
54	0.7	2.0	0.4	0.6	0.1	<0.1
55	0.8	2.2	0.5	0.5	0.1	0.1
56	0.6	2.2	0.4	0.6	0.1	<0.1
57	0.6	2.0	0.4	0.6	0.1	<0.1
58	0.8	2.3	0.5	0.8	0.2	0.1
59	0.8	2.6	0.5	1.0	0.1	<0.1
60	0.9	3.4	0.6	1.4	0.2	0.1
61	0.9	3.1	0.6	0.9	0.2	0.1
62	1.1	3.1	0.7	0.9	0.2	0.1
63	1.0	2.7	0.6	0.9	0.1	0.1
64	0.3	1.7	0.2	0.3	0.1	<0.1
65	0.3	1.5	0.2	0.3	0.1	<0.1
66	0.4	1.6	0.2	0.4	0.1	<0.1
67	0.3	1.4	0.2	0.3	0.1	<0.1
68	0.3	1.5	0.2	0.4	0.1	<0.1
69	0.9	3.6	0.6	1.1	0.2	0.1
70	1.2	5.9	0.7	1.8	0.2	0.1
71	1.0	4.5	0.6	1.3	0.2	0.1
72	0.9	3.6	0.6	1.2	0.2	0.1
73	1.2	4.3	0.7	1.5	0.2	0.1
74	1.4	6.9	0.9	1.8	0.2	0.1
75	1.8	4.5	1.3	1.7	0.4	0.2

Table A4-5: Maximum predicted concentrations – peak construction scenario – Hume Coal Project Only Increment + Neighbouring Emissions Sources

Receptor ID	Maximum Predicted Concentration (µg/m³)					Dust Deposition (g/m²/month)
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	
76	2.0	4.5	1.4	1.8	0.4	0.2

Table A4-6: Maximum predicted concentrations – peak operations scenario – Hume Coal Project Only Increment + Neighbouring Emissions Sources

Receptor ID	Maximum Predicted Concentration (µg/m³)							Dust Deposition (g/m²/month)
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	1-hour NO_2	Annual NO_2	
1	0.4	1.4	0.2	0.4	0.1	67.0	1.5	<0.1
2	0.4	1.3	0.2	0.5	0.1	43.6	1.4	<0.1
3	0.5	1.6	0.3	0.5	0.1	44.3	1.5	<0.1
4	0.5	3.7	0.3	0.6	0.1	62.2	1.7	<0.1
5	0.6	3.1	0.3	0.5	0.1	67.8	1.8	<0.1
6	0.6	2.6	0.3	0.5	0.1	67.9	1.8	<0.1
7	0.6	2.5	0.3	0.4	0.1	67.2	1.8	<0.1
8	0.6	2.9	0.3	0.5	0.1	62.5	2.0	<0.1
10	0.7	3.3	0.4	0.6	0.1	52.9	2.1	0.1
12	0.9	4.5	0.5	0.8	0.1	50.2	2.4	0.1
13	0.8	3.9	0.4	0.7	0.1	50.1	2.4	0.1
14a	0.6	3.1	0.4	0.6	0.1	68.2	2.4	<0.1
14b	0.6	3.1	0.4	0.6	0.1	68.2	2.4	<0.1
15	0.6	2.5	0.4	0.6	0.1	72.3	2.9	<0.1
16	0.7	1.8	0.4	0.7	0.2	89.6	4.1	<0.1
17	0.9	2.2	0.6	0.8	0.2	112.7	7.0	0.1
18	0.8	2.3	0.5	0.8	0.2	62.2	3.9	<0.1
19	1.2	3.4	0.7	1.1	0.2	87.3	5.1	0.1
20	1.4	7.7	0.9	2.0	0.3	80.3	5.1	0.1
21	1.7	9.3	1.0	2.4	0.3	70.9	5.3	0.2
22	2.8	13.4	1.7	4.0	0.5	89.6	6.6	0.3
23	0.9	4.7	0.6	0.9	0.2	63.6	3.5	0.1
24	1.0	5.0	0.6	1.4	0.2	77.5	3.4	0.1
25	5.0	13.5	3.2	2.1	0.6	85.2	7.0	0.2
26	2.8	9.6	1.9	1.7	0.5	112.2	10.7	0.2
27	2.1	8.1	1.4	1.2	0.3	94.6	5.0	0.1
28	2.4	6.1	1.4	1.3	0.5	140.1	13.1	0.1
29	2.3	3.9	1.3	1.4	0.3	120.9	6.9	0.2
30	0.8	2.2	0.5	0.8	0.2	73.7	3.2	0.1
31	0.4	1.5	0.2	0.6	0.1	64.1	1.8	<0.1
32	1.0	3.1	0.6	1.0	0.1	67.4	2.1	<0.1
33	0.5	1.9	0.4	0.7	0.1	58.5	1.9	<0.1
34	0.7	1.6	0.3	0.8	0.1	60.5	1.5	0.1
35	0.5	1.6	0.2	0.8	0.1	61.0	1.4	<0.1
36	0.7	1.7	0.3	0.9	0.1	50.8	1.4	0.1
37	0.8	1.7	0.3	1.0	0.2	54.7	1.5	0.1
38	1.0	1.6	0.4	0.8	0.2	60.4	1.7	0.1
39	1.3	2.2	0.5	1.6	0.3	60.2	1.8	0.1
40	1.1	1.6	0.4	1.2	0.2	63.2	1.7	0.1
41	1.0	1.5	0.4	1.1	0.2	82.1	1.9	0.1
42	1.1	1.8	0.4	1.1	0.2	81.8	1.9	0.1
43	0.8	1.8	0.4	1.2	0.2	67.9	2.2	0.1
44	0.9	1.8	0.4	0.7	0.2	68.4	2.2	0.1

Table A4-6: Maximum predicted concentrations – peak operations scenario – Hume Coal Project Only Increment + Neighbouring Emissions Sources								
Receptor ID	Maximum Predicted Concentration (µg/m³)							Dust Deposition (g/m²/month)
	Annual TSP	24-hour PM_{10}	Annual PM_{10}	24-hour $PM_{2.5}$	Annual $PM_{2.5}$	1-hour NO_2	Annual NO_2	
45	1.0	2.1	0.4	0.7	0.2	67.6	2.2	0.1
46	1.0	2.2	0.5	0.9	0.2	66.8	2.1	0.1
47	1.1	2.2	0.5	1.1	0.2	62.8	2.2	0.1
48	1.2	2.1	0.5	1.2	0.2	54.9	2.2	0.1
49	1.3	2.0	0.5	1.4	0.3	54.9	2.2	0.1
50	1.4	2.2	0.5	1.7	0.3	54.9	2.2	0.2
51	1.6	2.0	0.6	1.5	0.3	55.2	2.3	0.1
52	1.5	1.9	0.6	1.4	0.3	55.0	2.3	0.1
53	1.2	1.5	0.5	0.8	0.2	60.8	2.3	0.1
54	1.2	1.7	0.5	0.9	0.2	50.5	2.3	0.1
55	1.1	1.6	0.5	0.7	0.2	61.7	2.3	0.1
56	0.9	2.1	0.5	0.8	0.2	67.1	2.3	0.1
57	0.9	1.7	0.4	0.7	0.2	67.6	2.3	0.1
58	1.0	2.2	0.6	0.9	0.2	57.4	2.8	0.1
59	1.0	2.5	0.6	1.0	0.2	59.1	2.8	0.1
60	1.1	3.4	0.6	1.4	0.2	67.7	3.2	0.1
61	1.0	3.0	0.6	0.9	0.2	61.4	3.3	0.1
62	1.1	2.9	0.7	0.9	0.2	56.4	4.0	0.1
63	1.0	2.4	0.6	1.0	0.2	72.2	3.4	0.1
64	0.4	2.0	0.2	0.4	0.1	70.8	1.5	<0.1
65	0.4	1.4	0.2	0.4	0.1	65.9	1.5	<0.1
66	0.4	2.2	0.3	0.4	0.1	79.2	1.6	<0.1
67	0.4	1.1	0.2	0.4	0.1	65.1	1.4	<0.1
68	0.4	1.7	0.2	0.4	0.1	72.7	1.5	<0.1
69	0.9	3.6	0.6	1.1	0.2	77.0	3.6	0.1
70	1.1	5.9	0.7	1.8	0.2	76.8	4.3	0.1
71	1.0	4.4	0.6	1.3	0.2	75.7	4.0	0.1
72	0.9	3.5	0.6	1.3	0.2	72.0	3.6	0.1
73	1.2	4.3	0.7	1.5	0.2	79.6	4.4	0.1
74	1.3	6.9	0.8	1.8	0.3	82.3	4.9	0.1
75	1.9	4.6	1.3	1.7	0.4	72.4	5.9	0.2
76	2.0	4.5	1.4	1.9	0.4	79.6	5.6	0.2

APPENDIX 5
HUME COAL PROJECT INCREMENT-ONLY ISOPLETH PLOTS

The following figures present the predicted concentration isopleths from project-only construction and operational emissions for TSP, PM_{10}, $PM_{2.5}$ and dust deposition.

Annual average TSP concentrations (µg/m³) - construction scenario only

Hume Coal Project

Air Quality Impact And Greenhouse Gas Assessment

Figure A5.1

Annual average PM10 concentrations (µg/m³) - construction scenario only

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Figure A5.2

Annual average PM2.5 concentrations ($\mu g/m^3$) - construction scenario only

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Figure A5.3

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Annual average dust deposition levels (g/m²/month) - construction scenario only

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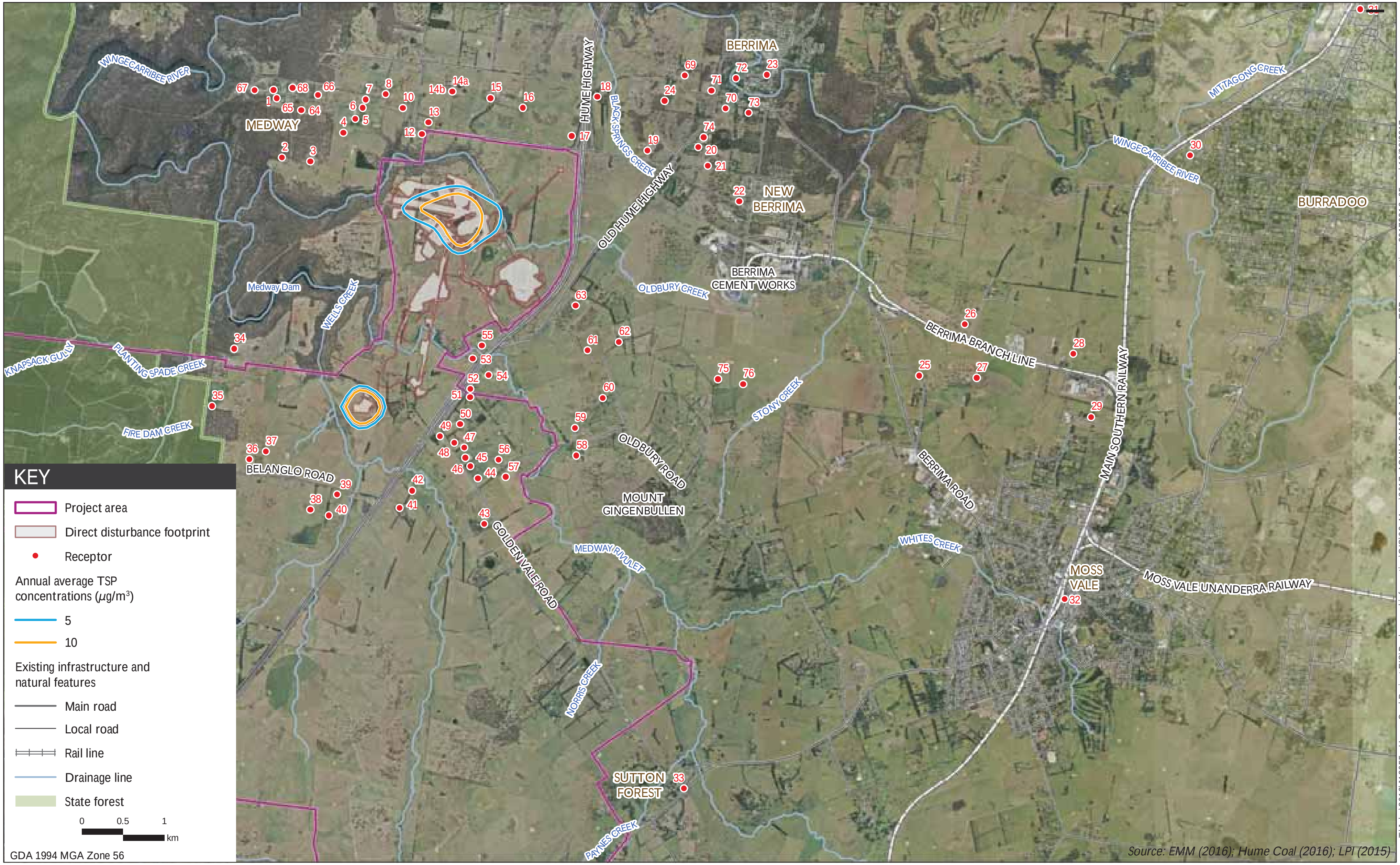
Figure A5.4



Annual average TSP concentrations (µg/m³) - operation scenario increment - watering only at stockpiles

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Figure A5.5

Annual average PM10 concentrations (µg/m³) -
operation scenario increment - watering only at stockpiles

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Figure A5.6

Annual average PM2.5 concentrations (µg/m³) - operation scenario increment - watering only at stockpiles

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Figure A5.7

Annual average dust deposition (g/m²/month) - operation scenario increment - watering only at product stockpiles

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Figure A5.8

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Annual average TSP concentration (µg/m³) -
operation scenario increment - veneering and watering at product stockpiles

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Figure A5.9

Annual average PM10 concentration (µg/m³) - operation scenario increment - veneering and watering at product stockpiles

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Figure A5.10

Annual average PM2.5 concentration ($\mu g/m^3$) - operation scenario increment - veneering and watering at product stockpiles

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Figure A5.11

Annual average dust deposition levels (g/m²/month) - operation scenario increment - veneering and watering at product stockpiles

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Figure A5.12