FINAL REPORT

WILPINJONG COAL MINE POLLUTION REDUCTION PROGRAM – ASSESSMENT AND BEST PRACTICE

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1 INTRODUCTION

1.1 OEH Best Practice

In June 2011 NSW Office of Environment and Heritage (OEH) published the document *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining* (referred to hereafter as 'the Best Practice Report')**(Donnelly *et al*., 2011)**. As an outcome of the Best Practice Report, OEH now requires a Pollution Reduction Program (PRP) to be included in the Environment Protection Licence for each coal mine in NSW.

1.2 PRP requirements

The PRP requires the licensee (the mine company) to conduct a site-specific best management practice, and to prepare a report on the practicability of implementing measures to reduce emissions of particulate matter (PM). The report must include the following:

- The identification, quantification and justification of the measures that are currently being used to reduce PM emissions.
- The identification, quantification and justification of additional best practice measures that could be used to minimise PM emissions.
- An evaluation of the practicability of implementing the best practice measures.
- A proposed timeframe for implementing all practicable best practice measures.

In preparing the report the licensee must refer to the document entitled *Coal Mine Particulate Matter Control Best Practice – Site Specific Determination Guideline* **(OEH, 2011)**, which details the process to be followed in the PRP. It also provides the required content and format of the PRP. **Table 1** presents a summary of the each of the requirements and a reference to the relevant section in this report.

1.3 Wilpinjong Coal Mine

1.3.1 Overview of Mining Operations

Wilpinjong Coal Mine is an open-cut mine located in the Hunter Valley Coal Fields of central NSW, approximately 40 km north-east of Mudgee and near the village of Wollar (**Figure 1**). The mine is owned by Peabody Energy Australia Pty Limited. Approval for the mine was granted by the NSW Minister for Planning in February 2006, and coal was first railed from the site in October of the same year. The mine is approved to operate over a period of approximately 21 years. The coal is currently mined under contract by Thiess, although there will be a transition to Peabody owner-operator status by March 2013. The client for this report - Wilpinjong Coal Pty Ltd. - operates as a subsidiary of Peabody Energy Australia.

A plan of the mine site is shown in **Figure 2**. The mining-related activities at Wilpinjong include open-cut mining, processing, rail loading, coal stockpiling and waste rock ('overburden') emplacement. Approval for a Modification to the mine (Application Number 05_0021 MOD4) was granted in September 2010. The Modification involves an incremental increase in the approved maximum run-of-mine (ROM) coal mining rate from 13 million tonnes per annum (Mtpa) to 15 Mtpa, a small increase in the maximum annual rate of overburden mined, expansion of the Coal Handling and Preparation Plant (CHPP), and construction of additional conveyors and transfer stations. No change is proposed to the approved life of to the Project or the approved extent of open-cut mining.

Table 1: PRP Guideline requirements and report reference

	Guideline Requirement		Report Reference
1) Identification, quantification and justification of existing measures that are being used to minimise particle emissions	a.	Estimate baseline emissions of TSP, PM_{10} and $PM_{2.5}$ (tonne per year) from each mining activity using US EPA AP-42 emission estimation techniques for both uncontrolled emissions (with no particulate matter controls in place) and controlled emissions (with current particulate matter controls in place).	Section 3.2
	b.	Rank the controlled emission estimates for TSP, PM_{10} and $PM_{2.5}$ emitted by each mining activity from highest to lowest.	Section 3.3
	c.	Identify the top four mining activities that contribute the highest emissions of TSP, PM_{10} and $PM_{2.5}$.	Section 3.3
2) Identification, quantification and justification of best practice measures that could be used to minimise particle emissions	a.	For each of the top four activities identified in Step 1(c) identify the measures that could be implemented to reduce emissions.	Section 4.1
	b.	For each of the top four activities identified in Step 1(c) estimate emissions of TSP, PM_{10} and $PM_{2.5}$ from each mining activity following the application of the measures identified in Step 2 (a).	Section 4.2
3) Evaluation of the practicability of implementing these best practice measures	a.	For each of the best practice measures identified in Step 2(a), assess the practicability associated with their implementation, by taking into consideration: i. Implementation costs ii. Regulatory requirements iii. Environmental impacts iv. Safety implications and v. Compatibility with current processes and proposed future developments.	Section 5.1, 5.2
	b.	Identify those best practices that will be implemented at the premises to reduce particle emissions.	Section 5.3
4) A proposed timeframe for implementing all practicable best practice measures	a.	For each of the best practice measures identified as being practicable in step 3(b), provide a timeframe for their implementation.	Section 6

Figure 1: Location of Wilpinjong mine (Peabody Energy, 2011).

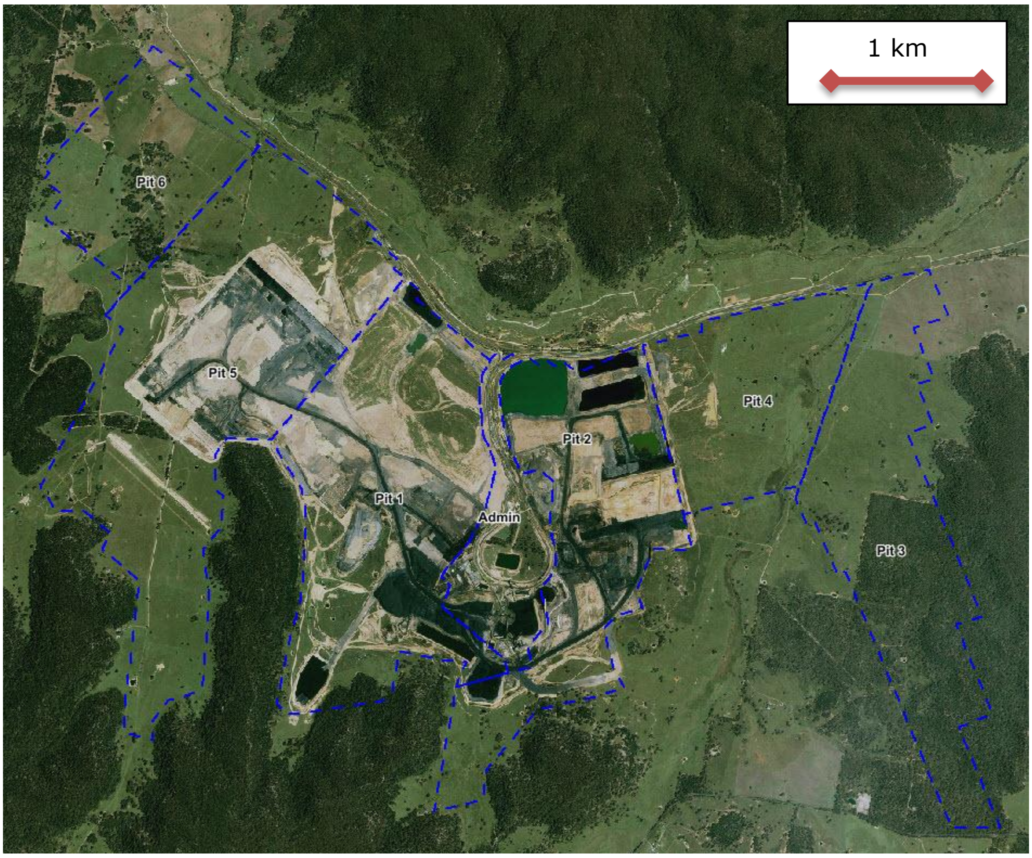


Figure 2: Map of Wilpinjong mine, full site

1.3.2 Environmental Protection Licence

The PRP requirement for a PM-control best practice assessment and report has been attached to the Environment Protection Licence (EPL) for Wilpinjong Coal Pty Ltd (Licence number 12425).

1.3.3 Previous air quality assessments

The original Air Quality Impact Assessment (AQIA) for the open-cut mining operations at Wilpinjong was completed by **Holmes Air Sciences (2005)** as a component of the original Environmental Impact Statement **(WCPL, 2005)**. The assessment for the modification was undertaken by PAEHolmes in 2010 **(PAEHolmes, 2010)**.

The 2005 Holmes Air Sciences assessment predicted compliance with relevant air quality criteria at all nearby private receptors except the nearest private residence to the north of Pit 6 (now mine owned).

2 METHODOLOGY

The methodology followed the steps in the OEH *Site-specific Determination Guideline*. These steps are described in the following sections. The results for each step are provided in the subsequent sections of the report.

2.1 Step 1: Emissions with current PM-control measures

This step involved identifying the separate PM-generating activities at the mine, identifying the measures that are currently being used to control PM emissions, and quantifying baseline PM emissions with the current measures in place.

2.1.1 Step 1a: Mining activities, current PM controls and baseline emissions

2.1.1.1 Mining activities

The main PM-generating activities which occur at open-cut coal mines are identified in the *Site-specific Determination Guideline*[a]. These activities are listed, with some minor modifications, in **Table 2**. The activities follow the sequence of coal extraction.

There are some relatively minor differences between the activities in **Table 2** and those in the OEH Guideline:

- In **Table 2** the activities are listed in broad chronological order in relation to the mining process.
- OEH provide no activity codes, and therefore to minimise ambiguity in **Table 2** a specific code has been allocated to each activity for the purposes of this Report.
- For some of the activities in the OEH Guideline (such as unloading coal and loading coal), the emission calculation method and potential controls are essentially the same, and in such instances the mining activities have been grouped in **Table 2**. However, some distinctions were retained to allow for disaggregation in the data supplied by the mine.
- OEH does not include vegetation clearance, topsoil removal and work on rehabilitation. These activities are included in **Table 2**.
- In **Table 2** there as distinction between drilling and blasting for overburden and coal.

The mining activities at Wilpinjong which corresponded to those in **Table 2** were identified through correspondance with the mine operator.

[a] Combustion sources (notably from heavy-duty diesel engines) are not explicitly defined in the OEH list. This is likely to be due to the fact that diesel emissions are included to some extent in the emission factors from the United States Environmental Protection Agency (USEAPA) that are recommended for use in PRP calculations. However, in June 2012 the World Health Organization classified diesel exhaust as being carcinogenic to humans, and being associated with an increased risk for lung cancer. This would provide a strong justification for the separate consideration of diesel exhaust in the PRP process, irrespective of the calculation method.

Table 2: PM-generating activities at coal mines (adapted from OEH, 2011)

Type of activity		Specific activity	
Code	**Description**	**Code**	**Description**
1	Vegetation clearance/removal	1.01	Scraping and removal
2	Topsoil and subsoil removal	2.01	Removal with scrapers
		2.02	Removal with bulldozers/excavators
		2.03	Loading to trucks & unloading at emplacement
		2.04	Hauling topsoil
3	Overburden and interburden removal	3.01	Drilling
		3.02	Blasting
		3.03	Draglines
		3.04	Bulldozers ripping/pushing/clean-up
		3.05	Loading to trucks & unloading at emplacement
		3.06	Hauling to emplacement
4	Coal removal	4.01	Drilling
		4.02	Blasting
		4.03	Bulldozers ripping/pushing/clean-up
		4.04a	Loading truck with ROM coal, unloading truck to ROM bin
		4.04b	Loading truck with ROM coal, unloading truck to ROM
		4.04c	Loading truck from ROM stockpile, unloading truck to ROM
		4.05	Hauling ROM coal
		4.06a	Material transfer: ROM bin to crusher
		4.06b	Material transfer: crusher to CHPP
		4.06c	Material transfer: CHPP to raw & product stockpiles
		4.06d	Material transfer: raw and product stockpiles to train
		4.07	Screening
		4.08	Crushing
		4.09	Bulldozing on ROM stockpiles
		4.10	Bulldozing on product stockpiles
5	Wind erosion	5.01	Exposed areas, including overburden dumps
		5.02	Active coal stockpiles
6	Road grading	6.01	Road grading
7	Rehabilitation	7.01	Bulldozing on rehab

2.1.1.2 Current PM-control measures

The measures currently used to control PM emissions at Wilpinjong were also identified through discussion with the mine operator. In addition, the technical specifications of any PM-control equipment were supplied to PAEHolmes by the mine operator.

The current PM control measures were then compared with those identified in the Best Practice Report in order to determine their likely effectiveness.

2.1.1.3 Baseline emissions

The *Site-specific Determination Guideline* requires baseline emissions of particulate matter to be calculated with current controls in place. This firstly requires the calculation of emissions with no controls in place, followed by the application of emission-reduction factors to allow current controls to be taken into account.

Emissions of particulate matter from each identified mining activity were estimated according to three different metrics:

- Total suspended particulate matter (TSP)
- Particulate matter with an aerodynamic diameter of less than 10 µm (PM_{10})
- Particulate matter with an aerodynamic diameter of less than 2.5 µm ($PM_{2.5}$)

For each activity and metric the emissions were estimated in tonnes per year, and for the calendar year 2011. The emission estimation techniques from the USEPA *AP-42 Compilation of Air Pollutant Emission Factors* were used for this purpose.

For the situation with no PM controls in place at the mine, the general form of the equation for emission estimation was:

$$E = A \times EF \qquad \text{Equation 1}$$

where:

E = emissions (*e.g.* kg/year)
A = activity (*e.g.* tonnes/year)
EF = emission factor (*e.g.* kg/tonne)

In other words the calculation of emissions involves the multiplication of an amount of activity (*e.g.* the amount of coal loaded to trucks, in tonnes per year) by an emission factor (*e.g.* the mass of PM_{10} emitted per tonne of coal loaded). The emission factor equations for all PM-generating mining activities (including activities not present at Wilpinjong) are presented in **Appendix A**.

The values for the activity data and equation variables, and descriptions of how these were obtained, are given in **Appendix B**. The activity data and the values of some of the variables used in the emission calculations were supplied primarily by the mine operator using a form designed by PAEHolmes. However, it was considered important to obtain site-specific data for a number of parameters. For example, the **USEPA (2006a)** states that the silt content of unsealed roads varies significantly with location, and therefore the use of site-specific data is strongly recommended. Consequently, several different materials – representing the different mining activities - were collected for analysis of silt content, moisture content, or both, depending on the requirements of the AP-42 emission factor equations. Further details of the measurement of silt and moisture content are provided in **Appendix C**.

Baseline emissions were then estimated for a situation with current PM controls in place at the mine. Prior to this, the mining activities in **Table 2** were further grouped for two reasons. Firstly, as noted earlier, several of the individual activities involved processes which were, as far as the method of calculating emissions (and hence the application of control measures) was concerned, identical (*e.g.* all hauling activities on unpaved roads). Secondly, it was assumed that any controls applicable to a group of activities would be applied to all specific activities within the group. The groups of activities are shown in **Table 3**.

Table 3: Grouped activities

Group	Description	Group	Description
A	Vegetation removal	I	Bulldozers on Coal
B	TS removal, scrapers	J	Loading/unloading coal
C	Bulldozers on topsoil, overburden, rehab.	K	Coal transfer
D	Loading/unloading topsoil and overburden	L	Coal screening
E	Hauling on unsealed roads	M	Coal crushing
F	Drilling	N	Wind erosion - exposed areas and overburden
G	Blasting	O	Wind erosion - active coal stockpiles
H	Draglines	P	Road grading

For the groups in **Table 3** emissions were then estimated for a situation with current PM controls in place at the mine. In this case Equation 1 was modified so that:

$$E = A \times EF \times (1 - ER/100) \qquad \text{Equation 2}$$

where:

ER = overall emission-control efficiency (%)

The effectiveness of each PM control measure was taken from the Best Practice Report (**Donnelly *et al*., 2011**), using assumptions where necessary to adapt the value(s) to the Wilpinjong case.

2.1.2 Step 1b: Ranking of mining activities

Using the baseline emission estimates for current controls from Step 1a, the annual TSP, PM_{10} and $PM_{2.5}$ emissions associated with each mining activity group in **Table 3** were ranked from highest to lowest.

2.1.3 Step 1c: Identification of highest emitting activities

Based on the results from Step 1b, the OEH *Site Specific Determination Guideline* dictates that the top four mining activities in terms of emissions of TSP, PM_{10} and $PM_{2.5}$ need to be taken forward for further consideration. However, any reductions in PM emissions are beneficial from a health perspective, and the top four activities are not necessarily the ones for which the greatest (or most cost-effective) reductions can be achieved. Therefore, OEH clarified the PRP requirements in a workshop held in Sydney[b], so that PRPs should now identify *any* activity for which there is potential to significantly reduce emissions. Consequently, in this Step the potential benefits of applying (provisional) best practice controls to all activities were also considered.

2.2 Step 2: Potential additional PM-control measures

2.2.1 Step 2a: Identification of measures

For each of the top four activities identified in Step 1c the control measures that could be implemented to reduce PM emissions were identified, taking into consideration the following:

[b] OEH PRP Stage 1 Consultant Workshop, Sydney, 8 May 2012.

- The Best Practice Report.
- Other relevant published information.
- Any relevant industry experience from Australia or overseas.

The *Site Specific Determination Guideline* requires the subject mine to quantify and justify particulate matter controls through supporting information. The efficiencies of different measures for controlling PM were sourced from the literature. However, it should be noted that these control efficiencies can be highly site-specific.

2.2.2 Step 2b: Emissions with control measures

For each of the top four activities identified in Step 1c, emissions of TSP, PM_{10} and $PM_{2.5}$ were estimated following the application of the measures identified in Step 2a.

2.3 Step 3: Practicability of implementing additional PM-control measures

2.3.1 Step 3a: Determining practicability of implementation

For each of the best practice PM-control measures identified in Step 2a, the overall practicability associated with its implementation was assessed by the mine operator. This assessment took into consideration the following:

- The mine operator's opinion on the practicability of the measures at an operational level.
- Details of any restrictions on implementation due to an existing approval or licence.
- Any regulatory requirements.
- Any new or additional environmental impacts - such as increased noise or increased use of fresh water - that might be associated with the control measures.
- Any safety implications, as noted by the mine operator.
- Details of compatibility with current processes and proposed future developments, where again provided by the mine operator.

2.3.2 Step 3b: Measures to be implemented

Following on from the evaluation of practicability, the best practices to be implemented at Wilpinjong to reduce PM emissions were identified.

2.4 Step 4: Timeframe for implementing additional measures

For each of the best practice measures identified as being practicable in Steps 3a and 3b, a timeframe for their implementation was developed by the mine operator.

3 EMISSIONS WITH CURRENT PM-CONTROL MEASURES

3.1 Mining activities and current controls

Table 4 shows the activities which occur at Wilpinjong. The only activities which were not included in the emission calculations were:

- Vegetation removal (not likely to represent a significant activity, and no calculation method available)
- Draglines on overburden (not used at Wilpinjong)
- Bulldozing on coal product stockpiles (activity included in wind erosion and maintenance calculation)

The activities which are currently controlled are shown in **Table 5**. The assumed effectiveness of the control measures for each type of activity, with the basis for the assumption is also given. Some of the control measures at Wilpinjong are shown in **Figure 3** and **Figure 4**.

Table 4: PM-generating activities occurring at Wilpinjong

Specific activity		Occurring at mine	Included in calculations
Code	Description		
1.01	Vegetation removal with scrapers	Yes	**No**
2.01	Topsoil removal with scrapers	Yes	Yes
2.02	Topsoil removal with bulldozers/excavators	Yes	Yes
2.03	Topsoil loading and unloading	Yes	Yes
2.04	Topsoil hauling	Yes	Yes
3.01	Overburden drilling	Yes	Yes
3.02	Overburden blasting	Yes	Yes
3.03	Overburden draglines	**No**	**No**
3.04	Overburden bulldozing	Yes	Yes
3.05	Overburden loading and unloading	Yes	Yes
3.06	Overburden hauling	Yes	Yes
4.01	Coal drilling	Yes	Yes
4.02	Coal blasting	Yes	Yes
4.03	Coal bulldozing (ripping, pushing, clean-up)	Yes	Yes
4.04a	Loading truck with ROM coal, unloading truck to ROM bin	Yes	Yes
4.04b	Loading truck with ROM coal, unloading truck to ROM stockpile	Yes	Yes
4.04c	Loading truck from ROM stockpile, unloading truck to ROM bin	Yes	Yes
4.05	Coal hauling	Yes	Yes
4.06a	Coal transfer: ROM bin to crusher	Yes	Yes
4.06b	Coal transfer: crusher to CHPP	Yes	Yes
4.06c	Coal transfer: CHPP to raw & product stockpiles	Yes	Yes
4.06d	Coal transfer: raw and product stockpiles to train	Yes	Yes
4.07	Coal screening	Yes	Yes
4.08	Coal crushing	Yes	Yes
4.09	Coal bulldozing (ROM stockpiles)	Yes	Yes
4.10	Coal bulldozing (product stockpiles)	Yes	**No**
5.01	Wind erosion on exposed areas, OB dumps	Yes	Yes
5.02	Wind erosion on active coal stockpiles	Yes	Yes
6.01	Grading roads	Yes	Yes
7.01	Rehabilitation bulldozing	Yes	Yes

Table 5: Current PM controls and assumed effectiveness

Group	Activity	Control measures currently in place	Effectiveness (% reduction in emissions)[a]	Assumption (emission control efficiencies are based on OEH Best Practice Report).
A	Vegetation removal	None	0%	-
B	Topsoil removal, scrapers	None	0%	-
C	Bulldozers on topsoil, overburden, rehabilitation	Wet routes	20%	Routes are already wet, but material is not. 20% used rather than 50% in Best Practice Report.
D	Loading/unloading topsoil and overburden	None	0%	-
E	Hauling on unsealed roads	Truck speed limited to 54 km/h	0%	Whilst the Best Practice Report provides reductions in PM for reductions in speed, there is no speed term in the AP-42 equation, so the actual effectiveness cannot be stated.
		Level 1 watering (i.e. <2l/m^2/h). Wilpinjong currently has a surplus of water.	50%	Haul roads are generally wet, and watered to an extent that is equivalent to Level 1. Based on 1.9 million litres per day, an assumed road length of 8 km and spray bar width of 8m, the watering intensity would be 1.25 l/m^2/h.
F	Drilling	Water curtains	90%	Curtains result in no visible dust. Effectiveness assumed to be similar to upper limit of range of values in Best Practice Report.
G	Blasting	None	0%	-
H	Draglines	Not applicable	Not applicable	-
I	Bulldozers on Coal	Wet routes	20%	Routes are already wet, but material is not. 20% used rather than 50% in Best Practice Report.
J	Loading/unloading coal			
	Loading truck with ROM coal/ unloading truck to ROM bin	Water sprays on ROM bin	25%	Applied to unloading at ROM bin only, so 25% rather than 50% in Best Practice Report.
	Loading truck with ROM coal/ unloading truck to ROM stockpile	None	0%	-
	Loading truck from ROM stockpile/ unloading truck to ROM bin	Water sprays on ROM bin	25%	Applied to unloading at ROM bin only, so 25% rather than 50% in Best Practice Report.
K	Coal transfer	Conveyors - Application of water at transfers; belt cleaning and spillage minimisation; enclosure. Transfers, train loading – Enclosure.	95%	Estimate based on cumulative effects of different control methods.
L	Coal screening	None	Not applicable	-
M	Coal crushing	None	0%	-
N	Wind erosion - exposed areas and overburden	None	0%	-
O	Wind erosion - active coal stockpiles	Pile shaping/orientation	50%	Assumed to be towards upper end of range in Best Practice Report (<60%)
P	Road grading	Surface treatment - watering grader routes. Graders also operated at 8 km/h.	75%	Based on watered grader routes and speed reduction.

(a) The values are taken from Donnelly *et al*. (2011), unless stated otherwise.

Figure 3: Watering of haul roads

Figure 4: Sprays on ROM bin

3.2 Baseline emissions with current controls

For each mining activity group at Wilpinjong, **Table 6** shows the TSP, PM_{10} and $PM_{2.5}$ emissions that *would have* occurred with no PM controls in place. Emissions were then recalculated taking into account the various PM-control measures that are *currently* in place at the mine. **Table 7** shows emissions with the current PM controls in place. With current controls emissions are around 40-45% lower than with no controls. The values with current controls were taken as the baseline for the study.

Table 6: PM emissions by activity during 2011 with no controls in place

Activity Group	Description	Emissions (tonnes/year) TSP	PM_{10}	$PM_{2.5}$
A	Vegetation removal	0.0	0.0	0.0
B	Topsoil removal, scrapers	4.7	0.0	0.0
C	Bulldozers on topsoil, overburden, rehabilitation	31.8	6.2	3.3
D	Loading/unloading topsoil and overburden	8.0	3.8	0.6
E	Hauling on unsealed roads	6,955.0	1,914.8	191.5
F	Drilling	91.2	47.4	2.7
G	Blasting	107.9	56.1	3.2
H	Draglines	0.0	0.0	0.0
I	Bulldozers on coal	125.1	26.1	2.8
J	Loading/unloading coal	2,631.8	333.4	50.0
K	Coal transfer	16.4	7.7	1.2
L	Coal screening	0.0	0.0	0.0
M	Coal crushing	30.3	13.5	0.0
N	Wind erosion - exposed areas and overburden	61.3	30.7	4.6
O	Wind erosion - active coal stockpiles	477.6	238.8	35.8
P	Road grading	52.7	18.4	1.6
	Total	**10,593.8**	**2,696.8**	**297.3**

Table 7: PM emissions by activity during 2011 with current controls in place

Activity Group	Description	Emissions (tonnes/year) TSP	PM_{10}	$PM_{2.5}$
A	Vegetation removal	0.0	0.0	0.0
B	Topsoil removal, scrapers	4.7	0.0	0.0
C	Bulldozers on topsoil, overburden, rehabilitation	25.5	4.9	2.7
D	Loading/unloading topsoil and overburden	8.0	3.8	0.6
E	Hauling on unsealed roads	3,477.5	957.4	95.7
F	Drilling	9.1	4.7	0.3
G	Blasting	107.9	56.1	3.2
H	Draglines	0.0	0.0	0.0
I	Bulldozers on coal	100.1	20.9	2.2
J	Loading/unloading coal	2,125.7	269.3	40.4
K	Coal transfer	0.8	0.4	0.1
L	Coal screening	0.0	0.0	0.0
M	Coal crushing	30.3	13.5	0.0
N	Wind erosion - exposed areas and overburden	61.3	30.7	4.6
O	Wind erosion - active coal stockpiles	238.8	119.4	17.9
P	Road grading	13.2	4.6	0.4
	Total	**6,202.8**	**1,485.6**	**168.1**

3.3 Ranking of mining activities

3.3.1 Ranking by emissions with current controls

The mining activity groups are ranked by baseline emissions (with current controls) of TSP, PM_{10} and $PM_{2.5}$ in **Table 8**, **Table 9** and **Table 10** respectively. In each case the top four ranked activities are highlighted in bold.

Table 8: Activity groups ranked by TSP emissions in 2011 (with current PM controls)

Rank	Mining activity	Emissions (tonnes/year)	% of total
1	**Hauling on unsealed roads**	**3,477.5**	**56%**
2	**Loading/unloading coal**	**2,125.7**	**34%**
3	**Wind erosion - active coal stockpiles**	**238.8**	**4%**
4	**Blasting**	**107.9**	**2%**
5	Bulldozers on coal	100.1	2%
6	Wind erosion - exposed areas and overburden	61.3	1%
7	Coal crushing	30.3	0%
8	Bulldozers on topsoil, overburden, rehabilitation	25.5	0%
9	Road grading	13.2	0%
10	Drilling	9.1	0%
11	Loading/unloading topsoil and overburden	8.0	0%
12	Topsoil removal, scrapers	4.7	0%
13	Coal transfer	0.8	0%
14	Vegetation removal	0.0	0%
15	Draglines	0.0	0%
16	Coal screening	0.0	0%
	TOTAL	**6,202.8**	**100%**

Table 9: Activity groups ranked by PM_{10} emissions in 2011 (with current PM controls)

Rank	Mining activity	Emissions (tonnes/year)	% of total
1	**Hauling on unsealed roads**	**957.4**	**64%**
2	**Loading/unloading coal**	**269.3**	**18%**
3	**Wind erosion - active coal stockpiles**	**119.4**	**8%**
4	**Blasting**	**56.1**	**4%**
5	Wind erosion - exposed areas and overburden	30.7	2%
6	Bulldozers on coal	20.9	1%
7	Coal crushing	13.5	1%
8	Bulldozers on topsoil, overburden, rehabilitation	4.9	0%
9	Drilling	4.7	0%
10	Road grading	4.6	0%
11	Loading/unloading topsoil and overburden	3.8	0%
12	Coal transfer	0.4	0%
13	Vegetation removal	0.0	0%
14	Topsoil removal, scrapers	0.0	0%
15	Draglines	0.0	0%
16	Coal screening	0.0	0%
	TOTAL	**1,485.6**	**100%**

Table 10: Activity groups ranked by $PM_{2.5}$ emissions in 2011 (with current PM controls)

Rank	Mining activity	Emissions (tonnes/year)	% of total
1	**Hauling on unsealed roads**	**95.7**	**57%**
2	**Loading/unloading coal**	**40.4**	**24%**
3	**Wind erosion - active coal stockpiles**	**17.9**	**11%**
4	**Wind erosion - exposed areas and overburden**	**4.6**	**3%**
5	Blasting	3.2	2%
6	Bulldozers on topsoil, overburden, rehabilitation	2.7	2%
7	Bulldozers on coal	2.2	1%
8	Loading/unloading topsoil and overburden	0.6	0%
9	Road grading	0.4	0%
10	Drilling	0.3	0%
11	Coal transfer	0.1	0%
12	Vegetation removal	0.0	0%
13	Topsoil removal, scrapers	0.0	0%
14	Draglines	0.0	0%
15	Coal screening	0.0	0%
16	Coal crushing	0.0	0%
	TOTAL	**168.1**	**100%**

The ranking differed according to the particle size metric, and each of the following activities was ranked in the top four for at least one metric:

- Loading and unloading of coal.
- Hauling on unsealed roads.
- Wind erosion of active coal stockpiles.
- Wind erosion of exposed areas and overburden.
- Blasting.

For all three PM metrics two activities – hauling on unsealed roads and loading/unloading coal – were by far the largest sources. When combined, these sources were responsible for 90% of TSP, 82% of PM_{10} and 81% of $PM_{2.5}$.

3.3.2 Ranking by potential emission savings

As noted earlier, the top four activities in an assessment of this type are not necessarily the ones for which the greatest (or most cost-effective) reductions can be achieved. Whilst not explicitly defined as a task in the OEH Guidelines, it was therefore considered important to identify *any* activity for which there was potential to significantly reduce emissions.

Consequently, the indicative potential benefits (*i.e.* emissions with provisional best practice PM controls minus emissions with current PM controls) of applying provisional best practice controls to all activities were also considered. The values for control effectiveness were taken from **Donnelly *et al.* (2011)**. As this was a provisional assessment, and is effectively covered in more detail in **Section 4**, the assumptions are not listed here.

The mining activities were then ranked in terms of the potential emission savings. This part of the work indicated that the largest absolute reductions in PM emissions could be achieved for the following activities (in order of priority):

- **Hauling on unsealed roads**
- **Wind erosion of active coal stockpiles**
- **Loading and unloading of coal**
- **Wind erosion of exposed areas and overburden**

These four activities accounted for around 90% of all potential reductions in PM emissions. The remaining effort therefore focussed on these activities. Blasting was no longer considered to be an important source, as there was no further scope for the application of control measures.

4 EMISSIONS WITH POTENTIAL ADDITIONAL PM-CONTROL MEASURES

4.1 Identification of additional measures

This section of the report presents the additional best practice measures available for each of the highest ranked mining activities, as well as their effectiveness. In each case, the information on control effectiveness was again taken from the Best Practice Report (**Donnelly *et al.*, 2011**).

4.1.1 Hauling on unsealed roads

The additional best practice measures to reduce PM emissions from hauling on unsealed roads are listed in **Table 11**. The mine operator has noted that excess water is available at Wilpinjong, and therefore dust suppressants have not been used to date. In April 2013 the current coal trucks (Cat 785, 130 tonnes) will be replaced by larger vehicles (Cat 793, 240 tonnes).

Table 11: Additional best practice control measures to reduce PM emissions from haul roads

Control measure		Effectiveness
Vehicles	Reduction in speed, 65 to 30 km/h[a]	50-85%
Surface Improvements	Pave the surface	>90%
	Low silt aggregate	30%
	Oil and double chip surface	80%
Surface Treatments	Level 2 watering (>2 $l/m^2/h$)	75%
	Dust suppressants	84%
	Hygroscopic salts	Av. 45% over 14 days
		82% within 2 weeks
	Lignosulphonates	66-70% over 23 days
	Polymer emulsions	70% over 58 days
	Tar and bitumen emulsions	70% over 20 days
Other	Use larger vehicles rather than smaller vehicles to minimise number of trips	90t to 220t: 40%[b] 140t to 220t: 20%[b] 140t to 360t: 45%[b]
	Use conveyors in place of haul roads	>95%

Notes
(a) Not applied, as speed is not included in AP-42 equation.
(b) Reductions achieved by the use of larger vehicles, conveyors and lower grader speeds have been calculated from the emission factors for these activities.

4.1.2 Wind erosion of active coal stockpiles

The additional best practice measures to reduce PM emissions from wind erosion of active coal stockpiles are provided in **Table 12**. The mine operator noted that bypassing stockpiles is not best practice for stockpile rotation.

Table 12: Additional best practice control measures to reduce PM emissions due to wind erosion of active coal stockpiles

Control Measure		Effectiveness
Avoidance	Bypass stockpiles[a]	100% reduction in wind erosion for coal bypassing stockpile
Surface stabilisation	Water spray	50%
	Dust suppressants	80-99%
	Surface crusting agent	95%
	Carry over wetting from load in	80%
Enclosure	Silo with bag house	95-100%
	3-sided enclosure around storage	75%
	Cover storage pile with a tarp during	99%[b]
Wind speed reduction	Vegetative wind breaks	30%
	Reduce pile height	30%
	Wind screens/wind fences/bunds	75-80%

Notes
(a) Not best practice for stockpile rotation
(b) Estimated based on the effectiveness of chemical surface treatments

4.1.3 Loading and unloading of coal

The additional best practice measures to reduce PM emissions from the loading and unloading of coal are provided in **Table 13**. Again, bypassing stockpiles was viewed as not being best practice for stockpile rotation.

Table 13: Additional best practice control measures to reduce PM emissions from the loading and unloading of coal

Control Measure		Effectiveness
Avoidance	Bypass ROM stockpiles[a]	50% reduction in dumping emissions for coal bypassing ROM stockpile Emissions associated with forming coal into stockpile (e.g. by dozer push) would be reduced by 100% for bypassing coal
Truck or loader dumping coal	Minimise drop height[b]	Reduce from 10 m to 5 m: 30%
	Water sprays on ROM pad	50%
Truck or loader dumping to ROM bin	Three sided and roofed enclosure of ROM bin	70%
	Three sided and roofed enclosure of ROM bin plus water sprays	85% by combing control factors from above.
	Enclosure with control device	90 – 98%

Notes
(a) Not best practice for stockpile rotation
(b) Reductions due to reduced drop heights have been inferred from the emission estimation equation for dropping material from a dragline.

4.1.4 Wind erosion of exposed areas and overburden

The additional best practice measures to reduce PM emissions from wind erosion of exposed areas and overburden are provided in **Table 14**.

Table 14: Additional best practice control measures to reduce PM emissions due to wind erosion of exposed areas and overburden

Control measure		Effectiveness
Avoidance	Minimise pre-strip	100% per m^2
Surface stabilisation	Water sprays	50%
	Dust suppressants	70-84%
	Paving and cleaning	>95%
	Application of gravel to stabilise disturbed open areas	84%
	Rehabilitation	99%
Wind speed reduction	Fences, screens, bunds or pits	30-80%
	Vegetative ground cover	70%

4.2 Emissions with control measures

For each of the top four activities identified in **Section 3.3**, the emissions of TSP, PM_{10} and $PM_{2.5}$ from each mining activity have been estimated following the application of the additional control measures identified in **Section 4.1**. The results of this exercise are presented in **Table 15** to **Table 18**. The assumptions made when applying the reductions are also noted.

Table 15: TSP, PM_{10} and $PM_{2.5}$ emissions following application of additional best practice measures – hauling on unsealed roads

Best practice control	% reduction from uncontrolled emission	Emissions with best practice control (t/year)		
		TSP	PM_{10}	$PM_{2.5}$
Pave the surface	90%	695.5	191.5	19.1
Low silt aggregate	30%	4,868.5	1,340.3	134.0
Oil and double chip surface	80%	1,391.0	383.0	38.3
Level 2 watering	75%	1,738.7	478.7	47.9
Dust suppressants	84%[(a)]	1,112.8	306.4	30.6
Larger vehicles, fewer trips	20%	5,564.0	1,531.8	153.2
Conveyors in place of roads	95%	347.7	95.7	9.6

Notes:
(a) Assumed maximum effectiveness

Table 16: TSP, PM_{10} and $PM_{2.5}$ emissions following application of additional best practice measures – wind erosion of active coal stockpiles

Best practice control	% reduction from uncontrolled emission	Emissions with best practice control (t/year)		
		TSP	PM_{10}	$PM_{2.5}$
Bypass stockpiles	100%	-	-	-
Water sprays	50%	238.8	119.4	17.9
Dust suppressants	90%[(a)]	47.8	23.9	3.6
Surface crusting agent	95%	23.9	11.9	1.8
Carry over wetting from load in	80%	95.5	47.8	7.2
Silo enclosure with bag house	97.5%[(a)]	11.9	6.0	0.9
3-sided enclosure for storage piles	75%	119.4	59.7	9.0
Cover with tarp during high winds	99%	4.8	2.4	0.4
Vegetative windbreaks	30%	334.3	167.2	25.1
Reduce pile height	30%	334.3	167.2	25.1
Wind screens/fences	77.5%[(a)]	107.5	53.7	8.1

Notes
(a) Middle of range in Best Practice Report

Table 17: TSP, PM_{10} and $PM_{2.5}$ emissions following application of additional best practice measures – loading and unloading of coal

Activity	Best practice control	% reduction from uncontrolled emission	Emissions with best practice control (t/year)		
			TSP	PM_{10}	$PM_{2.5}$
Load truck with ROM coal/ unload to ROM bin	Minimise drop height - reduce from 10 m to 5 m	15%[(b)]	1,204.6	152.6	22.9
	3-sided and roofed enclosure of ROM bin	35%[(b)]	921.1	116.7	17.5
	3-sided and roofed enclosure of ROM bin plus water sprays	42%[(b,c)]	821.9	104.1	15.6
	Enclosure with control device	42%[(a,b)]	821.9	104.1	15.6
Load truck with ROM coal/ unload to ROM stockpile	Minimise drop height - reduce from 10 m to 5 m	15%[(b)]	516.2	65.4	9.8
	Water sprays on ROM pad	50%[(b)]	303.7	38.5	5.8
Load truck from ROM stockpile/ unload to ROM bin	Minimise drop height - reduce from 10 m to 5 m	15%[(b)]	516.2	65.4	9.8

Notes
(a) Middle of range in Best Practice Report
(b) Applied to unloading only, so value in Best Practice Report halved.
(c) Obtained by combing factors for other controls.

Table 18: TSP, PM_{10} and $PM_{2.5}$ emissions following application of additional best practice measures – wind erosion of exposed areas and overburden

Best practice control	% reduction from uncontrolled emission	Emissions with best practice control (t/year)		
		TSP	PM_{10}	$PM_{2.5}$
Minimise pre-strip	100%	-	-	-
Water sprays	50%	30.7	15.3	2.3
Dust suppressants	84%[(a)]	9.8	4.9	0.7
Paving and cleaning	95%	3.1	1.5	0.2
Application of gravel to stabilise disturbed open areas	84%	9.8	4.9	0.7
Rehabilitation	99%	0.6	0.3	0.0
Fences, screens, bunds or pits	50%[(b)]	30.7	15.3	2.3
Vegetative ground cover	70%	18.4	9.2	1.4

Notes:
(a) Assumed maximum effectiveness
(b) Middle of range in Best Practice Report

5 PRACTICABILITY OF IMPLEMENTING ADDITIONAL PM-CONTROL MEASURES

This section of the Report provides an assessment of the practicability of implementing each of the additional best practice measures identified in **Section 3.3** for the top four emission-generating activities. This assessment was undertaken by the mine operator, and covered the aspects listed in **Section 2.3.1**. The assessment took into consideration the regulatory requirements, environmental impacts and safety implications of the measures, as well as their compatibility with the current processes and future developments.

5.1 Practicability

The results of the practicability assessment for the top four activities are summarised in **Table 19** to **Table 22**. Where a given measure was considered to be practicable according to each of the criteria examined, it was taken to be practicable overall. Measures that were considered impractical according to one or more of the assessment criteria were not considered further. To summarise, the practicable measures were:

- Hauling on unsealed roads - Increase watering to Level 2 (>2L/m²/h)
- Hauling on unsealed roads – Dust suppressants
- Wind erosion of active coal stockpiles – Wind screens/fences
- Wind erosion of exposed areas and overburden – Dust suppressants (hydromulching)

5.2 Best practice measures to be implemented

Wilpinjong is a mine with a current surplus of water. Because of this surplus, water management is an integral part of the mine operations, and a reverse osmosis plant is used to treat the surplus water prior to discharge. The intensive use of water for dust control on haul roads can be considered to be competitive with the use of chemical suppressants. Consequently, achieving a high level of control using the available water it is likely to be more cost-effective at Wilpinjong than large-scale investment in, and application of, chemical dust suppressants. Wilpinjong Coal Pty Ltd will therefore increase the watering of haul roads to Level 2 to further reduce PM emissions.

Nevertheless, the use of dust suppressants to reduce PM emissions from haul roads will also be considered. However, the emission factors and control efficiencies used in this report are generic, and may be different from those at the mine. Moreover, the optimisation of PM control depends upon factors which are not defined explicitly in the Best Practice Report (such as evaporation rate, amount of dust suppressant applied, *etc*.). Given the inherent site-specific uncertainties associated with the estimation of emissions, and the high cost of reducing emissions from haul roads using dust suppressants, Wilpinjong Coal Pty Ltd will evaluate the options in more detail based on trials and the collection of site-specific data, and will then decide whether to commit to additional controls. Dust suppressant trials are currently being conducted at Wambo, the sister mine of Wilpinjong. The results of the Wambo trials will be used to determine the need (or otherwise) for additional investigations at Wilpinjong.

The use of screens and fences to reduce wind erosion of coal stockpiles, and hydromulching (ROM batter and rail loop) to reduce wind erosion of exposed areas and overburden, will be introduced on a trial basis at Wilpinjong Mine.

Table 19: Review of the practicability of additional best practice measures – Hauling on unsealed roads

Best practice measure	Regulatory Requirements	Environmental Impacts	Safety Implications	Compatibility with current processes and proposed future developments	Practicable overall (Yes/No)	Additional comments from mine operator
Pave the surface	No	No (More resources needed, wasting resources when having to move haul road)	No (More resources needed, more vehicle interaction with paving trucks and haul trucks)	No (More resources needed, wasting resources when having to move haul road)	No	Would not be practicable due to heavy machinery and extensive scale of haul network.
Low silt aggregate	No	No (More resources needed to be imported from elsewhere, wasting resources when having to move haul road)	No (More resources needed to be imported from elsewhere, more vehicles on public roads to bring material to site)	No (More resources needed to be imported from elsewhere, wasting resources when having to move haul road)	No	Would not be practicable due to heavy machinery and extensive scale of haul network.
Oil and double chip surface	No	No (Waste products being placed on roads. When having to move haul road contaminated material needs to be treated)	No (Waste products being placed on roads. When having to move haul road contaminated material needs to be treated, danger to environment if not handled correctly or covered with collection)	No (Waste products being placed on roads. When having to move haul road contaminated material needs to be treated)	No	Would not be practicable due to heavy machinery and extensive scale of haul network.
Level 2 watering	No	Yes	Yes	Yes	Yes	**PRACTICABLE**
Dust suppressants	No	No (More resources needed, wasting resources when having to move haul road)	No (More resources needed, more vehicle interaction)	No (More resources needed, wasting resources when having to move haul road)	No	**PRACTICABLE**
Larger vehicles, fewer trips	No	No	No	No	Yes	From April 2013, using CAT793 instead of CAT785 (140-220t) for all movements. Doing already.
Conveyors in place of roads	No (Would require new consent)	No (Mining moves too much making conveyors redundant)	No (Installation, interaction in areas used currently by vehicles)	No (Mining moves too much making conveyors redundant)	No	Mining moves too much to have conveyors

Table 20: Review of the practicability of additional best practice measures – Wind erosion of active coal stockpiles

Best practice measure	Regulatory Requirements	Environmental Impacts	Safety Implications	Compatibility with current processes and proposed future developments	Practicable overall (Yes/No)	Additional comments from mine operator
Bypass stockpiles	No	No (Stockpiles that are left can be prone to spontaneous combustion)	No (Stockpiles that are left can be prone to spontaneous combustion)	No (Stockpiles that are left can be prone to spontaneous combustion)	No	Not best practice for stockpile rotation
Water sprays	No	No (Stockpiles can be prone to spontaneous combustion especially when wet)	No (Stockpiles can be prone to spontaneous combustion especially when wet)	No (Significant infrastructure requirements; effect on product coal specifications.)	No	
Dust suppressants	No	No (Stockpiles can be prone to spontaneous combustion especially when wet)	No (Stockpiles can be prone to spontaneous combustion especially when wet)	No (Significant infrastructure requirements; effect on product coal specifications.)	No	
Surface crusting agents	No	No (Stockpiles can be prone to spontaneous combustion especially when wet)	No (Stockpiles can be prone to spontaneous combustion especially when wet)	No (Significant infrastructure requirements; effect on product coal specifications.)	No	
Carry over wetting from load in	No	No (Stockpiles can be prone to spontaneous combustion especially when wet)	No (Stockpiles can be prone to spontaneous combustion especially when wet)	No (Stockpiles can be prone to spontaneous combustion especially when wet)	No	

Best practice measure	Regulatory Requirements	Environmental Impacts	Safety Implications	Compatibility with current processes and proposed future developments	Practicable overall (Yes/No)	Additional comments from mine operator
Silo enclosure with bag house	No	No (To support enclosures, would mean more area required to store coal, thereby increasing disturbance areas. Would increase traffic to site during construction.)	No (To support enclosures, would mean more risk for entrapment if required to enter bin for cleaning or maintenance. Would increase traffic to site during construction.)	No (To support enclosures, would mean more area required to store coal, thereby increasing disturbance areas. Would increase traffic to site during construction.)	No	Not feasible due to safety reasons
3-sided enclosure for storage piles	No	No	No	No	No	Size of stockpiles makes this option impractical
Cover with tarp during high winds	No	Yes	No (Stockpiles are constantly handled by machinery and would increase vehicle interaction. Stockpiles are too large for tarps. Trying to tie them down in high winds likely to cause damage and/or injuries)	No (Stockpiles are constantly handled by machinery and would increase vehicle interaction. Stockpiles are too large for tarps. Trying to tie them down in high winds likely to cause damage and/or injuries)	No	Not feasible due to safety reasons
Vegetative windbreaks	No	Yes	No (Areas around stockpiles are constantly handled by machinery and would decrease vehicle visibility.)	No (Areas around stockpiles are constantly handled by machinery and would decrease vehicle visibility.)	No	Not feasible due to space issues
Reduce pile height	No	Yes	Yes	Yes	Yes	Doing already. Piles are constructed to standards already. Maximum height of 10 m.
Wind screens/fences	No	Yes	Yes	Yes	Yes	**PRACTICABLE** Size of stockpiles could make this option impractical

Table 21: Review of the practicability of additional best practice measures – Loading and unloading of coal

Best practice measure	Regulatory Requirements	Environmental Impacts	Safety Implications	Compatibility with current processes and proposed future developments	Practicable overall (Yes/No)	Additional comments from mine operator
Minimise drop height - reduce from 10 m to 5 m	No	Yes	Yes	Yes	Yes	Doing already. Piles are constructed to standards already. Maximum dump out of truck is 11m, see spec sheet for CAT 785C haul truck. Ground clearance dump is 1.3 m
3-sided and roofed enclosure of ROM bin	No	Yes	No (Retrofitting existing ROM bin impractical due to location of bin)	No (Retrofitting existing ROM bin impractical due to location of bin)	No	
3-sided and roofed enclosure of ROM bin plus water sprays	No	Yes	No (Retrofitting existing ROM bin impractical due to location of bin)	No (Retrofitting existing ROM bin impractical due to location of bin)	No	
Enclosure with control device	No	Yes	No (Retrofitting existing ROM bin impractical due to location of bin)	No (Retrofitting existing ROM bin impractical due to location of bin)	No	
Water sprays on ROM pad	No	No (Stockpiles can be prone to spontaneous combustion especially when wet)	No (Stockpiles can be prone to spontaneous combustion especially when wet)	No (Stockpiles can be prone to spontaneous combustion especially when wet)	No	

Table 22: Review of the practicability of additional best practice measures – Wind erosion of exposed areas and overburden

Best practice measure	Regulatory Requirements	Environmental Impacts	Safety Implications	Compatibility with current processes and proposed future developments	Practicable overall (Yes/No)	Additional comments from mine operator
Minimise pre-strip	Yes	Yes	Yes	Yes	Yes	Doing already.
Water sprays	No	No (Active pit already watered. Placing machinery onto rehab areas could decrease success. After hydromulch trial - overburden dumps maybe done (depending results)	No (Active Pit already watered. Some rehab areas are unsuitable for vehicles, injury may occur. Overburden dumps may slump with excess watering - Vegetation is better)	No (Active Pit already watered. Some rehab areas are unsuitable for vehicles, injury may occur. Overburden dumps may slump with excess watering - Vegetation is better)	No	
Dust suppressants	No	Yes	Yes	Yes	Yes	**PRACTICABLE** Trialling hydromulching exposed batters of dumps, rail loop, ROM.
Paving and cleaning	No	No (More resources needed, wasting resources when having to move)	No (More vehicle interaction when constructing and maintenance)	No (Reduction in haulage productivity; increased maintenance)	No	Areas change constantly with mining
Application of gravel to stabilise disturbed open areas	No	No (Gravel would need to be brought into site from elsewhere and wasted when moving)	No (Gravel would need to be brought into site from elsewhere creating extra vehicle interaction on public roads)	No (Gravel would need to be brought into site from elsewhere and wasted when moving)	No	Trialling application of hay to disturbed land that can be rehabilitated but has yet to respond.
Rehabilitation	Yes	Yes	Yes	Yes	Yes	Doing already. Internal goal to rehabilitate minimum of 90% of available land.
Fences, screens, bunds or pits	No	No (More resources needed, wasting resources when having to move. In-pit dumping is used already as much as possible.)	No (More vehicle interaction. In-pit dumping is used already as much as possible.)	No (More resources needed, wasting resources when having to move. In-pit dumping is used already as much as possible.)	No	Areas change constantly with mining
Vegetative ground cover	No	Yes	Yes	Yes	Yes	Doing already. Trialling hydromulching exposed batters of dumps, rail loop, ROM.

6 IMPLEMENTATION TIMETABLE

Additional water carts will be introduced at the mine to enable Level 2 watering of haul roads by April 2013.

As noted in the previous section, the implementation of the other PM-control measures at the Wilpinjong Mine is subject to the completion of trials to determine site-specific effectiveness:

- The dust suppressant trial at the Wambo Mine is currently in progress.
- The wind erosion fencing will be introduced on a trial basis in the fourth quarter of 2012.
- Hydromulching will be introduced on a trial basis in the fourth quarter of 2012.

7 MONITORING AND TRACKING EFFECTIVENESS OF PM CONTROLS

7.1 Compliance monitoring for air quality

Various air quality monitoring activities are undertaken at the Wilpinjong Mine for compliance purposes. Air quality monitoring is conducted using a range of equipment, including:

- Tapered Element Oscillating Microbalance (TEOM). The TEOM is a real-time measurement of PM_{10}. The national ambient air quality standard for PM_{10} (designed to be protective of human health) is 50 µg/m³ for a 24-hour period.
- High Volume Air Sampler (HVAS) measuring PM_{10} and TSP. For TSP the standard is 90 µg/m³ for a 24-hour period.
- Dust depositional gauge (DDG) (indicating potential for nuisance). The criterion is 4 g/m^2/month.

Two TEOMs are used to monitor PM_{10} concentrations continuously. The first TEOM is on the western side of the mine, and is used to determine compliance with the ambient air quality standard. The second TEOM is on the eastern side of the mine, and is used for management purposes only. The High Volume Air Samplers are operated for a 24 hour period every six days, with air drawn through a filter paper at a measured rate. The filter paper is then analysed for dust. Three samplers monitor PM_{10}, and one sampler monitors TSP. Dust deposition is measured using nine gauges. Each month samples are sent to a laboratory for analysis of dust.

7.2 Rehabilitation

Wilpinjong has an internal goal to rehabilitate a minimum of 90% of the available land. The extent of the proposed rehabilitation in 2012 is shown in **Figure 5**.

Figure 5: Proposed rehabilitation for Wilpinjong Mine in 2012

7.3 Monitoring of long-term effectiveness

Long-term monitoring is required to ensure that any reductions in emissions following the introduction of control measures are maintained over the lifetime of the mine, and will enable the operator to check that progress is being made towards environmental targets.

On the 9 May 2012, OEH held an information session and workshop to provide feedback to consultants and mines on the PRPs received to date. A key outcome of the workshop was that the control effectiveness of both existing and proposed PM controls should be measured and reported, as follows:

> *"Control effectiveness must be supported by:*
>
> - *Key performance indicator*
> - *Monitoring method*
> - *Location, frequency and duration of monitoring*
> - *Monitoring data records and analysis*
> - *Management procedures"*

A common approach to tracking the effectiveness of such measures involves the use of key performance indicators (KPIs). Performance indicators should be meaningful, measureable, repeatable, comparable and auditable. Wilpinjong will therefore track the long-term effectiveness of PM controls at the Wilpinjong mine through the use of KPIs, and four potential KPIs are proposed below.

7.3.1 KPI-1: Emissions of PM_{10} per tonne of ROM coal

This headline KPI will provide an indication of the overall PM_{10} production of the mine relative to its coal production, as a combination of all activities. It makes direct use of the emissions inventory compiled for the PRP process.

The value of the KPI will change each year, as the generation of PM_{10} is dependent on any changes in the distribution of mining activities such as lengths of haul roads and dozer hours. However, as long as the activities remain similar each year, a downward trend in the KPI over time will indicate the effectiveness of the control measures that are being implemented.

The KPI will be recalculated on an annual basis using the PRP emissions inventory spreadsheet. The annual recalculation will be relatively straightforward, requiring input data on intensity for each mining activity (*e.g.* material production rates, VKT, bulldozer hours, etc).

It is also recommended that this KPI be improved by using site-specific input data (silt content, moisture content, control efficiency) and recommendations for improvements are outlined in **Section 7.4**.

Further details for this KPI are outlined in **Table 23**, along with objectives and targets and reporting requirements. If adopted for the mine, a site-specific procedure would be developed for this KPI.

7.3.2 KPI-2: Control of PM_{10} emissions

This KPI will quantify the progress of the mine towards achieving best practicable controls for PM_{10} emissions (**Donnelly *et al,* 2011**). It provides a measure of improvement of the mine as a whole by combining the efficiency of each individual control. It is therefore not dependent on such variables as productivity, VKT and bulldozer hours, as is the case for KPI-1.

The current control measure for each mining activity is compared with the best practically achievable control measure for that activity. This ratio is then weighted according to the contribution of that uncontrolled activity to the total uncontrolled annual emission. A mine that is operating with best practicable controls on activities producing the majority of emissions would score close to 100.

This KPI will be recalculated annually using the PRP emissions inventory spreadsheet, and it is recommended that it be improved by using site-specific data, as outlined in **Section 7.4**. Further details of the KPI, including the metric, objectives, targets and reporting requirements are given in **Table 23**. If adopted for the mine, a site-specific procedure would be developed for this KPI.

7.3.3 KPI-3: Opacity (visible dust emissions)

This KPI is designed to provide an indication of 'visible dust' emissions at the mine site. There are various methods for monitoring opacity, and the chosen method would determine the monitoring locations and intervals.

Further details for this KPI are outlined in **Table 23**, including the various methods and standards for measurement, the objectives and targets, and the reporting requirements. If adopted for the mine, a site-specific procedure would be developed for this KPI, depending on the chosen opacity monitoring method.

7.3.4 KPI-4: Watering intensity for haul roads

Hauling on unpaved roads is the major contributor to total dust emissions. Controlling emissions from this activity is therefore important, and there are a number of measures listed in the Best Practice Report which can produce significant reductions.

An existing control efficiency of 50% is assumed for this PRP report, equivalent to Level 1 watering (50%), as per the Best Practice Report. However, the report indicates that increasing this watering to Level 2 may achieve a control efficiency of 75%.

The actual site-specific control efficiency for haul roads for watering is unknown, and it is recommended that this is determined for Wilpinjong Mine. Once the site-specific control efficiency is measured, and the equivalent watering rate determined, it is used for tracking and reporting against this KPI.

Where the site-specific control efficiency is found to be less than 75%, the watering application rate required to achieve 75% control can be determined and used for tracking and reporting against this KPI.

Further details for this KPI are outlined in **Table 23**, including objectives and targets and reporting requirements. If adopted for the mine, a site-specific procedure would be developed for this KPI, relevant to the chosen monitoring method. The options for the measurement of site-specific control efficiencies are outlined in **Table 25**.

Table 23: Proposed key performance indicators

<table>
<tr><th colspan="5">KPI-1: Annual emissions of PM_{10} per tonne of ROM coal (kg PM_{10}/t ROM)</th></tr>
<tr><th>Metric</th><th>Method / Standard</th><th>Objective / Target</th><th>Frequency</th><th>Report</th></tr>
<tr><td>This KPI is defined as follows:
$$K1_y = \left(\frac{E_{PM10}}{M_{ROM}}\right)_y$$
Where:
K1y is the value of KPI-1 (in kg of PM_{10} per tonne of ROM coal) in year y
E_{PM10} is the total emission of PM_{10} from the mine (in kg, with current controls) in year y
M_{ROM} is the mass of ROM coal (in tonnes) mined in year y</td><td>Annual dust emissions inventory using PRP emissions inventory template</td><td>Downward trend in PM_{10}/ROM ratio until best practicable control is achieved</td><td>Annual (matching 12 month reporting period for annual reporting/ NPI)</td><td>Include in annual environment report</td></tr>
<tr><th colspan="5">KPI-2: PM_{10} emission control (%)</th></tr>
<tr><td>This KPI is defined as follows:
$$K2_y = \left(\frac{CF_i}{CF_{i-B}}\right) \times 100$$
Where:
K2y is the value of KPI-2 (%) in year y
CF_i is the current control factor for activity i in year y
CF_{i-B} is the best practicable control factor for activity i</td><td>Annual dust emissions inventory using PRP emissions inventory template in conjunction with site specific measurements of individual parameters and control efficiencies.</td><td>Progression towards 100%. This indicates that the mine is doing everything practicable and achievable within the constraints of operations, to reduce emissions.</td><td>Annual (matching 12 month reporting period for annual reporting/ NPI)</td><td>Include in environment report</td></tr>
</table>

KPI-3: Visible dust emissions (opacity)				
This KPI is defined as follows: $$K3_y = \bar{k}_y$$ Where: K3y is the value of KPI-3 (dimensionless) in year y $\bar{k}$y is the average opacity in year y	<u>Visual Observations</u> US EPA Method 9 – Visual Determination of the opacity of emissions from stationary sources San Joaquin Valley Air Pollution Control District (SJVAPCD) Rule 8011 General Requirements (Appendix A – Visual Determination of Opacity)	<20% Opacity at source - hauling, open pit and stockpile area	Weekly	Weekly operators log.
	<u>Digital Imagery</u> ASTM WK 30382 "*New Test Method for Determining the Opacity of Fugitive Emissions in the Outdoor Ambient Atmosphere, Using Digital Imagery*"	<20% Opacity at source	Continuous	
KPI 4: Watering intensity for hauling (l/VKT)				
This KPI is defined as follows: $$K4_y = \left(\frac{W_{Haul}}{VKT_{Haul}}\right)_y$$ Where: K4y is the value of KPI-3 (in litres per vehicle-kilometre) in year y W_{Haul} is the total amount of water applied to haul roads in year y VKT_{Haul} is the total number of vehicle-kilometres on haul roads in year y	N/A	No less than the level of watering (L/VKT) to achieve the site-specific control efficiency. (Derived through site-specific determination of watering control effectiveness)	Annual	Include in environment report

7.4 Recommendations for ongoing improvement of KPIs

Another key message from the OEH Workshop was the use of site-specific data in deriving PM emissions estimates for the PRP, such as:

- Material parameters – moisture and silt contents
- Meteorology
- Vehicle weight, speed, traffic volume
- Activity data – areas disturbed, stockpiles, material transfer

The available site-specific data has been used for the PM emissions estimates presented in this report. These data include material silt content, material moisture content, meteorology, and activity data.

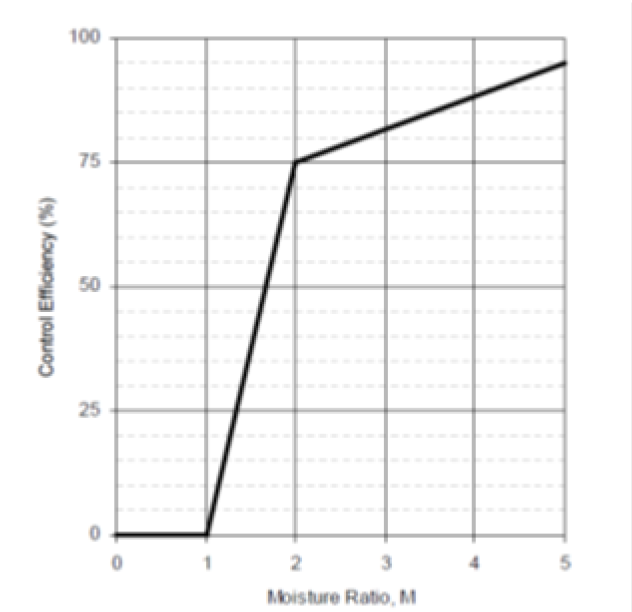
For ongoing evaluation against the KPIs, it is recommended that improvements are made to emission estimates using additional site-specific data and site specific control efficiencies are determined on a regular basis. The recommended monitoring parameters for input into the KPIs, along with measurement methods, are outlined in Table 24.

Table 24: Site specific measurements for improvements to KPI-1

Parameter	Measurement Method / Standard	Frequency
% moisture content (overburden dumps, ROM coal and product coal)	US EPA AP42 Appendix C.1 Procedures for Sampling Surface / Bulk Dust Loading US EPA AP42 Appendix C.2 Procedures for Laboratory Analysis of Surface Dust Loading Samples	Annual
% silt content (overburden dumps, ROM coal and product coal, haul roads)	US EPA AP42 Appendix C.1 Procedures for Sampling Surface / Bulk Dust Loading US EPA AP42 Appendix C.2 Procedures for Laboratory Analysis of Surface Dust Loading Samples	Annual
Threshold Friction Velocity for coal piles and exposed areas	US EPA AP42 Chapter 13.2.5	Annual
Dust Extinction Moisture Level (DEM[1]) (ROM and product coal)	AS 4156.6 – 2000 Coal Preparation Part 6: Determination of dust/moisture relationship for coal	One off (for each coal type or new seam)

Notes: [1] DEM is defined as the moisture level at which dustiness is reduced to a level of 10 (i.e. minor dust emissions expected during bulk handling operations).

Table 25: Site-specific control efficiencies

<table>
<tr><th>Parameter</th><th>Measurement Method / Standard</th><th>Frequency</th></tr>
<tr><td rowspan="2">Site Specific Watering Control Effectiveness</td><td>Mobile emissions monitoring device for unpaved roads. Method uses equipment designed to make direct measurements of dust concentrations as a result of vehicle traffic on the roadway as it travels. The system was developed by PAEHolmes for ACARP (publication pending).</td><td>Seasonal</td></tr>
<tr><td>Control Efficiency determined by linear relationship between control efficiency and moisture content of surface, shown below.


Moisture Ratio (M) as defined by US EPA AP 42 Chapter 13.2.2 Unpaved Roads:
$$M = \frac{Moisture\ content\ of\ watered\ road}{Moisture\ content\ of\ unwatered\ road}$$
Moisture Content determined by:
ASTM D2216-10 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D1557-09 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft (2,700 kN-m/m))</td><td>Seasonal</td></tr>
</table>

8 SUMMARY AND RECOMMENDATIONS

This Report addresses the requirements of the Coal Mine Particulate Matter Control Best Practice PRP, as attached to the Wilpinjong Coal Pty Ltd Environment Protection Licence (12425).

The methodology followed the steps in the OEH *Site-specific Determination Guideline*, and the study identified the following activities as being the most important in terms of emissions of TSP, PM_{10} and $PM_{2.5}$ with current controls in place:

- Hauling on unsealed roads
- Wind erosion of active coal stockpiles
- Loading and unloading of coal
- Wind erosion of exposed areas and overburden

These four activities were also associated with largest potential emission reductions.

Wilpinjong Mine already has a number of PM-control measures in place. The main control measures involve the application of water to haul roads and to coal, and these measures are reasonably effective. With current controls emissions of TSP, PM_{10} and $PM_{2.5}$ are all around 40-45% lower than with no controls in place.

Potential best practice control measures for the above activities were identified, and their practicability evaluated. The PM-control measures that were deemed practicable at the Wilpinjong Mine were:

- Hauling on unsealed roads - Increase watering to Level 2 (>2 $l/m^2/h$)
- Hauling on unsealed roads – Dust suppressants
- Wind erosion of active coal stockpiles – Wind screens/fences
- Wind erosion of exposed areas and overburden – Dust suppressants (hydromulching)

Wilpinjong Mine operates with a surplus of water. Consequently, achieving a high level of control using the available water it is likely to be more cost-effective at Wilpinjong than large-scale investment in, and application of, chemical dust suppressants. Wilpinjong Coal Pty Ltd will therefore increase the watering of haul roads to Level 2 to further reduce PM emissions.

Nevertheless, the use of dust suppressants to reduce PM emissions from haul roads will also be considered. Given the inherent site-specific uncertainties associated with the estimation of emissions, and the high cost of reducing emissions from haul roads using dust suppressants, Wilpinjong Coal Pty Ltd will evaluate the options in more detail based on trials and the collection of site-specific data, and will then decide whether to commit to additional controls. The results of the Wambo dust suppressant trials will be used to determine the need (or otherwise) for additional investigations at Wilpinjong.

The use of screens and fences to reduce wind erosion of coal stockpiles, and hydromulching (ROM batter and rail loop) to reduce wind erosion of exposed areas and overburden, will be introduced on a trial basis at Wilpinjong Mine.

Four potential key performance indicators have been presented for tracking the long-term effectiveness of the PM controls at Wilpinjong Mine. Again, it is recommended that improvements are made to emission estimates using additional site-specific data, and that site-specific control efficiencies are determined on a regular basis, to improve the reliability of the indicators.

9 REFERENCES

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Appendix A: Emission factors for mining activities

Table A1: Emission factors for mining activities

Activity Code	Activity Description	Units	TSP Emission Factor	PM_{10} Emission Factor	$PM_{2.5}$ Emission Factor	Source	Notes
1.01	Vegetation removal with scrapers						
2.01	Topsoil removal with scrapers	kg/t	0.029	No data, assumed to be zero	No data, assumed to be zero	AP-42 11.9.7 Table 11.9-4	-
2.02	Topsoil removal with bulldozers/excavators	kg/t	$2.6 \times \frac{S^{1.2}}{M^{1.3}}$	$0.3375 \times \frac{S^{1.5}}{M^{1.4}}$	0.105 × TSP	AP-42 11.9.7 Table 11.9-2	-
2.03	Topsoil loading and unloading	kg/t	$0.74 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.35 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.053 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	AP-42 13.2.4	Equation for aggregate storage piles
2.04	Topsoil hauling	kg/VKT	$\left(\frac{0.4536}{1.6093}\right) \times 4.9 \times \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 1.5 \times \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 0.15 \times \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	AP-42 13.2.2	Equation for wheel-generated particles from unpaved roads
3.01	Overburden drilling	kg/hole	0.59	0.52 × TSP (PM_{10} ratio assumed same as blasting AP-42 11.9.7 Table 11.9-2)	0.03 × TSP ($PM_{2.5}$ ratio assumed same as blasting AP-42 11.9.7 Table 11.9-2)	AP-42 11.9.7 Table 11.9-4	-
3.02	Overburden blasting	kg/blast	$0.00022 \times A^{1.5}$	0.52 × TSP	0.03 × TSP	AP-42 11.9.7 Table 11.9-2	-
3.03	Overburden draglines	kg/bcm	$0.0046 \times \frac{d^{1.1}}{M^{0.3}}$	$0.002175 \times \frac{d^{0.7}}{M^{0.3}}$	0.017 × TSP	AP-42 11.9.7 Table 11.9-2	-
3.04	Overburden bulldozing (ripping, pushing, clean-up)	kg/t	$2.6 \times \frac{S^{1.2}}{M^{1.3}}$	$0.3375 \times \frac{S^{1.5}}{M^{1.4}}$	0.105 × TSP	AP-42 11.9.7 Table 11.9-2	-
3.05	Overburden loading and unloading	kg/t	$0.74 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.35 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.053 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	AP-42 13.2.4	-

Activity Code	Description	Units	TSP Emission Factor	PM_{10} Emission Factor	$PM_{2.5}$ Emission Factor	Source	Notes
3.06	Overburden hauling	kg/VKT	$\left(\frac{0.4536}{1.6093}\right) \times 4.9 \times \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 1.5 \times \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 0.15 \times \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	AP-42 13.2.2	Equation for wheel-generated particles from unpaved roads
4.01	Coal drilling	kg/hole	0.59	0.52 × TSP (PM_{10} ratio assumed same as blasting AP-42 11.9.7 Table 11.9-2)	0.03 × TSP ($PM_{2.5}$ ratio assumed same as blasting AP-42 11.9.7 Table 11.9-2)	AP-42 11.9.7 Table 11.9-4	-
4.02	Coal blasting	kg/blast	$0.00022 \times A^{1.5}$	0.52 × TSP	0.03 × TSP	AP-42 11.9.7 Table 11.9-2	-
4.03	Coal bulldozing (ripping, pushing, clean-up)	kg/t	$35.6 \times \frac{s^{1.2}}{M^{1.4}}$	$6.33 \times \frac{s^{1.5}}{M^{1.4}}$	0.022 x TSP	AP-42 11.9.7 Table 11.9-2	-
4.04a 4.04b 4.04c	Coal truck loading and unloading	kg/t	$\frac{0.58}{M^{1.2}}$	$\frac{0.75 \times 0.0596}{M^{0.9}}$	0.019 × TSP	AP-42 11.9.7 Table 11.9-2	-
4.05	Coal hauling	kg/VKT	$\left(\frac{0.4536}{1.6093}\right) \times 4.9 \times \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 1.5 \times \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 0.15 \times \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	AP-42 13.2.2	Equation for wheel-generated particles from unpaved roads
4.06	Coal transfer operations	kg/t	$0.74 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.35 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.053 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	AP-42 13.2.4	-
4.07	Coal screening	kg/t	0.0125	0.0043	No data, assumed to be zero	AP-42 11.19.2 Table 11.19.2-1	-
4.08	Coal crushing	kg/t	0.0027	0.0012	No data, assumed to be zero	AP-42 11.19.2 Table 11.19.2-2	-

Activity Code	Description	Units	TSP Emission Factor	PM_{10} Emission Factor	$PM_{2.5}$ Emission Factor	Source	Notes
4.09	Coal bulldozing (ROM stockpiles)	kg/t	$35.6 \times \frac{s^{1.2}}{M^{1.4}}$	$6.33 \times \frac{s^{1.5}}{M^{1.4}}$	0.022 x TSP	AP-42 11.9.7 Table 11.9-2	-
4.10	Coal bulldozing (product stockpiles)	-	-	-	-	-	Included in equation for wind erosion on active coal stockpiles
5.01	Wind erosion on exposed areas, overburden dumps	kg/ha/h	0.1	0.5 × TSP (0.5 from AP-42 13.2.5)	0.075 × TSP (0.075 from AP-42 13.2.5)	AP-42 11.9.7 Table 11.9-4[(a)]	-
5.02	Wind erosion on active coal stockpiles	kg/ha/h	1.8 × u	0.5 × TSP (0.5 from AP-42 13.2.5)	0.075 × TSP (0.075 from AP-42 13.2.5)	AP-42 11.9.7 Table 11.9-2	-
6.01	Grading roads	kg/VKT	$0.0034 \times S^{2.5}$	$0.00336 \times S^{2.0}$	$0.0001054 \times S^{2.5}$	AP-42 11.9.7 Table 11.9-2	-
7.01	Rehab bulldozing	kg/t	$2.6 \times \frac{S^{1.2}}{M^{1.3}}$	$0.3375 \times \frac{S^{1.5}}{M^{1.4}}$	0.105 × TSP	AP-42 11.9.7 Table 11.9-2	Bulldozing overburden & front-end loaders on overburden

Where:

S = mean vehicle speed (km/h)
M = material moisture content (%)
U = mean wind speed (m/s)
W = mean vehicle weight (tonnes)
s = material silt content (or surface silt content in unpaved roads) (%). Silt is the fraction of particles smaller than 75 µm in diameter in the road surface material.
A = horizontal area (m^2)
d = drop height (m)

(a) An alternative method for the estimation of wind erosion from exposed areas is contained within AP-42 Chapter 13.2.5. The method takes into account site specific wind data, site-specific erodible material properties (threshold friction velocity, particle size distribution of the material eroded) and the frequency of material disturbance. Notwithstanding the data intensiveness of this approach, exercises in applying this method in mines to date has resulted in little or no wind initiated dust lift-off emissions being predicted from active mine sites. As such, the AP-42 Chapter 11.9.7 approach has been adopted. This is considered both conservative and applicable to the estimation of wind erosion emissions over the longer term.

Appendix B: Activity data and equation variables

Table B1: Activity data and measurement methods

Activity		Parameter			
Code	**Description**	**Description**	**Value**	**Units**	**Method**
1.01	Vegetation removal with scrapers	Number of scrapers stripping topsoil	3	-	Scrapers supplied by contractors to move topsoil. Contractors have 3 scrapers on site, and these are only used for topsoil movement.
2.01	Topsoil removal with scrapers	Amount of material stripped	162,456	t/year	Based on truck/scraper counts from the load sheets and reconciled to surveyed topsoil stockpiles on site.
2.02	Topsoil removal with bulldozers/excavators	Number of dozers stripping topsoil	1	-	Very little activity (mainly scrapers). No dozers allocated specifically to topsoil stripping.
		Time spent by each dozer on topsoil	82	hours/year	Hours booked in Open Cut Data Capture (OCDC) database and allocated to specific categories. Hours are adjusted weekly to the service meter readings (SMU) for the various equipment. Hours allocated to topsoil stripping reported from the OCDC database.
2.03	Topsoil loading and unloading	Amount topsoil handled	518,030[(a)]	t/year	Quantity based on truck/scraper counts from the load sheets.
2.04	Topsoil hauling	Amount topsoil handled	680,486[(a)]	t/year	Quantity based on truck counts, as captured in the OCDC database.
		Weight per trip (vehicle payload)	28.5	tonnes	From the OEM data sheet.
		Length of return trip	2.4	km	Estimate average, based on locations and areas where topsoil has been removed.
3.01	Overburden drilling	Number of holes drilled per year	10,783	holes/year	Daily tally sheets from drills entered in drilling register.
3.02	Overburden blasting	Number of blasts per year	37	blasts/year	Blasts entered into the blasting register.
3.03	Overburden draglines	Volume of material	0	m^3/year	Not applicable. No dragline on site.
3.04	Overburden bulldozing	Number of bulldozers working on overburden	4	-	Four dozers are allocated to the dozer push operation.
		Time spent by each bulldozer on overburden	3,572	hours/year	Hours allocated to production dozing reported from the OCDC database.
3.05	Overburden loading and unloading	Overburden amount handled	18,786,228[(b)]	BCM/year	Quantity based on truck counts as captured in the OCDC database and reconciled to survey pick-up each month.
		Density of overburden	2.1	t/m^3	Historic average used, correlates with survey pick-ups.

Activity		Parameter			
Code	**Description**	**Description**	**Value**	**Units**	**Method**
3.06	Overburden hauling	Overburden amount hauled	12,346,380[b]	BCM/year	Quantity based on truck counts in OCDC database and reconciled to survey pick-up each month.
		Density of overburden	2.1	t/m^3	Historic average used, correlates with survey pick-ups.
		Weight per trip (vehicle payload)	136	tonnes	From OEM data sheet.
		Length of return trip	2.5	km	Estimate average, based on locations and areas where overburden has been removed and dumped.
4.01	Coal drilling	Number of holes drilled per year	143,751	holes/year	Daily tally sheets from drills entered in the drilling register.
4.02	Coal blasting	Number of blasts per year	98	blasts/year	Blasts are surveyed and entered into the blasting register.
4.03	Coal bulldozing (ripping, pushing, clean-up)	Number of dozers working on coal removal	4	-	Four dozers are allocated to the coal removal operation.
		Time spent by each dozer on coal removal	5,440	hours/year	Hours allocated to coal ripping/pushing reported from the OCDC database.
4.04a	Coal truck loading and unloading - Loading truck with ROM coal / unloading truck to ROM bin	Total weight loaded and unloaded	17,830,996	t/year	Quantity based on truck counts as captured in the OCDC database and reconciled to survey pick-up each month. Allocated based on assumption that 70% of ROM coal goes directly to ROM bin, and remaining 30% goes via ROM stockpile, taking into account rehandling.
4.04b	Coal truck loading and unloading - Loading truck with ROM coal / unloading truck to ROM stockpile	Total weight loaded and unloaded	7,641,856	t/year	
4.04c	Coal truck loading and unloading - Loading truck from ROM stockpile / unloading truck to ROM bin	Total weight loaded and unloaded	7,641,856	t/year	
4.05	Coal hauling	Coal amount hauled	12,736,426	t/year	Quantity based on truck counts as captured in the OCDC database and reconciled to survey pick-up each month.
		Weight per trip (vehicle payload)	136	tonnes	From the OEM data sheet.
		Length of return trip	6.6	km	Estimate average, based on locations and areas where overburden has been removed and dumped.
4.06a	Coal transfer - ROM bin to crusher	Weight handled/transferred	11,216,769	t/year	Based on truck counts, as captured in the OCDC database, and belt scales at the various transfer points. Figures are

Activity		Parameter			
Code	**Description**	**Description**	**Value**	**Units**	**Method**
4.06b	Coal transfer - crusher to CHPP	Weight handled/transferred	11,216,769	t/year	reconciled to survey pick-up each month.
4.06c	Coal transfer - CHPP to product stockpile	Weight handled/transferred	11,216,769	t/year	
4.06d	Coal transfer - raw & product stockpiles to train	Weight handled/transferred	8,984,468	t/year	Amount of product coal.
4.07	Coal screening	Amount of coal screened	0	t/year	Quantity based on belt scales at the various transfer points. Figures reconciled to survey pick-up each month.
4.08	Coal crushing	Amount of coal crushed	11,216,769	t/year	Quantity based on truck counts as captured in the OCDC database and belt scales at the various transfer points. Figures reconciled to survey pick-up each month.
4.09	Coal bulldozing (ROM stockpiles)	Number of dozers on stockpiles	1	-	No dedicated dozers allocated to ROM stockpiles.
		Time spent by each dozer on stockpiles	3,206	hours/year	Hours allocated to ROM stockpile management reported from the OCDC database.
4.10	Coal bulldozing (product stockpiles)	-	-	-	Included in equation for wind erosion on active coal stockpiles
5.01	Wind erosion: exposed areas, OB dumps	Surface area	70	ha	Estimate scaled from aerial photograph.
5.02	Wind erosion: active coal stockpiles	Surface area	13	ha	Monthly stockpile survey.
6.01	Grading roads	Number of graders used	3	-	Three graders on site.
		Hours of operation per grader	2,856(c)	h	Hours from the service meter readings (SMU) for the graders.
7.01	Rehabilitation bulldozing	Number of dozers working on rehab	4	-	No dozers dedicated for rehab only, but four are utilised when not required in rip/push or production dozing.
		Time spent by each dozer on rehab	2,571	h/year	Hours allocated to rehab reported from the OCDC database.
		Area of active rehab	50	ha	Estimate scaled from aerial photograph.

(a) Converted using a density of 1.5 t/m^3 (source: http://www.anra.gov.au/topics/soils/pubs/national/agriculture_asris_density.html)
(b) The difference is due to material being pushed by bulldozers.
(c) Based on an assumption of 80% utilisation.

Table B2: Equation variables and measurement methods

Activity Code	Activity Description	Parameter Description	Value	Units	Method
1.01	Vegetation removal with scrapers	Not applicable			
2.01	Topsoil removal with scrapers	Not applicable			
2.02	Topsoil removal with bulldozers/excavators	Silt content of topsoil	7.5	%	Topsoil sampled from dumps and stored in airtight polythene bag and sealed container. Silt fraction determined using ASTM-C-136 method [a]. Average value for two samples.
		Moisture content of topsoil	5.9	%	Topsoil sampled from dumps and stored in airtight polythene bag and sealed container. Moisture content determined using ASTM-D-2216 method [b]. Average value for two samples.
2.03	Topsoil loading and unloading	Average wind speed	2.33	m/s	Derived from hourly wind speed data collected between 2004 and 2010 at Wilpinjong meteorological station.
		Moisture content of topsoil	5.9	%	See 2.02
2.04	Topsoil hauling	Mean gross vehicle weight	49	tonnes	OEM data sheet.
		Silt content of haul road	7.1	%	Road dust swept from surface using dustpan and brush. Sample stored in airtight polythene bag and sealed container. Silt fraction determined using ASTM-C-136 method [a]. Average value for two sites.
3.01	Overburden drilling	Not applicable			
3.02	Overburden blasting	Area per blast	16,940	m^2/blast	Blasts are surveyed and entered into the blasting register.
3.03	Overburden draglines	Not applicable			
		Not applicable			
3.04	Overburden bulldozing	Silt content of overburden	1.3	%	Overburden sampled from dumps and stored in airtight polythene bag and sealed container. Silt fraction determined using ASTM-C-136 method [a].
		Moisture content of overburden	12.5	%	Overburden sampled from dumps and stored in airtight polythene bag and sealed container. Moisture content determined using ASTM-D-2216 method [b].
3.05	Overburden loading and unloading	Average wind speed	2.33	m/s	See 2.03
		Moisture content of overburden	12.5	%	See 3.04

Activity		Parameter			
Code	Description	Description	Value	Units	Method
3.06	Overburden hauling	Mean gross vehicle weight	250	tonnes	OEM data sheet.
		Silt content of haul road	7.1	%	See 2.04
4.01	Coal drilling	Not applicable			
4.02	Coal blasting	Area per blast	25,915	m^2/blast	Blasts are surveyed and entered into the blasting register.
4.03	Coal bulldozing (ripping, pushing, clean-up)	Silt content of coal	1.7	%	Coal sampled from bulldozing area (D2 coal) and stored in airtight polythene bag and sealed container. Silt fraction determined using ASTM-C-136 method [a].
		Moisture content of coal	6.6	%	Coal sampled from bulldozing area (D2 coal) and stored in airtight polythene bag and sealed container. Moisture content determined using ASTM-D-2216 method [b].
4.04	Coal truck loading and unloading	Moisture content of coal	5.2	%	Raw unwashed product coal sampled from conveyors and stored in airtight polythene bag and sealed container. Moisture content determined using ASTM-D-2216 method [b].
4.05	Coal hauling	Mean gross vehicle weight	250	tonnes	OEM data sheet.
		Silt content of haul road	7.1	%	See 2.04
4.06	Coal transfer operations	Average wind speed	2.33	m/s	See 2.03
		Moisture content of coal	4.7	%	Washed product coal sampled from stockpile and stored in airtight polythene bag and sealed container. Silt fraction determined using ASTM-C-136 method [a]. Average of two samples.
4.07	Coal screening	Not applicable			
4.08	Coal crushing	Not applicable			
4.09	Coal bulldozing (ROM stockpiles)	Silt content of coal	1.5	%	Coal sampled from ROM stockpile (E coal) and stored in airtight polythene bag and sealed container. Silt fraction determined using ASTM-C-136 method [a].
		Moisture content of coal	5.6	%	Coal sampled from ROM stockpile (E coal) and stored in airtight polythene bag and sealed container. Moisture content determined using ASTM-D-2216 method [b].
4.10	Coal bulldozing (product stockpiles)	-	-	-	Included in equation for wind erosion on active coal stockpiles

Activity		Parameter			
Code	Description	Description	Value	Units	Method
5.01	Wind erosion on exposed areas,	Not applicable			
5.02	Wind erosion on active coal	Average wind speed	2.33	m/s	See 2.03
6.01	Grading roads	Mean vehicle speed	8	km/h	Estimated.
7.01	Rehabilitation bulldozing	Silt content	7.5	%	Value for topsoil used. See 2.02.
		Moisture content	5.9	%	Value for topsoil used. See 2.02.

(a) Silt fraction was determined by measuring the proportion of loose dry surface dust that passed a 200-mesh screen, using the ASTM-C-136 method (see Appendix C.1 and C.2 of AP-42).

(b) Moisture content was determined by weighing a sample before and after oven drying, using the ASTM-D-2216 method (See Appendix C.1 and C.2 of AP-42).

Appendix C: Measurement of silt and moisture content

C1 Sample collection

The sampling of material at the Wilpinjong Mine is described below. At least one sample was collected for each major type of material handled within the facility, with the total amount of material and number of samples obtained being limited by time and budgetary constraints.

C1.1 Haul road dust

Suitable active haul roads were identified by the mine operator. For safety reasons samples could only be obtained from two locations, as shown in **Figure C1**. At each location the sampling method for haul road dust followed, as closely as possible, that described in Appendix C.1 of AP-42. Road dust was swept from a trafficked section of road (in the vehicle tracks) using a dustpan and brush. The dust sample was taken over an area of approximately 2 m^2, and care was taken not to abrade the underlying road surface. Sweeping was also performed slowly so that the amount of fine surface material injected into the air was minimised. The sample was then transferred immediately to a polythene bag, which was subsequently sealed and stored in an airtight plastic container.

Figure C1: Map of Wilpinjong Mine showing sampling locations.

C1.2 Topsoil, overburden and coal

The same method was used to obtain samples of topsoil, overburden, ROM coal from stockpiles, unwashed product coal, washed product coal and coal being handled by bulldozers. The method followed that described in Appendix C.2 of AP-42. Locations for representative sampling were identified by the mine operator. At these locations material had recently been loaded into the piles. Around 5-10 kg of material was collected with a hand shovel from the surface to a depth of 10-15 cm. The sample was then transferred immediately to a polythene bag, which was subsequently sealed and stored in an airtight plastic container. The sampling locations are again shown in **Figure C1**.

C2 Sample analysis

The samples were analysed by an accredited laboratory (SGS in Newcastle). Silt and moisture content were determined using the standard analytical methods identified in Appendix C.1 of AP-42. ASTM[c] method C-136 (sieve analysis) was used to determine silt content, and ASTM method D-2216 was used to determine moisture content.

C3 Results

The results of the tests are given in **Table C1**. The original laboratory report is also provided on the following pages.

Table C1: Results of laboratory tests

Sample no.	Location/activity	Date	Time	Silt content (%)	Moisture content (%)
PAE01	Haul road near ROM bin	23/05/2012	10:00	7.52	-
PAE02	Bulldozers – ROM (E) coal stockpiles	23/05/2012	10:15	1.49	5.55
PAE03	Haul road near pit 2	23/05/2012	10:25	6.60	-
PAE04	Bulldozers ripping (D2) coal	23/05/2012	10:35	1.74	6.55
PAE05	Overburden dumps	23/05/2012	11:10	1.31	12.54
PAE06	Topsoil dump near CHPP	23/05/2012	11:25	6.76	5.66
PAE07				8.20	6.17
PAE08	Raw unwashed product coal. Samples combined.	23/05/2012	11:45	-	5.24
PAE09					
PAE10					
PAE11	Washed product coal	23/05/2012	11:55	1.57	4.57
PAE12				1.24	4.86

- Not required

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ANALYSIS REPORT

Report Status:	**FINAL**
Client:	**Pacific Environment Limited**
Reported to:	**Daniel Cullen** **Email: daniel.cullen@paeholmes.com** **Website: WWW.pelgroup.com**
SGS Reference:	**NM01036**
Description:	**PAE 01, PAE 02, PAE 03, PAE 04** **PAE 05, PAE 06, PAE 07, PAE 08** **PAE 09, PAE 010, PAE 011, PAE 012**
Date Received:	**24 May 2012**

This report supersedes any previous reports which may have been issued.

Date Reported:	**06.06.2012**
Reported By:	Louise Witt **Louise Witt** **Deputy Manager - Newcastle**

A member of the SGS Group

SGS Australia Pty Ltd (ACN 000 964 278)

Report Status:	**FINAL**
Attention:	**Daniel Cullen**
Client:	**Pacific Environment Limited**
SGS Reference:	**NM01036**
Description:	**PAE 01, PAE 02, PAE 03, PAE 04** **PAE 05, PAE 06, PAE 07, PAE 08** **PAE 09, PAE 010, PAE 011, PAE 012**
Samples Received:	**May 24, 2012**

ANALYSIS RESULTS

Analysis		PAE 01	PAE 02	PAE 03
Total Moisture	%	N/A	5.55	N/A
Sizing -0.075	%	7.52	1.49	6.60

Analysis		PAE 04	PAE 05	PAE 06
Total Moisture	%	6.55	12.54	5.66
Sizing -0.075	%	1.74	1.31	6.76

Analysis		PAE 07	PAE 08	PAE 09
Total Moisture	%	6.17	5.24	5.24
Sizing -0.075	%	8.20	N/A	N/A

Analysis		PAE 010	PAE 011	PAE 012
Total Moisture	%	5.24	4.57	4.86
Sizing -0.075	%	N/A	1.57	1.24