REPORT

ROCGLEN COAL MINE -PARTICULATE MATTER CONTROL BEST PRACTICE POLLUTION REDUCTION PROGRAM

Whitehaven Coal Limited

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A PEL Company

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1 INTRODUCTION

The Rocglen Coal Mine (RCM) is an open-cut mine managed by Whitehaven Coal Mining Ltd, located in the Gunnedah Basin, 28km north of Gunnedah in northern NSW. The Rocglen Coal Mine commenced operations in 2008 and is licensed to extract up to 1.5 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal.

1.1 Background

In 2011, the NSW Environmental Protection Agency (EPA)[a] published the document '*NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining*' (hereafter called 'the Best Practice Report') (**Donnelly et al., 2011**).

As an outcome of the Best Practice Report, EPA developed a Pollution Reduction Program (PRP) that requires each mine company to prepare a report on the practicability of implementing best practice measures to reduce particle emissions.

The Coal Mine Particulate Matter Control Best Practice PRP is included in the Environmental Protection Licences 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 (BMP) 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 '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* (referred to as the 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 1.1** presents a summary of the Guideline requirements and a reference to the relevant section in this report.

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

Table 1.1: 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 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 2.3**
	c. Identify the top four mining activities that contribute the highest emissions of TSP, PM_{10} and $PM_{2.5}$.	**Section 2.3**
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 3**
	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 3**
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 3**
	b. Identify those best practices that will be implemented at the premises to reduce particle emissions.	**Section 4**
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 4**

1.3 Overview of Mining at Rocglen Coal Mine

Mining operations are conducted 19.5 hours per day Monday to Friday and 11 hours on Saturday, with no operations on Sundays, albeit the site is licensed to operate 24hrs/day seven days per week. Mining generally follows the extraction sequence below:

Progressive vegetation clearing and soil stripping is undertaken ahead of the advancing open cut mining operation, and would typically be conducted using a fleet of dozers, scrapers and a water cart/truck. Drill and blast techniques are used for the removal of competent overburden (and interburden).

Following blasting, overburden and interburden is to be removed by excavator and dump truck, with supporting dozers. The overburden/interburden is placed in out-of-pit mine waste rock emplacements, or as infill in the mine void, behind the advancing open cut mining operations. Waste rock emplacements are shaped by dozers for rehabilitation.

Coal mining involves excavators loading ROM coal into haul trucks for haulage to the ROM pad for coal crushing, screening and loadout facilities into haulage contractor trucks. Sized ROM coal is transported to the Whitehaven Coal Handling and Preparation Plant (CHPP).

1.4 Mining Activity and Emission Factors

The Best Practice Guideline defines mining activities in the Site-specific Determination Guideline. Not all of these activities necessarily occur at the RCM during the PRP reporting period and for the purposes of emission estimation, some activities are grouped.

The activities included in the emission estimation for the PRP are shown in **Table 1.2**.

The minor changes to the EPA defined activities are:

- For some of the activities in the Site-specific Determination 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.
- The EPA didn't include certain activities (vegetation clearance, topsoil removal, rehabilitation, sealed roads, ventilation shafts (for underground mines)) and where relevant, these activities have been added.

The relevant emission factors for each of these activities are presented in **Appendix A**.

Table 1.2: PM-generating activities at coal mines (adapted from OEH, 2011)

General Activity	Specific Activity	Relevant to Rocglen Coal Mine
Surface preparation	Vegetation clearance/removal	Yes
	Topsoil and subsoil removal with scrapers	Yes
	Topsoil removal with bulldozers/excavators	No
	Topsoil loading to trucks & unloading	No
	Hauling topsoil	No
Overburden and interburden removal	Drilling	Yes
	Blasting	Yes
	Draglines	No
	Bulldozers ripping/pushing/clean-up	Yes
	Loading to trucks & unloading at emplacement	Yes
	Hauling to emplacement	Yes
Coal removal	Drilling	No
	Blasting	No
	Bulldozers ripping/pushing/clean-up	Yes
	Loading truck with ROM coal, unloading truck to ROM pad	Yes
	Loading truck from ROM stockpile, unloading truck to ROM hopper	Yes
	Hauling ROM coal	Yes
	Coal transfer operations[a]	Yes
	Screening	Yes
	Crushing	Yes
	Bulldozing on ROM stockpiles	Yes
	Bulldozing on product stockpiles	No
Wind erosion	Exposed areas, including overburden dumps	Yes
	Active coal stockpiles	Yes
Road Maintenance	Graders on haul roads	Yes
Rehabilitation	Bulldozing on rehab	Yes
Mine Ventilation	Ventilation Shaft Emissions	No

Note: [a]*e.g.* coal > ROM stockpile from conveyor, coal from ROM hopper to conveyor, unloading to trains from conveyor, *etc.*

2 EXISTING MEASURES USED TO MINIMISE PARTICLE EMISSIONS

Emissions were calculated using the relevant USEPA AP-42 emission estimation techniques for both uncontrolled emissions and controlled emissions (**Appendix A**) and activity data provided by the mine (**Appendix B**).

2.1 Estimated Emissions –No Controls

TSP, PM_{10} and $PM_{2.5}$ emission estimates have been calculated for mining activities that occurred during June 2010 – July 2011at the RCM. Emission estimates have been made with no particulate matter controls in place (uncontrolled - **Table 2.1**.) as well as with current particulate matter controls in place (controlled- **Section 2.2**).

A summary of the emissions without dust controls is provided in **Table 2.1**.

Table 2.1 Summary of PM emissions with no controls in place (tonnes/year)

ACTIVITY	TSP	PM_{10}	$PM_{2.5}$
Blasting	4.1	2.1	0.1
Bulldozers on Coal	62.6	17.2	1.4
Bulldozers on OB	154.1	37.2	15.9
Coal Crushing	2.8	1.2	0.0
Coal Screening	12.8	8.9	0.0
Drilling	2.0	1.1	0.1
Graders	0.2	0.1	0.0
Hauling on Unsealed Roads	556.5	129.1	12.9
Hauling Sealed Roads- Non-EPA Activity Category	91.8	17.6	2.5
Material Transfer Coal (Transfer Points)	155.3	20.5	3.0
Material Transfer OB	20.0	9.4	1.4
Topsoil - Non-EPA Activity Category	1.1	0.0	0.0
Trucks Loading and Unloading coal	141.8	18.7	2.7
Trucks Unloading OB	20.0	9.4	1.4
Wind Erosion - Stockpiles	4.4	2.2	0.3
Wind Erosion on Open Areas	135.8	67.9	10.2
Total	**1,365.1**	**342.7**	**51.9**

Notes:OB = overburden. PM = particulate matter

2.2 Estimated Emissions- Existing Controls

Emissions were then recalculated taking into account various control factors for the dust controls that RCM has in place. These controls, as well as the control factor applied, are listed in **Table 2.2**. The control factors listed are sourced from the Best Practice Report (**Donnelly et al., 2011**).

Table 2.2 Summary of Existing Air Quality Controls

PRP Activity Category	Existing Control	OEH level of control (%)	Control applied (%)
Hauling on Unsealed Roads	Water carts on all trafficked areas • Up to hourly on unpaved roads • Measured at Level 1	50	50
Wind Erosion on OB area	Minimise pre-strip (reduction applies to area avoided) – currently in place to coincide with flora/fauna goals.	100	30
	Rehabilitation goals	99	
	In-pit dump	30-80	
	Progressive Rehabilitation (vegetative ground-cover)	70	70
Loading and unloading overburden	Minimise excavator drop height, external trainer engaged.	30	0
	Truck or loader drop height limited to 20 m instead of 40 m.	-	0
	Real time air quality monitoring addresses this with procedures in place to stand down in dusty conditions	-	
	Bulldozers on OB locked in 2nd gear to minimise travel speed	-	
Drilling	Water injection on all drill rigs	3-96	50
	Dust curtains in use	-	
Blasting	Delay shot to avoid unfavourable weather conditions	-	0
Crushing	Crushers and bins enclosed	50	50
	Top of bin and crusher output enclosed	-	
Screening	Enclosure	50	50
Material Transfer of Coal	Water sprays on conveyors and bins and at transfer points	50	50
	Conveyors partially enclosed	40	
	Scrapers used on conveyors	-	
	Conveyed material kept moist	-	
Wind Erosion – stockpiles	Stockpiles kept at relatively low height due to constant load-out	30	30
Trucks Loading and Unloading Coal	Truck or loader dumping coal - always dropped to ground (rather than at height). Excavator drop height limited to truck height	30	30
	Water sprays on ROM hopper	50	50
Grading roads	Graders average 7.5 km/h	75	75
Stacking and Reclaiming product	Coal stockpiles bypassed – no product collection at the site	100	100
Topsoil removal and emplacement	Scrapers are used to strip and emplace topsoil, hence no haulage of topsoil	-	0
	Soil naturally or artificially moist	-	0

A summary of the predicted annual emissions incorporating existing dust controls is provided in **Table 2.3**.

Table 2.3: Summary of PM emissions with current controls in place (tonnes/y)

ACTIVITY	TSP	PM_{10}	$PM_{2.5}$
Blasting	4.1	2.1	0.1
Bulldozers on Coal	62.6	17.2	1.4
Bulldozers on OB	154.1	37.2	15.9
Coal Crushing	1.4	0.6	0.0
Coal Screening	6.4	4.4	0.0
Drilling	1.0	0.5	0.0
Graders	0.1	0.0	0.0
Hauling on Unsealed Roads	278.3	64.6	6.5
Hauling Sealed Roads- Non-EPA Activity Category	91.8	17.6	2.5
Material Transfer Coal (Transfer Points)	77.7	10.2	1.5
Material Transfer OB	20.0	9.4	1.4
Topsoil - Non-EPA Activity Category	1.1	0.0	0.0
Trucks Loading and Unloading coal	120.5	15.9	2.3
Trucks Unloading OB	20.0	9.4	1.4
Wind Erosion - Stockpiles	3.1	1.5	0.2
Wind Erosion on Open Areas	93.3	46.6	7.0
Total	**946.9**	**237.5**	**40.5**

2.3 Activity Ranking – Existing Controls

Activities are ranked in terms of total annual emission (existing controls) and presented in **Table 2.4**.In accordance with the Best Practice Guideline, the top four ranked activities according to estimated mass particulate emissions for TSP, PM_{10} and $PM_{2.5}$ are shown in bold.

An evaluation of Best Practice measures for following activities is therefore presented in **Section 3**:

- Hauling on unsealed roads;
- Wind erosion of exposed areas / dumps;
- Trucks loading and unloading coal;
- Bulldozers on overburden.

Hauling on sealed roads also featured in the top four ranking activities for PM_{10} and $PM_{2.5}$, however, it is not identified by the EPA as a mining activity, or within the Best Practice Report. In fact, paving of unsealed roads is identified as a best practice measure. Hauling on sealed roads is therefore not considered further in this report.

Table 2.4: Ranked activities by mass emissions(controlled)

Rank	Mining Activity	Emissions (t/y)
TSP		
1	**Hauling on Unsealed Roads**	**278.3**
2	**Bulldozers on OB**	**154.1**
3	**Trucks Loading and Unloading coal**	**120.5**
4	**Wind Erosion on Open Areas**	**93.3**
5	Hauling Sealed Roads- Non-EPA Activity Category	91.8
6	Material Transfer Coal (Transfer Points)	77.7
7	Bulldozers on Coal	62.6
8	Trucks Unloading OB	20.0
9	Material Transfer OB	20.0
10	Coal Screening	6.4
11	Blasting	4.1
12	Wind Erosion - Stockpiles	3.1
13	Coal Crushing	1.4
14	Topsoil - Non-EPA Activity Category	1.1
15	Drilling	1.0
16	Graders	0.1
PM_{10}		
1	**Hauling on Unsealed Roads**	**64.6**
2	**Wind Erosion on Open Areas**	**46.6**
3	**Bulldozers on OB**	**37.2**
4	**Hauling Sealed Roads- Non-EPA Activity Category**	**17.6**
5	Bulldozers on Coal	17.2
6	Trucks Loading and Unloading coal	15.9
7	Material Transfer Coal (Transfer Points)	10.2
8	Trucks Unloading OB	9.4
9	Material Transfer OB	9.4
10	Coal Screening	4.4
11	Blasting	2.1
12	Wind Erosion - Stockpiles	1.5
13	Coal Crushing	0.6
14	Drilling	0.5
15	Graders	0.0
16	Topsoil - Non-EPA Activity Category	0.0

Rank	Mining Activity	Emissions (t/y)
	$PM_{2.5}$	
1	**Bulldozers on OB**	**15.9**
2	**Wind Erosion on Open Areas**	**7.0**
3	**Hauling on Unsealed Roads**	**6.5**
4	**Hauling Sealed Roads- Non-EPA Activity Category**	**2.5**
5	Trucks Loading and Unloading coal	2.3
6	Material Transfer Coal (Transfer Points)	1.5
7	Trucks Unloading OB	1.4
8	Material Transfer OB	1.4
9	Bulldozers on Coal	1.4
10	Wind Erosion - Stockpiles	0.2
11	Blasting	0.1
12	Drilling	0.0
13	Graders	0.0
14	Coal Crushing	0.0
15	Coal Screening	0.0
16	Topsoil - Non-EPA Activity Category	0.0

3 PRACTICABILITY OF IMPLEMENTING ADDITIONAL BEST PRACTICE MEASURES

Based on the information presented in **Section 2** it is clear that RCM already has a number of PM-control measures in place. With current controls, emissions of TSP, PM_{10} and $PM_{2.5}$ are approximately 30% lower than with no controls in place.

The practicability associated with the implementation of each of the additional best practice measures (as documented within the Best Practice Report) was evaluated for the top four emission-generating activities. The evaluation was undertaken by the mine operators by taking into consideration the criteria outlined in the Guideline, as follows:

- Implementation costs.
- Regulatory requirements.
- Environmental impacts.
- Safety implications.
- Compatibility with current processes and proposed future developments.

The results of the evaluation are presented in **Table 3.1** (haul roads), **Table 3.2** (wind erosion), **Table 3.3** (loading and unloading coal) and **Table 3.4** (dozers on overburden).

Where a given measure was considered to be practicable according to each of the criteria examined, it was taken to be practicable overall. Those measures deemed to be practicable overall were then taken forward for costing. Measures that were considered not practicable according to one or more of the assessment criteria were not considered further.

Existing controls are already in place for many of the top-ranking activities, and 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 further controls may be considered for these top-ranking activities, an assessment of the remaining site activities has also been undertaken to assess whether further controls may be appropriate. It was therefore considered important to identify *any* activity for which there is potential to significantly reduce emissions.

The remaining (lower ranking activities) have also been evaluated and are included in **Table 3.5**.

It is noted that the emission reduction values presented assume an existing level of control where relevant, as presented in **Table 2.2**.

Table 3.1: BPM to reduce particulate matter emissions from haul roads

Best Practice Control		% control	Practicality Evaluation: Current Use	Regulatory	Environmental	Safety	Compatibility	Practicable Y/N	Comments	Potential reduction in dust emission (t/y): TSP	PM_{10}	$PM_{2.5}$	Potential reduction in dust emission as % of total site dust emission (current controls): TSP	PM_{10}	$PM_{2.5}$
										Existing control efficiency of 50% is assumed (see Table 2.2)					
Vehicle speed restrictions	Reduction from 75 km/hr to 50 km/hr	40-75%	N	Y	Y	Y	N	N	Current speed limit on site is 60km/hr as per Surface Transport Management Plan approved by DRE and not easily changed	111.3	25.8	2.6	12%	11%	6%
	Reduction from 65 km/hr to 30 km/hr	50-85%	N	Y	N	Y	N	N	Reduction in productivity - not energy efficient if diggers waiting for trucks to return to circuit	139.2	32.3	3.3	15%	14%	8%
Surface improvement	Pave the surface	>90%	N	Y	Y	Y	N	N	Haul roads are of a temporary nature	222.7	51.7	5.2	24%	22%	13%
	Low silt aggregate	30%	N	Y	Y	Y	N	N	Silt content determined by in-situ material - not easily changed	83.5	19.4	2.0	9%	8%	5%
	Oil and double chip surface	80%	N	N	N	N	N	N	Possibility of spills and environmental concerns	167.0	38.8	3.9	18%	16%	10%
Surface treatments	Watering (standard procedure)	10-74%	Y	Y	Y	Y	Y	Y	Current Practice	-	-	-	-	-	-
	Watering Level 1 (2 L/m2/h)	50%	Y	Y	Y	Y	Y	Y	Measured at Level 1	-	-	-	-	-	-
	Watering Level 2 (>2 L/m2/h)	75%	N	Y	Y	N	N	N	Not practical as creates a hazard with slippery haul roads	139.2	32.3	3.3	15%	14%	8%
	Watering twice a day	55%	Y						Roads are watered once per hour	-	-	-	-	-	-

Best Practice Control		% control	Practicality Evaluation: Current Use	Regulatory	Environmental	Safety	Compatibility	Practicable Y/N	Comments	Potential reduction in dust emission (t/y) — Existing control efficiency of 50% is assumed (see Table 2.2): TSP	PM_{10}	$PM_{2.5}$	Potential reduction in dust emission as % of total site dust emission (current controls): TSP	PM_{10}	$PM_{2.5}$
Surface treatments	Suppressant	84%(d)	N	Y	Y	Y	N	N	Not practical or cost effective	233.8	54.3	5.5	25%	23%	13%
	Hygroscopic salts	45%-82%(e)	N	Y	?	?	N	N	As Above	125.2 - 228.2	29.1 - 53.0	2.9 – 5.3	13% - 24%	12% - 22%	7% to 13%
	Ligno-sulphonates	66-70% (over 23 days)	N						As Above	183.7 – 194.8	42.6 – 45.2	4.3 – 4.6	19% - 21%	18% - 19%	*11%
	Polymer emulsions	70% over 58 days	N						As Above	194.8	45.2	4.6	21%	19%	11%
	Tar and bitumen emulsions	70% over 20 days	N						As Above	194.8	45.2	4.6	21%	19%	11%
	Sealed/ salt-encrusted	-	N						As Above	-	-	-	-	-	-
Other	Use of larger vehicles	90t to 220t: 40%	N	Y	Y	Y	N	N	Trucks already 140t	111.3	25.8	2.6	12%	11%	6%
		140t to 220t; 20%	N	Y	Y	Y	Y	Y	BPM costed	55.7	12.9	1.3	6%	5%	3%
		140t to 360t: 45%	N	Y	Y	?	N	N	As Above	125.2	29.1	2.9	13%	12%	7%
	Conveyors	>95%	N	N	?		N	N	Capital costs - not approved - energy consumption (no access to power grid)	264.4	61.4	6.2	28%	26%	15%

Notes: [a]Reductions achieved by the use of larger vehicles, conveyors and lower grader speeds have been calculated from the emission factors for these activities.

b km/hr = kilometres per hour.
l/m2/hr = litres per square metre per hour.
t = tonnes.

Source: Donnelly *et al,* 2011

Table 3.2: BPM to reduce particulate matter emissions from wind erosion of open areas

Best Practice Control		% control	Practicality Evaluation: Current Use	Regulatory	Environmental	Safety	Compatibility	Practicable Y/N	Evaluation Comments from Mine	Potential reduction in dust emission (t/y) TSP	PM10	PM2.5	Potential reduction in dust emission as % of total site dust emission (current controls) TSP	PM10	PM2.5
										Existing control efficiency of 30% is assumed, (70% for rehabilitation area) (see Table 2.2)					
Avoidance	Minimise pre-strip	100% per m2 of pre-strip avoided	Y	Y	Y	Y	Y	Y	In place on basis of restricting clearing for 12 months to coincide with flora/fauna requirements	-	-	-	-	-	-
Surface stabilisation	Watering	50%	N	Y	Y	N	N	N	Depends on water availability. Safety implications of slumping of emplacements.	46.7	23.3	3.5	5%	10%	9%
	Chemical suppressants	70-84%	N	Y	Y	Y	N	N	As above	65.3 - 71.6	32.6 – 35.7	4.9 – 5.4	7%-8%	14% - 16%	12% - 15%
	Paving and cleaning	>95%	N	Y	Y	Y	N	N	Impractical to pave the pit and rehab areas	88.6	44.3	6.7	9%	19%	16%
	Application of gravel to stabilise disturbed open areas	84%	N	Y	Y	?	N	N	Additional disturbance would be required to win the gravel impractical	71.6	35.7	5.4	8%	15%	13%
	Rehabilitation goals	99%	Y	Y	Y	Y	Y	Y	Current practice	-	-	-	-	-	-
Wind speed reduction	Fencing, bunding, shelterbelts or in-pit dump	30-80%	Y	Y	Y	Y	Y	Y	In pit dumping when practical	-	-	-	-	-	-
	Vegetative ground cover	70%	Y	Y	Y	Y	Y	Y	Seeded to cover as soon as practicable once reshaped to grade.	52.6	26.2	3.9	6%	11%	10%

Table 3.3: BPM to reduce particulate matter emissions from trucks loading and unloading coal

Best Practice Control		% control per OEH	Practicability factors: Current Use	Regulatory	Environmental	Safety	Compatibility	Practicable Y/N	Comments	Potential reduction in dust emission (t/y) TSP	PM10	PM2.5	Potential reduction in dust emission as % of total site dust emission (current controls) TSP	PM10	PM2.5
										Existing control efficiency of 0% to 50% is assumed (see Table 2.2)					
Avoidance	Bypass ROM stockpiles	50%	N	Y	Y	Y	N	N	Not currently in place but will occur once extension is approved and ROM coal is transported direct to adjoining mine infrastructure	49.6	6.6	1.0	5%	3%	2%
		100%	N	Y	Y	Y	N	N	Not currently in place but will occur once extension is approved and ROM coal is transported direct to adjoining mine infrastructure	120.5	15.9	2.3	13%	7%	6%
Truck or loader dumping ROM coal	Minimise drop height (10m to 5m)	30%	Y	Y	Y	Y	Y	Y	Always drop to the ground - drop height restricted to truck height	-	-	-	-	-	-
	Water sprays on ROM pad	50%	N	Y	Y	Y	N	N	Water availability	60.3	8.0	1.2	6%	3%	3%
Truck or loader dumping to ROM bin	Water sprays on ROM bin or sprays on ROM pad	50%	Y	Y	Y	Y	Y	Y	Sprays on conveyor on entry to bin	-	-	-	-	-	-
	Enclosed dump hopper (3 sides and a roof)	70%	Y	Y	Y	Y	Y	Y	Three sides on hopper - but no roof	78.0	10.3	1.5	8%	4%	4%
	Enclosed dump hopper (3 sides and a roof) plus water sprays	85%	N	Y	Y	N	N	N	As above	99.2	13.1	1.9	10%	6%	5%
	Enclosure with control device	90-98%	N	Y	Y	N	N	N	As above	106.3 - 117.7	14.0 – 15.5	2.0 – 2.2	11% - 12%	6% - 7%	5% - 6%

Table 3.4: BPM to reduce particulate matter emissions from bulldozers on overburden

Best Practice Control	% control per OEH	Practicability factors: Current Use	Regulatory	Environmental	Safety	Compatibility	Practicable Y/N	Comments	Potential reduction in dust emission (t/y) — Existing control efficiency of 0% is assumed (see Table 2.2): TSP	PM10	PM2.5	Potential reduction in dust emission as % of total site dust emission (current controls): TSP	PM10	PM2.5
Minimise travel speed and distance	Not quantified	Y	Y	Y	Y	Y	Y	Locked in 2nd gear	-	-	-	-	-	-
Keep travel routes and materials moist	50%	N	Y	Y	N	N	N	Can keep travel routes moist but not coal/overburden during pushing.	77.1	18.6	8.0	8%	8%	20%

Table 3.5: BPM to reduce particulate matter emissions from remaining activities

Best Practice Control	% control per OEH	Practicability factors: Current Use	Regulatory	Environmental	Safety	Compatibility	Practicable Y/N	Comments	Potential reduction in dust emission (t/y) TSP	PM10	PM2.5	Potential reduction in dust emission as % of total site dust emission (current controls) TSP	PM10	PM2.5
Trucks unloading overburden (assumed control efficiency of 0%, see **Table 2.2**)														
Minimising drop height (Reduce from 3m to 1.5m)	30%	Y	Y	Y	Y	Y	Y	Dump drop height limited to 20m instead of 40m	-	-	-	-	-	-
Water application	50%	N	Y	Y	N	N	N	Not practical	10.0	4.7	0.7	2%	2%	2%
Modify activities in windy conditions	Not quantified	Y	Y	Y	Y	Y	Y	Real time air quality monitoring addresses this with procedures in place to stand down dusty activities.	-	-	-	-	-	-
Blasting(assumed control efficiency of 0%, see **Table 2.2**)														
Design: delay shout to avoid unfavourable weather conditions	Not quantified	Y	Y	Y	Y	Y	Y	In practice	-	-	-	-	-	-
Design: minimise area blasted	Not quantified	N	Y	Y	N	N	N	Not always practical for safety and operational reasons	-	-	-	-	-	-
Graders(assumed control efficiency of 75%, see **Table 2.2**)														
Grader speed reduction from 16km/hr to 8 km/hr	75%	Y						Grader currently operate 8km/hr	0.1	0.0	0.0	0%	0%	0%

Best Practice Control		% control per OEH	Practicability factors: Current Use	Regulatory	Environmental	Safety	Compatibility	Practicable Y/N	Comments	Potential reduction in dust emission (t/y): TSP	PM10	PM2.5	Potential reduction in dust emission as % of total site dust emission (current controls): TSP	PM10	PM2.5
Watering grader routes		50%	N	Y	Y	Y	N	N	Not practical for road construction - better to water after road surface has been disturbed	0.1	0.0	0.0	0%	0%	0%
Scrapers on topsoil(assumed control efficiency of 0%, see **Table 2.2**)															
Soil naturally or artificially moist		-	Y	-	-	-	-	-	-	-	-	-	-	-	-
Drilling(assumed control efficiency of 50%, see **Table 2.2**)															
Wet	Water injection sprays while drilling	3-96% NIOSH document	Y	Y	Y	Y	Y	Y	All rigs use water injection	-	-	-	-	-	-
Dry collection	Fabric filters	99	Y	Y	Y	Y	Y	Y	Dust curtains in use	1.0	0.5	0.0	0%	0%	0%
	Cyclone	80-90	N	Y	Y	Y	Y	Y	Not considered necessary for such as small source	0.6 -0.8	0.3 - 0.4	0.0	0%	0%	0%

Best Practice Control		% control per OEH	Current Use	Regulatory	Environmental	Safety	Compatibility	Practicable Y/N	Comments	Potential reduction in dust emission (t/y)			Potential reduction in dust emission as % of total site dust emission (current controls)		
										TSP	PM10	PM2.5	TSP	PM10	PM2.5
Wind erosion - coal stockpiles(assumed control efficiency of 30%, see **Table 2.2**)															
Avoidance	Bypassing stockpiles	100%	N	Y	Y	Y	N	N	Not possible	3.1	1.5	0.2	0%	0%	0%
Surface stabilisation	Water sprays	50%	N	Y	Y	Y	Y	Y		0.9	0.4	0.1	0%	0%	0%
	Chemical wetting agents	80-99%	N	Y	Y	Y	Y	N	Not necessary	2.2 - 3.1	1.1 - 1.5	0.1 - 0.2	0%	0%	0%
	Surface crusting agent	95%	N	Y	Y	Y	Y	N	Stockpile residence time is very short - so impractical to apply	2.9	1.4	0.2	0%	0%	0%
	Carry over wetting from load in	80%	N	Y	Y	Y	Y	N	Not practical	2.2	1.1	0.1	0%	0%	0%
Enclosure	Silo with bag house	95-100%	Y	Y	Y	Y	Y	Y	Crusher and bins enclosed	2.9 - 3.1	1.4 - 1.5	0.2	0%	0%	0%
	Cover storage pile with a tarp during high winds	99%	N	Y	Y	N	N	N	Not practical	3.1	1.5	0.2	0%	0%	0%
Wind speed reduction	Vegetative windbreaks	30%	N	Y	Y	N	N	N	Safety risk with equipment near trees etc	0.9	0.5	0.1	0%	0%	0%
	Reduced pile height	30%	Y	Y	Y	Y	Y	Y	Stockpile height limited due to constant load out from site	0.0	0.0	0.0	0%	0%	0%

Best Practice Control		% control per OEH	Practicability factors: Current Use	Regulatory	Environmental	Safety	Compatibility	Practicable Y/N	Comments	Potential reduction in dust emission (t/y)			Potential reduction in dust emission as % of total site dust emission (current controls)		
										TSP	PM10	PM2.5	TSP	PM10	PM2.5
Wind speed reduction	Wind screens/fences	75->80%	N	Y	Y	N	N	N	Safety risk	2.3	1.1	0.2	0%	0%	0%
	Pile shaping/orientation	<60%	N	Y	Y	Y	N	N	Stockpile height limitations reduces effectiveness	0.0	0.0	0.0	0%	0%	0%
	Erect 3-sided enclosure around storage piles	75%	N	Y	Y	N	N	N	As above	2.3	1.1	0.2	0%	0%	0%
	Rock armour and/or topsoil applied	-	N	Y	N	N	N	N	Not possible	0.0	0.0	0.0	0%	0%	0%
Conveyor and transfers (assumed control efficiency of 50%, see **Table 2.2**)															
Conveyors	Application of water at transfers	50%	Y	Y	Y	Y	Y	Y	In place	0.0	-0.1	0.0	0%	0%	0%
	Wind shielding - roof or side wall	40%	Y	Y	Y	Y	Y	Y	In place partially enclosed	0.0	0.0	0.0	0%	0%	0%
	Wind shielding - roof AND side wall	70%	N	Y	Y	Y	N	N	Cost implications.	31.1	4.1	0.6	3%	2%	1%
	Belt cleaning and spillage minimisation	Not quantified	Y	Y	Y	Y	Y	Y	In place and operating - belts have scrapers in place	0.0	0.0	0.0	0%	0%	0%
Transfers	Enclosure	70%	Y	Y	Y	Y	Y	Y	At top of bin and crusher output	31.1	4.1	0.6	3%	2%	1%

	Best Practice Control	% control per OEH	Practicability factors: Current Use	Regulatory	Environmental	Safety	Compatibility	Practicable Y/N	Comments	Potential reduction in dust emission (t/y)			Potential reduction in dust emission as % of total site dust emission (current controls)		
										TSP	PM10	PM2.5	TSP	PM10	PM2.5
	Enclosure and fabric filters	-	N	Y	Y	Y	N	N	Not practical	-	-	-	-	-	-

3.1 Estimated Emissions for Practical BPM

Table 3.6 summarizes BPM identified as practicable for the mining activities at Rocglen, the potential reduction of dust emissions due to implementing the BPM and the potential reduction of emissions as a percentage of the total dust emissions from Rocglen.

Calculations indicate that the greatest potential reductions in emissions are achieved through the use of larger vehicles for hauling, followed by the installation of a roof on the ROM hopper. Further consideration of costs is provided in **Section 3.2**

Table 3.6: Estimated Emissions for Practical BPM

Mining Activity	BPM	Dust Emissions after BPM (t/y)			Potential Reduction as % of total site dust emission		
		TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Loading and dumping ROM coal	Enclosure of coal hopper (three sides and a roof) note that the hopper currently has three sides.	21.3	2.8	0.4	5%	3%	3%
Hauling on unsealed roads	Use of larger trucks (140t - 220t) (20%)	222.6	51.7	12.7	6%	5%	3%
Conveyors and Transfers [1]	Wind shielding - roof and wall	-	-	-	-	-	-
Wind erosion on coal stockpiles	Water sprays: pipe from pit water dam, sprinklers with stands, generator, high pressure pump	3	1.1	0.5	0.3%	0.5%	0.4%

Note: [1] Wind erosion from surfaces of the conveyors not estimated as not considered a significant source.

3.2 Implementation Cost Evaluation

For the measures identified in **Table 3.6**, an additional cost evaluation was completed and summarised below. Full details provided in **Appendix C**.

- For unloading coal to ROM hopper the net cost per tonne of PM_{10} abated as a result of the installation of a roof was calculated to be in the order of \$40,000/tonne-PM_{10} in the first year, \$1000/tonne-PM_{10} annually thereafter and a total of \$50,000/tonne-PM_{10} over 10 years.
- For hauling on unsealed roads, the net cost per tonne of PM_{10} abated as a result of increasing haul truck sizes would be of the order of \$3 million/tonne-PM_{10} in the first year, \$900,000/tonne-PM_{10} annually thereafter and a total of \$11 million/tonne-PM_{10} over 10 years.
- For conveyors, emissions were estimated for transfer points, however wind erosion from the surfaces of conveyors was not considered as this is considered a very small source. The estimated total cost for the installation of side walls on the conveyors is in the order of \$610,000 over 10 years. The reduction in emissions that this would achieve is expected to be minor, on the basis that the emission factor for wind erosion for TSP is 1 tonne/ha/year and the surface area for conveyors on site would be relatively small.

- For wind erosion and maintenance of coal stockpiles the net cost per tonne of PM_{10} abated as a result of fixed water sprays was calculated to be in the order of $2 million/tonne-$PM_{10}$ in the first year, $200,000/tonne-$PM_{10}$ annually thereafter and a total of $4 million/tonne-$PM_{10}$ over 10 years.

4 IMPLEMENTATION OF PRACTICAL BPM

Based on a result of the practicability evaluation and subsequent cost evaluation, significant PM reductions cannot be achieved without significant cost.

The largest source and that with the greatest potential for additional controls is hauling on unsealed roads. The use of larger trucks does not present as a viable option in terms of cost effectiveness per tonne of PM_{10} supressed, therefore it is recommended that that site specific control efficiency is determined for Rocglen (currently assumed as 50%) so that the required watering rates and suppressant application frequencies are better understood, as outlined in **Section 5.5**. Once this is understood, additional controls (increased watering, suppressants) can be investigated for implementation.

5 MONITORING AND TRACKING THE EFFECTIVENESS OF BPM

On the 9 May 2012, the EPA held an information session and workshop to provide feedback to consultants and mines on the dust PRPs received to date. A key outcome of the workshop (referred to as 'Key Message 3' (**EPA, 2012**)) was that the control effectiveness of both existing and proposed BPM 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*"

In accordance with EPA expectations, the following Key Performance Indicators (KPIs) are proposed for Rocglen.

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

This headline KPI will provide an indication of the overall effectiveness of all PM controls (for all activities) at Rocglen, and makes direct use of the emissions inventory compiled for the PRP process.

The value of the KPI will change each year depending not only on the application of control measures, but also on any changes in the distribution of mining activities (*e.g*. as the lengths of haul roads change).

The KPI will be recalculated on an annual basis (AEMR reporting period) 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, dozer hours etc). For consistency, it is recommended that future National Pollutant Inventory (NPI) reporting periods and emission calculations are aligned with this more refined calculation method.

It is also recommended that this KPI is improved by using site specific input data (silt content, moisture content, control efficiencies). An outline of the monitoring recommended for improvements to this KPI is outlined in **Section 5.5**.

Further details for this KPI are outlined in **Table 5.1**, along with objectives and targets and reporting requirements. If adopted for the mine, a site specific procedure would be developed for this KPI.

5.2 KPI-2 Control of PM_{10} Emissions

This KPI will quantify the progress of the mine towards achieving best practicable controls on 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 dozer hours as is the case for KPI-1.

The current control measure for each mining activity is compared to 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 5.5**. Further details about the KPI, including the metric, objectives, targets and reporting requirements are outlined in **Table 5.1**. If adopted for the mine, a site specific procedure would be developed for this KPI.

5.3 KPI-3 Opacity (Visible Dust Emissions)

This KPI is designed to provide an indication of visibility 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 5.1**, including the various methods and standards for measurement, 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 opacity monitoring method.

5.4 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, as per the Best Practice Report. The actual site specific control efficiency for the Rocglen haul roads, for watering is unknown, and it is recommended that this is determined. 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 50%, the watering rate required for achieve 50% control can be determined and used for tracking and reporting against this KPI.

Further details for this KPI are outlined in **Table 5.1** 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 5.3**.

Table 5.1: KPIs for BPM

<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 AEMR/NPI)</td><td>Include in AEMR</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 AEMR/NPI)</td><td>Include in AEMR</td></tr>
</table>

<table>
<tr><th colspan="5">KPI-3 – Visible Dust Emissions (Opacity)</th></tr>
<tr><td rowspan="2">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</td><td>Visual Observations
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 Apacity)</td><td><20% Opacity at source - hauling, open pit and stockpile area</td><td>Weekly</td><td>Weekly operators log.</td></tr>
<tr><td>Digital Imagery
ASTM WK 30382 “New Test Method for Determining the Opacity of Fugitive Emissions in the Outdoor Ambient Atmosphere, Using Digital Imagery”</td><td><20% Opacity at source</td><td>Continuous</td><td></td></tr>
<tr><th colspan="5">KPI 4 - Watering Intensity for Hauling (L/VKT)</th></tr>
<tr><td>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</td><td>N/A</td><td>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)</td><td>Annual</td><td>Include in AEMR</td></tr>
</table>

5.5 Recommendations for Ongoing improvement of KPIs

Another key message from the EPA information sessions (referred to as 'Key Message 2' (**EPA, 2012**)) 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 provided by the mine (refer **Appendix B**) and used for the PM emissions estimates presented in the report.

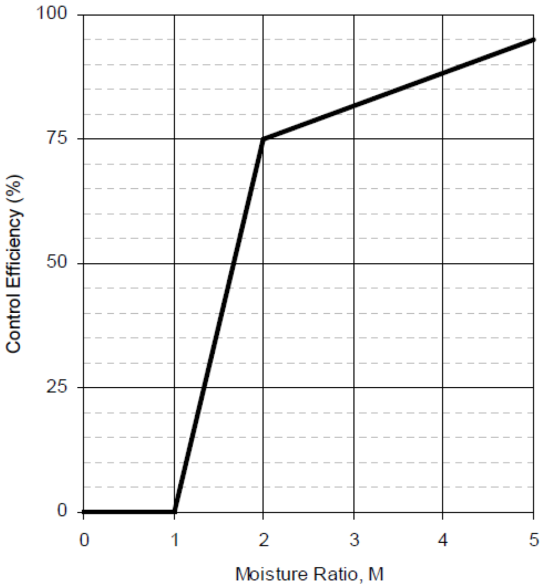
However, due to time constraints the sampling and analysis of material properties was not completed. For ongoing evaluation against the KPIs, it is recommended that improvements are made to emission estimates using site specific data and site specific control efficiencies are determined. The recommended monitoring for input into the KPIs are outlined in **Table 5.2**. Measurement methods for determination of site specific controls for water are outlined in **Table 5.3**.

Table 5.2: 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)

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 5.3: 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>

6 REFERENCES

Donnelly, S.-J., Balch, A., Wiebe, A., Shaw, N., Welchman, S., Schloss, A., Castillo, E., Henville, K., Vernon, A., Planner, J. (2011). "NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and / or Minimise Emissions of Particulate Matter from Coal Mining" Prepared by Katestone Environmental Pty Ltd for Office of Environment and Heritage June 2011.

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USEPA (2006b). AP-42 Compilation of Emission Factors, Section 13.2.4 - Aggregate Handling And Storage Piles, November 2006.
http://www.epa.gov/ttnchie1/ap42/ch13/final/c13s0204.pdf

APPENDIX A: EMISSION FACTOR EQUATIONS

Table A1: Emission factors for mining activities

Activity Code	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: MINE ACTIVITY DATA

Information required for emissions inventory calculation

1. VEGETATION CLEARANCE AND REMOVAL

Activity	Calculation	Variable	Variable description	Value	Units
Scraping and removing vegetation	Intensity	$N_{Scrape,Veg}$	Number of scrapers	4	-
		$A_{Scrape,Veg}$	Area stripped	17	ha/year

2. TOPSOIL (AND SUBSOIL) REMOVAL

Activity	Calculation	Variable	Variable description	Value	Units
Stripping with scrapers	Emission factor	$N_{Strip,Topsoil}$	Number of scrapers stripping topsoil	4	-
		$W_{Strip,Topsoil}$	Amount of material stripped	34,800 m3/Year	tonnes/year
OR Stripping with bulldozers/excavators	Intensity	$N_{Strip,Topsoil}$	Number of dozers stripping topsoil	N/A	-
		$T_{Strip,Topsoil}$	Time spent by each dozer on topsoil	N/A	hours/year
	Emission factor	$s_{Strip,Topsoil}$	Silt content of topsoil	N/A	%
		$M_{Strip,Topsoil}$	Moisture content of topsoil	N/A	%
Loading and emplacing	Intensity	$w_{Load,Topsoil}$	Amount topsoil handled	N/A	tonnes/year
	Emission factor	$U_{Load,Topsoil}$	Average wind speed	2.24	m/s
		$M_{Load,Topsoil}$	Moisture content of topsoil	N/A	%
Hauling topsoil	Intensity	$w_{Haul,Topsoil}$	Amount topsoil handled	N/A	tonnes/year
	Emission factor	$wt_{Haul,Topsoil}$	Weight per trip (vehicle payload)	N/A	tonnes
		$L_{Haul,Topsoil}$	Length of return trip	N/A	km
		$W_{Haul,Topsoil}$	Mean gross vehicle weight for hauling topsoil	N/A	tonnes
		$s_{Haul,Topsoil}$	Silt content of haul road	2	%

3. OVERBURDEN (AND INTERBURDEN) REMOVAL

Activity	Calculation	Variable	Variable description	Value	Units
Drilling	Intensity	$N_{Drill,OB}$	Number of holes drilled per year	3474	holes/year
Blasting	Intensity	$N_{Blast,OB}$	Number of blasts per year	26	blasts/year
	Emission factor	$A_{Blast,OB}$	Area per blast	7950	m^2/blast
Draglines	Intensity	$V_{Drag,OB}$	Volume of material	N/A	m^3
	Emission factor	$d_{Drag,OB}$	Drop distance	N/A	m
		$M_{Drag,OB}$	Moisture content of overburden	2	%
Loading and emplacing	Intensity	$w_{Load,OB}$	Overburden amount handled	7,483,088 BCM/Year	BCM/year
		$d_{Load,OB}$	Density of overburden	2.2	t/m^3
	Emission factor	$U_{Load,OB}$	Average wind speed	2.24	m/s
		$M_{Load,OB}$	Moisture content of overburden	2	%
Hauling OB	Intensity	$w_{Haul,OB}$	Overburden amount hauled	7,483,088 BCM/Year	BCM/year
		$d_{Haul,OB}$	Density of overburden	2.2	t/m^3
	Emission factor	$wt_{Haul,OB}$	Weight per trip (vehicle payload)	150	tonnes
		$L_{Haul,OB}$	Length of return trip	1.2	km
		$W_{Haul,OB}$	Gross vehicle weight	246	tonnes
		$s_{Haul,OB}$	Silt content of haul road	10	%
Bulldozing	Intensity	$N_{Dozer,OB}$	Number of bulldozers working on overburden	3	-
		$T_{Dozer,OB}$	Time spent by each bulldozer on overburden	3002	hours/year
	Emission factor	$s_{Dozer,OB}$	Silt content of overburden	10	%
		$M_{Dozer,OB}$	Moisture content of overburden	2	%

3. COAL REMOVAL

Activity	Calculation	Variable	Variable description	Value	Units
Bulldozers ripping/pushing/clean-up	Intensity	$N_{Dozer,Coal}$	Number of dozers working on coal removal	1	-
		$T_{Dozer,Coal}$	Time spent by each dozer on coal removal	2981	hours/year
	Emission factor	$s_{Dozer,Coal}$	Silt content of coal	5	%
		$M_{Dozer,Coal}$	Moisture content of coal	6	%
Drilling	Intensity	$N_{Drill,Coal}$	Number of holes drilled per year	N/A	holes/year
Blasting	Intensity	$N_{Blast,Coal}$	Number of blasts per year	N/A	blasts/year
	Emission factor	$A_{Blast,Coal}$	Area per blast	N/A	m^2/blast
All truck loading and unloading operations (*e.g.* ROM coal > trucks, ROM coal > stockpile, ROM coal > hopper, *etc.*)	Intensity	$w_{Load,Coal}$	Total weight loaded and unloaded	1,049,584	tonnes/year
	Emission factor	$M_{Load,Coal}$	Moisture content of coal	6	%
Hauling Coal	Intensity	$w_{Haul,Coal}$	Coal amount hauled	1,049,584	tonnes/year
	Emission factor	$wt_{Haul,Coal}$	Weight per trip (vehicle payload)	150	tonnes
		$L_{Haul,Coal}$	Length of return trip	1.2	km
		$W_{Haul,Coal}$	Gross vehicle weight	246	tonnes
		$s_{Haul,Coal}$	Silt content of ROM coal	5	%
All material transfer operations (*e.g.* coal > ROM stockpile from conveyor, coal from ROM hopper to conveyor,	Intensity	$w_{Trans,Coal}$	Weight handled/transferred	1249789	tonnes/year
		$N_{Trans,Coal}$	Number of handling, transfer points	4	-
	Emission factor	$U_{Trans,Coal}$	Average wind speed	2.24	m/s
		$M_{Trans,Coal}$	Moisture content of coal	6	%
Screening	Intensity	$w_{Screen,Coal}$	Amount Coal screened	1021578	tonnes/year
Crushing	Intensity	$w_{Crush,Coal}$	Amount Coal Crushed	1021578	tonnes/year
Bulldozing on ROM stockpiles	Intensity	$N_{Dozer,Coal}$	Number of dozers working on stockpiles	1	-
		$T_{Dozer,Coal}$	Time spent by each dozer on stockpiles	150	hours/year
	Emission factor	$s_{Dozer,Coal}$	Silt content of coal	5	%
		$M_{Dozer,Coal}$	Moisture content of coal	6	%
Bulldozing on product stockpiles	Intensity	$N_{Dozer,Coal}$	Number of dozers working on stockpiles	1	-
		$T_{Dozer,Coal}$	Time spent by each dozer on stockpiles	150	hours/year
	Emission factor	$s_{Dozer,Coal}$	Silt content of coal	5	%
		$M_{Dozer,Coal}$	Moisture content of coal	6	%

4. WIND EROSION

Activity	Calculation	Variable	Variable description	Value	Units
Exposed areas, including overburden dumps	Intensity	$a_{Expos.,Wind}$	Surface area	150	ha
Active coal stockpiles	Intensity	$a_{Active,Wind}$	Surface area	5	ha
	Emission factor	$s_{Active,Wind}$	Silt content	5	%
		$p_{Active,Wind}$	No. of days with rainfall > 0.25 mm	93	days
		$f_{Active,Wind}$	% of time with wind speed > 5.4 m/s		%

5. ROAD GRADING

Activity	Calculation	Variable	Variable description	Value	Units
Road grading	Intensity	N_{Grade}	Number of graders employed at site	3	-
		T_{Grade}	Utilisation Rate (or hours of operation)	3774.45	%
	Emission factor	S_{Grade}	Mean vehicle speed	8	km/h

6. REHABILITATION

Activity	Calculation	Variable	Variable description	Value	Units
Bulldozing on rehab	Intensity	$N_{Dozer,Rehab}$	Number of dozers working on rehab	4	-
		$T_{Dozer,Rehab}$	Time spent by each dozer on rehab	50.2	hours/year
		$A_{Dozer,Rehab}$	Area of active rehab	5	ha
	Emission factor	$s_{Dozer,Rehab}$	Silt content	10	%
		$M_{Dozer,Rehab}$	Moisture content	2	%

APPENDIX C: COSTING

MINING ACTVITY	**Hauling on unsealed roads**											
Specific best practice measure	Use of Larger Trucks (140t - 220t) (20%)											
Mass emissions through application of best practice (tonnes/year)	TSP	222.6										
	PM10	51.7										
	PM2.5	12.7										
Current emissions (tonnes/year) - current control 75%	TSP	278.3										
	PM10	64.6										
	PM2.5	15.9										
Total emission reduction from use of best practice measure (tonnes/year)	TSP	56										
	PM10	13										
	PM2.5	3										
Year		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Cost specific capital items (list each item)	Cat 793 x 7 - Assuming current 785's are replaced with 793's and 777's are replaced with surplus 785's.	$ 28,000,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 28,000,000**
			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
	Total capital costs	**$ 28,000,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 28,000,000**
Labour costs including directly related on-costs (list each item)	parts x 4	$ 911,953	$ 911,953	$ 911,953	$ 911,953	$ 911,953	$ 911,953	$ 911,953	$ 911,953	$ 911,953	$ 911,953	**$ 9,119,530**
	body repair x 4	$ 606,305	$ 606,305	$ 606,305	$ 606,305	$ 606,305	$ 606,305	$ 606,305	$ 606,305	$ 606,305	$ 606,305	**$ 6,063,050**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Cost of specific materials and other items (list each item)	tyres x 4	$ 1,426,600	$ 1,426,600	$ 1,426,600	$ 1,426,600	$ 1,426,600	$ 1,426,600	$ 1,426,600	$ 1,426,600	$ 1,426,600	$ 1,426,600	**$ 14,266,000**
	fuel x 4	$ 8,217,216	$ 8,217,216	$ 8,217,216	$ 8,217,216	$ 8,217,216	$ 8,217,216	$ 8,217,216	$ 8,217,216	$ 8,217,216	$ 8,217,216	**$ 82,172,160**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
	Total material and other costs	**$ 11,162,074**	**$ 11,162,074**	**$ 11,162,074**	**$ 11,162,074**	**$ 11,162,074**	**$ 11,162,074**	**$ 11,162,074**	**$ 11,162,074**	**$ 11,162,074**	**$ 11,162,074**	**$ 111,620,740**
	Total costs	**$ 39,162,074**	**$ 11,162,074**	**$ 11,162,074**	**$ 11,162,074**	**$ 11,162,074**	**$ 11,162,074**	**$ 11,162,074**	**$ 11,162,074**	**$ 11,162,074**	**$ 11,162,074**	**$ 139,620,740**
Estimate additional cost per tonne of particulate matter suppressed from TSP, PM10 and PM2.5*	TSP	$ 703,595	$ 200,540	$ 200,540	$ 200,540	$ 200,540	$ 200,540	$ 200,540	$ 200,540	$ 200,540	$ 200,540	**$ 2,508,457**
	PM10	$ 3,031,120	$ 863,938	$ 863,938	$ 863,938	$ 863,938	$ 863,938	$ 863,938	$ 863,938	$ 863,938	$ 863,938	**$ 10,806,559**
	PM2.5	$ 12,315,118	$ 3,510,086	$ 3,510,086	$ 3,510,086	$ 3,510,086	$ 3,510,086	$ 3,510,086	$ 3,510,086	$ 3,510,086	$ 3,510,086	**$ 43,905,893**
Cost saving from implementing each best practice measure (list each item)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
	Total savings	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Net costs	**$ 39,162,074**	**$ 11,162,074**	**$ 11,162,074**	**$ 11,162,074**	**$ 11,162,074**	**$ 11,162,074**	**$ 11,162,074**	**$ 11,162,074**	**$ 11,162,074**	**$ 11,162,074**	**$ 139,620,740**
Estimate net cost per tonne of particulate matter suppressed for TSP, PM10 and PM2.5 *	TSP	$ 703,595	$ 200,540	$ 200,540	$ 200,540	$ 200,540	$ 200,540	$ 200,540	$ 200,540	$ 200,540	$ 200,540	$ 2,508,457
	PM10	$ 3,031,120	$ 863,938	$ 863,938	$ 863,938	$ 863,938	$ 863,938	$ 863,938	$ 863,938	$ 863,938	$ 863,938	$ 10,806,559
	PM2.5	$ 12,315,118	$ 3,510,086	$ 3,510,086	$ 3,510,086	$ 3,510,086	$ 3,510,086	$ 3,510,086	$ 3,510,086	$ 3,510,086	$ 3,510,086	$ 43,905,893

MINING ACTVITY	Loading and dumping ROM coal											
Specific best practice measure	Enclosed Dump Hopper (3 sides and a roof) (70%)											
Mass emissions through application of best practice (tonnes/year)	TSP	21.3										
	PM10	2.8										
	PM2.5	0.4										
Current emissions (tonnes/year) - current control 50%	TSP	71.0										
	PM10	9.3										
	PM2.5	1.3										
Total emission reduction from use of best practice measure (tonnes/year)	TSP	50										
	PM10	7										
	PM2.5	1										
Year		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Cost specific capital items (list each item)		$ 250,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 250,000**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Total capital costs		**$ 250,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 250,000**
Labour costs including directly related on-costs (list each item)		$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	**$ 50,000**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Cost of specific materials and other items (list each item)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Total material and other costs		**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 50,000**
Total costs		**$ 255,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 300,000**
Estimate additional cost per tonne of particulate matter suppressed from TSP, PM10 and PM2.5*	TSP	$ 5,131	$ 101	$ 101	$ 101	$ 101	$ 101	$ 101	$ 101	$ 101	$ 101	**$ 6,036**
	PM10	$ 39,171	$ 768	$ 768	$ 768	$ 768	$ 768	$ 768	$ 768	$ 768	$ 768	**$ 46,083**
	PM2.5	$ 280,220	$ 5,495	$ 5,495	$ 5,495	$ 5,495	$ 5,495	$ 5,495	$ 5,495	$ 5,495	$ 5,495	**$ 329,670**
Cost saving from implementing each best practice measure (list each item)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Total savings		**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Net costs		**$ 255,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 5,000**	**$ 300,000**
Estimate net cost per tonne of particulate matter suppressed for TSP, PM10 and PM2.5 *	TSP	$ 5,131	$ 101	$ 101	$ 101	$ 101	$ 101	$ 101	$ 101	$ 101	$ 101	$ 6,036
	PM10	$ 39,171	$ 768	$ 768	$ 768	$ 768	$ 768	$ 768	$ 768	$ 768	$ 768	$ 46,083
	PM2.5	$ 280,220	$ 5,495	$ 5,495	$ 5,495	$ 5,495	$ 5,495	$ 5,495	$ 5,495	$ 5,495	$ 5,495	$ 329,670

MINING ACTVITY	Wind Erosion - Coal Stockpiles											
Specific best practice measure	Water Sprays (50%)											
Mass emissions through application of best practice (tonnes/year)	TSP	3.00										
	PM10	1.10										
	PM2.5	0.15										
Current emissions (tonnes/year) - current control 0%	TSP	6.00										
	PM10	2.20										
	PM2.5	0.30										
Total emission reduction from use of best practice measure (tonnes/year)	TSP	3										
	PM10	1										
	PM2.5	0										
Year		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Cost specific capital items (list each item)	pipe from pit water dam, sprinklers with stands, generator, high pressure pump etc. incl. Installation	$ 2,000,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 2,000,000**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
	Total capital costs	**$2,000,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 2,000,000**
Labour costs including directly related on-costs (list each item)	Maintence and operating costs including fuel	$ 230,000	$ 230,000	$ 230,000	$ 230,000	$ 230,000	$ 230,000	$ 230,000	$ 230,000	$ 230,000	$ 230,000	**$ 2,300,000**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Cost of specific materials and other items (list each item)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
	Total material and other costs	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 2,300,000**
	Total costs	**$2,230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 4,300,000**
Estimate additional cost per tonne of particulate matter suppressed from TSP, PM10 and PM2.5*	TSP	$ 743,333	$ 76,667	$ 76,667	$ 76,667	$ 76,667	$ 76,667	$ 76,667	$ 76,667	$ 76,667	$ 76,667	**$ 1,433,333**
	PM10	$ 2,027,273	$ 209,091	$ 209,091	$ 209,091	$ 209,091	$ 209,091	$ 209,091	$ 209,091	$ 209,091	$ 209,091	**$ 3,909,091**
	PM2.5	$14,866,667	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 1,533,333	**$ 28,666,667**
Cost saving from implementing each best practice measure (list each item)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
	Total savings	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Net costs	**$2,230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 230,000**	**$ 4,300,000**
Estimate net cost per tonne of particulate matter suppressed for TSP, PM10 and PM2.5 *	TSP	$ 743,333	$ 76,667	$ 76,667	$ 76,667	$ 76,667	$ 76,667	$ 76,667	$ 76,667	$ 76,667	$ 76,667	$ 1,433,333
	PM10	$ 2,027,273	$ 209,091	$ 209,091	$ 209,091	$ 209,091	$ 209,091	$ 209,091	$ 209,091	$ 209,091	$ 209,091	$ 3,909,091
	PM2.5	$14,866,667	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 1,533,333	$ 28,666,667

MINING ACTVITY	Conveyors and Transfers											
Specific best practice measure	Wind Shielding - roof and wall (70%)											
Mass emissions through application of best practice (tonnes/year)	TSP	0										
	PM10	0										
	PM2.5	0										
Current emissions (tonnes/year) - current control 40%	TSP	0										
	PM10	0										
	PM2.5	0										
Total emission reduction from use of best practice measure (tonnes/year)	TSP	0										
	PM10	0										
	PM2.5	0										
Year		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Cost specific capital items (list each item)	Engineers investigation and drawings	$ 20,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 20,000**
	Hire of equipment eg. EWP's	$ 20,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 20,000**
	Supply materials and install	$ 200,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 200,000**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
	Total capital costs	**$ 240,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 240,000**
Labour costs including directly related on-costs (list each item)	Maintenance	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	**$ 20,000**
	Operational access to conveyor	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	**$ 350,000**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Cost of specific materials and other items (list each item)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
	Total material and other costs	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 370,000**
	Total costs	**$ 277,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 610,000**
Estimate additional cost per tonne of particulate matter suppressed from TSP, PM10 and PM2.5*	TSP	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	**#DIV/0!**
	PM10	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	**#DIV/0!**
	PM2.5	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	**#DIV/0!**
Cost saving from implementing each best practice measure (list each item)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
	Total savings	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Net costs	**$ 277,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 610,000**
Estimate net cost per tonne of particulate matter suppressed for TSP, PM10 and PM2.5 *	TSP	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	PM10	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	PM2.5	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Wind erosion from surfaces of the conveyors not estimated as not considered a significant source.