REPORT

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

Whitehaven Coal Pty Ltd

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1 INTRODUCTION

The Sunnyside Coal Mine is an open-cut mine owned by Namoi Mining Pty Ltd. and operated by Whitehaven Coal Mining Pty Ltd. The mine is located in the Gunnedah basin, approximately 15 km west of Gunnedah, 2 km north of the Oxley Highway in Northern NSW.

The mine commenced operation in 2009 and is currently licensed to extract up to 1 million tonnes per annum (Mtpa) of ROM coal. The Sunnyside operation will have exhausted existing coal reserves within the next 2 years.

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 3.1**
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** and **Section 3.2**
	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 Operations at Sunnyside

Mining operations are conducted between 7:00am to 10:00pm each Monday to Friday and 7:00am to 6:00pm on Saturdays. No mining occurs on Sundays or public holidays.

All mining during the reporting period was undertaken by open cut methods using the techniques identified in the Mine Operations Plan (MOP), namely:

- Topsoil and subsoil removal by open bowl scraper;
- Friable overburden removal by scraper;
- Drilling and blasting the underlying competent overburden;
- Overburden (and interburden) removal by bulldozers and/or excavator and dump trucks, with the overburden placed in waste emplacements.
- Coal extraction by excavator loading into haul trucks for transport to the ROM stockpile.

With the exception of coal crushing to <150 mm, no coal processing is undertaken at Sunnyside with ROM coal 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 Sunnyside Coal Mine (SCM) 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, 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 Sunnyside 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 to ROM pad / hopper	Yes
	Re-handle of ROM	Yes
	Hauling ROM coal	Yes
	Coal transfer operations[(a)]	Yes
	Screening	Yes
	Crushing	Yes
	Bulldozing on ROM stockpiles	Yes
	Bulldozing on product stockpiles	Yes
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 2011 at the SCM.

Emission estimates have been made with no particulate matter controls in place (uncontrolled -**Table 2.1**).

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

PRP activity	TSP	PM_{10}	$PM_{2.5}$
Blasting	1.6	0.8	0.05
Bulldozers on Coal	24.5	7.5	0.54
Bulldozers on OB	164.5	39.7	17.28
Coal crushing	0.8	0.4	0.00
Coal Screening	3.9	2.7	0.09
Drilling	1.5	0.8	0.04
Graders	11.5	4.0	0.36
Hauling on Unsealed Roads	1,942.6	524.3	52.43
Material Transfer Coal	0.2	0.1	0.01
Material Transfer OB	21.0	0.0	0.00
Trucks Loading & Unloading OB	46.8	22.1	3.35
Trucks Loading and Unloading coal	89.7	13.4	1.70
Wind Erosion & Maintenance - Stockpiles	37.2	18.6	2.79
Wind Erosion Exposed Areas / Dumps	52.4	26.2	3.93
Grand Total	**2,398.2**	**660.7**	**82.58**

2.2 Estimated Emissions – Existing Controls

Emissions were then recalculated taking into account various control factors for the dust controls that Sunnyside mine have in place. These controls, as well as the control factor applied, are listed in **Table 2.2**. The control factors adopted are the default values contained within the Best Practice Report (**Donnelly et al., 2011**).

Table 2.2 Summary of Existing Air Quality Controls

PRP Activity Category	Existing Control	EPA level of control (%)	Control applied (%)
Hauling on Unsealed Roads	Water carts on all trafficked areas	75	75
Wind Erosion on OB area	Minimise pre-strip (reduction applies to area avoided).	100	0
	Rehabilitation goals	99	
	Progressive Rehabilitation (vegetative ground-cover)	70	
	In pit dumping	30-80	
Loading and unloading overburden	Minimise excavator drop height	-	0
	Truck or loader drop height limited to 20 m instead of 40 m.	30	
Dozers on OB	Bulldozers on OB locked in 2nd gear to minimise travel speed	-	0
Drilling	Water injection on all drill rigs	3-96	50
	Dust curtains in use	-	
Blasting	Delay shot to avoid unfavourable weather conditions	-	0
Crushing	Crusher enclosed	-	50
	Watering	50	
Material Transfer of Coal	Water sprays on at transfer points	50	50
	Scrapers used on conveyors	-	
	Crusher enclosed	-	
Wind Erosion – stockpiles	Coal 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)	30	0
Grading roads	Graders average 7.5 km/h	75	0
Topsoil removal and emplacement	Scrapers are used to strip and emplace topsoil, hence no haulage of topsoil	-	0

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

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

PRP activity	TSP	PM_{10}	$PM_{2.5}$
Blasting	1.6	0.8	0.05
Bulldozers on Coal	24.4	7.5	0.50
Bulldozers on OB	164.5	39.7	17.28
Coal crushing	0.4	0.2	0.00
Coal Screening	3.9	2.7	0.09
Drilling	0.4	0.8	0.01
Graders	11.5	4.0	0.36
Hauling on Unsealed Roads	485.6	131.1	13.11
Material Transfer Coal	0.1	0.0	0.01
Material Transfer OB	21.0	0.0	0.00
Trucks Loading & Unloading OB	46.8	22.1	3.35
Trucks Loading and Unloading coal	89.7	13.4	1.70
Wind Erosion & Maintenance - Stockpiles	37.1	13.0	1.95
Wind Erosion Exposed Areas / Dumps	52.4	26.2	3.93
Grand Total	**939.6**	**261.7**	**42.35**

2.3 Activities Rank – 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;
- Bulldozers on Overburden;
- Loading and Unloading Coal;
- Wind Erosion on exposed areas; and
- Trucks loading and unloading overburden

Table 2.4: Activity rank of the estimated controlled emissions by mass

Rank	Mine activity	(tonnes/yr)
TSP		
1	**Hauling on Unsealed Roads**	**485.6**
2	**Bulldozers on OB**	**164.5**
3	**Trucks Loading and Unloading coal**	**89.7**
4	**Wind Erosion Exposed Areas / Dumps**	**52.4**
5	Trucks Loading & Unloading OB	46.8
6	Wind Erosion & Maintenance - Stockpiles	37.1
7	Bulldozers on Coal	24.4
8	Material Transfer OB	21.0
9	Graders	11.5
10	Coal Screening	3.9
11	Blasting	1.6
12	Drilling	0.4
13	Coal crushing	0.4
14	Material Transfer Coal	0.1
PM_{10}		
1	**Hauling on Unsealed Roads**	**131.1**
2	**Bulldozers on OB**	**39.7**
3	**Wind Erosion Exposed Areas / Dumps**	**26.2**
4	**Trucks Loading & Unloading OB**	**22.1**
5	Trucks Loading and Unloading coal	13.4
6	Wind Erosion & Maintenance - Stockpiles	13.0
7	Bulldozers on Coal	7.5
8	Graders	4.0
9	Coal Screening	2.7
10	Blasting	0.8
11	Drilling	0.8
12	Coal crushing	0.2
13	Material Transfer Coal	0.0
14	Material Transfer OB	0.0
$PM_{2.5}$		
1	**Bulldozers on OB**	**17.28**
2	**Hauling on Unsealed Roads**	**13.11**
3	**Wind Erosion Exposed Areas / Dumps**	**3.93**
4	**Trucks Loading & Unloading OB**	**3.35**
5	Wind Erosion & Maintenance - Stockpiles	1.95
6	Trucks Loading and Unloading coal	1.70
7	Bulldozers on Coal	0.50
8	Graders	0.36
9	Coal Screening	0.09
10	Blasting	0.05
11	Drilling	0.01
12	Material Transfer Coal	0.01
13	Material Transfer OB	0.00
14	Coal crushing	0.00

3 PRACTICABILITY OF IMPLEMENTING ADDITIONAL BEST PRACTICE MEASURES

Based on the information presented in **Section 2** it is clear that Sunnyside already has a number of PM-control measures in place. With current controls, emissions of TSP, PM_{10} and $PM_{2.5}$ are all approximately 40% to 50% 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 **Table 3.1** (haul roads), **Table 3.2** (bulldozers on overburden), **Table 3.3** (loading and unloading coal), **Table 3.4** (wind erosion on overburden), and **Table 3.5** (loading and unloading overburden).

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

It is important to note that the values presented assume the controls as presented in **Table 2.2**.

It is noted that for many of the top-ranking site activities existing controls are in place. 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. The remaining (lower ranking activities) have also been evaluated and are included in **Table 3.6**.

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

Best Practice Control		% control per OEH	Practicality Evaluation						Comments	Potential reduction in dust emission (t/y) after BPM			Potential reduction in dust emission as % of total site dust emission (current controls)		
			Current Use	Regulatory	Environmental	Safety	Compatibility	Practicable Y/N		TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
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 Mgmt Plan approved by DRE and not easily changed	194.1-363.9	52.4-98.2	5.2- 9.8	22%	20%	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	242.6-412.4	65.5-111.3	6.5- 11.1	28%	25%	8%
Surface improvements	Pave the surface	>90%	N	Y	Y	Y	N	N	Impractical to pave temporary haul roads	291.1	78.6	7.9	33%	30%	9%
	Low silt aggregate	30%	N	Y	Y	Y	N	N	Silt content determined by in-situ material - not easily changed	145.6	39.3	3.9	17%	15%	5%
	Oil and double chip surface	80%	N	N	N	N	N	N	Potential for environmental damage (spill)	97.0	26.2	2.6	11%	10%	3%
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			N			Measured at level 1. Level 2 watering is not practical as it makes the haul roads too slippery.	0.0	0.0	0.0	0%	0%	0%
	Watering grader routes	50%	N	Y	Y	Y	N	N	Not practical for road construction - better to water after road surface has been disturbed	242.6	65.5	6.5	28%	25%	8%
	Watering twice a day for industrial unpaved road	55%	Y						Roads are watered once per hour	-	-	-	-	-	-
	Suppressants	84%(d)	N						Not cost effective for scale of operation	407.6	110.0	11.0	47%	42%	13%

Best Practice Control		% control per OEH	Practicality Evaluation						Comments	Potential reduction in dust emission (t/y) after BPM			Potential reduction in dust emission as % of total site dust emission (current controls)		
			Current Use	Regulatory	Environmental	Safety	Compatibility	Practicable Y/N		TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
	Hygroscopic salts	45%-82%(e)	N	Y			N	N	Not cost effective for scale of operation	218.4-397.9	58.9-107.4	5.9- 10.7	25%	23%	7%
	Lignosulphonates	66-70% (over 23 days)	N	Y			N	N	Not cost effective for scale of operation	320.3-339.7	86.5-91.7	8.6- 9.2	37%	33%	10%
	Polymer emulsions	70% over 58 days	N	Y			N	N	Not cost effective for scale of operation	339.7	91.7	9.2	39%	35%	11%
	Tar and bitumen emulsions	70% over 20 days	N	Y			N	N	Not cost effective for scale of operation	339.7	91.7	9.2	39%	35%	11%
	Sealed or salt-encrusted	-	N	Y			N	N	Not cost effective for scale of operation	0.0	0.0	0.0	0%	0%	0%
Other	Use of larger vehicles	90t to 220t: 40%	N	Y	Y	Y	N	N	Trucks already 140t	194.1	52.4	5.2	22%	20%	6%
		140t to 220t; 20%	N	Y	Y	Y	N	N	Not cost effective at this point in operation	97.0	26.2	2.6	11%	10%	3%
		140t to 360t: 45%	N	Y	Y	Y	N	N	Not cost effective at this point in operation	218.4	58.9	5.9	25%	23%	7%
		100 t to 149 t	N	Y	Y	Y	N	N	Not cost effective at this point in operation	101.9	27.5	2.8	12%	11%	3%
	Conveyors	>95%	N	N	Y	Y	N	N	Capital costs - not approved - energy consumption (no access to power grid)	388.2	104.8	10.5	44%	40%	12%

Table 3.2: BPM to reduce particulate matter emissions from bulldozers on overburden

		Practicality Evaluation							Potential reduction in dust emission (t/y)			Potential reduction in dust emission as % of total site dust emission (current controls)		
Best Practice Control	% control per OEH	Current Use	Regulatory	Environmental	Safety	Compatibility	Practicable Y/N	Comments	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
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	79.3	19.2	8.3	9%	7%	10%

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

Best Practice Control		% control per OEH	Practicality Evaluation: Current Use	Regulatory	Environmental	Safety	Compatibility	Practicable Y/N	Comments	Potential reduction in dust emission (t/y) after BPM: TSP	PM10	PM2.5	Potential reduction in dust emission as % of total site dust emission (current controls): TSP	PM10	PM2.5
Avoidance	Bypass ROM stockpiles	50%	N	Y	Y	Y	N	N	Not possible	9.7	4.7	1.0	1%	2%	1%
		100%	N	Y	Y	Y	N	N	Not possible	75.3	13.5	1.9	9%	5%	2%
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	37.6	6.7	1.0	4%	3%	1%
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%	N	Y	Y	Y	Y	Y	3 sides on hopper - but not a roof - cost implications and practicality of a roof.	35.9	8.2	1.4	4%	3%	2%
	Enclosed dump hopper (3 sides and a roof) plus water sprays	85%	N	Y	Y	N	N	N	3 sides on hopper - but not a roof - cost implications and practicality of a roof.	55.6	10.9	1.6	6%	4%	2%
	Enclosure with control device	90-98%	N	Y	Y	N	N	N	3 sides on hopper - but not a roof - cost implications and practicality of a roof.	62.2	11.7	1.7	7%	5%	2%

Table 3.4: BPM to reduce particulate matter emissions from wind erosion of overburden dumps

Best Practice Control		% control per OEH	Practicality Evaluation: Current Use	Regulatory	Environmental	Safety	Compatibility	Practicable Y/N	Comments	Potential reduction in dust emission (t/y) after BPM: TSP	PM_{10}	$PM_{2.5}$	Potential reduction in dust emission as % of total site dust emission (current controls): TSP	PM_{10}	$PM_{2.5}$
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.	26.2	13.1	2.0	3%	5%	2%
	Chemical suppressants	70-84%	N	Y	Y	Y	N	N	Depends on water availability. Safety implications of slumping of emplacements.	36.7- 44.0	18.3-22.0	2.8-3.3	4%	7%	3%
	Paving and cleaning	>95%	N	Y	Y	Y	N	N	Not practical to pave exposed areas	49.8	24.9	3.7	6%	10%	4%
	Application of gravel to stabilise disturbed open areas	84%	N	Y	Y	?	N	N	Additional disturbance to win the gravel - cost and impractical	44.0	22.0	3.3	5%	9%	4%
	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.	-	-	-	-	-	-
	Primary rehabilitation	-	Y	Y	Y	Y	Y	Y	Seeded to cover as soon as practicable once reshaped to grade.	-	-	-	-	-	-

Table 3.5: BPM to reduce particulate matter emissions from loading and unloading overburden

			Practicality Evaluation							Potential reduction in dust emission (t/y) after BPM			Potential reduction in dust emission as % of total site dust emission (current controls)		
ACTIVITY	Best Practice Control	% control per OEH	Current Use	Regulatory	Environmental	Safety	Compatibility	Practicable Y/N	Comments	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Minimising drop height (trucks)	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	11.7	5.5	0.8	1%	2%	1%
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.	-	-	-	-	-	-
Minimising drop height (Excavator)	Reduce from 3m to 1.5m	30%	Y	Y	Y	Y	Y	Y	Implement best practice Excavator drop heights and included in training manual - have external trainer	-	-	-	-	-	-

Table 3.6: BPM to reduce particulate matter emissions from remaining activities

				Practicality Evaluation							Potential reduction in dust emission (t/y) after BPM			Potential reduction in dust emission as % of total site dust emission (current controls)		
ACTIVITY	Best Practice Control		% control per OEH	Current Use	Regulatory	Environmental	Safety	Compatibility	Practicable Y/N	Comments	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Blasting	Design: delay shot to avoid unfavourable weather conditions		Not quantified	Y	Y	Y	Y	Y	Y	Current practice	-	-	-	-	-	-
	Design: minimise area blasted		Not quantified	N	Y	Y	N	N	N	Not always practical for safety and operational reasons	-	-	-	-	-	-
Graders	Grader speed reduction from 16km/hr to 8 km/hr		75%	Y						Grader currently operate 8km/hr	-	-	-	-	-	-
Scrapers on topsoil	Soil naturally or artificially moist		-	Y							-	-	-	-	-	-
Drilling	Wet	Water injection sprays while drilling	3-96% NIOSH document	Y	Y	Y	Y	Y	Y	All rigs use water injection	-	-	-	-	-	-
	Dry collecti on	Fabric filters	99	N	N	N	N	N	N		0.4	0.8	0.0	0%	0%	0%
		Cyclone	80-90	N	N	N	N	N	N		0.1	0.6	0.0	0%	0%	0%

			Practicality Evaluation							Potential reduction in dust emission (t/y) after BPM			Potential reduction in dust emission as % of total site dust emission (current controls)		
ACTIVITY	Best Practice Control	% control per OEH	Current Use	Regulatory	Environmental	Safety	Compatibility	Practicable Y/N	Comments	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Conveyors	Application of water at transfers	50%	Y	Y	Y	Y	Y	Y	Current practice	-	-	-	-	-	-
	Wind shielding - roof or side wall	40%	Y	Y	Y	Y	Y	Y	Current practice	-	-	-	-	-	-
	Wind shielding - roof AND side wall	70%	N	Y	Y	Y	Y	Y	BPM Costed	35.9	8.2	1.4	4%	3%	2%
	Belt cleaning and spillage minimisation	Not quantified	Y	Y	Y	Y	Y	Y	In place and operating - belts have scrapers in place	-	-	-	-	-	-
Transfers	Enclosure	70%	Y	Y	Y	Y	Y	Y	At top of bin and crusher output	35.9	8.2	1.4	4%	3%	2%
	Enclosure and fabric filters	-	N	Y	Y	Y	N	N	Not practical	-	-	-	-	-	-

Best Practice Control		% control per OEH	Practicality Evaluation: Current Use	Regulatory	Environmental	Safety	Compatibility	Practicable Y/N	Comments	Potential reduction in dust emission (t/y) after BPM: TSP	PM_{10}	$PM_{2.5}$	Potential reduction in dust emission as % of total site dust emission (current controls): TSP	PM_{10}	$PM_{2.5}$
Wind Erosion and Maintenance – Coal Stockpiles															
Avoidance	Bypassing stockpiles	100%	N	Y	Y	Y	N	N	Not possible	37.1	13.0	2.0	4%	5%	2%
Surface stabilisation	Water sprays	50%	Y	Y	Y	Y	Y	Y	Sprays on conveyors and bins. Fixed sprays costed	-	-	-	-	-	-
	Chemical wetting agents	80-99%	N	Y	Y	Y	Y	N	Not necessary	29.7	9.3	1.4	3%	4%	2%
	Surface crusting agent	95%	N	Y	Y	Y	Y	N	Stockpile residence time is very short - so impractical to apply	35.2	12.1	1.8	4%	5%	2%
	Carry over wetting from load in	80%	N	Y	Y	Y	Y	N	Not practical	29.7	9.3	1.4	3%	4%	2%
Enclosure	Silo with bag house	95-100%	Y	Y	Y	Y	Y	Y	Bins enclosed	-	-	-	-	-	-
	Cover storage pile with a tarp during high winds	99%	N	Y	Y	N	N	N	Not practical	36.7	12.8	1.9	4%	5%	2%
Wind speed reduction	Vegetative windbreaks	30%	N	Y	Y	N	N	N	Safety risk with equipment near trees etc	11.1	0.0	0.0	1%	0%	0%
	Reduced pile height	30%	Y	Y	Y	Y	Y	Y	Stockpile height limited due to constant load out from site	11.1	0.0	0.0	1%	0%	0%
	Wind screens/fences	75->80%	N	Y	Y	N	N	N	Safety risk	27.8	8.4	1.3	3%	3%	1%
	Pile shaping/orientation	<60%	N	Y	Y	Y	N	N	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	27.8	8.4	1.3	3%	3%	1%

3.1 Estimated Emissions for Practical BPM

Table 3.7 summarises the additional BPM identified as practicable (not accounting for cost) for mining activities at Sunnyside. The dust emissions after implementing the BPM are presented and the potential reduction of emissions as a percentage of the total emissions. Calculations indicate that the greatest potential reductions in emissions are achieved through the use of larger vehicles for hauling. Further consideration of costs is provided in **Section 3.2**.

Table 3.7: 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}	$PM_{2.5}$
Hauling on unsealed roads [1]	Use of larger trucks	388.2	104.8	10.5	10.5%	10.1%	5.8%
Wind Erosion and Maintenance – Stockpiles [2]	Water sprays on stockpiles	18.55	6.51	0.98	2.0%	2.5%	2.2%
Conveyors [3]	Shielding – roof and side wall						

Note: [1]Control efficiency of 20% assumed. [2]Emissions reductions are calculated for wind erosion on stockpiles plus dozers operating on stockpiles. [3]Wind erosion from surfaces of the conveyors not estimated as not considered a significant source.

3.2 Implementation Cost Evaluation

For all measures identified in **Table 3.7**, an additional cost evaluation was completed and summarised below. Full details provided in **Appendix C**.

- 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 \$520,000/tonne-PM_{10} in the first year, \$213,000/tonne-PM_{10} annually thereafter and a total of \$2.4 million/tonne-PM_{10} over 10 years.
- 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 \$342,000/tonne-PM_{10} in the first year, \$35,000/tonne-PM_{10} annually thereafter and a total of \$660,000/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 \$24,000/tonne-PM_{10} in the first year, \$4,000/tonne-PM_{10} annually thereafter and \$60,000/tonne-PM_{10} 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.

4 IMPLEMENTATION OF ADDITIONAL BPM

The remaining mine life for the Sunnyside Coal Mine is 2 years. The installation of additional BPM would have minimal benefit in reducing PM emissions and therefore not additional BPM are recommended for implementation.

4.1 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. Key recommendations from the workshop included using site specific data in deriving PM emissions estimates for the PRP and ongoing monitoring and reporting on the effectiveness of controls.

Given that the Sunnyside Coal Mine will be exhausted within 2 years, the implementation of additional monitoring and reporting requirements is not expected to provide any additional benefit in terms of reducing PM emissions or tracking performance of existing controls.

5 REFERENCES

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APPENDIX A: EMISSION FACTOR EQUATIONS

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	Activity 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	Activity 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	2	-
		$A_{Scrape,Veg}$	Area stripped	16.93	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	2	-
		$W_{Strip,Topsoil}$	Amount of material stripped	72,140	tonnes/year
OR Stripping with bulldozers/excavators	Intensity	$N_{Strip,Topsoil}$	Number of dozers stripping topsoil	0	-
		$T_{Strip,Topsoil}$	Time spent by each dozer on topsoil	0	hours/year
	Emission factor	$s_{Strip,Topsoil}$	Silt content of topsoil	10	%
		$M_{Strip,Topsoil}$	Moisture content of topsoil	2.5	%
Loading and emplacing	Intensity	$w_{Load,Topsoil}$	Amount topsoil handled	89,316	tonnes/year
	Emission factor	$U_{Load,Topsoil}$	Average wind speed	2	m/s
		$M_{Load,Topsoil}$	Moisture content of topsoil	2.5	%
Hauling topsoil	Intensity	$w_{Haul,Topsoil}$	Amount topsoil handled	89,316	tonnes/year
	Emission factor	$wt_{Haul,Topsoil}$	Weight per trip (vehicle payload)	34	tonnes
		$L_{Haul,Topsoil}$	Length of return trip	1.2	km
		$W_{Haul,Topsoil}$	Mean gross vehicle weight for hauling topsoil	86	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	2,480	holes/year
Blasting	Intensity	$N_{Blast,OB}$	Number of blasts per year	15	blasts/year
	Emission factor	$A_{Blast,OB}$	Area per blast	6,145	m^2/blast
Draglines	Intensity	$V_{Drag,OB}$	Volume of material	0	m^3
	Emission factor	$d_{Drag,OB}$	Drop distance	0	m
		$M_{Drag,OB}$	Moisture content of overburden	2	%
Loading and emplacing	Intensity	$w_{Load,OB}$	Overburden amount handled	10,157,388	BCM/year
		$d_{Load,OB}$	Density of overburden	2.2	t/m^3
	Emission factor	$U_{Load,OB}$	Average wind speed	2	m/s
		$M_{Load,OB}$	Moisture content of overburden	2	%
Hauling OB	Intensity	$w_{Haul,OB}$	Overburden amount hauled	10,157,388	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	1.9	km
		$W_{Haul,OB}$	Gross vehicle weight	246	tonnes
		$s_{Haul,OB}$	Silt content of haul road	6.4	%
Bulldozing	Intensity	$N_{Dozer,OB}$	Number of bulldozers working on overburden	2	-
		$T_{Dozer,OB}$	Time spent by each bulldozer on overburden	4,737.70	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	1,429.10	hours/year
	Emission factor	$s_{Dozer,Coal}$	Silt content of coal	6.2	%
		$M_{Dozer,Coal}$	Moisture content of coal	9	%
Drilling	Intensity	$N_{Drill,Coal}$	Number of holes drilled per year	0	holes/year
Blasting	Intensity	$N_{Blast,Coal}$	Number of blasts per year	15	blasts/year
	Emission factor	$A_{Blast,Coal}$	Area per blast	0	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	1,080,395	tonnes/year
	Emission factor	$M_{Load,Coal}$	Moisture content of coal	9	%
Hauling Coal	Intensity	$w_{Haul,Coal}$	Coal amount hauled	1,080,395	tonnes/year
	Emission factor	$wt_{Haul,Coal}$	Weight per trip (vehicle payload)	50	tonnes
		$L_{Haul,Coal}$	Length of return trip	2.2	km
		$W_{Haul,Coal}$	Gross vehicle weight	120	tonnes
		$s_{Haul,Coal}$	Silt content of ROM coal	6.2	%
All material transfer operations (*e.g.* coal > ROM stockpile from conveyor, coal from ROM hopper to conveyor,	Intensity	$w_{Trans,Coal}$	Weight handled/transferred	313,909	tonnes/year
		$N_{Trans,Coal}$	Number of handling, transfer points	4	-
	Emission factor	$U_{Trans,Coal}$	Average wind speed	2	m/s
		$M_{Trans,Coal}$	Moisture content of coal	9	%
Screening	Intensity	$w_{Screen,Coal}$	Amount Coal screened	313,909	tonnes/year
Crushing	Intensity	$w_{Crush,Coal}$	Amount Coal Crushed	313,909	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	238.1	hours/year
	Emission factor	$s_{Dozer,Coal}$	Silt content of coal	6.2	%
		$M_{Dozer,Coal}$	Moisture content of coal	9	%
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	238.1	hours/year
	Emission factor	$s_{Dozer,Coal}$	Silt content of coal	6.2	%
		$M_{Dozer,Coal}$	Moisture content of coal	9	%

4. WIND EROSION

Activity	Calculation	Variable	Variable description	Value	Units
Exposed areas, including overburden dumps	Intensity	$a_{Expos.,Wind}$	Surface area	59.84	ha
Active coal stockpiles	Intensity	$a_{Active,Wind}$	Surface area	1.18	ha
	Emission factor	$s_{Active,Wind}$	Silt content	6.2	%
		$p_{Active,Wind}$	No. of days with rainfall > 0.25 mm	72	days
		$f_{Active,Wind}$	% of time with wind speed > 5.4 m/s	4.8	%

5. ROAD GRADING

Activity	Calculation	Variable	Variable description	Value	Units
Road grading	Intensity	N_{Grade}	Number of graders employed at site	1	-
		T_{Grade}	Utilisation Rate (or hours of operation)	2,335.3	%
	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	1	-
		$T_{Dozer,Rehab}$	Time spent by each dozer on rehab	476.37	hours/year
		$A_{Dozer,Rehab}$	Area of active rehab	14.7	ha
	Emission factor	$s_{Dozer,Rehab}$	Silt content	10	%
		$M_{Dozer,Rehab}$	Moisture content	2.5	%

APPENDIX C: COSTING

Cost of Implementation for Larger Trucks

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	388.2										
	PM10	104.8										
	PM2.5	10.5										
Current emissions (tonnes/year) - current control 75%	TSP	485.2										
	PM10	131.0										
	PM2.5	13.099										
Total emission reduction from use of best practice measure (tonnes/year)	TSP	97										
	PM10	26										
	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 2 - Assuming current 785's are replaced with 793's	$ 8,000,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 8,000,000**
			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Total capital costs		**$ 8,000,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 8,000,000**
Labour costs including directly related on-costs (list each item)	parts x 4	$ 455,977	$ 455,977	$ 455,977	$ 455,977	$ 455,977	$ 455,977	$ 455,977	$ 455,977	$ 455,977	$ 455,977	**$ 4,559,765**
	body repair x 4	$ 303,153	$ 303,153	$ 303,153	$ 303,153	$ 303,153	$ 303,153	$ 303,153	$ 303,153	$ 303,153	$ 303,153	**$ 3,031,525**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Cost of specific materials and other items (list each item)	tyres x 4	$ 713,300	$ 713,300	$ 713,300	$ 713,300	$ 713,300	$ 713,300	$ 713,300	$ 713,300	$ 713,300	$ 713,300	**$ 7,133,000**
	fuel x 4	$ 4,108,608	$ 4,108,608	$ 4,108,608	$ 4,108,608	$ 4,108,608	$ 4,108,608	$ 4,108,608	$ 4,108,608	$ 4,108,608	$ 4,108,608	**$ 41,086,080**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Total material and other costs		**$ 5,581,037**	**$ 5,581,037**	**$ 5,581,037**	**$ 5,581,037**	**$ 5,581,037**	**$ 5,581,037**	**$ 5,581,037**	**$ 5,581,037**	**$ 5,581,037**	**$ 5,581,037**	**$ 55,810,370**
Total costs		**$ 13,581,037**	**$ 5,581,037**	**$ 5,581,037**	**$ 5,581,037**	**$ 5,581,037**	**$ 5,581,037**	**$ 5,581,037**	**$ 5,581,037**	**$ 5,581,037**	**$ 5,581,037**	**$ 63,810,370**
Estimate additional cost per tonne of particulate matter suppressed from TSP, PM10 and PM2.5*	TSP	$ 139,945	$ 57,509	$ 57,509	$ 57,509	$ 57,509	$ 57,509	$ 57,509	$ 57,509	$ 57,509	$ 57,509	**$ 657,529**
	PM10	$ 518,396	$ 213,032	$ 213,032	$ 213,032	$ 213,032	$ 213,032	$ 213,032	$ 213,032	$ 213,032	$ 213,032	**$ 2,435,680**
	PM2.5	$ 5,183,964	$ 2,130,315	$ 2,130,315	$ 2,130,315	$ 2,130,315	$ 2,130,315	$ 2,130,315	$ 2,130,315	$ 2,130,315	$ 2,130,315	**$ 24,356,802**
Cost saving from implementing each best practice measure (list each item)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Total savings		**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Net costs		**$ 13,581,037**	**$ 5,581,037**	**$ 5,581,037**	**$ 5,581,037**	**$ 5,581,037**	**$ 5,581,037**	**$ 5,581,037**	**$ 5,581,037**	**$ 5,581,037**	**$ 5,581,037**	**$ 63,810,370**
Estimate net cost per tonne of particulate matter suppressed for TSP, PM10 and PM2.5 *	TSP	$ 139,945	$ 57,509	$ 57,509	$ 57,509	$ 57,509	$ 57,509	$ 57,509	$ 57,509	$ 57,509	$ 57,509	$ 657,529
	PM10	$ 518,396	$ 213,032	$ 213,032	$ 213,032	$ 213,032	$ 213,032	$ 213,032	$ 213,032	$ 213,032	$ 213,032	$ 2,435,680
	PM2.5	$ 5,183,964	$ 2,130,315	$ 2,130,315	$ 2,130,315	$ 2,130,315	$ 2,130,315	$ 2,130,315	$ 2,130,315	$ 2,130,315	$ 2,130,315	$ 24,356,802

Cost of Implementation for Water Sprays on Stockpiles

MINING ACTVITY	Wind Erosion - Coal Stockpiles											
Specific best practice measure	Water Sprays (50%)											
Mass emissions through application of best practice (tonnes/year)	TSP	18.55										
	PM10	6.51										
	PM2.5	0.98										
Current emissions (tonnes/year) - current control 0%	TSP	37.10										
	PM10	13.02										
	PM2.5	1.95										
Total emission reduction from use of best practice measure (tonnes/year)	TSP	19										
	PM10	7										
	PM2.5	1										
Year		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Cost specific capital items (list each item)	Pipe from nearby bore, 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	$ 120,213	$ 12,399	$ 12,399	$ 12,399	$ 12,399	$ 12,399	$ 12,399	$ 12,399	$ 12,399	$ 12,399	**$ 231,801**
	PM10	$ 342,435	$ 35,318	$ 35,318	$ 35,318	$ 35,318	$ 35,318	$ 35,318	$ 35,318	$ 35,318	$ 35,318	**$ 660,301**
	PM2.5	$ 2,282,900	$ 235,456	$ 235,456	$ 235,456	$ 235,456	$ 235,456	$ 235,456	$ 235,456	$ 235,456	$ 235,456	**$ 4,402,005**
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	$ 120,213	$ 12,399	$ 12,399	$ 12,399	$ 12,399	$ 12,399	$ 12,399	$ 12,399	$ 12,399	$ 12,399	$ 231,801
	PM10	$ 342,435	$ 35,318	$ 35,318	$ 35,318	$ 35,318	$ 35,318	$ 35,318	$ 35,318	$ 35,318	$ 35,318	$ 660,301
	PM2.5	$ 2,282,900	$ 235,456	$ 235,456	$ 235,456	$ 235,456	$ 235,456	$ 235,456	$ 235,456	$ 235,456	$ 235,456	$ 4,402,005

Cost of Implementation for Wind Shielding on Conveyors

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	22.6										
	PM10	4.0										
	PM2.5	0.6										
Current emissions (tonnes/year) - current control 50%	TSP	75.3										
	PM10	13.5										
	PM2.5	1.930										
Total emission reduction from use of best practice measure (tonnes/year)	TSP	53										
	PM10	9										
	PM2.5	1										
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	$ 150,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 150,000**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Total capital costs		**$ 190,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 190,000**
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		**$ 227,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 560,000**
Estimate additional cost per tonne of particulate matter suppressed from TSP, PM10 and PM2.5*	TSP	$ 4,307	$ 702	$ 702	$ 702	$ 702	$ 702	$ 702	$ 702	$ 702	$ 702	**$ 10,626**
	PM10	$ 24,042	$ 3,919	$ 3,919	$ 3,919	$ 3,919	$ 3,919	$ 3,919	$ 3,919	$ 3,919	$ 3,919	**$ 59,311**
	PM2.5	$ 168,066	$ 27,394	$ 27,394	$ 27,394	$ 27,394	$ 27,394	$ 27,394	$ 27,394	$ 27,394	$ 27,394	**$ 414,613**
Cost saving from implementing each best practice measure (list each item)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Total savings		**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Net costs		**$ 227,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 37,000**	**$ 560,000**
Estimate net cost per tonne of particulate matter suppressed for TSP, PM10 and PM2.5 *	TSP	$ 4,307	$ 702	$ 702	$ 702	$ 702	$ 702	$ 702	$ 702	$ 702	$ 702	$ 10,626
	PM10	$ 24,042	$ 3,919	$ 3,919	$ 3,919	$ 3,919	$ 3,919	$ 3,919	$ 3,919	$ 3,919	$ 3,919	$ 59,311
	PM2.5	$ 168,066	$ 27,394	$ 27,394	$ 27,394	$ 27,394	$ 27,394	$ 27,394	$ 27,394	$ 27,394	$ 27,394	$ 414,613