REPORT

NARRABRI MINE -PARTICULATE MATTER CONTROL BEST PRACTICE POLLUTION REDUCTION PROGRAM

Whitehaven Coal Limited

Report No: 6680A

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A PEL Company

PROJECT TITLE:	NARRABRI MINE - PARTICULATE MATTER CONTROL BEST PRACTICE POLLUTION REDUCTION PROGRAM
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1 INTRODUCTION

The Narrabri Mine (NM) is an underground mine operated by Narrabri Coal Operations Pty Ltd (NCOPL) located 10km north-northwest of Baan Baa in northern NSW. The Narrabri Mine commenced operations in 2008 and has approval to produce up to 8 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal.

The Narrabri Mine is a joint venture between Narrabri Coal Pty Ltd (70.0%) (a wholly owned subsidiary of Whitehaven Coal Limited), Upper Horn Investments Limited (7.5%), Electronic Power Development Co. Ltd (7.5%), EDF Trading (7.5%) and Daewoo International Corporation and Korea Resources Corporation (7.5%).

1.1 Background

In 2011, the NSW Environment Protection Authority (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 2.1**
	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 Narrabri Mine

Extraction of coal is performed utilising longwall mining methods with mining operations approved to be conducted 24 hours per day, seven days per week.

Recovered coal is transported via conveyors from pit bottom to the pit top area. At the pit top area, the ROM coal is transferred from underground reclaim tunnels via conveyor to a breaker and Coal Handling and Preparation Plant (CHPP). The coal is fed through the breaker, the coarse material is taken off as reject and the <16mm coal transferred directly to the product coal stockpile area (approximately 60%) and the remainder transferred to the CHPP for washing (approximately 40%). The <50mm coal is transferred to the product coal stockpile area and the fine material is dewatered via a belt press and added to the product coal stockpile area.

The product coal is drawn from stockpiles via underground reclaim tunnels and conveyed to the train load-out bin. The loading of product coal is automated to trains on the Narrabri Mine Rail Siding.

A mine ventilation system provides a safe working environment for the workers underground with mine ventilation air (MVA) discharged through a ventilation shaft located on the west mains.

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 Narrabri Mine for the PRP reporting period and for the purposes of emission estimation, some activities have been grouped. The activities included in the emission estimation for the PRP are show 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 Narrabri Mine
Surface preparation	Vegetation clearance/removal	Limited to drill sites
	Topsoil and subsoil removal with scrapers	No
	Topsoil removal with bulldozers/excavators	Limited to drill sites
	Topsoil loading to trucks & unloading	No
	Hauling topsoil	No
Overburden and interburden removal	Drilling	Yes (bore holes only)
	Blasting	No
	Draglines	No
	Bulldozers ripping/pushing/clean-up	No
	Loading to trucks & unloading at emplacement	No
	Hauling to emplacement	No
Coal removal	Drilling	Yes (bore holes only)
	Blasting	No
	Bulldozers ripping/pushing/clean-up	No
	Loading truck with ROM coal, unloading truck to ROM pad	No
	Loading truck from ROM stockpile, unloading truck to ROM hopper	No
	Hauling ROM coal	No
	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	Limited for small areas at drill sites/rehab
	Active coal stockpiles	Yes
Road Maintenance	Graders on haul roads	Yes
Rehabilitation	Bulldozing on rehab	Activities on rehab include rollers/excavators/trucks)
Mine Ventilation	Ventilation Shaft Emissions	Yes

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 April 2010 – March 2011 at the Narrabri Mine. Emission estimates have been made with no particulate matter controls in place and a summary is provided in **Table 2.1**.

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

ACTIVITY	TSP	PM_{10}	$PM_{2.5}$
Bulldozers on Coal Stockpiles	62.4	16.5	1.37
Vent Shaft - Non-EPA Activity Category	18.9	18.9	18.9
Active Rehab Excavators/ rollers/ trucks	12.9	2.5	1.36
Graders	3.7	1.4	0.11
Wind Erosion - Stockpiles	1.3	0.7	0.10
Wind Erosion on Open Areas	1.8	0.9	0.13
Coal crushing	1.7	0.8	0.00
Material Transfer Coal (Conveyors / Transfer)	2.8	1.3	0.20
Loading Coal Stockpiles	0.3	0.2	0.02
Drilling	0.2	0.1	0.00
Train Loading	0.2	0.1	0.01
Screening	8.1	2.8	0.00
Grand Total	**114.1**	**46.0**	**22.2**

2.2 Estimated Emissions- Existing Controls

Emissions were then recalculated taking into account various control factors for the dust controls that Narrabri Mine 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

<table>
<tr><th>PRP Activity Category</th><th>Description of Control</th><th>EPA level of control (%)</th><th>Control applied (%)</th></tr>
<tr><td>Coal Crushing</td><td>Enclosed in CHPP</td><td>-</td><td>100%</td></tr>
<tr><td>Screening</td><td>Enclosed in CHPP</td><td>-</td><td>100%</td></tr>
<tr><td rowspan="2">Material Transfer Coal</td><td>Water sprays on conveyors and at transfer points</td><td>50%</td><td rowspan="2">50% (Watering) + 70% (Enclosure) – for transfers</td></tr>
<tr><td>Conveyors partially enclosed</td><td>40%</td></tr>
<tr><td>Loading Coal Stockpiles</td><td>Watering</td><td>50%</td><td>50%</td></tr>
<tr><td rowspan="3">Drilling</td><td>Water injection sprays while drilling</td><td>3-96% NIOSH document</td><td rowspan="3">50%
(Watering)</td></tr>
<tr><td>Fabric filters</td><td>99</td></tr>
<tr><td>Cyclone</td><td>80-90</td></tr>
<tr><td>Graders</td><td>Watering Grader Routes</td><td>-</td><td>50% (Watering)</td></tr>
<tr><td>Excavators/ rollers/ trucks on Active Rehab</td><td>Keeping travel routes moist</td><td>-</td><td>50% (Watering)</td></tr>
<tr><td rowspan="4">Wind Erosion on Open Areas</td><td>Minimize pre strip</td><td>100% per m2 of pre-strip avoided</td><td rowspan="4">50%
(Watering)</td></tr>
<tr><td>Watering</td><td>50%</td></tr>
<tr><td>Application of gravel to stabilise disturbed open areas</td><td>84%</td></tr>
<tr><td>Primary rehabilitation</td><td>-</td></tr>
<tr><td>Train Loading</td><td>Enclosure</td><td>-</td><td>70% (Enclosure)</td></tr>
</table>

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}	$PM_{2.5}$
Bulldozers on Coal Stockpiles	62.4	16.5	1.37
Vent Shaft - Non-EPA Activity Category	18.9	18.9	18.92
Active Rehab Excavators/ rollers/ trucks	6.5	1.3	0.68
Graders	1.8	0.7	0.06
Wind Erosion - Stockpiles	1.3	0.7	0.10
Wind Erosion on Open Areas	0.9	0.4	0.07
Coal crushing	0.0	0.0	0.00
Material Transfer Coal	0.7	0.3	0.05
Loading Coal Stockpiles	0.2	0.1	0.01
Drilling	0.1	0.02	0.00
Train Loading	0.1	0.02	0.00
Screening	0.0	0.00	0.00
Grand Total	**93.6**	**39.3**	**21.3**

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.

Emissions from the ventilation shaft are not evaluated as it is not a PRP specified activity category. Excavators / rollers on active rehab and graders have also not been evaluated as no guidance is provided within the Best Practice Report for reducing particulate emissions from these two activities, other than the current practice of application of watering.

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

- Bulldozers on coal stockpiles.
- Wind erosion from stockpiles.

Table 2.4: Ranked activities by mass emissions (controlled)

Rank	Mining Activity	Emissions (t/y)
	TSP	
1	**Bulldozers on Coal Stockpiles**	**62.4**
2	**Vent Shaft - Non-EPA Activity Category**	**18.9**
3	**Active Rehab Excavators/ rollers/ trucks**	**6.5**
4	**Graders**	**1.8**
5	Wind Erosion - Stockpiles	1.3
6	Wind Erosion on Open Areas	0.9
7	Material Transfer Coal	0.7
8	Loading Coal Stockpiles	0.2
9	Drilling	0.1
10	Train Loading	0.1
11	Coal crushing	0.0
12	Screening	0.0
	PM_{10}	
1	**Vent Shaft - Non-EPA Activity Category**	**18.9**
2	**Bulldozers on Coal Stockpiles**	**16.5**
3	**Active Rehab Excavators/ rollers/ trucks**	**1.3**
4	**Graders**	**0.7**
5	Wind Erosion - Stockpiles	0.7
6	Wind Erosion on Open Areas	0.4
7	Material Transfer Coal	0.3
8	Loading Coal Stockpiles	0.1
9	Drilling	0.02
10	Train Loading	0.02
11	Coal crushing	0.0
12	Screening	0.0

Rank	Mining Activity	Emissions (t/y)
	$PM_{2.5}$	
1	**Vent Shaft - Non-EPA Activity Category**	**18.9**
2	**Bulldozers on Coal Stockpiles**	**1.4**
3	**Active Rehab Excavators/ rollers/ trucks**	**0.7**
4	**Wind Erosion - Stockpiles**	**0.1**
5	Wind Erosion on Open Areas	0.1
6	Graders	0.1
7	Material Transfer Coal	0.1
8	Loading Coal Stockpiles	0.01
9	Train Loading	0.00
10	Drilling	0.00
11	Coal crushing	0.00
12	Screening	0.00

3 PRACTICABILITY OF IMPLEMENTING ADDITIONAL BEST PRACTICE MEASURES

Based on the information presented in **Section 2** it is clear that the Narrabri Mine already has a number of PM-control measures in place. With current controls, emissions of TSP, PM_{10} and $PM_{2.5}$ are between approximately 5% - 20% 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 where BPM controls have been outlined. 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** (dozers on stockpiles) and **Table 3.2** (wind erosion – coal stockpiles)

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 3.3**.

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

Table 3.1: BPM to reduce particulate matter emissions from bulldozers on coal stockpiles

Best Practice Control	% control per OEH	Current Use	Practicability Evaluation				Practicable Y/N	Comments	Potential reduction in dust emission (t/y)			Potential reduction in dust emission as % of total site dust emission (current controls)		
									Existing control efficiency of 0% is assumed (see Table 2.2)					
			Regulatory	Environmental	Safety	Compatibility			TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Minimize travel speed and distance	Not quantified	Y	-	-	-	-	-	Speed limited on dozers	-	-	-	-	-	-
Keep travel routes and materials moist	50%	Y	Y	Y	Y	Y	Y	Travel routes are actively kept moist. Water sprays on coal stockpiles evaluated in Table 3.2.	31.18	8.23	0.69	33.32%	20.97%	3.23%

Table 3.2: BPM to reduce particulate matter emissions from wind erosion from coal stockpiles

Best Practice Control		% control per OEH	Current Use	Practicability factors: Regulatory	Practicability factors: Environmental	Practicability factors: Safety	Practicability factors: 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	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Avoidance	Bypassing stockpiles	100%	N	N	N	N	N	N		1.31	0.66	0.10	1.40%	1.67%	0.46%
Surface stabilisation	Water sprays	50%	Y	Y	Y	Y	Y	Y	Sprays on gantry to assist in unloading from product tripper. Cost for fixed water sprays evaluated	0.66	0.33	0.05	0.70%	0.84%	0.23%
	Chemical wetting agents	80-99%	N	Y	Y	Y	N	N		1.05-1.30	0.53-0.65	0.08-0.10	1.12%-1.39%	1.34%-1.66%	0.37%-0.46%
	Surface crusting agent	95%	N	Y	Y	Y	N	N		1.25	0.62	0.09	1.33%	1.59%	0.44%
	Carry over wetting from load in	80%	Y	-	-	-	-	-		1.05	0.53	0.08	1.12%	1.34%	0.37%
Enclosure	Silo with bag house	95-100%	N	Y	Y	Y	Y	N	Crusher, breaker enclosed	1.25-1.31	0.62-0.66	0.09-0.10	1.33%-1.40%	1.59%-1.67%	0.44%-0.46%
	Cover storage pile with a tarp during high winds	99%	N	Y	Y	N	N	N	Not practical	1.30	0.65	0.10	1.39%	1.66%	0.46%

Note: Any existing control factors for "water sprays" and "carry over wetting from load in" has not been taken to account in calculating potential reduction in dust emissions as the quantification is unclear.

Best Practice Control		% control per OEH	Current Use	Practicability factors: 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}	$PM_{2.5}$
Wind speed reduction	Vegetative windbreaks	30%	N	Y	Y	Y	Y	N	Box cut and amenity bund provide some protection	0.39	0.20	0.03	0.42%	0.50%	0.14%
	Reduced pile height	30%	N	Y	Y	Y	Y	N	Already limited by infrastructure	0.39	0.20	0.03	0.42%	0.50%	0.14%
	Wind screens/fences	75->80%	N	Y	Y	N	N	N	Safety risk, already limited space	0.99-1.05	0.49-0.53	0.07-0.08	1.05%-1.12%	1.26%-1.34%	0.35%-0.37%
	Pile shaping/orientation	<60%	N	Y	Y	N	N	N	Narrow area from tripper to reclaim tunnels	0.79	0.39	0.06	0.84%	1.00%	0.28%
	Erect 3-sided enclosure around storage piles	75%	N	Y	Y	N	N	N	Limited space, amenity bund etc provide some shelter	0.99	0.49	0.07	1.05%	1.26%	0.35%
	Rock armour and/or topsoil applied	-	N	Y	N	N	N	N	Not practical	-	-	-	-	-	-

Table 3.3: BPM to reduce particulate matter emissions from remaining activities

Best Practice Control		% control per OEH	Current Use	Practicability factors: 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	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Conveyor and transfers (assumed control efficiency of 50%+70% for transfer, see **Table 2.2**)															
Conveyors	Application of water at transfers	50%	Y	-	-	-	-	-	Current practice	0	0	0	0	0	0
	Wind shielding - roof or side wall	40%	Y	-	-	-	-	-	Wind erosion from surface of conveyors not considered	-	-	-	-	-	-
	Wind shielding - roof AND side wall	70%	N	Y	Y	Y	N	N	Cost implication	3.6	1.7	0.0	0%	0%	0%
	Belt cleaning and spillage minimisation	Not quantified	Y	-	-	-	-	-	Current practice	-	-	-	-	-	-
Transfers	Enclosure	70%	Y	-	-	-	-	-	Current practice	-	-	-	-	-	-
	Enclosure and fabric filters	-	N	Y	Y	Y	N	N	Not practical	-	-	-	-	-	-

Best Practice Control		% control per OEH	Current Use	Practicability factors: 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}	$PM_{2.5}$
Drilling (assumed control efficiency of 50%, see **Table 2.2**)															
Wet	Water injection sprays while drilling	3-96% NIOSH document	Y	-	-	-	-	-	Current practice	0	0	0	0	0	0
Dry collection	Fabric filters	99	N	Y	Y	Y	Y	Y	Only minor drilling (bore holes) completed not costed as considered a minor source	0.05	0.02	0.00	0.05%	0.06%	0.01%
	Cyclone	80-90	N	Y	Y	Y	Y	Y		-	-	-	-	-	-
Loading Coal Stockpiles (assumed control efficiency of 50%, see **Table 2.2**)															
Variable height stack		25%	N	Y	Y	Y	N	N	Tripper is mobile, not practical with current setup	0.04	0.02	0.00	0.05%	0.05%	0.01%
Boom tip water sprays		50%	N	Y	Y	Y	Y	N	'Fog Cannon' sprays being investigated as boom sprays not compatible with operations	0	0	0	0	0	0
Telescopic chute with water sprays		75%	N	Y	Y	Y	Y	Y	Being investigated for telescopic chute for product stockpile loading	0.13	0.06	0.01	0.14%	0.15%	0.04%
Total enclosure		-	N	Y	Y	Y	N	N	Not practical	-	-	-	-	-	-

Note: Current controls are taken in to account for "Variable height stack" but not for "Telescopic chute with water sprays" when calculating potential reduction in dust emissions.

Best Practice Control		% control	Current Use	Practicality Evaluation				Practicable Y/N	Evaluation Comments from Mine	Potential reduction in dust emission (t/y)			Potential reduction in dust emission as % of total site dust emission (current controls)		
				Regulatory	Environmental	Safety	Compatibility			Existing control efficiency of 75% is assumed (see Table 2.2)					
										TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Wind Erosion on Exposed Areas (assumed control efficiency of 50%, see **Table 2.2**)															
Avoidance	Minimise pre-strip	100% per m2 of pre-strip avoided	Y	-	-	-	-	-		-	-	-	-	-	-
Surface stabilisation	Watering	50%	Y	-	-	-	-	-							
	Chemical suppressants	70-84%	N	Y	Y	Y	N	N	Relatively small areas disturbed at any one time, drill sites etc. No overburden /interburden emplacement areas	-	-	-	-	-	-
	Paving and cleaning	>95%	N	Y	Y	Y	N	N		-	-	-	-	-	-
	Application of gravel to stabilize disturbed open areas	84%	Y	-	-	-	-	-		-	-	-	-	-	-
	Rehabilitation goals	99%	Y	-	-	-	-	-		-	-	-	-	-	-
Wind speed reduction	Fencing, bunding, shelterbelts or in-pit dump	30-80%	N/A							-	-	-	-	-	-
	Vegetative ground cover	70%	Y	-	-	-	-	-	Seeded to cover as soon as practicable once reshaped to grade.	-	-	-	-	-	-

3.1 Estimated Emissions for Practical BPM

Table 4.1 summarises BPM identified as practicable (not accounting for cost) for the mining activities at Narrabri Mine. 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 installation of a fixed water spray system on coal stockpiles, which would reduce emissions associated with wind erosion and dozers on stockpiles. Further consideration of costs is provided in **Section 3.2**.

The reductions in emissions achieved through the installation of a telescopic chute with sprays are minor, based on this source being a small contributor, however the mine have indicated this is currently being investigated for implementation.

3.2 Implementation Cost Evaluation

For all measures identified in in **Table 4.1**, an additional cost evaluation was completed and summarised below. Full details provided in **Appendix C**.

- For wind erosion and maintenance of coal stockpiles the net cost per tonne of PM_{10} abated as a result of the installation of fog cannon type sprays, as normal 'boom' sprays cannot be installed due to already high product moisture, was calculated to be in the order of \$600,000/tonne-PM_{10} in the first year, \$46,000/tonne-PM_{10} annually thereafter and a total of \$1 million/tonne-PM_{10} over 10 years.
- For loading coal stockpiles the net cost per tonne of PM10 abated as a result of a telescopic chute with sprays would be of the order of \$7 million/tonne-PM_{10} in the first year, \$700,000/tonne-PM_{10} annually thereafter and a total of \$14 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 \$1.6 million over 10 years (\$525,000 for one wall, which allows for easier access). 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 due to the compact design of the coal processing area at Narrabri Mine.

4 IMPLEMENTATION OF PRACTICAL BPM

Based on a result of the practicability evaluation and subsequent cost evaluation, the following additional BPM are proposed for implementation at Narrabri Mine.

- Install telescopic chute with sprays for stockpile loading – end of FY2013/14.

Wind erosion and maintenance (dozers) on coal stockpiles is the largest emission source at Narrabri Mine. While the installation of a fixed water spray system on stockpiles is not cost effective in terms of the PM reduction achieved at current production rate, the installation of a fog cannon spray system is being investigated. Methods for ongoing assessment of performance, in terms of key performance indicators are outlined in in **Section 5.**

Table 4.1: 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 Coal Stockpiles	Telescopic chute with water sprays	0.17	0.16	0.01	0.1%	0.3%	0.04%
Wind Erosion and Maintenance – Stockpiles [1]	Stockpile watering	32	8.6	0.7	34%	19%	3%
Conveyors [2]	Shielding – one side	-	-	-	-	-	-
Conveyors [2]	Shielding – two sides	-	-	-	-	-	-

Note: [1] Emission reductions are calculated for wind erosion on stockpiles plus dozers operating on stockpiles. [2] Wind erosion from surfaces of the conveyors not estimated as not considered a significant source.

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 Narrabri Mine.

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 Narrabri Mine, 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 (NPI 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 5.4**.

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 5.4**. 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.

Table 5.1: KPIs for BPM

KPI-1 – Annual emissions of PM_{10} per tonne of ROM coal (kg PM_{10}/t ROM)				
Metric	**Method / Standard**	**Objective / Target**	**Frequency**	**Report**
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	Annual dust emissions inventory using PRP emissions inventory template	Downward trend in PM_{10}/ROM ratio until best practicable control is achieved	Annual (matching 12 month reporting period for AEMR/NPI)	Include in AEMR
KPI-2 – PM_{10} Emission Control (%)				
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	Annual dust emissions inventory using PRP emissions inventory template in conjunction with site specific measurements of individual parameters and control efficiencies.	Progression towards 100%. This indicates that the mine is doing everything practicable and achievable within the constraints of operations, to reduce emissions.	Annual (matching 12 month reporting period for AEMR/NPI)	Include in AEMR

KPI-3 – Visible Dust Emissions (Opacity)				
This KPI is defined as follows: $$K3_y = \bar{k}_y$$ Where: K3y is the value of KPI-3 (dimensionless) in year y $\bar{k}_y$ is the average opacity in year y	<u>Visual Observations</u> US EPA Method 9 – Visual Determination of the opacity of emissions from stationary sources San Joaquin Valley Air Pollution Control District (SJVAPCD) Rule 8011 General Requirements (Appendix A – Visual Determination of Apacity)	<20% Opacity at source - hauling and stockpile area	Weekly	Weekly operators log.
	<u>Digital Imagery</u> ASTM WK 30382 "*New Test Method for Determining the Opacity of Fugitive Emissions in the Outdoor Ambient Atmosphere, Using Digital Imagery*"	<20% Opacity at source	Continuous	

5.4 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 provides 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**.

Table 5.2: Site specific measurements for improvements to KPI-1

Parameter	Measurement Method / Standard	Frequency
% moisture content (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 (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
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)

6 REFERENCES

EPA (2012) EPA Presentation Tuesday 8th May 2012 "Dust Stop PRP Stage 1 Consultant Workshop".

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.

OEH (2011). Coal Mine Particulate Matter Control Best Practice - Site-specific determination guideline. November 2011. New South Wales Office of Environment and Heritage, Sydney. November 2011. http://www.environment.nsw.gov.au/resources/air/20110813coalmineparticulate.pdf

USEPA (1998). AP-42 Compilation of Emission Factors, Section 13.2.4 – Western Surface Coal Mining, October 1998. http://www.epa.gov/ttnchie1/ap42/ch11/final/c11s09.pdf

USEPA (2004). AP-42 Compilation of Emission Factors, Section 11.19.2 - Crushed Stone Processing and Pulverized Mineral Processing, August 2004. http://www.epa.gov/ttnchie1/ap42/ch11/final/c11s1902.pdf

USEPA (2006a). AP-42 Compilation of Emission Factors, Section 13.2.2 - Unpaved Roads. November 2006. http://www.epa.gov/ttnchie1/ap42/ch13/final/c13s0202.pdf

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

Whitehaven Coal Limited (2011). Annual Environmental Management Report for the Narrabri Mine, 30 April 2011.

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	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: SITE 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		-
		$L_{Scrape,Veg}$	Distance travelled per scraper		km/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		-
		$T_{Strip,Topsoil}$	Time spent by each scraper on topsoil		hours/year
OR Stripping with bulldozers/excavators	Intensity	$N_{Strip,Topsoil}$	Number of dozers stripping topsoil		-
		$T_{Strip,Topsoil}$	Time spent by each dozer on topsoil		hours/year
	Emission factor	$s_{Strip,Topsoil}$	Silt content of topsoil		%
		$M_{Strip,Topsoil}$	Moisture content of topsoil		%
Loading and emplacing	Intensity	$w_{Load,Topsoil}$	Amount topsoil handled		tonnes/year
	Emission factor	$U_{Load,Topsoil}$	Average wind speed		m/s
		$M_{Load,Topsoil}$	Moisture content of topsoil	0	%
Hauling topsoil	Intensity	$w_{Haul,Topsoil}$	Amount topsoil handled		tonnes/year
	Emission factor	$v_{Haul,Topsoil}$	Weight per trip (vehicle payload)		tonnes
		$L_{Haul,Topsoil}$	Length of return trip		km
		$W_{Haul,Topsoil}$	Mean gross vehicle weight for hauling topsoil		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	265	holes/year
Blasting	Intensity	$N_{Blast,OB}$	Number of blasts per year		blasts/year
	Emission factor	$A_{Blast,OB}$	Area blasted		m^2/year
Draglines	Intensity	$V_{Drag,OB}$	Volume of material		m^3
	Emission factor	$d_{Drag,OB}$	Drop distance		m
		$M_{Drag,OB}$	Moisture content of overburden		%
Loading and emplacing	Intensity	$w_{Load,OB}$	Overburden amount handled		BCM/year
		$d_{Load,OB}$	Density of overburden		kg/m^3
	Emission factor	$U_{Load,OB}$	Average wind speed		m/s
		$M_{Load,OB}$	Moisture content of overburden		%
Hauling OB	Intensity	$w_{Haul,OB}$	Overburden amount hauled	0	BCM/year
		$d_{Haul,OB}$	Density of overburden		kg/m^3
	Emission factor	$wt_{Haul,OB}$	Weight per trip (vehicle payload)	0	tonnes
		$L_{Haul,OB}$	Length of return trip	0	km
		$W_{Haul,OB}$	Gross vehicle weight	0	tonnes
		$s_{Haul,OB}$	Silt content of haul road	0	%
Bulldozing	Intensity	$N_{Dozer,OB}$	Number of bulldozers working on overburden	0	-
		$T_{Dozer,OB}$	Time spent by each bulldozer on overburden	0	hours/year
	Emission factor	$s_{Dozer,OB}$	Silt content of overburden	0	%
		$M_{Dozer,OB}$	Moisture content of overburden	0	%

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		-
		$T_{Dozer,Coal}$	Time spent by each dozer on coal removal		hours/year
	Emission factor	$s_{Dozer,Coal}$	Silt content of coal	7	%
		$M_{Dozer,Coal}$	Moisture content of coal	6	%
Drilling	Intensity	$N_{Drill,Coal}$	Number of holes drilled per year		holes/year
Blasting	Intensity	$N_{Blast,Coal}$	Number of blasts per year		blasts/year
	Emission factor	$A_{Blast,Coal}$	Area blasted		m^2/year
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		tonnes/year
	Emission factor	$M_{Load,Coal}$	Moisture content of coal		%
Hauling Coal	Intensity	$w_{Haul,Coal}$	Coal amount hauled		tonnes/year
	Emission factor	$wt_{Haul,Coal}$	Weight per trip (vehicle payload)		tonnes
		$L_{Haul,Coal}$	Length of return trip		km
		$W_{Haul,Coal}$	Gross vehicle weight		tonnes
		$s_{Haul,Coal}$	Silt content of ROM coal		%
All material transfer operations (*e.g.* coal > ROM stockpile from conveyor, coal from ROM hopper to conveyor,	Intensity	$w_{Trans,Coal}$	Weight handled/transferred	321937	tonnes/year
		$N_{Trans,Coal}$	Number of handling, transfer points	18	-
	Emission factor	$U_{Trans,Coal}$	Average wind speed	4.2	m/s
		$M_{Trans,Coal}$	Moisture content of coal	12.9	%
Screening	Intensity	$w_{Screen,Coal}$	Amount Coal screened		tonnes/year
Crushing	Intensity	$w_{Crush,Coal}$	Amount Coal Crushed		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	720	hours/year
	Emission factor	$s_{Dozer,Coal}$	Silt content of coal	7	%
		$M_{Dozer,Coal}$	Moisture content of coal	6	%
Bulldozing on product stockpiles	Intensity	$N_{Dozer,Coal}$	Number of dozers working on stockpiles	2	-
		$T_{Dozer,Coal}$	Time spent by each dozer on stockpiles	624	hours/year
	Emission factor	$s_{Dozer,Coal}$	Silt content of coal	7	%
		$M_{Dozer,Coal}$	Moisture content of coal	7	%

4. WIND EROSION

Activity	Calculation	Variable	Variable description	Value	Units
Exposed areas, including overburden dumps	Intensity	$a_{Expos.,Wind}$	Surface area		ha
Active coal stockpiles	Intensity	$a_{Active,Wind}$	Surface area	1.5	ha
	Emission factor	$s_{Active,Wind}$	Silt content		%
		$p_{Active,Wind}$	No. of days with rainfall > 0.25 mm	73	days
		$f_{Active,Wind}$	% of time with wind speed > 5.4 m/s	5	%

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)	2080	hours/year
	Emission factor	S_{Grade}	Mean vehicle speed	4	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	1235	hours/year
		$A_{Dozer,Rehab}$	Area of active rehab	2	ha
	Emission factor	$s_{Dozer,Rehab}$	Silt content		%
		$M_{Dozer,Rehab}$	Moisture content		%

7. MINE VENTILLATION

Activity	Calculation	Variable	Variable description	Value	Units
Ventilation Shafts	Intensity	V_{shaft}	Total Air Flow	9,460,800,000	m3/year
	Emission factor	$C_{vent\ TSP}$	In stack concentrations - TSP		mg/m3
		$C_{vent\ PM10}$	In stack concentrations - PM10		mg/m3
		$C_{vent\ PM2.5}$	In stack concentrations - PM2.5		mg/m3

APPENDIX C: COSTING

Cost of Implementation for Telescopic chute with water sprays

MINING ACTVITY	Stacking and Reclaiming Product Coal											
Specific best practice measure	Telescopic Chute with Water Sprays (75%)											
Mass emissions through application of best practice (tonnes/year)	TSP	0.04										
	PM10	0.04										
	PM2.5	0.003										
Current emissions (tonnes/year) - current control 0%	TSP	0.17										
	PM10	0.16										
	PM2.5	0.01										
Total emission reduction from use of best practice measure (tonnes/year)	TSP	0.13										
	PM10	0.12										
	PM2.5	0.01										
Year		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Cost specific capital items (list each item)	telescopic chute incl. installation (product tripper)	$ 600,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 600,000**
	telescopic chute incl. installation (bypass stacker)	$ 250,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 250,000**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
	Total capital costs	**$ 850,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 850,000**
Labour costs including directly related on-costs (list each item)	Maintenance costs incl. materials (product tripper)	$ 60,000	$ 60,000	$ 60,000	$ 60,000	$ 60,000	$ 60,000	$ 60,000	$ 60,000	$ 60,000	$ 60,000	**$ 600,000**
	Maintenance costs incl. materials (bypass stacker)	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	**$ 250,000**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Cost of specific materials and other items (list each item)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
	Total material and other costs	**$ 85,000**	**$ 85,000**	**$ 85,000**	**$ 85,000**	**$ 85,000**	**$ 85,000**	**$ 85,000**	**$ 85,000**	**$ 85,000**	**$ 85,000**	**$ 850,000**
	Total costs	**$ 935,000**	**$ 85,000**	**$ 85,000**	**$ 85,000**	**$ 85,000**	**$ 85,000**	**$ 85,000**	**$ 85,000**	**$ 85,000**	**$ 85,000**	**$ 1,700,000**
Estimate additional cost per tonne of particulate matter suppressed from TSP, PM10 and PM2.5*	TSP	$ 7,333,333	$ 666,667	$ 666,667	$ 666,667	$ 666,667	$ 666,667	$ 666,667	$ 666,667	$ 666,667	$ 666,667	**$ 13,333,333**
	PM10	$ 7,791,667	$ 708,333	$ 708,333	$ 708,333	$ 708,333	$ 708,333	$ 708,333	$ 708,333	$ 708,333	$ 708,333	**$ 14,166,667**
	PM2.5	$124,666,667	$11,333,333	$11,333,333	$11,333,333	$11,333,333	$11,333,333	$11,333,333	$11,333,333	$11,333,333	$11,333,333	**$226,666,667**
Cost saving from implementing each best practice measure (list each item)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
	Total savings	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
	Net costs	**$ 935,000**	**$ 85,000**	**$ 85,000**	**$ 85,000**	**$ 85,000**	**$ 85,000**	**$ 85,000**	**$ 85,000**	**$ 85,000**	**$ 85,000**	**$ 1,700,000**
Estimate net cost per tonne of particulate matter suppressed for TSP, PM10 and PM2.5 *	TSP	$ 7,333,333	$ 666,667	$ 666,667	$ 666,667	$ 666,667	$ 666,667	$ 666,667	$ 666,667	$ 666,667	$ 666,667	$ 13,333,333
	PM10	$ 7,791,667	$ 708,333	$ 708,333	$ 708,333	$ 708,333	$ 708,333	$ 708,333	$ 708,333	$ 708,333	$ 708,333	$ 14,166,667
	PM2.5	$124,666,667	$11,333,333	$11,333,333	$11,333,333	$11,333,333	$11,333,333	$11,333,333	$11,333,333	$11,333,333	$11,333,333	$ 226,666,667

Cost of Implementation for Water Sprays

MINING ACTVITY	Wind Erosion and maintenance by dozer - Coal Stockpiles											
Specific best practice measure	Water Sprays (50%)											
Mass emissions through application of best practice (tonnes/year)	TSP	31.9										
	PM10	8.6										
	PM2.5	0.7										
Current emissions (tonnes/year) - current control 0%	TSP	63.7										
	PM10	17.1										
	PM2.5	1.5										
Total emission reduction from use of best practice measure (tonnes/year)	TSP	32										
	PM10	9										
	PM2.5	1										
Year		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Cost specific capital items (list each item)	Pipes, fog cannon sprinklers etc incl. installation	$ 5,000,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 5,000,000**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Total capital costs		**$5,000,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 5,000,000**
Labour costs including directly related on-costs (list each item)	Maintenance and operating costs	$ 400,000	$ 400,000	$ 400,000	$ 400,000	$ 400,000	$ 400,000	$ 400,000	$ 400,000	$ 400,000	$ 400,000	**$ 4,000,000**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Cost of specific materials and other items (list each item)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Total material and other costs		**$ 400,000**	**$ 400,000**	**$ 400,000**	**$ 400,000**	**$ 400,000**	**$ 400,000**	**$ 400,000**	**$ 400,000**	**$ 400,000**	**$ 400,000**	**$ 4,000,000**
Total costs		**$5,400,000**	**$ 400,000**	**$ 400,000**	**$ 400,000**	**$ 400,000**	**$ 400,000**	**$ 400,000**	**$ 400,000**	**$ 400,000**	**$ 400,000**	**$ 9,000,000**
Estimate additional cost per tonne of particulate matter suppressed from TSP, PM10 and PM2.5*	TSP	$ 169,545	$ 12,559	$ 12,559	$ 12,559	$ 12,559	$ 12,559	$ 12,559	$ 12,559	$ 12,559	$ 12,559	**$ 282,575**
	PM10	$ 630,841	$ 46,729	$ 46,729	$ 46,729	$ 46,729	$ 46,729	$ 46,729	$ 46,729	$ 46,729	$ 46,729	**$ 1,051,402**
	PM2.5	$ 7,346,939	$ 544,218	$ 544,218	$ 544,218	$ 544,218	$ 544,218	$ 544,218	$ 544,218	$ 544,218	$ 544,218	**$ 12,244,898**
Cost saving from implementing each best practice measure (list each item)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Total savings		**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Net costs		**$5,400,000**	**$ 400,000**	**$ 400,000**	**$ 400,000**	**$ 400,000**	**$ 400,000**	**$ 400,000**	**$ 400,000**	**$ 400,000**	**$ 400,000**	**$ 9,000,000**
Estimate net cost per tonne of particulate matter suppressed for TSP, PM10 and PM2.5 *	TSP	$ 169,545	$ 12,559	$ 12,559	$ 12,559	$ 12,559	$ 12,559	$ 12,559	$ 12,559	$ 12,559	$ 12,559	$ 282,575
	PM10	$ 630,841	$ 46,729	$ 46,729	$ 46,729	$ 46,729	$ 46,729	$ 46,729	$ 46,729	$ 46,729	$ 46,729	$ 1,051,402
	PM2.5	$ 7,346,939	$ 544,218	$ 544,218	$ 544,218	$ 544,218	$ 544,218	$ 544,218	$ 544,218	$ 544,218	$ 544,218	$ 12,244,898

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	0.0										
	PM10	0.0										
	PM2.5	0.0										
Current emissions (tonnes/year) - current control 40%	TSP	0.0										
	PM10	0.0										
	PM2.5	0.0										
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)	Supply materials and install	$ 450,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 450,000**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
	Total capital costs	**$ 450,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 450,000**
Labour costs including directly related on-costs (list each item)	Maintenance	$ 4,500	$ 4,500	$ 4,500	$ 4,500	$ 4,500	$ 4,500	$ 4,500	$ 4,500	$ 4,500	$ 4,500	**$ 45,000**
	Operational access to conveyor	$ 112,500	$ 112,500	$ 112,500	$ 112,500	$ 112,500	$ 112,500	$ 112,500	$ 112,500	$ 112,500	$ 112,500	**$ 1,125,000**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Cost of specific materials and other items (list each item)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
	Total material and other costs	**$ 117,000**	**$ 117,000**	**$ 117,000**	**$ 117,000**	**$ 117,000**	**$ 117,000**	**$ 117,000**	**$ 117,000**	**$ 117,000**	**$ 117,000**	**$ 1,170,000**
	Total costs	**$ 567,000**	**$ 117,000**	**$ 117,000**	**$ 117,000**	**$ 117,000**	**$ 117,000**	**$ 117,000**	**$ 117,000**	**$ 117,000**	**$ 117,000**	**$ 1,620,000**
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	**$ 567,000**	**$ 117,000**	**$ 117,000**	**$ 117,000**	**$ 117,000**	**$ 117,000**	**$ 117,000**	**$ 117,000**	**$ 117,000**	**$ 117,000**	**$ 1,620,000**
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!

Note: emissions were not estimated for wind erosion from conveyors, as emissions were expected to be minor. Therefore cost per tonne of PM suppressed could not be calculated.

Cost of Implementation for Wind Shielding on Conveyors (one wall)

MINING ACTVITY	Conveyors and Transfers											
Specific best practice measure	Wind Shielding - roof and 1 side wall											
Mass emissions through application of best practice (tonnes/year)	TSP	0.0										
	PM10	0.0										
	PM2.5	0.0										
Current emissions (tonnes/year) - current control 40%	TSP	0.0										
	PM10	0.0										
	PM2.5	0.0										
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)	Supply materials and install	$ 250,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 250,000**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
	Total capital costs	**$ 250,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 250,000**
Labour costs including directly related on-costs (list each item)	Maintenance	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	**$ 25,000**
	Operational access to conveyor	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	**$ 250,000**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Cost of specific materials and other items (list each item)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
	Total material and other costs	**$ 27,500**	**$ 27,500**	**$ 27,500**	**$ 27,500**	**$ 27,500**	**$ 27,500**	**$ 27,500**	**$ 27,500**	**$ 27,500**	**$ 27,500**	**$ 275,000**
	Total costs	**$ 277,500**	**$ 27,500**	**$ 27,500**	**$ 27,500**	**$ 27,500**	**$ 27,500**	**$ 27,500**	**$ 27,500**	**$ 27,500**	**$ 27,500**	**$ 525,000**
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	**$ 277,500**	**$ 27,500**	**$ 27,500**	**$ 27,500**	**$ 27,500**	**$ 27,500**	**$ 27,500**	**$ 27,500**	**$ 27,500**	**$ 27,500**	**$ 525,000**
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!

Note: emissions were not estimated for wind erosion from conveyors, as emissions were expected to be minor. Therefore cost per tonne of PM suppressed could not be calculated.