MAC-ENC-PRG-003

ASSESSMENT OF COAL MINE PARTICULATE MATTER CONTROL BEST PRACTICE
POLLUTION REDUCTION PROGRAM

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1. Introduction

Hunter Valley Energy Coal Pty Ltd (HVEC) operates the Mt Arthur Coal complex which consists of approved open cut and underground mining operations, a rail loop and associated rail loading facilities. The operations are located in the Upper Hunter Valley, NSW approximately five kilometres south west of Muswellbrook. In FY 2011, Mt Arthur Coal produced 16.5 million tonnes per annum (mtpa) coal for domestic and overseas markets, and is currently in a major growth phase, with approval to mine up to 36 Mtpa coal from open cut and underground mining methods.

Mt Arthur Coal complies with stringent air quality requirements, and consistently trials and implements best practice measures to reduce particulate emissions and its impact on surrounding communities. This review of best practice management is seen as an opportunity to continue to improve dust management practices at Mt Arthur Coal as the mine continues to grow.

1.1 Background

In December 2010, the NSW Office of Environment and Heritage (OEH) published the draft best practice document '*NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining*' (OEH, 2011a). The 'Best Practice Report' was finalised in June 2011.

As an outcome of the Best Practice Report, OEH developed a Pollution Reduction Program (PRP) that requires Mt Arthur Coal 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 has been attached to the Mt Arthur Coal Environmental Protection Licence (EPL 11457) as varied on 8 August 2011. The *'Coal Mine Particulate Matter Control Best Practice – Site Specific Determination Guideline'* (OEH, 2011b) was utilised in the preparation of this assessment report. Table 1-1 presents a summary of the determination guideline requirements and a reference to the relevant section in this report.

Table 1-1: PRP Guideline Requirements and Report Reference

Guideline Requirement			Report Reference
1)	Identify, quantity and justify 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 2.2
		c. Identify the top four mining activities that contribute the highest emissions of TSP, PM_{10} and $PM_{2.5}$	Section 2.3
2)	Identify, quantity and justify measures 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 3.1
		b. For each of the top four activities identified in Step 1(c) estimate emissions of TSP, PM10 and PM2.5 from each mining activity following the application of the measures identified in Step 2 (a)	Section 3.2
3)	Evaluate 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: • Implementation status; • Regulatory requirements; • Environmental impacts; • Safety implications; and • Compatibility with current processes and proposed future developments.	Section 4.1
		b. Identify those best practices that will be implemented at the premises to reduce particle emissions.	Section 4.2
4)	Propose a 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 4.3

1.2 Mining activity and associated emission factors

In the context of this report, the determination guideline (OEH, 2011b) defines mining activities as listed below. The relevant emission factors for each of these activities are presented in Table 1-2.

- Wheel generated particles on unpaved roads;
- Wind erosion of overburden;
- Loading and dumping overburden;
- Blasting;
- Bulldozing coal;
- Trucks unloading overburden;
- Bulldozing overburden;
- Front-end loaders on overburden;
- Wind erosion of exposed areas;
- Wind erosion of coal stockpiles;
- Unloading from coal stockpiles;
- Dragline;
- Trucks unloading coal;
- Loading coal stockpiles;
- Graders;
- Drilling;
- Coal crushing;
- Material transfer of coal;
- Scrapers on overburden;
- Train loading;
- Screening; or
- Material transfer of overburden.

Not all of these activities occurred at Mt Arthur Coal during the FY11 baseline and the associated emission factors have been marked as not applicable (N/A) in Table 1-2. Section 2 presents the calculated emissions for the activities relevant to Mt Arthur Coal.

Table 1-2: Emission Factors

PRP activity	Units	TSP Emission Factor	PM_{10} Emission Factor	$PM_{2.5}$ Emission Factor	Source
Wheel generated particulates on unpaved roads	kg/VKT	$\left(\frac{0.4536}{1.6093}\right) \times 4.9 * \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 1.5 * \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 0.15 * \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	AP-42 13.2.2
Wind erosion of overburden[(a)]	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 Table 11.9-4
Loading and dumping overburden	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
Blasting	kg/blast	$0.00022 \times A^{1.5}$	0.52 * TSP	0.03 * TSP	AP-42 11.9 Table 11.9-2
Bulldozing coal	kg/t	$35.6 \times \frac{s^{1.2}}{M^{1.3}}$	$6.33 \times \frac{s^{1.5}}{M^{1.4}}$	0.022 x TSP	AP-42 11.9 Table 11.9-2
Trucks unloading overburden	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
Bulldozing overburden & front-end loaders on overburden	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 Table 11.9-2
Wind erosion of exposed areas[(a)]	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 Table 11.9-4
Wind erosion of 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 Table 11.9-2
Unloading from coal stockpiles	kg/t	$\frac{0.580}{M^{1.2}}$	$\frac{0.0447}{M^{0.9}}$	0.019 * TSP	AP-42 11.9 Table 11.9-2
Dragline[N/A]	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 Table 11.9-2
Trucks unloading coal	kg/t	$\frac{0.580}{M^{1.2}}$	$\frac{0.0447}{M^{0.9}}$	0.019 * TSP	AP-42 11.9 Table 11.9-2
Loading coal stockpiles	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 (Note: AP-42 11.9 Table 11.9-4 has Train loading emission factor but footnote direct user to Chapter 13 for more accurate emissions factors.)
Graders	kg/VKT	$0.0034 \times S^{2.5}$	$0.00336 \times S^{2.0}$	$0.0001054 \times S^{2.5}$	AP-42 11.9 Table 11.9-2
Drilling overburden	kg/hole	0.59	0.52 * TSP	0.03 * TSP	AP-42 11.9 Table 11.9-4

PRP activity	Units	TSP Emission Factor	PM_{10} Emission Factor	$PM_{2.5}$ Emission Factor	Source
			(PM_{10} ratio assumed same as blasting AP-42 11.9 Table 11.9-2)	($PM_{2.5}$ ratio assumed same as blasting AP-42 11.9 Table 11.9-2)	
Drilling coal[N/A]	kg/hole	0.1	0.52 * TSP (PM_{10} ratio assumed same as blasting AP-42 11.9 Table 11.9-2)	0.03 * TSP ($PM_{2.5}$ ratio assumed same as blasting AP-42 11.9 Table 11.9-2)	AP-42 11.9 Table 11.9-4
Coal crushing[(c)]	kg/t	0.0027	0.0012	No data	AP-42 11.19.2 Table 11.19.2-2
Material transfer of coal	kg/t	$\frac{0.580}{M^{1.2}}$	$\frac{0.0447}{M^{0.9}}$	0.019 * TSP	AP-42 11.9 Table 11.9-2
Scrapers on overburden	kg/t	0.029 [(b)]	No data	No data	AP-42 11.9 Table 11.9-4
Train loading	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 (Note: AP-42 11.9-7 Table 11.9-4 has default train loading emission factor but footnote directs user to Chapter 13 for more accurate emissions factors.)
Screening[(c)]	kg/t	0.0125	0.0043	No data	AP-42 11.19.2 Table 11.19.2-1
Material transfer of overburden	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

Where:

A	=	horizontal area (m2)
M	=	material moisture content (%)
s	=	material silt content (or surface silt content in unpaved roads) (%)
u	=	wind speed (m/s)
d	=	drop height (m)
W	=	mean vehicle weight (tonnes)
S	=	mean vehicle speed (km/h)

Notes:

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 to Hunter Valley 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 approach has been adopted. This is considered both conservative and applicable to the estimation of wind erosion emissions over the longer term.

b) The equation referenced relates to topsoil removal by scraper. No data is provided within the AP-42 relating to scraper activity on overburden. Nor is this activity identified within the activities conducted at Mt Arthur Coal.

c) Coal crushing and screening take place in an enclosed building and are considered such minor sources of emissions that they have not been considered further.

N/A – these activities did not take place at Mt Arthur Coal during FY11.

2. Existing measures used to minimise particle emissions

2.1 Estimated baseline emissions

In accordance with Step 1a of the PRP requirement (see Table 1-1), emissions of current activities have been calculated:

a) with no controls in place (modelled emissions); and

b) taking into account all the controls currently implemented to control dust at Mt Arthur Coal (modelled emissions).

TSP, PM_{10} and $PM_{2.5}$ emission estimates have been calculated for mining activities that occurred between July 2010 and June 2011 (the baseline period) at Mt Arthur Coal, using the relevant US EPA AP42 emission factors as listed in Table 1-2. The assumptions used to calculate the emissions (i.e. activity intensity and location) are provided in Supplement 1.

For the purposes of this report exposed areas primarily included the active pit and areas actively rehabilitated. The remaining disturbed areas were classified as either overburden or coal stockpiles.

The following terminology of some of the PRP activities as named in Section 1.2 and Table 1-2 has been modified throughout the report to provide further clarity:

- *Wheel generated particles on unpaved roads* – modified to 'Hauling on unpaved roads'.
- *Loading and dumping overburden* – identified as an apparent duplicate of the PRP activities 'Trucks unloading overburden' and 'Material transfer of overburden' (already included in Section 1.2 and Table 1-2).
- *Material transfer of overburden* – modified to 'Material transfer of overburden (loading OB)' to account for apparent duplicate outlined above.
- *Drilling* – separated into two categories ('Drilling overburden' and 'Drilling coal') as there is a different emission factor calculation corresponding to each material type.
- *Material transfer of coal* – modified to 'Material transfer of coal (loading trucks).

2.1.1. Modelled emissions – no controls

A summary of the modelled emissions without particulate matter controls is provided in Table 2-1.

It is important to note that these calculations are provided in accordance with the PRP guideline only and do not reflect actual emissions from Mt Arthur Coal, as particulate matter controls are currently applied to most activities, as detailed in Section 2.1.2.

Table 2-1: Summary of modelled particulate matter emissions with no controls in place – current activities (tonnes per year)

ACTIVITY	TSP	PM_{10}	$PM_{2.5}$
Drilling overburden	56.8	29.6	1.7
Blasting	190.9	99.3	5.7
Material transfer of overburden (loading OB)	363.8	172.1	26.1
Hauling on unpaved roads	15088.1	3508.2	350.8
Trucks unloading overburden	363.8	172.1	26.1
Bulldozing overburden and rehab	1368.8	330.8	143.7
Bulldozing Coal	539.1	123.3	11.9
Material transfer of coal (loading trucks)	823.4	118.4	15.6
Trucks unloading coal	822.9	118.3	15.6
Loading coal stockpiles	3.3	1.6	0.2
Train loading	3.3	1.6	0.2
Wind erosion of overburden	438.5	219.2	32.9
Wind erosion of exposed areas	50.8	25.4	3.8
Wind erosion of coal stockpiles	1482.1	741.1	111.2
Graders	188.2	65.8	5.8
Total	**21,784**	**5,727**	**751**

2.1.2. Modelled emissions – current controls

2.1.2.1. Current dust control strategies at Mt Arthur Control

In April 2011, a detailed review of dust control strategies in place at Mt Arthur Coal was completed by PAEHolmes and Glade Consulting. A site visit was completed together with interviews of relevant site personnel.

Table 2-2 to Table 2-11 present a summary of the best management controls as identified in OEH, 2011a, that were observed to be in operation at Mt Arthur Coal during the review and/or confirmed with relevant personnel, and the control efficiency applied to the emission calculations. It is important to note that not all controls in place have a specific control efficiency associated with the calculation of emissions, even though the control measure will reduce the total emissions of the activity (eg no blasting in adverse weather). In Table 2-2 to Table 2-11, “No control applied” has been noted where there is no control efficiency available to apply in the emission calculation.

Table 2-12 summarises the controls that can be directly applied to the emissions calculations to achieve a reduction in emission quantity.

It is important to note that not all dust management strategies in place at Mt Arthur Coal have a specific control efficiency associated with the calculation of emissions. For example:

- operations are modified in adverse weather conditions. Haul truck/dozer/scraper operation are ceased until water cart applies water to working area;
- two additional water carts have recently been added to the fleet;
- topsoil stripping operations have a dedicated water cart;
- Mt Arthur Coal has partially enclosed product coal delivery conveyor loading points;
- rehabilitation goals are set each financial year and reported on in the Annual Environmental Management Report.

Table 2-2: **Management of particulate matter from haul roads**

Control	April 2011 Dust Review Findings	Control Efficiency Applied to Emission Calculations (%)
Covered product trucks	Not applicable All product coal transported by rail or conveyor.	No control applied
Haul road watering	Yes Mining operational areas watered with up to five water carts. Mt Arthur Coal has a program that requires all operators to actively monitor road conditions and to call for water carts when required (above wheel height). However this is subjective and consistency of application has not been assessed. Note: Since the April review, a total of two new water carts have been added to the fleet.	84%
Chemical dust suppressant on unsealed roads	Partial RT9 (a non-hazardous liquid polymer) used on red rock gravel roads (water only on mudstone based roads). Red rock gravel used on all longer-term roads in the mine.	
Road sweeping	Partial Sealed roads (entrance road, car park and light traffic areas around the administration office, coal handling and preparation plant and workshop) are swept as required.	No control applied
Road grading	Yes Including maintenance of drainage design features at intersections (cross fall or camber).	No control applied
Road Design Ramps less than 8% Eliminate sweeping intersections Avoid potential equipment interactions	Partial Mt Arthur Coal ramp standard limits slopes to 10%. Site has one sweeping intersection designed to minimise cycle times. Haul roads are designed to minimise vehicle interactions.	No control applied
Permanent sealing site roads	Partial Entrance road, car park and light traffic areas (around the admin office, coal handling and preparation plant and workshop) have sealed roads. Mt Arthur Coal currently achieves the best possible result as it is not feasible to seal a road used by a haul truck.	No control applied

Control	April 2011 Dust Review Findings	Control Efficiency Applied to Emission Calculations (%)
Dust shaker grid[a]	No	No control applied
Maintain all sealed roads	Yes	No control applied
Minimise haul distances	No Limited by mine design – mine progressing west away from infrastructure.	No control applied
Well defined haul routes	Yes	No control applied
Speed limits on haul roads (40km/hr)	Partial Mt Arthur Coal haul road speed limit is 60 kilometres per hour with an alarm speed monitoring system implemented.	No control applied
Grader speed reduction from 16km/hr to 8km/hr	Yes First and second gear operating speeds up to 7 kilometres per hour with an alarm speed monitoring system implemented.	No control applied
Watering during peak activity periods (shift changes)	Yes Interview with open cut examiner confirmed staggered change over at shift change/crib break, allowing watering to continue.	No control applied
Larger trucks	Partial 328-tonne and 240-tonne capacity trucks used for overburden removal. 180-tonne capacity trucks used for coal recovery.	No control applied as the emission equation for hauling on upaved roads includes the mass of vehicles.

Note:
a) Dust shaker grid or rumble strips are used to remove loose material from a vehicle by vibration as the vehicle travels across the grid or strip.

Table 2-3: Management of particulate matter from wind erosion

Control	April 2011 Dust Review Findings	Control Efficiency Applied to Emission Calculations (%)
Water exposed areas/active areas	No Majority of exposed areas is inaccessible by water cart.	No control applied
Topsoil stripping when moisture is elevated but not sodden	No Timing of topsoil stripping/clearing driven by need to minimise impacts on fauna - generally undertaken during the months of September, October, March, April and May, with rainfall higher in the summer months. Procedures do not require an assessment of topsoil moisture prior to stripping. In 2010, 135,431 cubic metres of topsoil was stripped.	No control applied
Chemical dust suppressants	No	No control applied
Coal Stockpile moisture content measured and controlled	Yes Measured as part of spontaneous combustion management. Stockpile life cycles are closely monitored. Water sprays are used to control moisture content.	No control applied
Wind barriers	No	No control applied
Water application by fixed sprays or water cart on run-of-mine (ROM) Pad	Yes Water cart observed on run-of-mine pad.	No control applied
Suppressant on ROM stockpiles	No	No control applied
Rehabilitate temporary landform	Yes In 2010, aerial seeding trial (185 hectares) of temporary landform. Note: Approximately 260 hectares of aerial seeding has been undertaken since the April review.	70% to areas being actively rehabilitated
Progressive final rehabilitation	Yes 909 hectares rehabilitated (30% of area disturbed).	No control applied
Seeding topsoil	Yes Topsoil stockpiles sighted had vegetation cover (mainly weeds). Stockpiled topsoil as at 30 December 2010 was 4,193,283 cubic metres.	70% to areas being actively rehabilitated
Use of ameliorants to improve soil	No	No control applied
Hydraulic mulch seeding	No Hydromulching has been used in limited situations.	No control applied
Use of Organic Growth Medium (OGM)	No Note: Since the April review organic matter has been added to topsoil in most areas that have been rehabilitated.	No control applied
Rehabilitation Strategy	No DA09-0062 requires a rehabilitation strategy to be developed by 2012*. Note: Since the April review, a Mt Arthur Coal Rehabilitation Strategy has been drafted and lodged with the Department of Planning and Infrastructure for approval.	No control applied

* Rehabilitation commitments are incorporated into the Mt Arthur Coal Complex Open Cut Mining Operations Plan and communicated annually in the Annual Environmental Management Report.

Table 2-4: Management of particulate matter from bulldozing

Control	April 2011 Dust Review Findings	Control Efficiency Applied to Emission Calculations (%)
Keep travel routes and material moist	During this review, the use of water carts was observed and during the inspection of the mining area, travel routes were well watered. The material moved with dozers is not actively kept watered at Mt Arthur Coal, however recently disturbed material is inherently moist.	No control applied as only travel routes kept moist.

Table 2-5: Management of particulate matter from blasting

Control	April 2011 Dust Review Findings	Control Efficiency Applied to Emission Calculations (%)
No Blasting during adverse weather conditions	Yes Prior to each blast, a pre-blast environmental assessment is conducted. This reviews wind speed, wind direction, temperature inversions and the location and size of blast. Blasts are postponed if environmental conditions are unfavourable.	No control applied
Blast during day only	Yes	No control applied
Advise local residents of blasting times	Yes	No control applied
Gravel stemming blast holes	Yes All blast holes are stemmed to ensure blast efficiency and reduce overpressure effects. Use of suitable quality stemming material – being either drill cuttings, rock sourced from site or imported gravel, when necessary.	No control applied
Blast protocol	Yes	No control applied
Coordination with surrounding mines	Yes A blasting window has been agreed with neighbouring mines and blasts generally are fired accordingly.	No control applied
Design: Minimise area blasted	No Open cut examiner interviewed indicated that some virgin areas are first dug with excavator and no blasting required – dependant on geology.	No control applied

Table 2-6: Management of particulate matter from drilling

Control	April 2011 Dust Review Findings	Control Efficiency Applied to Emission Calculations (%)
Drill rigs have dust curtains	Yes	No control applied
Water sprays on the drill	Yes	70%
Fabric filters on the drill - Dry collection: Air extraction to a filter bag (fabric filter cycle)	No	No control applied
No drilling in adverse weather	No	No control applied
Drill area moistened	No	No control applied

Table 2-7: Management of particulate matter from loading and dumping overburden in the GMR – open cut mines and combined open cut and underground mines

Control	April 2011 Dust Review Findings	Control Efficiency Applied to Emission Calculations (%)
Water sprays or boom spray on water cart	Yes	50%
Automatic water sprays	No	No control applied
Minimise drop height(1)	No The dump height at Mt Arthur Coal is greater than 10 metres on the outside of VD1.	No control applied
Suspension or modification of operations during adverse weather	Yes Real-time monitoring systems and a SMS alarming system are used to alert open cut examiners when dust emissions are approaching criteria, so operations can be modified. If there is excessive dust on site and insufficient available water carts then operations are suspended/modified.	No control applied
No dumping on high emplacements in strong winds	Yes Including avoid tipping into strong headwinds.	No control applied

Notes:
(1) Minimising the drop height from excavator to truck and truck to ground would minimise emissions. Truck dumps with a drop greater than 6metres are recommended to have a stacking tube or full enclosure of the dump (Katestone section 9.7).

Table 2-8: Management of particulate matter from run-of-mine (ROM) pad(1)

Control	April 2011 Dust Review Findings	Control Efficiency Applied to Emission Calculations (%)
Automatic water sprays whilst dumping into ROM hopper	Yes	85%
ROM hopper enclosure of three sides and a roof	Yes	
Water application by fixed spray or water cart on ROM pad	Yes – water carts are used on the ROM pad.	No control applied
Enclosure with fabric filter (2)	No	No control applied

Notes
(1) Mt Arthur Coal aims to minimise the amount of material that was stockpiled on the ROM pad, with coal being dumped directly into the ROM bin whenever possible. This practice avoids particulate emissions associated with double handling of coal and wind erosion.
(2) None of the mines surveyed were utilising this management control. An enclosed ROM hopper with a control device provides 90-98 percent effectiveness in reducing particulate emissions, compared to a three sided and roofed enclosure with water sprays that provides 85 percent effectiveness.

Table 2-9: Management of particulate matter from conveyors and transfers

Control	April 2011 Dust Review Findings	Control Efficiency Applied to Emission Calculations (%)
Conveyor wind shielding – roof	Yes	Due to the negligible emissions from conveyor operations, emissions have not been explicitly assessed and as such no control applied
Conveyor wind shielding – one or two sides	Yes Roof and side.	
Waters sprays at transfers	Yes	
Enclosed transfers	Yes	
Soft-loading chutes	Yes	
Belt cleaning and spillage minimisation on conveyors	Yes Periodically cleaned.	

Table 2-10: Management of particulate matter from materials handling

Control	April 2011 Dust Review Findings	Control Efficiency Applied to Emission Calculations (%)
Water sprays or boom spray on water cart	Stockpile sprays start automatically (three settings) in windy conditions (>6 metres per second) – dependant on coal quality.	No control applied
Active site area cleaned regularly	Yes Contract cleaning crew are utilised.	
Coal sizer ventilated through filter	No	
Variable height stacker or tripper with chute/windshield	No	
Bucket wheel, portal or bridge reclaimer	No Coal reclaimed from stockpile with under-stockpile conveyors (reclaim tunnel). Reclaim tunnel with minimal mechanical disturbance recognised as a control measure, but effectiveness not assessed.	
Dust extractor system at CHPP	N/A – dust extraction would not be appropriate as the coal preparation is largely a wet process. The plant is also located within an enclosed building for dust minimisation.	

Table 2-11: Management of particulate matter from materials handling

Control	April 2011 Dust Review Findings	Control Efficiency Applied to Emission Calculations (%)
Use of profilers to manage overloading or under loading of wagons	Yes	No control applied
Maintain a consistent profile (loading via front-end loaders and clam shells produces uneven loads that are susceptible to spillage and reduce the effectiveness of suppressants)	Yes	
Maintaining the 100 mm freeboard around the edge of the wagon	Yes	
Application of a suppressant to the surface of the coal profile	Not applicable All product coal transported by rail or conveyor.	
Removing parasitic coal from the surface of the wagons before leaving the mine site	Not applicable All product coal transported by rail or conveyor.	
Covering load (e.g. tarpaulins or lid)	Not applicable All product coal transported by rail or conveyor.	
Wagon wheel wash	Not applicable All product coal transported by rail or conveyor.	

The control factor applied to the emission calculations are listed in Table 2-12.

Table 2-12: Summary of current dust controls and level of control applied

Mining Activity	Control measure currently in place	Level of control applied (%)	OEH 2011a reference
Drilling	Water sprays.	70	Table 82[a]
Hauling on unsealed roads	Dust suppressants.	84	Table 66
Truck or loader dumping ROM coal at ROM pad	Water sprays on run-of-mine pad.	50	Table 90
Truck or loader dumping to ROM bin	Enclosed dump hopper (three sides and a roof) plus water sprays.	85	Table 95
Loading coal stockpiles	Boom tip water sprays.	50	Table 97
Reclaiming product coal (unloading product stockpiles)	Underground therefore no emissions.	100	Table 97[b]
Wind erosion of exposed areas	Vegetative ground cover.	70 (applied to active rehab areas only)	Table 71
Wind erosion of coal stockpiles	Water sprays.	50	Table 72

Notes:

a) OEH 2011a provides a range between 3 percent and 95 percent control for use of water sprays while drilling. The value of 70% is provided in the NPI Emission Estimation Technique Manual (NPI, 2011) and has been adopted for this report.

b) The control effectiveness of underground reclaim is not specifically addressed in OEH, 2011a. However, it is noted that use of a reclaim results in minimal mechanical disturbance and operational experience has demonstrated no emissions are generated from this activity.

Emissions with current particulate matter controls identified in Table 2-12 were calculated taking into account control factors for the identified particulate matter controls that Mt Arthur Coal has in place.

A summary of the emissions with current particulate matter controls in place is provided in Table 2-13.

Table 2-13: Summary of particulate matter emissions with current controls in place – current activities (tonnes per year)

ACTIVITY	TSP	PM_{10}	$PM_{2.5}$
Drilling	17.0	8.9	0.5
Blasting	190.9	99.3	5.7
Material transfer of overburden (loading OB)	363.8	172.1	26.1
Hauling on unpaved roads	2411.8	560.7	56.1
Trucks unloading overburden	363.8	172.1	26.1
Bulldozing overburden and rehab	1368.8	330.8	143.7
Bulldozing coal	539.1	123.3	11.9
Material transfer of coal (loading trucks)	823.4	118.4	15.6
Trucks unloading coal	123.4	17.8	2.3
Loading coal stockpiles	1.7	0.8	0.1
Train loading	3.3	1.6	0.2
Wind erosion of overburden	438.5	219.2	32.9
Wind erosion of exposed areas	47.3	23.6	3.5
Wind erosion of coal stockpiles	741.1	370.5	55.6
Graders	94.1	32.9	2.9
Total	**7,528**	**2,252**	**383**

2.2 Activities Rank

The calculated emissions from the current mining activities (current controls in place) listed in Table 2-13 were ranked from highest to lowest according to their total emissions. The rank of each activity differs depending on the particle size, and so three sets of results are presented in Table 2-14.

Table 2-14: Ranked activities by mass emissions – current activities

Rank	Mining Activity	Emissions (t/y)
	TSP	
1	Hauling on unpaved roads	2,411.8
2	Bulldozing overburden and rehabilitation	1,368.8
3	Material transfer of coal (loading trucks)	823.4
4	Wind erosion of coal stockpiles	741.1
5	Bulldozing coal	539.1
6	Wind erosion of overburden	438.5
7	Material transfer of overburden (loading overburden)	363.8
8	Trucks unloading overburden	363.8
9	Blasting	190.9
10	Trucks unloading coal	123.4
11	Graders	94.1
12	Wind erosion of exposed areas	47.3
13	Drilling	17.0
14	Train loading	3.3
15	Loading coal stockpiles	1.7
	PM_{10}	
1	Hauling on unpaved roads	526.2
2	Wind erosion of coal stockpiles	370.5
3	Bulldozing overburden and rehabilitation	330.8
4	Wind erosion of overburden	219.2
5	Material transfer of overburden (loading overburden)	172.1
6	Trucks unloading overburden	172.1
7	Bulldozing coal	123.3
8	Material transfer of coal (loading trucks)	118.4
9	Blasting	99.3
10	Graders	32.9
11	Wind erosion of exposed areas	23.6
12	Trucks unloading coal	17.8
13	Drilling	8.9
14	Train loading	1.6
15	Loading coal stockpiles	0.8
	$PM_{2.5}$	
1	Bulldozing overburden and rehabilitation	143.7
2	Wind erosion of coal stockpiles	55.6
3	Hauling on unpaved roads	52.6
4	Wind erosion of overburden	32.9
5	Material transfer of overburden (loading overburden)	26.1
6	Trucks unloading overburden	26.1
7	Material transfer of coal (loading trucks)	15.6
8	Bulldozing coal	11.9
9	Blasting	5.7
10	Wind erosion of exposed areas	3.5
11	Graders	2.9
12	Trucks unloading coal	2.3
13	Drilling	0.5
14	Train loading	0.2
15	Loading coal stockpiles	0.1

2.3 Highest particulate matter emitting activities

The top four ranked current activities according to mass particulate emissions (current controls in place) are listed in Table 2-15 for TSP, PM_{10} and $PM_{2.5}$.

Table 2-15: Top four activities for each particle size group (mass) – current activities

Rank	Mining Activity
TSP	
1	Hauling on unpaved roads
2	Bulldozing overburden and rehabilitation
3	Material transfer of coal (loading trucks)
4	Wind erosion of coal stockpiles
PM_{10}	
1	Hauling on unpaved roads
2	Wind erosion of coal stockpiles
3	Bulldozing overburden and rehabilitation
4	Wind erosion of overburden
$PM_{2.5}$	
1	Bulldozing overburden and rehabilitation
2	Wind erosion of coal stockpiles
3	Hauling on unpaved roads
4	Wind erosion of overburden

3. Best Practice Measures (BPM)

3.1 BPM available for top four highest PM contributors

Table 3-1 presents the best practice measures available for each of the current activities identified in as contributing to the top four on an emissions basis for each of the particle size fractions.

3.2 Estimated resultant emissions

Table 3-2 presents the resultant emissions of TSP, PM_{10} and $PM_{2.5}$ for current activities after applying the best practice measures identified in Table 3-1. The highlighted values show measures that would result in higher emissions than current operations.

Table 3-1: Best practice measures available to control Top 4 emissions in baseline

Activity	OEH 2011a reference	Best practice		In use at Mt Arthur Coal	% reduction per OEH 2011a	Size fraction
Hauling on unpaved roads	Table 66	Vehicle speed restrictions	Reduction from 65 km/hr to 30 km/hr[(a)]	Y	50-85%[(b)]	All
			Grader speed reductions form 16km/h to 8km/h[(c)]	Y	N/A	
		Surface improvements	Pave the surface	N	>90%	
			Low silt aggregate	Y	30% [(d)]	
			Oil and double chip surface	N	80%	
		Surface treatments	Watering (standard procedure)	N/A[(e)]	10-74%	
			Watering Level 1 (2 L/m^2/h)	N/A[(e)]	50%	
			Watering Level 2 (>2 L/m^2/h)	Y	75%	
			Watering grader routes	Y	50%	
			Watering twice a day for industrial unpaved road	N/A[(e)]	55%	
			Suppressants	Y	84%	
			Hygroscopic salts	N/A[(e)]	45%-82%[(f)]	
			Lignosulphonates	N/A[(e)]	66-70% (over 23 days)	
			Polymer emulsions	N/A[(e)]	70% over 58 days	
			Tar and bitumen emulsions	N/A[(e)]	70% over 20 days	
		Other	Use of larger vehicles	In part	90t to 220t: 40% 140t to 220t; 20% 140t to 360t: 45%	
			Conveyors	N	>95%	
Bulldozing overburden	Table 76	Travel routes and material kept moist		In part[(g)]	50%	All
Material transfer of coal (loading trucks)	Table 95	No controls are identified for the loading of run-of-mine coal in-pit		N/A	-	TSP
Wind erosion of coal stockpiles	Table 72	Avoidance	Bypassing stockpiles	N	100%	All
		Surface stabilisation	Water sprays	Y	50%	
			Chemical wetting agents	N	80-99%	
			Surface crusting agent	N	95%	
		Enclosure	Silo with bag house	N	95-100%	
			Cover storage pile with a tarp during high winds	N	99%	
		Wind speed reduction	Vegetative windbreaks	N	30%	
			Reduced pile height	N	30%	
			Wind screens/fences	N	75->80%	

Activity	OEH 2011a reference	Best practice		In use at Mt Arthur Coal	% reduction per OEH 2011a	Size fraction
			Pile shaping/orientation	N	<60%	
			Erect 3-sided enclosure around storage piles	N	75%	
Wind erosion of overburden	Table 71	Avoidance	Minimise pre-strip. EMP should specific a benchmark for optimal performance and report annually against benchmark	N	100% per m2 of pre-strip avoided	PM_{10} & $PM_{2.5}$
		Surface stabilisation	Watering	N	50%	
			Chemical suppressants	N	70-84%	
			Paving and cleaning	N	>95%	
			Application of gravel to stabilise disturbed open areas	N	84%	
			Rehabilitation. EMP should specify a rehabilitation goal and report annually against progress to meeting goal	Y[(i)]	99%	
		Wind speed reduction	Fencing, bunding, shelterbelts or in-pit dump[(h)]	N	30-80%	
			Vegetative ground cover	N	70%	

Note:

a) Haul road speed limit is currently 60 kilometres per hour.
b) It is noted that the emission factor to calculate emissions due to hauling on unsealed roads does not include a variable related to the speed of the vehicles.
c) Grader operational speeds are limited to approximately 8 kilometres per hour.
d) Major haul roads at Mt Arthur are constructed from 'red rock' which is material is crushed to less than 50 millimetre size and incorporated into the haul road surface. This provides an improved surface integrity by increasing road life and compaction, reducing the development of fine material and also reducing rolling resistance of trucks. Sampling completed at Mt Arthur Coal has shown that the surface silt content is approximately 3 percent. The emission factor for hauling on unpaved roads incorporates this already low silt content.
e) Mt Arthur Coal already uses dust suppressants and is currently achieving control above this.
f) Average 45 percent over 14 days; 82 percent within two weeks.
g) Whilst Mt Arthur Coal either treats its travel routes with dust suppressant, or keeps them moist, it does not currently actively keep the material moist. Therefore no allowance was made in the emission calculations for keeping the travel routes moist.
h) Height should be greater than the height of the erodible surface.
i) Rehabilitation commitments are incorporated into the Mt Arthur Coal Complex Open Cut Mining Operations Plan and communicated annually in the Annual Environmental Management Report (AEMR).

Table 3-2: Mass emissions applying best practice measures – TSP (tonnes per year)

Rank	Mining Activity	Modelled emissions - no controls t/y	Current control	% control applied to uncontrolled	Modelled emissions - current controls t/y	Best Practice Control		% reduction per OEH 2011a	Modelled emissions after application of Best Practice Minimum reduction t/y	Maximum reduction t/y	Comments
TSP											
1	Hauling on unpaved roads	15,088	Dust suppressants	84%	2,263	Vehicle speed restrictions	Reduction from 65 km/hr to 30 km/hr[a]	50-85%	1,132	339	Applied to emissions with current controls as this would be an additional measure
						Surface improvements	Pave the surface	>90%	1,509		Applied to emissions with no controls as this would be an alternative measure
							Low silt aggregate	30%	Emissions from hauling include the already low silt content of roads at Mt Arthur Coal		
							Oil and double chip surface	80%	3,018		Applied to emissions with no controls as this would be an alternative measure
						Surface treatments	Watering (standard procedure)	10-74%	13,579	3,923	
							Watering Level 1 (2 L/m²/h)	50%	7,544		
							Watering Level 2 (>2 L/m²/h)	75%	3,772		
							Watering grader routes	50%	Emissions from grading are calculated separately to those from hauling on unpaved roads		
							Watering twice a day for industrial unpaved road	55%	6,790		Applied to emissions with no controls as this would be an alternative measure
							Suppressants	84%	Currently in use		
							Hygroscopic salts	45%-82%	8,298	4,225	Applied to emissions with no controls as this would be an alternative measure
							Lignosulphonates	66-70% (over 23 days)	5,130	4,526	
							Polymer emulsions	70% over 58 days	4,526		
							Tar and bitumen emulsions	70% over 20 days	4,526		
						Other	Use of larger vehicles	90t to 220t: 40%	N/A		328-tonne and 240-tonne capacity trucks are used for overburden removal; 180 tonne trucks are used for coal recovery. The emissions reduction is only applied to the emissions with current controls generated from haulage of coal as this would be an additional measure to the use of dust suppressants.
								140t to 220t; 20%	N/A		
								140t to 360t: 45%	1,923		
							Conveyors	>95%	754		Applied to emissions with no controls as this would be an alternative measure
2	Bulldozing OB and rehab	1,369	Travel routes kept moist but not material	0%	1,369	Travel routes and material kept moist		50%	685		Applied to emissions with no controls as this would be an alternative measure
3	Material transfer of coal (loading trucks)	823	None	0%	823	None identified in OEH 2011 or through workshop or through site-based workshop			823		No controls identified
4	Wind erosion of stockpiles	1,482	Water sprays	50%	741	Avoidance	Bypassing stockpiles	100%	0		Applied to emissions with no controls as this would be an alternative measure
						Surface stabilisation	Water sprays	50%	Currently in use		
							Chemical wetting agents	80-99%	296	15	Applied to emissions with no controls as this would be an alternative measure
							Surface crusting agent	95%	1,408		Applied to emissions with no controls as this would be an alternative measure
						Enclosure	Silo with bag house	95-100%	74	0	Applied to emissions with no controls as this would be an alternative measure
							Cover storage pile with a tarp during high winds	99%	7		Applied to emissions with current controls as this would be an additional measure
						Wind speed reduction	Vegetative windbreaks	30%	519		Applied to emissions with current controls as this would be an additional measure
							Reduced pile height	30%	519		Applied to emissions with current controls as this would be an additional measure
							Wind screens/fences	75->80%	185	148	Applied to emissions with current controls as this would be an additional measure
							Pile shaping/orientation	<60%	296		Applied to emissions with current controls as this would be an additional measure
							Erect 3-sided enclosure around storage piles	75%	185		Applied to emissions with current controls as this would be an additional measure

*The highlighted values show measures that would result in higher emissions than current operations.

Table 3-3: Mass emissions applying best practice measures – PM10 (tonnes per year)

Rank	Mining Activity	Modelled emissions - no controls t/y	Current control	% control applied to uncontrolled	Modelled emissions - current controls t/y	Best Practice Control		% reduction per OEH 2011a	Modelled emissions after application of Best Practice Minimum reduction t/y	Maximum reduction t/y	Comments
PM2.5											
1	Hauling on unpaved roads	351	Dust suppressants	84%	53	Vehicle speed restrictions	Reduction from 65 km/hr to 30 km/hr[3]	50-85%	27	8	Applied to emissions with current controls as this would be an additional measure
						Surface improvements	Pave the surface	>90%	35		Applied to emissions with no controls as this would be an alternative measure
							Low silt aggregate	30%	Emissions from hauling include the already low silt content of roads at Mt Arthur Coal		
							Oil and double chip surface	80%	70		Applied to emissions with no controls as this would be an alternative measure
						Surface treatments	Watering (standard procedure)	10-74%	316	91	
							Watering Level 1 (2 L/m²/h)	50%	176		
							Watering Level 2 (>2 L/m²/h)	75%	13		
							Watering grader routes	50%	Emissions from grading are calculated separately to those from hauling on unpaved roads		
							Watering twice a day for industrial unpaved road	55%	158		Applied to emissions with no controls as this would be an alternative measure
							Suppressants	84%	Currently in use		
							Hygroscopic salts	45%-82%	193	98	
							Lignosulphonates	66-70% (over 23 days)	119	105	Applied to emissions with no controls as this would be an alternative measure
							Polymer emulsions	70% over 58 days	105		
							Tar and bitumen emulsions	70% over 20 days	105		
						Other	Use of larger vehicles	90t to 220t: 40%	N/A		328-tonne and 240-tonne capacity trucks are used for overburden removal; 180 tonne trucks are used for coal recovery. The emissions reduction is only applied to the emissions with current controls generated from haulage of coal as this would be an additional measure to the use of dust suppressants.
								140t to 220t; 20%	N/A		
								140t to 360t: 45%	45		
							Conveyors	>95%	18		Applied to emissions with no controls as this would be an alternative measure
2	Wind erosion of stockpiles	111	Water sprays	50%	56	Avoidance	Bypassing stockpiles	100%	0		Applied to emissions with no controls as this would be an alternative measure
						Surface stabilisation	Water sprays	50%	Currently in use		
							Chemical wetting agents	80-99%	22	1	Applied to emissions with no controls as this would be an alternative measure
							Surface crusting agent	95%	105		Applied to emissions with no controls as this would be an alternative measure
						Enclosure	Silo with bag house	95-100%	6	0	Applied to emissions with no controls as this would be an alternative measure
							Cover storage pile with a tarp during high winds	99%	1		Applied to emissions with current controls as this would be an additional measure
						Wind speed reduction	Vegetative windbreaks	30%	39		Applied to emissions with current controls as this would be an additional measure
							Reduced pile height	30%	39		Applied to emissions with current controls as this would be an additional measure
							Wind screens/fences	75->80%	14	11	Applied to emissions with current controls as this would be an additional measure
							Pile shaping/orientation	<60%	22		Applied to emissions with current controls as this would be an additional measure
							Erect 3-sided enclosure around storage piles	75%	14		Applied to emissions with current controls as this would be an additional measure
3	Bulldozing OB and rehab	144	Travel routes kept moist but not material	0%	144	Travel routes and material kept moist		50%	72		Applied to emissions with no controls as this would be an alternative measure
4	Wind erosion of OB	33	None	0	33	Avoidance	Minimise pre-strip	100% per m2 pf pre-strip avoided	Not quantifiable as dependant on area not pre-stripped		
						Surface stabilisation	Watering	50%	17		Applied to emissions with current controls as this would be an additional measure
							Chemical suppressants	70-84%	10	5	Applied to emissions with current controls as this would be an additional measure
							Paving and cleaning	>95%	2		Applied to emissions with current controls as this would be an additional measure
							Application of gravel to stabilise disturbed open areas	84%	5		Applied to emissions with current controls as this would be an additional measure
							Rehabilitation goals	99%	Not quantifiable as dependant on area rehabilitated		
						Wind speed reduction	Fencing, bunding, shelterbelts or in-pit dump	30-80%	23	7	Applied to emissions with current controls as this would be an additional measure
							Vegetative ground cover	70%	10		Applied to emissions with current controls as this would be an additional measure

* The highlighted values show measures that would result in higher emissions than current operations.

Table 3-4: Mass emissions applying best practice measures – PM2.5 (t/y)

Rank	Mining Activity	Modelled emissions - no controls t/y	Current control	% control applied to uncontrolled	Modelled emissions - current controls t/y	Best Practice Control		% reduction per OEH 2011a	Modelled emissions after application of Best Practice Minimum reduction t/y	Maximum reduction t/y	Comments
PM2.5											
1	Hauling on unpaved roads	351	Dust suppressants	84%	53	Vehicle speed restrictions	Reduction from 65 km/hr to 30 km/hr[3]	50-85%	27	8	Applied to emissions with current controls as this would be an additional measure
						Surface improvements	Pave the surface	>90%	35		Applied to emissions with no controls as this would be an alternative measure
							Low silt aggregate	30%	Emissions from hauling include the already low silt content of roads at Mt Arthur Coal		
							Oil and double chip surface	80%	70		Applied to emissions with no controls as this would be an alternative measure
						Surface treatments	Watering (standard procedure)	10-74%	316	91	
							Watering Level 1 (2 L/m²/h)	50%	176		
							Watering Level 2 (>2 L/m²/h)	75%	13		
							Watering grader routes	50%	Emissions from grading are calculated separately to those from hauling on unpaved roads		
							Watering twice a day for industrial unpaved road	55%	158		Applied to emissions with no controls as this would be an alternative measure
							Suppressants	84%	Currently in use		
							Hygroscopic salts	45%-82%	193	98	
							Lignosulphonates	66-70% (over 23 days)	119	105	Applied to emissions with no controls as this would be an alternative measure
							Polymer emulsions	70% over 58 days	105		
							Tar and bitumen emulsions	70% over 20 days	105		
						Other	Use of larger vehicles	90t to 220t: 40%	N/A		328-tonne and 240-tonne capacity trucks are used for overburden removal; 180 tonne trucks are used for coal recovery. The emissions reduction is only applied to the emissions with current controls generated from haulage of coal as this would be an additional measure to the use of dust suppressants.
								140t to 220t; 20%	N/A		
								140t to 360t: 45%	45		
							Conveyors	>95%	18		Applied to emissions with no controls as this would be an alternative measure
2	Wind erosion of stockpiles	111	Water sprays	50%	56	Avoidance	Bypassing stockpiles	100%	0		Applied to emissions with no controls as this would be an alternative measure
						Surface stabilisation	Water sprays	50%	Currently in use		
							Chemical wetting agents	80-99%	22	1	Applied to emissions with no controls as this would be an alternative measure
							Surface crusting agent	95%	105		Applied to emissions with no controls as this would be an alternative measure
						Enclosure	Silo with bag house	95-100%	6	0	Applied to emissions with no controls as this would be an alternative measure
							Cover storage pile with a tarp during high winds	99%	1		Applied to emissions with current controls as this would be an additional measure
						Wind speed reduction	Vegetative windbreaks	30%	39		Applied to emissions with current controls as this would be an additional measure
							Reduced pile height	30%	39		Applied to emissions with current controls as this would be an additional measure
							Wind screens/fences	75->80%	14	11	Applied to emissions with current controls as this would be an additional measure
							Pile shaping/orientation	<60%	22		Applied to emissions with current controls as this would be an additional measure
							Erect 3-sided enclosure around storage piles	75%	14		Applied to emissions with current controls as this would be an additional measure
3	Bulldozing OB and rehab	144	Travel routes kept moist but not material	0%	144	Travel routes and material kept moist		50%	72		Applied to emissions with no controls as this would be an alternative measure
4	Wind erosion of OB	33	None	0	33	Avoidance	Minimise pre-strip	100% per m2 pf pre-strip avoided	Not quantifiable as dependant on area not pre-stripped		
						Surface stabilisation	Watering	50%	17		Applied to emissions with current controls as this would be an additional measure
							Chemical suppressants	70-84%	10	5	Applied to emissions with current controls as this would be an additional measure
							Paving and cleaning	>95%	2		Applied to emissions with current controls as this would be an additional measure
							Application of gravel to stabilise disturbed open areas	84%	5		Applied to emissions with current controls as this would be an additional measure
							Rehabilitation goals	99%	Not quantifiable as dependant on area rehabilitated		
						Wind speed reduction	Fencing, bunding, shelterbelts or in-pit dump	30-80%	23	7	Applied to emissions with current controls as this would be an additional measure
							Vegetative ground cover	70%	10		Applied to emissions with current controls as this would be an additional measure

* The highlighted values show measures that would result in higher emissions than current operations.

4. Evaluation of practicability of BPM

4.1 Practicability of implementation of BPM

For each of the BPM identified in Section 3.1, the practicability of implementing each one was assessed by taking into consideration:

- implementation costs;
- regulatory requirements;
- environmental impacts;
- safety implications; and
- compatibility with current processes and proposed future developments.

A practicability assessment workshop was held at Mt Arthur Coal with all relevant and experienced personnel to determine which measures were feasible to be costed for implementation. The results of the practicability assessment workshop are displayed in Table 4-1. The assessment specifically excluded any BPM:

- which is already implemented at Mt Arthur Coal;
- for which the published control efficiency factor was inferior to that of the current control implemented (in same control category);
- considered not to be appropriate for implementation at Mt Arthur Coal for the reasons noted in Table 4-1. This initial filtering exercise was necessary in order to focus the practicability assessment workshop on BPM for which a greater level of examination was justified.

As presented in Table 4-1 seven BPM were identified as practicable from a regulatory, environmental, safety and operational standpoint.

Preliminary implementation costs were compiled only for any BPM assessed as practicable from a regulatory, environmental, safety and operational standpoint and for which sufficient information (to at least a pre-feasibility level of project definition) relevant to the BPM was available on which to base the financial calculations.

Preliminary implementation costs were compiled for the following BPM:

- change in overburden haul truck fleet composition toward a greater proportion of larger trucks;
- application of chemical wetting agents to run-of-mine (ROM) stockpiles;
- application of surface crusting agent to run-of-mine (ROM) stockpiles; and
- application of chemical suppressants to overburden storage areas.

The preliminary implementation costings have been developed at a conceptual level only and will need to be defined further prior to implementation.

Table 4-1: Summary of site-based workshop

Mining Activity	Best Practice Measure		% reduction per OEH 2011a	Assessment of Practicability: Y = possible; N = not possible. General Comments	Implementation costs	Regulatory Requirements	Environmental Impacts	Safety Implications	Compatibility with current processes and proposed future developments	Practicable Y/N
Hauling on unpaved roads	Vehicle speed restrictions	Reduction from 65 km/hr to 30 km/hr	50-85%	-	Not assessed	Y	N - increase in vehicle noise; would require more trucks to meet production requirements, and hence result in increased GHG emissions	N - increase in vehicle and surface mobile equipment interactions resulting from more machinery in same area of disturbance	N - reduction in haulage productivity; increased maintenance on engine and components	N - as assessed at site-based workshop
	Surface improvements	Pave the surface	>90%	Already incorporate low silt aggregate ('red rock') into haul road surface. Emissions from hauling include the already low silt content of roads at Mt Arthur Coal. Pavement of haul routes would not be practicable due to heavy machinery and extensive scale of haul network	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	N - as assessed by initial filtering exercise
		Low silt aggregate	30%							
		Oil and double chip surface	80%							
	Surface treatments	Watering (standard procedure)	10-74%	Inferior control efficiency to current control implemented (in same control category)	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	N/A - already implemented; N - inferior control efficiency to current control implemented (in same control category)
		Watering Level 1 (2 L/m^2/h)	50%							
		Watering Level 2 (>2 L/m^2/h)	75%							
		Watering twice a day for industrial unpaved road	55%							
		Suppressants	84%[(d)]	Already implemented						
		Hygroscopic salts	45%-82%	Inferior control efficiency to current control implemented (in same control category)						
		Lignosulphonates	66-70% (over 23 days)							
		Polymer emulsions	70% over 58 days							
		Tar and bitumen emulsions	70% over 20 days							
	Other	Use of larger vehicles	90t to 220t: 40%	-	Preliminary costings developed. More detailed financial analysis will be undertaken	Y	Y	Y	Y	Y - as assessed at site-based workshop
			140t to 220t; 20%							
			140t to 360t: 45%							
		Conveyors	>95%	Internal review determined not viable at present	Not assessed	N - would require new consent	N - unknown air quality impacts	Y	N - not operationally viable due to dynamic nature of operations	N - as assessed at site-based workshop
	In-pit crusher conveyors		Not determined							
Bulldozing OB and rehab	Travel routes and material kept moist		50%	Travel routes only are kept moist	Not assessed	Y	N - projected high water use requirements	Y	N - no feasible method for applying moisture to overburden storage areas	N - as assessed at site-based workshop
Wind erosion of stockpiles	Avoidance	Bypassing stockpiles	100%	-	Not assessed	Y	Y	Y	Y (current) - approximately 10% currently bypassed on opportunity only at product stockpiles, possible application for ROM coal N (future) - under stacker/reclaimer mode	N - as assessed at site-based workshop

	Surface stabilisation	Water sprays	50%	Already implemented	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	N/A - already implemented
		Chemical wetting agents	80-99%	50% of ROM stockpiles only (water cart access restrictions) - product stockpiles are disturbed too frequently	Preliminary costings developed. More detailed financial analysis will be undertaken	Y	Y	Y	N (current) - significant infrastructure requirement; effect on product coal specification; Y (future)	Y - as assessed at site-based workshop (50% of ROM stockpiles only)
		Surface crusting agent	95%	50% of ROM stockpiles only (water cart access restrictions) - product stockpiles are disturbed too frequently	Preliminary costings developed. More detailed financial analysis will be undertaken	Y	Y	Y	N (current) - significant infrastructure requirement; effect on product coal specification; Y (future)	Y - as assessed at site-based workshop (50% of ROM stockpiles only)
	Enclosure	Silo with bag house	95-100%	Height of stockpiles makes these options impractical	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	N - as assessed by initial filtering exercise
		Cover storage pile with a tarp during high winds	99%							
	Wind speed reduction	Vegetative windbreaks	30%	-	Not assessed	Y	Y	Y	Y	Y - as assessed at site-based workshop
		Reduced pile height	30%	-	Not assessed	N - would require new consent	Y	Y	N - limited footprint available for stocks	N - as assessed at site-based workshop
		Wind screens/fences	75->80%	Possible visual impacts	Not assessed	Y	Y	Y	Y	Y - as assessed at site-based workshop
		Pile shaping/orientation	<60%	Already implemented on site but the default AP-42 emission factor does not pile shaping and orientation into account	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	N/A - already implemented
		Erect 3-sided enclosure around storage piles	75%	Height of stockpiles makes this option impractical	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	N - as assessed by initial filtering exercise
Wind erosion of OB	Avoidance	Minimise pre-strip. EMP should specify a benchmark for optimal performance and report annually against benchmark.	100%	-	Not assessed	Y	Y	N - insufficient working room	N - geotechnical issues associated with highwall angle; insufficient working room limiting pit expansion	N - as assessed at site-based workshop
	Surface stabilisation	Watering	50%	-	Not assessed	Y	Y	Y	N - insufficient water available for large scale watering of overburden areas	N - as assessed at site-based workshop
		Chemical suppressants	70-84%	Can only access approx. 20% of area with water cart	Preliminary costings developed. More detailed financial analysis will be undertaken	Y	Y	Y	Y	Y - as assessed at site-based workshop (for maximum 20% of area)
		Paving and cleaning	> 95%	Pavement of overburden storage areas would not be practicable due to issues of scale and access	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	N - as assessed by initial filtering exercise
		Application of gravel to stabilise disturbed open areas	84%	Pavement of overburden storage areas would not be practicable due to issues of scale and supply of suitable material	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	N - as assessed by initial filtering exercise
		Rehabilitation. EMP should specific a rehabilitation goal and report annually against progress to meeting goal.	99%	Already implemented	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	N/A - already implemented
	Wind speed reduction	Fencing, bunding, shelterbelts or in-pit dump[(g)]	30-80%	-	Not assessed	N - may require new consent	Y	Y	N - not feasible given large scale of OB dumps	N - as assessed at site-based workshop
		Vegetative ground cover	70%	-	Not assessed	Y	Y	Y	Y	Y - as assessed at site-based workshop

4.2 Identification of BPM to be implemented

The detailed site review of measures to control dust completed in April 2011 identified that Mt Arthur Coal already employs a significant number of best practice measures in the day-to-day operations of the site to reduce emissions of particulate from coal mining activities. Mt Arthur Coal continually seeks to identify measures to further reduce particulate emissions, demonstrated with the commencement of aerial seeding of overburden storage areas.

With a significant number of BPM already implemented, the remaining measures identified include those that have not been tested on such large scale operations and will require further investigation and possible trials before understanding whether they have applications at Mt Arthur Coal.

Further detailed evaluation will be undertaken to inform a decision on the implementation of each of the seven BPM. This evaluation will include more detailed financial analysis, assessment of technical feasibility and validation of emission reduction potential.

Table 4-2 identifies those BPM that are to undergo further detailed evaluation.

Table 4-2: BPM to undergo further detailed evaluation

Mining Activity	Best Practice Measure
Hauling on unpaved roads	Use of larger overburden trucks
Wind erosion of stockpiles	Chemical wetting agents
	Surface crusting agent
	Vegetative windbreaks
	Wind screens/fences
Wind erosion of OB	Chemical suppressants
	Vegetative ground cover

It is noted that due to the generic nature of the emission factors used in the emission calculations, there is significant uncertainty in the emissions calculations, especially in regards to emissions from wind erosion. As such, Mt Arthur Coal is also committed to developing emission factors specific for the site.

4.3 Proposed timeframe for implementation of best practice measures

Table 4-3 presents a timeframe for completion of the detailed evaluation of the BPM's identified.

Table 4-3: Proposed timeframe for completion of detailed evaluation of BPM

Mining Activity	Best Practice Measure	Completion Date for Detailed Evaluation
Hauling on unpaved roads	Use of larger overburden trucks	1 March 2013
Wind erosion of stockpiles	Chemical wetting agents	31 December 2013
	Surface crusting agent	31 December 2013
	Vegetative windbreaks	30 June 2013
	Wind screens/fences	30 June 2013
Wind erosion of overburden	Chemical suppressants	31 December 2013
	Vegetative ground cover	30 June 2013

Mt Arthur Coal will implement a program to develop site specific emissions factors by 1 March 2013.

4.4 Conclusions

This report has been produced to address the requirements of the Coal Mine Particulate Matter Control Best Practice PRP as attached to the Mt Arthur Coal Environmental Protection Licences (EPL 11457) as varied in August 2011. A detailed site review of measures to control dust was completed in April 2011 and identified that Mt Arthur Coal already employs a significant number of best practice measures in the day-to-day operations of the site to reduce emissions of particulate from coal mining activities.

The work completed for the PRP has identified that, based on generic AP-42 emission factors, the following represent the highest ranked activities in terms of particulate emissions:

- hauling on unsealed roads;
- bulldozing overburden and rehab;
- material transfer of coal (loading trucks);
- wind erosion of coal stockpiles; and
- wind erosion of overburden areas.

Potential BPM for each of the above activities were identified, and their practicability evaluated in a site-based workshop held with relevant experienced site personnel.

The BPM that were considered practicable for further consideration are:

- change in overburden haul truck fleet composition toward a greater proportion of larger trucks;
- use of chemical wetting agents/surface crusting agents on run-of-mine stockpiles;
- wind screens/fences and vegetative windbreaks on coal stockpiles;
- use of chemical suppressants on overburden storage areas; and
- vegetative ground cover on overburden storage areas.

With a significant number of BPM already implemented, the remaining measures identified include those that have not been tested on such large scale operations and will require further investigation and possible trials before understanding whether they have applications at Mt Arthur Coal.

Mt Arthur Coal will complete further detailed evaluation to inform a decision on the implementation of each of these options.

5. References

NPI (2011)
'Emission Estimation Technique for Mining – Version 3.1' National Pollutant Inventory. January 2012. Available from http://www.npi.gov.au/publications/emission-estimation-technique/mining.html.

OEH (2011a).
'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 (2011b).
'Coal Mine Particulate Matter Control Best Practice – Site Specific Determination Guideline'.

Supplement 1: Assumptions for baseline emission calculations

Figure 1 shows the location of activities at Mt Arthur Coal in FY11.

The pit identifications are as follows:

- Macleans Hill (MC);
- Windmill (WM);
- Huon (HU);
- Calool (CA);
- Roxburgh (RX);
- Ayredale (AY); and
- Saddlers (Nth, Cen, Sth) (SN, SC, SS).

Table S1- 1 and Table S1-2 present the assumptions and emission calculations for modelled emissions with no controls in place and modelled emissions with current controls in place respectively.

Figure 1: Mt Arthur Coal – mining activity FY11

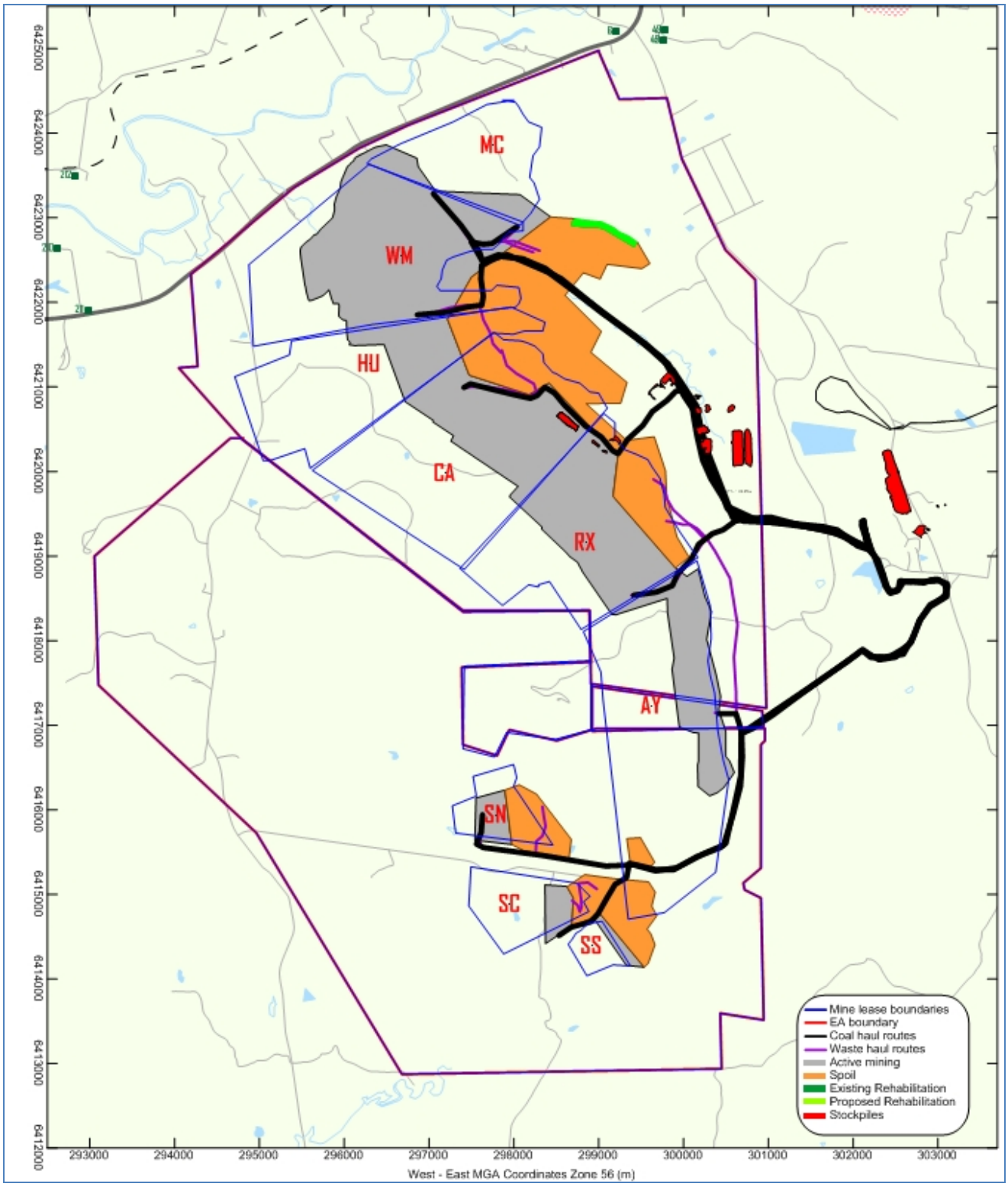

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Table S1- 1: Emission calculations FY11 – modelled emissions with no controls in place

OEH PRP Activity Category	ACTIVITY	TSP emission/year for FY2010-11 in kg	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units	Variable 4	units	Variable 5	units	% control
Drilling	OB - Drilling - MC	431	731	holes/y	0.59	kg/hole											0 % control
	OB - Drilling - WM	21,589	36,592	holes/y	0.59	kg/hole											0 % control
	OB - Drilling - HU	4,566	7,738	holes/y	0.59	kg/hole											0 % control
	OB - Drilling - CA	14,411	24,425	holes/y	0.59	kg/hole											0 % control
	OB - Drilling - RX	14,805	25,093	holes/y	0.59	kg/hole											0 % control
	OB - Drilling - AY	958	1,624	holes/y	0.59	kg/hole											0 % control
	OB - Drilling - SC	34	58	holes/y	0.59	kg/hole											0 % control
	OB - Drilling - SN	36	61	holes/y	0.59	kg/hole											0 % control
Blasting	OB - Blasting - MC	1,457	1	blasts/y	1457	kg/blast	35,270	Area of blast in square metres									0 % control
	OB - Blasting - WM	65,576	45	blasts/y	1457	kg/blast	35,270	Area of blast in square metres									0 % control
	OB - Blasting - HU	23,316	16	blasts/y	1457	kg/blast	35,270	Area of blast in square metres									0 % control
	OB - Blasting - CA	48,089	33	blasts/y	1457	kg/blast	35,270	Area of blast in square metres									0 % control
	OB - Blasting - RX	29,145	20	blasts/y	1457	kg/blast	35,270	Area of blast in square metres									0 % control
	OB - Blasting - AY	2,914	2	blasts/y	1457	kg/blast	35,270	Area of blast in square metres									0 % control
	OB - Blasting - S	20,401	14	blasts/y	1457	kg/blast	35,270	Area of blast in square metres									0 % control
Material transfer OB (loading overburden)	OB - Sh/Ex/FELs loading - MC	2,761	1,320,235	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Sh/Ex/FELs loading - WM	138,207	66,097,908	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Sh/Ex/FELs loading - HU	29,228	13,978,294	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Sh/Ex/FELs loading - CA	92,253	44,120,398	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Sh/Ex/FELs loading - RX	94,774	45,326,042	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Sh/Ex/FELs loading - AY	6,134	2,933,510	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Sh/Ex/FELs loading - SC	219	104,664	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Sh/Ex/FELs loading - SN	232	111,048	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
Wheel generated particles on unpaved roads	OB - Hauling to emplacement - MC	26,469	1,320,235	t/y	0.02005	kg/t	278	t/truck load	347	Vehicle gross mass (t)	1.2	km/return trip	4.6	kg/VKT (uncontrolled)	3	% silt content	0 % control
	OB - Hauling to emplacement - WM	3,533,855	66,097,908	t/y	0.05346	kg/t	278	t/truck load	347	Vehicle gross mass (t)	3.2	km/return trip	4.6	kg/VKT (uncontrolled)	3	% silt content	0 % control
	OB - Hauling to emplacement - HU	560,501	13,978,294	t/y	0.04010	kg/t	278	t/truck load	347	Vehicle gross mass (t)	2.4	km/return trip	4.6	kg/VKT (uncontrolled)	3	% silt content	0 % control
	OB - Hauling to emplacement - CA	2,211,422	44,120,398	t/y	0.05012	kg/t	278	t/truck load	347	Vehicle gross mass (t)	3.0	km/return trip	4.6	kg/VKT (uncontrolled)	3	% silt content	0 % control
	OB - Hauling to emplacement - RX	3,180,593	45,326,042	t/y	0.07017	kg/t	278	t/truck load	347	Vehicle gross mass (t)	4.2	km/return trip	4.6	kg/VKT (uncontrolled)	3	% silt content	0 % control
	OB - Hauling to emplacement - AY	294,069	2,933,510	t/y	0.10024	kg/t	278	t/truck load	347	Vehicle gross mass (t)	6.0	km/return trip	4.6	kg/VKT (uncontrolled)	3	% silt content	0 % control
	OB - Hauling to emplacement - SC	2,798	104,664	t/y	0.02673	kg/t	278	t/truck load	347	Vehicle gross mass (t)	1.6	km/return trip	4.6	kg/VKT (uncontrolled)	3	% silt content	0 % control
	OB - Hauling to emplacement - SN	5,566	111,048	t/y	0.05012	kg/t	278	t/truck load	347	Vehicle gross mass (t)	3.0	km/return trip	4.6	kg/VKT (uncontrolled)	3	% silt content	0 % control
Trucks unloading OB (dumping overburden)	OB - Emplacing at dumps - MC	2,761	1,320,235	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Emplacing at dumps - WM	138,207	66,097,908	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Emplacing at dumps - HU	29,228	13,978,294	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Emplacing at dumps - CA	92,253	44,120,398	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Emplacing at dumps - RX	94,774	45,326,042	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Emplacing at dumps - AY	6,134	2,933,510	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Emplacing at dumps - SC	219	104,664	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Emplacing at dumps - SN	232	111,048	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
Bulldozing overburden	OB - Dozers on O/B - MC	10,362	619	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %							0 % control
	OB - Dozers on O/B - WM	518,779	30,999	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %							0 % control
	OB - Dozers on O/B - HU	109,711	6,556	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %							0 % control
	OB - Dozers on O/B - CA	346,286	20,692	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %							0 % control
	OB - Dozers on O/B - RX	355,748	21,257	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %							0 % control
	OB - Dozers on O/B - AY	23,024	1,376	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %							0 % control
	OB - Dozers on O/B - SC	821	49	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %							0 % control
	OB - Dozers on O/B - SN	872	52	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %							0 % control
	OB - Dozers on Rehabilitation - total	3,208	192	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %							0 % control
Bulldozing coal	CL - Dozers ripping - MC	-	0	h/y	16.5	kg/h	5	silt content in %	8	moisture content in %							0 % control
	CL - Dozers ripping - WM	100,465	6,107	h/y	16.5	kg/h	5	silt content in %	8	moisture content in %							0 % control
	CL - Dozers ripping - HU	61,414	3,733	h/y	16.5	kg/h	5	silt content in %	8	moisture content in %							0 % control
	CL - Dozers ripping - CA	92,225	5,606	h/y	16.5	kg/h	5	silt content in %	8	moisture content in %							0 % control
	CL - Dozers ripping - RX	76,721	4,664	h/y	16.5	kg/h	5	silt content in %	8	moisture content in %							0 % control
	CL - Dozers ripping - AY	382	23	h/y	16.5	kg/h	5	silt content in %	8	moisture content in %							0 % control
	CL - Dozers ripping - SC	2,424	147	h/y	16.5	kg/h	5	silt content in %	8	moisture content in %							0 % control
	CL - Dozers ripping - SN	12,568	764	h/y	16.5	kg/h	5	silt content in %	8	moisture content in %							0 % control
Material transfer coal	CL - Loading ROM to trucks - MC	-	0	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
	CL - Loading ROM to trucks - WM	238,804	4,992,530	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
	CL - Loading ROM to trucks - HU	145,979	3,051,907	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
	CL - Loading ROM to trucks - CA	219,218	4,583,072	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
	CL - Loading ROM to trucks - RX	182,365	3,812,600	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
	CL - Loading ROM to trucks - AY	907	18,972	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
	CL - Loading ROM to trucks - SC	5,761	120,452	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
	CL - Loading ROM to trucks - SN	29,875	624,574	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
Wheel generated particles on unpaved roads	CL - Hauling ROM coal to dump hopper - MC	-	0	t/y	0.33259	kg/t	172	t/load	231.515	Vehicle gross mass (t)	14.8	km/return trip	3.9	kg/VKT (uncontrolled)	3	% silt content	0 % control
	CL - Hauling ROM coal to dump hopper - WM	1,705,363	4,992,530	t/y	0.34158	kg/t	172	t/load	231.515	Vehicle gross mass (t)	15.2	km/return trip	3.9	kg/VKT (uncontrolled)	3	% silt content	0 % control
	CL - Hauling ROM coal to dump hopper - HU	1,056,196	3,051,907	t/y	0.34608	kg/t	172	t/load	231.515	Vehicle gross mass (t)	15.4	km/return trip	3.9	kg/VKT (uncontrolled)	3	% silt content	0 % control
	CL - Hauling ROM coal to dump hopper - CA	1,400,710	4,583,072	t/y	0.30563	kg/t	172	t/load	231.515	Vehicle gross mass (t)	13.6	km/return trip	3.9	kg/VKT (uncontrolled)	3	% silt content	0 % control
	CL - Hauling ROM coal to dump hopper - RX	599,752	3,812,600	t/y	0.15731	kg/t	172	t/load	231.515	Vehicle gross mass (t)	7.0	km/return trip	3.9	kg/VKT (uncontrolled)	3	% silt content	0 % control
	CL - Hauling ROM coal to dump hopper - AY	4,519	18,972	t/y	0.23821	kg/t	172	t/load	231.515	Vehicle gross mass (t)	10.6	km/return trip	3.9	kg/VKT (uncontrolled)	3	% silt content	0 % control
	CL - Hauling ROM coal to dump hopper - SC	31,400	120,452	t/y	0.26068	kg/t	172	t/load	231.515	Vehicle gross mass (t)	11.6	km/return trip	3.9	kg/VKT (uncontrolled)	3	% silt content	0 % control
	CL - Hauling ROM coal to dump hopper - SN	244,223	624,574	t/y	0.39102	kg/t	172	t/load	231.515	Vehicle gross mass (t)	17.4	km/return trip	3.9	kg/VKT (uncontrolled)	3	% silt content	0 % control
Trucks unloading coal	CL - unloading ROM coal at stockpile/hopper - MC	-	0	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
	CL - unloading ROM coal at stockpile/hopper - WM	238,804	4,992,530	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
	CL - unloading ROM coal at stockpile/hopper - HU	145,979	3,051,907	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
	CL - unloading ROM coal at stockpile/hopper - CA	219,218	4,583,072	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
	CL - unloading ROM coal at stockpile/hopper - RX	182,365	3,812,600	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
	CL - unloading ROM coal at stockpile/hopper - AY	907	18,972	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
	CL - unloading ROM coal at stockpile/hopper - SC	5,761	120,452	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
	CL - unloading ROM coal at stockpile/hopper - SN	29,875	624,574	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
Material transfer coal	CL - Rehandle ROM coal at stockpilepile/hopper	475	9,933	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
Bulldozing coal	CL - Dozers at CHPP	192,951	15,330	h/y	12.6	kg/h	4	silt content in %	8	moisture content in %							0 % control
Wheel generated particles on unpaved roads	CL - Transporting rejects	230,637	3,337,583	t/y	0.06910	kg/t	172	t/load	231.515	Vehicle gross mass (t)	3.075	km/return trip	3.9	kg/VKT (uncontrolled)	3	% silt content	0 % control
Loading coal stockpiles	CL - Loading product coal stockpile	3,326	15,139,614	t/y	0.000	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	10	moisture content of coal in %							0 % control
Train loading	CL - Loading coal to trains	3,326	15,139,614	t/y	0.00022	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	10	moisture content of coal in %							0 % control
Wind erosion on overburden	WE - OB spoil area - All pits	438,467	500.5	ha	0.1	kg/ha/h	8760	h/y									0 % control
Wind erosion of exposed areas	WE - Open pit - All pits	45,746	52.2	ha	0.1	kg/ha/h	8760	h/y									0 % control
	WE - Active rehab	5,031	5.7	ha	0.1	kg/ha/h	8760	h/y									0 % control
Wind erosion of coal stockpiles	WE - all stockpiles	1,482,118	28.6	ha	5.9	kg/ha/h	3.29	Average windspeed (m/s)	8760	h/y							0 % control
Graders	Grading roads	188,205	305,792	km	0.61547	kg/VKT	8	speed of graders in km/h									0 % control

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Table S1-2: Emission calculations FY2010-11 – modelled emissions with current controls in place

OEH PRP Activity Category	ACTIVITY	TSP emission/year for 2010 in kg	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units	Variable 4	units	Variable 5	units	% control
Drilling	OB - Drilling - MC	129	731	holes/y	0.59	kg/hole											70 % control
	OB - Drilling - WM	6,477	36,592	holes/y	0.59	kg/hole											70 % control
	OB - Drilling - HU	1,370	7,738	holes/y	0.59	kg/hole											70 % control
	OB - Drilling - CA	4,323	24,425	holes/y	0.59	kg/hole											70 % control
	OB - Drilling - RX	4,441	25,093	holes/y	0.59	kg/hole											70 % control
	OB - Drilling - AY	287	1,624	holes/y	0.59	kg/hole											70 % control
	OB - Drilling - SC	10	58	holes/y	0.59	kg/hole											70 % control
	OB - Drilling - SN	11	61	holes/y	0.59	kg/hole											70 % control
Blasting	OB - Blasting - MC	1,457	1	blasts/y	1457	kg/blast	35,270	Area of blast in square metres									0 % control
	OB - Blasting - WM	65,576	45	blasts/y	1457	kg/blast	35,270	Area of blast in square metres									0 % control
	OB - Blasting - HU	23,316	16	blasts/y	1457	kg/blast	35,270	Area of blast in square metres									0 % control
	OB - Blasting - CA	48,089	33	blasts/y	1457	kg/blast	35,270	Area of blast in square metres									0 % control
	OB - Blasting - RX	29,145	20	blasts/y	1457	kg/blast	35,270	Area of blast in square metres									0 % control
	OB - Blasting - AY	2,914	2	blasts/y	1457	kg/blast	35,270	Area of blast in square metres									0 % control
	OB - Blasting - S	20,401	14	blasts/y	1457	kg/blast	35,270	Area of blast in square metres									0 % control
Material transfer OB (loading overburden)	OB - Sh/Ex/FELs loading - MC	2,761	1,320,235	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Sh/Ex/FELs loading - WM	138,207	66,097,908	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Sh/Ex/FELs loading - HU	29,228	13,978,294	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Sh/Ex/FELs loading - CA	92,253	44,120,398	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Sh/Ex/FELs loading - RX	94,774	45,326,042	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Sh/Ex/FELs loading - AY	6,134	2,933,510	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Sh/Ex/FELs loading - SC	219	104,664	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Sh/Ex/FELs loading - SN	232	111,048	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
Wheel generated particles on unpaved roads	OB - Hauling to emplacement - MC	3,970	1,320,235	t/y	0.02005	kg/t	278	t/truck load	347	Vehicle gross mass (t)	1.2	km/return trip	4.6	kg/VKT (uncontrolled)	3	% silt content	85 % control
	OB - Hauling to emplacement - WM	530,078	66,097,908	t/y	0.05346	kg/t	278	t/truck load	347	Vehicle gross mass (t)	3.2	km/return trip	4.6	kg/VKT (uncontrolled)	3	% silt content	85 % control
	OB - Hauling to emplacement - HU	84,075	13,978,294	t/y	0.04010	kg/t	278	t/truck load	347	Vehicle gross mass (t)	2.4	km/return trip	4.6	kg/VKT (uncontrolled)	3	% silt content	85 % control
	OB - Hauling to emplacement - CA	331,713	44,120,398	t/y	0.05012	kg/t	278	t/truck load	347	Vehicle gross mass (t)	3.0	km/return trip	4.6	kg/VKT (uncontrolled)	3	% silt content	85 % control
	OB - Hauling to emplacement - RX	477,089	45,326,042	t/y	0.07017	kg/t	278	t/truck load	347	Vehicle gross mass (t)	4.2	km/return trip	4.6	kg/VKT (uncontrolled)	3	% silt content	85 % control
	OB - Hauling to emplacement - AY	44,110	2,933,510	t/y	0.10024	kg/t	278	t/truck load	347	Vehicle gross mass (t)	6.0	km/return trip	4.6	kg/VKT (uncontrolled)	3	% silt content	85 % control
	OB - Hauling to emplacement - SC	420	104,664	t/y	0.02673	kg/t	278	t/truck load	347	Vehicle gross mass (t)	1.6	km/return trip	4.6	kg/VKT (uncontrolled)	3	% silt content	85 % control
	OB - Hauling to emplacement - SN	835	111,048	t/y	0.05012	kg/t	278	t/truck load	347	Vehicle gross mass (t)	3.0	km/return trip	4.6	kg/VKT (uncontrolled)	3	% silt content	85 % control
Trucks unloading OB (dumping overburden)	OB - Emplacing at dumps - MC	2,761	1,320,235	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Emplacing at dumps - WM	138,207	66,097,908	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Emplacing at dumps - HU	29,228	13,978,294	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Emplacing at dumps - CA	92,253	44,120,398	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Emplacing at dumps - RX	94,774	45,326,042	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Emplacing at dumps - AY	6,134	2,933,510	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Emplacing at dumps - SC	219	104,664	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
	OB - Emplacing at dumps - SN	232	111,048	t/y	0.00209	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %							0 % control
Bulldozing overburden	OB - Dozers on O/B - MC	10,362	619	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %							0 % control
	OB - Dozers on O/B - WM	518,779	30,999	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %							0 % control
	OB - Dozers on O/B - HU	109,711	6,556	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %							0 % control
	OB - Dozers on O/B - CA	346,286	20,692	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %							0 % control
	OB - Dozers on O/B - RX	355,748	21,257	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %							0 % control
	OB - Dozers on O/B - AY	23,024	1,376	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %							0 % control
	OB - Dozers on O/B - SC	821	49	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %							0 % control
	OB - Dozers on O/B - SN	872	52	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %							0 % control
	OB - Dozers on Rehabilitation - total	3,208	192	h/y	16.7	kg/h	10	silt content in %	2	moisture content in %							0 % control
Bulldozing coal	CL - Dozers ripping - MC	-	0	h/y	16.5	kg/h	5	silt content in %	8	moisture content in %							0 % control
	CL - Dozers ripping - WM	100,465	6,107	h/y	16.5	kg/h	5	silt content in %	8	moisture content in %							0 % control
	CL - Dozers ripping - HU	61,414	3,733	h/y	16.5	kg/h	5	silt content in %	8	moisture content in %							0 % control
	CL - Dozers ripping - CA	92,225	5,606	h/y	16.5	kg/h	5	silt content in %	8	moisture content in %							0 % control
	CL - Dozers ripping - RX	76,721	4,664	h/y	16.5	kg/h	5	silt content in %	8	moisture content in %							0 % control
	CL - Dozers ripping - AY	382	23	h/y	16.5	kg/h	5	silt content in %	8	moisture content in %							0 % control
	CL - Dozers ripping - SC	2,424	147	h/y	16.5	kg/h	5	silt content in %	8	moisture content in %							0 % control
	CL - Dozers ripping - SN	12,568	764	h/y	16.5	kg/h	5	silt content in %	8	moisture content in %							0 % control
Material transfer coal	CL - Loading ROM to trucks - MC	-	0	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
	CL - Loading ROM to trucks - WM	238,804	4,992,530	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
	CL - Loading ROM to trucks - HU	145,979	3,051,907	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
	CL - Loading ROM to trucks - CA	219,218	4,583,072	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
	CL - Loading ROM to trucks - RX	182,365	3,812,600	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
	CL - Loading ROM to trucks - AY	907	18,972	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
	CL - Loading ROM to trucks - SC	5,761	120,452	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
	CL - Loading ROM to trucks - SN	29,875	624,574	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
Wheel generated particles on unpaved roads	CL - Hauling ROM coal to dump hopper - MC	-	0	t/y	0.33259	kg/t	172	t/load	231.515	Vehicle gross mass (t)	14.8	km/return trip	3.9	kg/VKT (uncontrolled)	3	% silt content	85 % control
	CL - Hauling ROM coal to dump hopper - WM	255,804	4,992,530	t/y	0.34158	kg/t	172	t/load	231.515	Vehicle gross mass (t)	15.2	km/return trip	3.9	kg/VKT (uncontrolled)	3	% silt content	85 % control
	CL - Hauling ROM coal to dump hopper - HU	158,429	3,051,907	t/y	0.34608	kg/t	172	t/load	231.515	Vehicle gross mass (t)	15.4	km/return trip	3.9	kg/VKT (uncontrolled)	3	% silt content	85 % control
	CL - Hauling ROM coal to dump hopper - CA	210,106	4,583,072	t/y	0.30563	kg/t	172	t/load	231.515	Vehicle gross mass (t)	13.6	km/return trip	3.9	kg/VKT (uncontrolled)	3	% silt content	85 % control
	CL - Hauling ROM coal to dump hopper - RX	89,963	3,812,600	t/y	0.15731	kg/t	172	t/load	231.515	Vehicle gross mass (t)	7.0	km/return trip	3.9	kg/VKT (uncontrolled)	3	% silt content	85 % control
	CL - Hauling ROM coal to dump hopper - AY	678	18,972	t/y	0.23821	kg/t	172	t/load	231.515	Vehicle gross mass (t)	10.6	km/return trip	3.9	kg/VKT (uncontrolled)	3	% silt content	85 % control
	CL - Hauling ROM coal to dump hopper - SC	4,710	120,452	t/y	0.26068	kg/t	172	t/load	231.515	Vehicle gross mass (t)	11.6	km/return trip	3.9	kg/VKT (uncontrolled)	3	% silt content	85 % control
	CL - Hauling ROM coal to dump hopper - SN	36,633	624,574	t/y	0.39102	kg/t	172	t/load	231.515	Vehicle gross mass (t)	17.4	km/return trip	3.9	kg/VKT (uncontrolled)	3	% silt content	85 % control
Trucks unloading coal	CL - unloading ROM coal at stockpile/hopper - MC	-	0	t/y	0.04783	kg/t	8	moisture content of coal in %									85 % control
	CL - unloading ROM coal at stockpile/hopper - WM	35,821	4,992,530	t/y	0.04783	kg/t	8	moisture content of coal in %									85 % control
	CL - unloading ROM coal at stockpile/hopper - HU	21,897	3,051,907	t/y	0.04783	kg/t	8	moisture content of coal in %									85 % control
	CL - unloading ROM coal at stockpile/hopper - CA	32,883	4,583,072	t/y	0.04783	kg/t	8	moisture content of coal in %									85 % control
	CL - unloading ROM coal at stockpile/hopper - RX	27,355	3,812,600	t/y	0.04783	kg/t	8	moisture content of coal in %									85 % control
	CL - unloading ROM coal at stockpile/hopper - AY	136	18,972	t/y	0.04783	kg/t	8	moisture content of coal in %									85 % control
	CL - unloading ROM coal at stockpile/hopper - SC	864	120,452	t/y	0.04783	kg/t	8	moisture content of coal in %									85 % control
	CL - unloading ROM coal at stockpile/hopper - SN	4,481	624,574	t/y	0.04783	kg/t	8	moisture content of coal in %									85 % control
Material transfer coal	CL - Rehandle ROM coal at stockpilepile/hopper	475	9,933	t/y	0.04783	kg/t	8	moisture content of coal in %									0 % control
Bulldozing coal	CL - Dozers at CHPP	192,951	15,330	h/y	12.6	kg/h	4	silt content in %	8	moisture content in %							0 % control
Wheel generated particles on unpaved roads	CL - Transporting rejects	34,596	3,337,583	t/y	0.06910	kg/t	172	t/load	231.515	Vehicle gross mass (t)	3.075	km/return trip	3.9	kg/VKT (uncontrolled)	3	% silt content	85 % control
Loading coal stockpiles	CL - Loading product coal stockpile	1,663	15,139,614	t/y	0.000	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	10	moisture content of coal in %							50 % control
Train loading	CL - Loading coal to trains	3,326	15,139,614	t/y	0.00022	kg/t	1.766	average of (wind speed/2.2)^1.3 in m/s	10	moisture content of coal in %							0 % control
Wind erosion on overburden	WE - OB spoil area - All pits	438,467	500.5	ha	0.1	kg/ha/h	8760	h/y									0 % control
Wind erosion of exposed areas	WE - Open pit - All pits	45,746	52.2	ha	0.1	kg/ha/h	8760	h/y									0 % control
	WE - Active rehab	1,509	5.7	ha	0.1	kg/ha/h	8760	h/y									70 % control
Wind erosion of coal stockpiles	WE - all stockpiles	741,059	28.6	ha	5.9	kg/ha/h	3.29	Average windspeed (m/s)	8760	h/y							50 % control
Graders	Grading roads	94,102	305,792	km	0.61547	kg/VKT	8	speed of graders in km/h									50 % control