Centennial Coal

Airly Coal Mine

Site Specific Particulate Matter Control Best Practice Assessment

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Best Practice Assessment

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Site Specific Particulate Matter Control

Best Practice Assessment

PREPARED BY:

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
2 Lincoln Street Lane Cove NSW 2066 Australia

(PO Box 176 Lane Cove NSW 1595 Australia)
T: 61 2 9428 8100 F: 61 2 9427 8200
E: sydney@slrconsulting.com www.slrconsulting.com

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EXECUTIVE SUMMARY

Background

Airly Coal Mine (Airly) operates an underground coal mine and a coal handling plant (CHP) in the Western Region of New South Wales (NSW). The operation is located approximately 40 kilometres (km) north-northwest of Lithgow and approximately 4 km northeast of Capertree.

Mining at Airly is undertaken within Mining Lease 1331 (ML1331) issued by the DPI in 1993 and Licence A232 also issued by the DPI in 2010. Approval is granted for an underground mining operation for extraction of up to 1.8 million tonnes per annum (Mtpa) of coal with all coal to be transported offsite via rail.

Airly is currently in the process of transition from trial mining to full production and as such a number of construction activities are ongoing at the site.

Pollution Reduction Program

In 2011, the NSW Environmental Protection Authority (EPA) required, through a Pollution Reduction Program, that Airly Mine provide a report which examines in detail the potential measures which could be employed to further reduce particulate emissions from the mine. This is part of a larger program which aims to reduce particulate emissions from the coal mining industry as a whole in NSW.

Emissions were required to be quantified using United States Environmental Protection Agency approved emission factors without controls applied. Emission controls currently in place at Airly Mine were identified, and the control efficiency afforded by each applied measure, obtained through a literature review and site specific data were applied to these emissions.

Particulate emission sources were ranked according to the scale of emissions over a one year period with sources contributing to 95% of total site TSP emissions identified and taken forward for further assessment. The assessment required that additional controls were investigated, and the feasibility of implementing each control option was assessed with consideration to implementation costs, regulatory requirements, environmental impacts, safety implications and compatibility with current processes and any proposed future developments.

Following this feasibility assessment, a timeframe for implementation of particulate management measures was required to be provided.

It is noted that the EPA requirement was for generic emission factors to be applied to all emissions sources in the calculation of particulate emissions. Certain emission factors (for example for wind erosion of coal stockpiles) do not take into account the moisture content of the coal at Airly Mine. Given that emissions from wind erosion sources represent over half of the calculated particulate emissions from the Mine, it may be considered that particulate emissions reported within this study tend to represent an overestimation of the actual emissions from the site.

Findings

A range of particulate control measures have been identified which are compatible with a range of considerations (regulatory, environmental, safety and site compatibility). A cost benefit analysis identified that the use of wind breaks around exposed areas at the site provided emissions reductions at the lowest cost (<$5K per tonne PM_{10} suppressed). However, given the early stages of mine development and the low level of particulate reduction afforded by this measure, it has not been committed to at this time.

EXECUTIVE SUMMARY

Ongoing Actions and Implementation Timeframe

Airly Mine currently implements a number of particulate management measures. In the case of coal stockpiles (product coal and emergency coal stockpiles), these management measures are often implemented on an as-needs basis. Such measures include the use of water cannons and water carts to suppress dust emissions during hot, dry and windy conditions. In the interests of refining these management measures to ensure that particulate matter emissions are minimised with due regard to the conservation of water resources, Airly Mine will commit to performing a series of tests of coal to determine the propensity for dust generation through appropriate testing (e.g. Dust Extinction Moisture [DEM])[1]. This will allow an assessment of the likelihood of wind erosion more accurately than using generic emission factors. Site specific testing will also allow more targeted dust mitigation strategies to be designed (e.g. specific meteorological conditions under which water spraying is initiated) to minimise dust emissions from the site.

[1] DEM tests allow the moisture content at which the coal is deemed to emit no dust to be determined. Combined with wind tunnel dust-lift off tests and a number of moisture contents below the DEM, the wind speed at which erosion is initiated can be calculated and appropriate management measures employed at the mine site in conjunction with site meteorological data.

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Appendix A	NSW EPA Coal Mine Particulate Matter Control Best Practice – Site Specific Determination Guideline
Appendix B	USEPA AP-42 Emission Factors used in Calculation of Particulate Emissions
Appendix C	Detailed Cost/Benefit Tables for Selected Dust Management Measures

1 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR Consulting) was commissioned by Airly Coal Mine (Airly), to perform this assessment, which has included a site inspection, emissions estimation and the identification, quantification and justification of existing and proposed control measures for the site. The study was performed in accordance with the *Coal Mine Particulate Matter Control – Best Practice: Site Specific Determination Guideline*[2] issued by the New South Wales (NSW) Environmental Protection Authority (EPA) in November 2011.

The findings of this assessment are presented in the following report for submission to EPA.

1.1 Background

In 2010, the NSW EPA commissioned a detailed review of particulate matter (PM) emissions from coal mining activities in the Greater Metropolitan Region of NSW. This review was completed in 2011 and one of the key recommendations of the study was that each mine should carry out a site-specific determination of best management practice. This recommendation has been adopted by the EPA through the implementation of the "*Dust Stop*" program.

The Dust Stop program aims to ensure that the most reasonable and practical particulate control options are implemented by each coal mine. Under this program, all coal mines in NSW are required to prepare a report that compares their current operation with international best practice. Mines are also required to report on the practicability of implementing each best practice measure and for any measures found to be practicable, are required to provide a timetable for implementation. Once complete, copies of each report are required to be available on the mine's website.

The Dust Stop program is being implemented through pollution-reduction programs (PRPs) as operating conditions under the Environmental Protection Licence (EPL). A PRP was issued to Airly in August 2011 requiring that a Site Specific Particulate Matter Control Best Practice Assessment be prepared for the site.

1.2 Guidance

EPA has provided guidance on the general structure and methodology of the assessment report. For clarification, the guidance provided has been reproduced in **Appendix A**.

Briefly, the process that is required is indicated below. For each required step in the procedure, reference has been provided to the relevant sections in this assessment report:

1. Identify, quantify and justify existing measures that are being used to minimise particle emissions — **Section 2**
2. Identify, quantify and justify best practice measures that could be used to minimise particle emissions — **Section 3**
3. Evaluate the practicability of implementing these best practice measures — **Section 4**
4. Propose a timeframe for implementing all practicable best practice measures — **Section 5**

Further to this provided guidance, EPA held a workshop for coal mining companies and their consultants on 8 May 2012. The outcome of this workshop was further clarified guidance relating to the requirements of EPA. These clarifications are summarised as follows:

- The use of air quality monitoring data to identify that sites are complying with EPA ambient air quality criteria and therefore justify that there is no need to apply further controls is not acceptable. The aim of the PRP process is to reduce particulate emissions as a whole and is not primarily concerned with ambient concentrations.

[2] http://www.environment.nsw.gov.au/resources/air/20110813coalmineparticulate.pdf

- More site specific data is required. For example, material (silt/moisture), meteorology, vehicles (weights, speeds) and activity data. Where such data is not available, the justification of what *is* used is required, with potentially a recommendation and commitment by the site to collect this data in the future.
- Reports are required to be transparent and consistent with the mine AEMR.
- Reports need to include further detail on the control effectiveness of measures applied to each source. Although the guideline document identifies that the Katestone document should be referred to, blindly following the Katestone report is not acceptable practice.
- When control measures are recommended for implementation, some form of confirmation that controls are effective is required, or at least some indication of how the success of each measures' implementation will be measured. This might include KPI's, methods of monitoring, the location, frequency and duration of monitoring, and procedures for management.
- Economic review of each identified measure needs to consider depreciation (ATO rule TR2011/2012 for Coal Mining (Code 06000 and 10900). For off-highway trucks (including articulated, rigid dump, service, fuel and water trucks), the life of assets is classed as 10 years by the ATO.
- The salvage value of, for example trucks also needs to be considered (end of mine life and replacements).
- Implementation commitments will be written into Environmental Protection Licences in some form, but will be flexible if measures are not deemed to be viable at a later date.
- Although the guidance document identifies that the top four emission sources should be assessed, some professional judgement is required. The top four should not be blindly assessed. For example, if the top four only contribute 50% to total site emissions then more sources should be included. The top four sources should cover about 95% of total site emissions.

1.3 Description of the Coal Mine

1.3.1 Background to Airly Coal Mine

Airly Coal Mine (Airly) operates an underground coal mine and a coal handling plant (CHP) in the Western Region of New South Wales (NSW). The operation is located approximately 40 kilometres (km) north-northwest of Lithgow and approximately 4 km northeast of Capertree.

Mining at Airly is undertaken within Mining Lease 1331 (ML1331) issued by the DPI in 1993 and Licence A232 also issued by the DPI in 2010. Approval is granted for an underground mining operation for extraction of up to 1.8 million tonnes per annum (Mtpa) of coal with all coal to be transported offsite via rail.

It is noted that Airly is currently in the process of transition from trial mining to full production and as such a number of construction activities are ongoing at the site.

1.3.2 Mining and Coal Processing Operations

During the most recent Annual Environmental Management Report (AEMR) period of 1 January 2011 to 31 December 2011 the quantities of coal production and waste generation were reported as presented in **Table 1** (replicated from Table 6, AEMR, 2011 p15).

Table 1 Production and Waste Summary, Airly 2011

Parameter	Reporting Period 1 January 2011 to 31 December 2011
Topsoil Stripped	70,000 m^3
Topsoil Used/Spread	53,500 m^3
Waste Rock	157,930 m^3
ROM Coal Mined	498,285 tonnes
Processing Waste	0 tonnes
Product	179,689 tonnes

Taken from Table 6, Airly AEMR 2011 p15

Coal Mining

The original trial mine involved a box cut and three mine entries into the Lithgow seam which were developed off the highwall. These entries were sealed upon trial mine completion. During the 2010 reporting period, an additional three portals were developed, and one of the original portals reopened and amended for use. The life of mine use of the portals will be:

- Portal 1 - Return air ventilation through the mine ventilation fans commissioned in 2011
- Portal 2 – Main underground to surface conveyor belt system
- Portal 3 – Heavy vehicle traveling road from main pit top lay-down area to the underground mine. A temporary jiffy conveyor located in portal 3 was decommissioned in 2011.
- Portal 4 – Light vehicle traveling road from the site administration area, bathhouse, and muster area to the underground mine.

During the reporting period up until the completion of the underground to surface trunk conveyor in March 2011, coal was brought to the surface via a temporary jiffy conveyor system and stored on the surface at the emergency coal stockpile area. From this stockpile area, the coal was fed directly onto conveyor CV01 via a hopper for processing in the coal handling plant and storage on the site's ROM stockpile.

Since commissioning of the underground trunk conveyor (UC01) in March 2011, coal is fed directly onto surface conveyor CV01 via UC01, bypassing the previous need for coal handling in the pit top area. Total production during the 2011 AEMR period was 498,285 tonnes.

Waste rock moved during the construction period represents a combination of cut and fill. Not all topsoil generated was used in the rehabilitation of batters as the area stripped far exceeded the total area available for revegetation works. This is a consequence of constructing new infrastructure. However the topsoil has been emplaced and represents a long term storage area and will not be required for at least 20 years or until such time as the coal resource has been mined. The material will be available for the final rehabilitation of the mine on closure.

Coal Processing and Load-Out

The coal handling plant (crusher building) was completed and commissioned by Laing O'Rourke in March 2010. Coal produced up to this time was utilised in the 'wet' commissioning of the belt and crushing system. There is no washery on site and no coal was washed or rejects produced during the reporting period.

Coal production increased during the 2011 period and is scheduled to progressively increase during the coming reporting period as new underground crews continue to begin go online in 2012, with the third mining unit coming online by the end of 2012.

A second mining unit began on site in May 2011. Additional recruitment of crews, which began in March and June 2011, supplemented this second unit to perform production on both day and afternoon shift.

Ore and Product Stockpiles

As noted previously, during the reporting period, up until the completion of the underground to surface trunk conveyor in March 2011, coal was brought to the surface via a temporary jiffy conveyor system and stored on the surface at the emergency coal stockpile area. Since commissioning of the underground trunk conveyor (UC01) in March 2011, coal is fed directly onto surface conveyor CV01 via UC01, bypassing the previous need for coal handling in the pit top area.

The minus 50 mm sized coal ROM stockpile pad is sized to provide an as-formed 39,000 t stockpile (or 30,000 t and 9,000 t in two product stockpiles) and in excess of 160,000 t with push out by dozer. Coal is reclaimed from the ROM stockpile by three underground feeders which feed coal onto CV03 for transfer to the rail load out system.

In the event of a failure, the emergency stockpile in the pit top area adjacent to CV01, can be utilised for storage.

Material Movement

As previously outlined, material is moved around Airly by conveyor. Product coal is transported off site by trains. A number of haul roads exist around the site although these are used mostly for light (<2 t) vehicles.

The length of each haul road is presented in **Table 2** with information on the haul road width, annual use and mean vehicle weight.

Table 2 Details of Haul Roads

Haul Road	Length (m)	Width (m)	Annual Trip Frequency (2-way)	Mean Vehicle Weight (tonnes)
Torbane	1,200	5	4,700	2
Access	2,100	6	49,350	2
Pit Top	400	6	4,700	2
Airly Gap (Exploration)	4,000	5	1,040	2

Source: Airly pers. comm. 2012

Airly has provided details of the number of conveyors on site. A total of 3 conveyors (CV01, CV02 and CV03), with 5 (non-underground) transfer points are located on site with a total of 2,987,710 tonnes (498,285 t x 6) moved by conveyor in the 2011 AEMR reporting period. CV01 transports coal to the crusher building while CV02 and CV03 transport coal to the main coal stockpile and train loading bin, respectively.

Material Details

Details of the moisture and silt content of ROM coal and haul routes are presented in **Table 3**

Table 3 Characteristics of Handled Materials and Haul Routes

Material / Route	Silt Content (%)	Moisture Content (%)
Coal (ROM)	6	3.3*
Haul Routes (unsealed)	6	variable

* Assay Certificates available on request

Bulldozer Operation

A bulldozers is used at Airly to maintain stockpiles and push coal to reclaim tunnels. Information provided by Airly has identified the list of equipment used on site as presented in **Table 4**.

Table 4 Material Handling Equipment, Tonnages Handled and Operational Hours

Equipment	Number	Hours of Operation (per year)	
Bulldozers	1	Coal	500 hours

Source: Airly Pers. Comm 2012

Exposed Areas and Coal Stockpiles

Five areas at Airly are available to be eroded by the wind. Details of these areas are presented in **Table 5**.

Table 5 Areas Available for Wind Erosion

Area Name	Area (ha)	Comments
Exposed Areas		
Pit Top	1.8	Water Truck used for dust suppression
Carpark	0.7	
Topsoil Stockpile		
Topsoil Stockpile	2.9	Cover crops used for dust suppression
Coal Stockpiles		
Coal Stockpile	2.2	9 x water cannons used for dust suppression
Emergency Stockpile	0.6	Water Truck used for dust suppression

1.4 Project Approval Conditions

Although there are no specific air quality assessment criteria contained in the original EIS, modified EIS or Environmental Protection Licence (EPL), Airly has adopted the air quality criteria outlined in **Table 6**.

Table 6 Impact Assessment Criteria for Particulate Matter and Dust Deposition

Pollutant	Averaging Period	Criterion	
Total suspended particulate matter (TSP)	Annual	90 µg/m^3	
Particulate matter <10 µm (PM_{10})	Annual	30 µg/m^3	
	24 hour	50 µg/m^3	
		Maximum increase in deposited dust level	**Maximum total deposited dust level**
Deposited dust	Annual	2 g/m^2/month	4 g/m^2/month

1.5 Environmental Licence Conditions

The EPA regulates the operations conducted at Airly through an EPL issued under the Protection of the Environment Operations Act 1997 (POEO Act). Environmental Protection Licence number 12374 contains the following conditions in relation to dust (with the exception of the requirements in condition U1, which are considered within this report):

> *O3.1 The premises must be maintained in a condition which minimises or prevents the emission of dust from the premises*

Airly operates a complaints recording and management system as part of their over-arching management system and in accordance with Condition M4 of the EPL. In the last 12 months, Airly has received no complaints relating to dust generation.

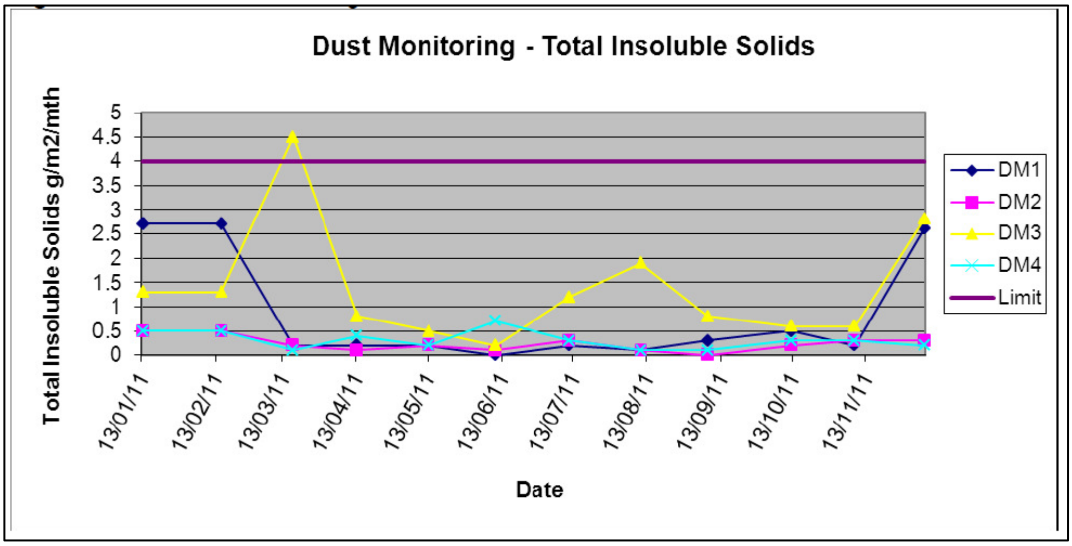
EPA do not have any current Notices issued to Airly.

The EPL requires that four dust monitoring sites are maintained in accordance with Condition P1.1. One is located at the Pit Top, one at Airly homestead, one at the Parr residence and one near the Leishman residence. Results for the most recent reporting period are presented in **Figure 1**.

Annual average insoluble solids were below 4 g/m^2/month for all dust deposition gauges during 2011 An elevated result was observed at DM3 in March 2011 although the annual compliance criteria was achieved.

Results of air quality monitoring are presented for contextual information only. It is acknowledged that evidence of compliance with Project Approval conditions is not adequate justification to not implement further dust controls on site.

Figure 1 Dust Deposition Monitoring Results – Airly Coal Mine 2011



2 IDENTIFICATION OF EXISTING CONTROL MEASURES & EMISSION ESTIMATION

1. Identify, quantify and justify existing measures that are being used to minimise particle emissions

1.1 Estimate baseline emissions of TSP, PM_{10} and $PM_{2.5}$ (tonne per year) from each mining activity. This estimate must:

- *Utilise USEPA AP-42 emission estimation techniques (or other method as approved in writing by the EPA),*
- *Calculate uncontrolled emissions (with no particulate matter controls in place), and*
- *Calculate controlled emissions (with current particulate matter controls in place).*

Notes: These particulate matter controls must be clearly identified, quantified and justified with supporting information. This means adding supporting information and evidence, including monitoring data, record keeping, management plans and/or operator training.

1.2 Using the results of the controlled emission estimates generated from Step 1.1, rank the mining activities according to the mass of TSP, PM_{10} and $PM_{2.5}$ emitted by each mining activity per year from highest to lowest.

1.3 Identify the top four mining activities from step 1.2 that contribute the highest emissions of TSP, PM_{10} and $PM_{2.5}$.

2.1 Estimation of Baseline Particulate Emissions

In the estimation of baseline emissions of particulate matter, United States Environmental Protection Agency (USEPA) AP-42, *Compilation of Air Pollutant Emission Factors* estimation techniques have been utilised, as prescribed in the methodology presented in **Appendix A** and reproduced above.

AP-42 Chapter 11 (Mineral Products Industry) and AP-42 Chapter 13 (Miscellaneous Sources) have been referenced to estimate emissions from mining activities occurring at Airly Mine. **Table 7** presents a summary of the AP-42 reference sections for the various emission factors used in this assessment report.

Table 7 Particulate Emissions Sources and Relevant USEPA AP-42 Emission Factors

Emissions Source	AP-42 Chapter	Notes
Bulldozing coal	Chapter 11.9 Western Surface Coal Mining (1998)	
Material transfer of coal by conveyor	Chapter 11.9 Western Surface Coal Mining (1998)	
Loading coal stockpiles	Chapter 11.9 Western Surface Coal Mining (1998)	
Wind erosion of coal stockpiles	Chapter 11.9 Western Surface Coal Mining (1998)	
Coal crushing	Chapter 11.24 Metallic Minerals Processing (1982)	Adopted in the NPI in absence of coal specific factors
Coal screening	Chapter 11.24 Metallic Minerals Processing (1982)	
Loading coal to trains	Chapter 11.9 Western Surface Coal Mining (1998)	
Wheel generated particulates on unpaved roads	Chapter 13.2.2 Unpaved Roads (2006)	

Appendix B outlines the emission factors used for each activity occurring at Airly.

A discussion of the annual activity related to each action and the subsequent calculated emission rates of TSP, PM_{10} and $PM_{2.5}$ are provided in **Section 2.1.1**. As required by the EPA, emissions are presented firstly as uncontrolled emissions, and secondly as emissions with controls currently employed in place.

2.1.1 Activity Data

Annual activity data for the activities presented in **Table 7** are provided in **Table 8** for wind erosion sources and in **Table 9** for material handling operations. Information on haul roads has previously been provided in **Table 2**.

Table 8 Annual Activity Data for Wind Erosion Sources

Open Area	Total Area (ha)	Active Area (ha)	Emission Factor Applied to Active Area
Pit Top	1.8	1.8	Wind Erosion of Exposed Areas (AP-42 Chapter 11.9)
Car Park	0.7	0.7	Wind Erosion of Exposed Areas (AP-42 Chapter 11.9)
Topsoil Stockpile	2.9	2.9	Wind Erosion of Exposed Areas (AP-42 Chapter 11.9)
Coal Stockpile	2.2	2.2	Wind Erosion of Coal Stockpile Areas (AP-42 Chapter 11.9)
Emergency Stockpile	0.6	0.6	Wind Erosion of Coal Stockpile Areas (AP-42 Chapter 11.9)

Table 9 Annual Activity Data for Material Handling Operations

Operation / Activity	Activity Rate (Annual)	Units	Notes
COAL			
Conveying of ROM Coal to CHP	498,285	tonnes	1 transfer point
Secondary Crushing	498,285	tonnes	
Tertiary Crushing	498,285	tonnes	
Screening	498,285	tonnes	All Coal to CHP
Conveying to Coal Stockpile (or Emergency Stockpile)	996,570	tonnes	2 transfer points (2 x 498,285 t)
Dumping of Coal to Coal Stockpile	498,285	tonnes	
Dozer on Coal Stockpile	500	hours	
Underground Reclaim of Coal from Coal Stockpile	498,285	tonnes	
Conveyor to Train Loading Bin	498,285	tonnes	
Loading Train Loading Bin	498,285	tonnes	
Loading Trains	498,285	tonnes	

2.1.2 Uncontrolled Particulate Emissions

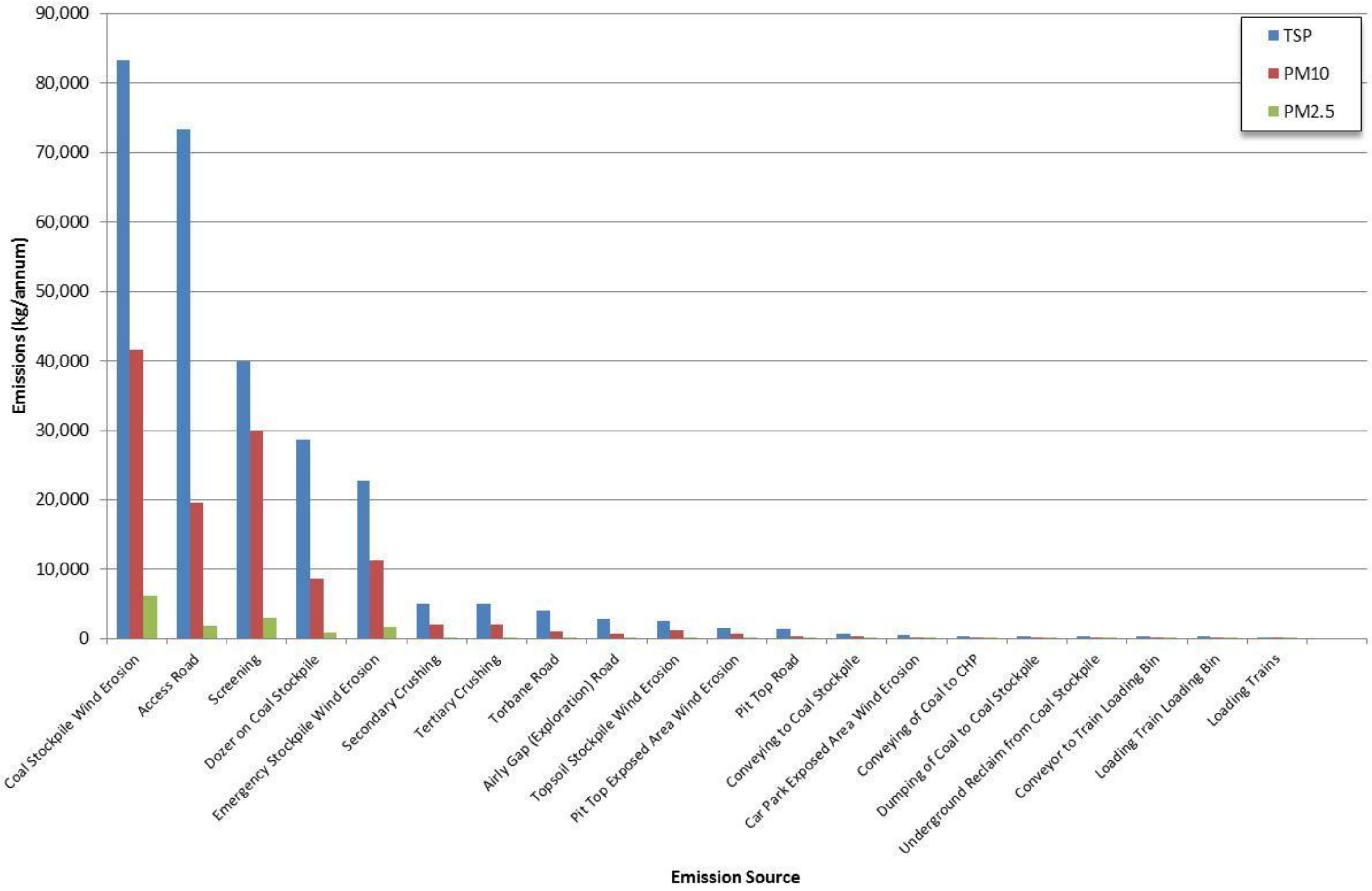
Using the emission factors calculated in **Appendix B** and the annual activity data presented in **Section 2.1.1**, the annual (uncontrolled) particulate emissions from Airly are presented in **Table 10** and graphically in **Figure 2**.

Table 10 Uncontrolled Annual Particulate Emissions – Airly Mine

Emission Source	TSP Emissions (kg/year)	PM_{10} Emissions (kg/year)	$PM_{2.5}$ Emissions (kg/year)	Cumulative % Contribution to Total TSP Emissions
Coal Stockpile Wind Erosion	83,255	41,628	6,244	30.5
Access Road	73,424	19,567	1,957	57.3
Screening	39,863	29,897	2,990	71.9
Dozer on Coal Stockpile	28,726	8,743	874	82.4
Emergency Stockpile Wind Erosion	22,706	11,353	1,703	90.7
Secondary Crushing	4,983	1,993	199	92.6
Tertiary Crushing	4,983	1,993	199	94.4
Torbane Road	3,996	1,065	106	95.8
Airly Gap (Exploration) Road	2,947	785	79	96.9
Topsoil Stockpile Wind Erosion	2,465	1,233	123	97.8
Pit Top Exposed Area Wind Erosion	1,530	765	77	98.4
Pit Top Road	1,332	355	35	98.9
Conveying to Coal Stockpile	655	310	31	99.1
Car Park Exposed Area Wind Erosion	595	298	30	99.3
Conveying of Coal to CHP	328	155	15	99.4
Dumping of Coal to Coal Stockpile	328	155	15	99.6
Underground Reclaim from Coal Stockpile	328	155	15	99.7
Conveyor to Train Loading Bin	328	155	15	99.8
Loading Train Loading Bin	328	155	15	99.9
Loading Trains	199	85	8	100.0
TOTAL	**273,299**	**120,845**	**14,730**	**-**

Note: Values are calculated using generic emission factors (refer **Appendix B**) and does not comprise of actual site specific measurements.

Figure 2 Uncontrolled Annual Particulate Emissions – Airly Mine



2.2 Existing Control Measures

Airly operate an Air Quality Management Plan with the measures identified in the following sections being implemented as part of that plan (refer Section 3.4.1, AEMR, 2011 p26 and Air Quality Management Plan). Where relevant, emission control factors for each dust suppression activity are provided. Control factors are sourced from a number of publications including:

- Katestone Environmental 2010, "*NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining"*, December 2010
- Australian Government Department of Sustainability, Environment, Water, Population and Communities 2012, "*National Pollutant Inventory Emission Estimation Technique for Mining", Version 3.1*, January 2012
- Countess Environmental 2006, *"WRAP Fugitive Dust Handbook"*, September, 2006
- US Department of Health and Human Services 2012, *"Dust Control Handbook for Industrial Minerals Mining and Processing"*, January 2012

It is acknowledged that emission control factors can be highly variable, and are generally based on site and material specific field trials. Where possible, the entire range of control factors for each relevant activity from the references above are presented with the most appropriate factor, taking into consideration the source of the data, being taken forward for application within this report.

Where a considerable level of uncertainty exists, or where the emission source has the potential to contribute a significant percentage to the site dust balance, further work is proposed.

It is noted that several measures to reduce dust emissions are employed on an "as-needs" basis. Given that these control measures will be employed during certain weather conditions (the frequency of which vary from year to year), the control factors afforded by these measures are not considered. However, these measures will continue to be employed and will act to further reduce particulate emissions over and above those reported in this study.

2.2.1 Dust Suppression

- *Timed use of water trucks on the main access road during daytime hours and prior to shift changes to ensure dust from light vehicles entering and leaving site is controlled.*

Sealing of the site access road was performed in January 2012, eliminating the need for regular road watering.

- *Vacuum sweeping of hardstand areas.*
- *Strict adherence to speed limits on all unsealed roads including the main access road.*
- *Sprinkler system in place on ROM stockpile that can be utilised during dry and windy conditions to limit airborne dust generation. Nine water cannons are in place including three either side of the stockpile and three above the stockpile on the stacker gantry (see* **Figure 3***)*

Figure 3 Water Cannons in Operation at Coal Stockpile

- *Conveyors are enclosed on three sides to prevent dust generation.*
- *Crusher building is enclosed.*
- *Trains loaded via a train loading bin.*
- *Revegetation of all exposed soil.*
- *Landscaping/visual screen along Torbane Road which also acts as a wind break to the coal stockpile.*

Haul Road Dust Suppression

Haul road dust suppression is achieved through the use of road sealing (on main access road), the use of water sprays on unsealed roads on an as-needs basis and strict adherence to speed restrictions.

Various emission control factors are quoted in literature and include:

- 90% control for paving (Katestone, 2010)
- 50%-85% control for speed reduction from 65 km/hr to 30 km/hr.

The use of water sprays on unsealed roads has a range of control factors from 10% to 75% which is related to the application rate (litres/m^2/hour). As the use of water sprays on roads at the Airly mine is performed on an as-needs basis, the application rate over the annual period is not known. Therefore, for the purposes of this assessment, the application rate is assumed to be zero.

For the purposes of this assessment, the use of paving on roads is assumed to affect a particulate reduction of 90%, with the use of speed restrictions assumed to result in a particulate reduction of 50%.

Water Sprays and Enclosure of Conveyors and CHP

The CHP is enclosed. Various emission control factors are quoted in literature, and include:

- 70% for enclosure (NPI, 2011);
- 50% for water sprays on transfer points (Katestone Environmental, 2010)
- 40% for wind shielding on roof or side walls (Katestone Environmental, 2010)
- 70% for wind shielding on roof and side walls (Katestone Environmental, 2010)
- 70% for enclosure (Katestone Environmental, 2010).

For this assessment a control factor of 70% has been assumed for the enclosure of the CHP operations (secondary and tertiary crushing and screening [primary crushing occurs underground]).

The enclosure on three sides of the conveyors is assumed to result in a particulate emission reduction of 70% relating to the enclosure of roof and side walls.

Watering of Active Stockpiles

Watering is the principal means of dust suppression for active stockpiles areas at Airly, which is reported in the literature to provide a control factor of 50% (NPI, 2011 and Katestone Environmental, 2010).

Wind Screens

The use of a vegetative wind break along Torbane Road is used at Airly to reduce wind erosion on the coal stockpile. The use of vegetative wind breaks is quoted in the literature to provide a control factor of 30% (Katestone Environmental, 2010).

Revegetation of Topsoil Stockpiles

The use of cover crops on the topsoil stockpiles is used to reduce wind erosion from this source. Literature suggests that for rehabilitation of exposed areas, a control factor of 99% may be applicable (Katestone Environmental, 2010), although in the case of the use of vegetative ground cover, a control factor of 70% may be more applicable (Katestone Environmental, 2010), and is used in this instance for the Airly Mine.

Loading Trains via Loading Bin

No control factors are available in the literature for the use of a train loading bin. Correspondingly, no control factor can be applied in this instance.

2.2.2 Summary of Control Factors Assumed for Existing Particulate Control Measures

As part of this assessment, a site audit was conducted in July 2012 to identify and verify the current dust control measures being implemented at Airly. A summary of the existing control measures identified as currently being implemented at Airly is provided in **Table 11**.

Table 11 Control Factors Assumed for Existing Control Measures

Dust Mitigation Measure	Applied Control Factor	Notes
Use of water trucks	0%	Occurs on as-needs basis – no factor can be applied.
Speed limits on unsealed roads	50%	For reduction from 65 km/hr to 30 km/hr
Water sprays on stockpiles	50%	For use of water sprays
Conveyors enclosed on three sides	70%	For enclosure on roof and side walls
Crusher building is enclosed.	70%	For enclosure
Trains loaded via a train loading bin.	0%	No control factor available
Revegetation of all exposed soil.	70%	For the use of vegetative ground cover
Vegetative wind break	30%	For the use of vegetative wind break on Torbane Road

Presented in **Table 12** are the calculated particulate emissions from Airly Mine with current emission controls applied. These are also presented graphically in **Figure 4**. A comparison of the total emissions by source (controlled and uncontrolled) is presented in **Figure 5**.

Table 12 Controlled Annual Particulate Emissions – Airly Mine

Emission Source	TSP Emissions (kg/year)	PM_{10} Emissions (kg/year)	$PM_{2.5}$ Emissions (kg/year)	Cumulative % Contribution to Total TSP Emissions
Coal Stockpile Wind Erosion	41,628	20,814	3,122	33.8
Dozer on Coal Stockpile	28,726	8,743	874	57.1
Emergency Stockpile Wind Erosion	22,706	11,353	1,703	75.5
Screening	11,959	8,969	897	85.2
Access Road	7,342	1,957	196	91.2
Torbane Road	1,998	532	53	92.8
Pit Top Exposed Area Wind Erosion	1,530	765	77	94.1
Secondary Crushing	1,495	598	60	95.3
Tertiary Crushing	1,495	598	60	96.5
Airly Gap (Exploration) Road	1,474	393	39	97.7
Topsoil Stockpile Wind Erosion	740	370	37	98.3
Pit Top Road	666	177	18	98.8
Car Park Exposed Area Wind Erosion	595	298	30	99.3
Loading Trains	199	85	8	99.5
Conveying to Coal Stockpile	197	93	9	99.6
Dumping of Coal to Coal Stockpile	164	77	8	99.8
Conveying of Coal to CHP	98	46	5	99.8
Conveyor to Train Loading Bin	98	46	5	99.9
Loading Train Loading Bin	98	46	5	100.0
Underground Reclaim from Coal Stockpile	-	-	-	100.0
TOTAL	**123,208**	**55,960**	**7,206**	**-**

Note: Values are calculated using generic emission factors (refer **Appendix B**) and does not comprise of actual site specific measurements.

Figure 4 Controlled Annual Particulate Emissions – Airly Mine

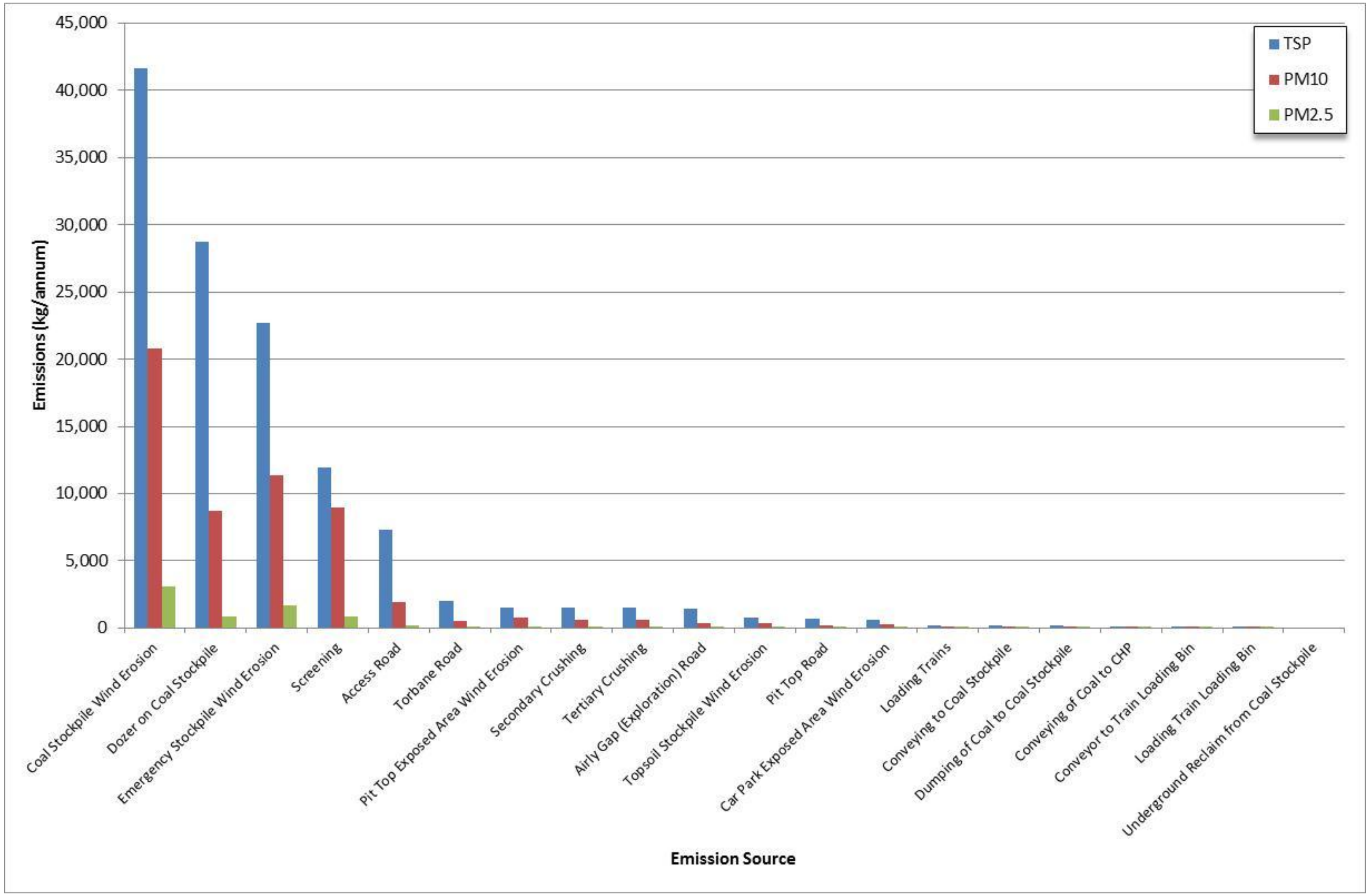
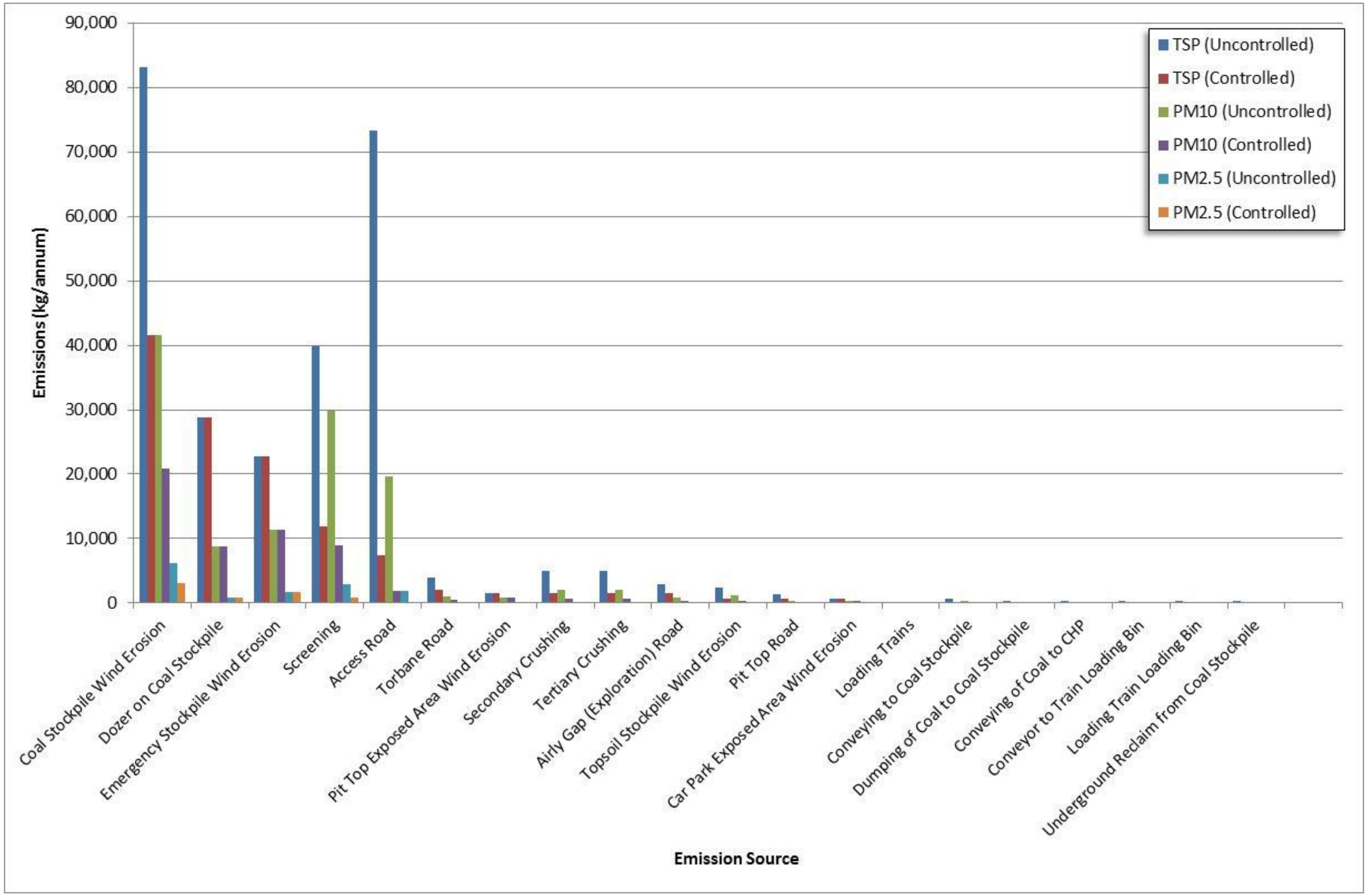


Figure 5 Comparison of Uncontrolled versus Controlled Particulate Emissions – Airly Mine



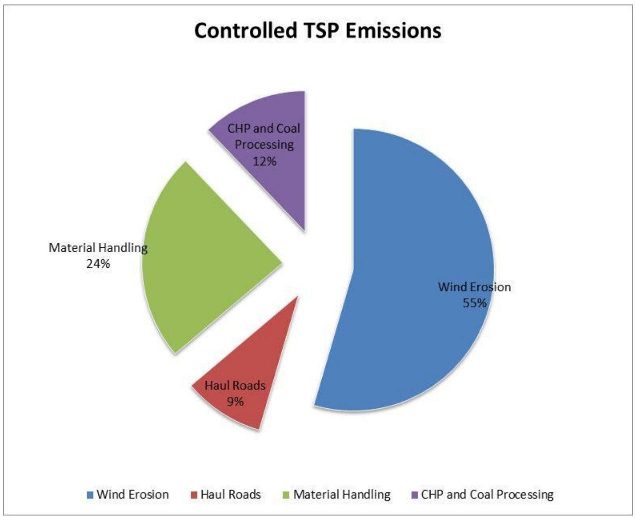
Particulate emissions are presented by source group (wind erosion, haul roads, material handling and extraction and CHP and coal loading operations at the CHP and product stockpile areas) in **Table 13** and **Figure 6**.

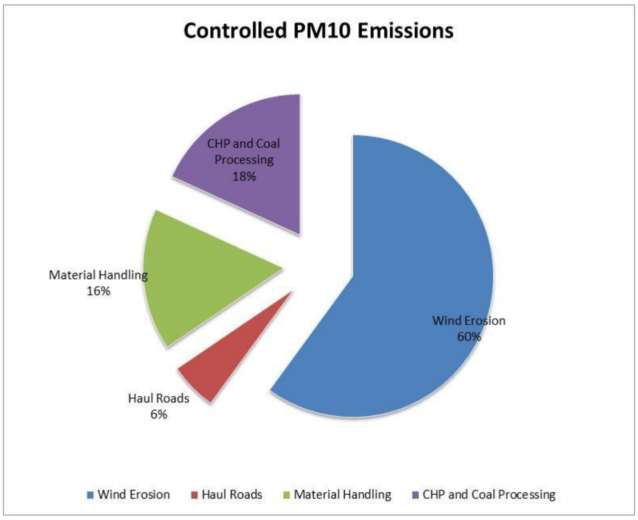
Table 13 Comparison of Uncontrolled and Controlled Particulate Emissions

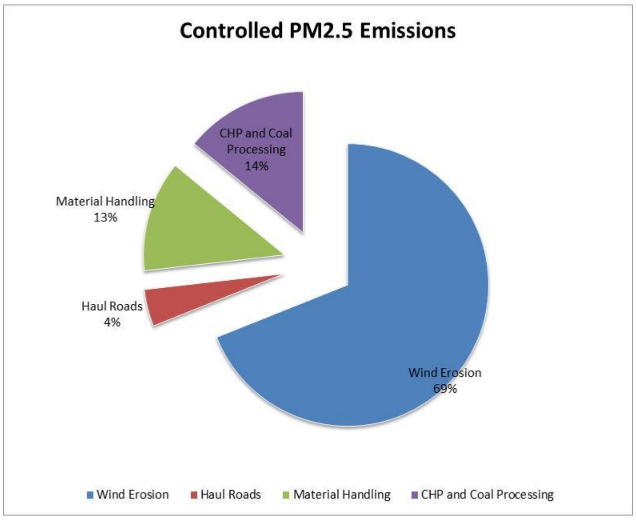
Emission Source Group	Uncontrolled Emissions (kg/annum)			Controlled Emissions (kg/annum)		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Wind Erosion	110,551	55,275	8,177	67,198	33,599	4,968
Haul Roads	81,699	21,772	2,177	11,480	3,059	306
Material Handling	31,220	9,913	991	29,581	9,138	914
CHP and Coal Processing	49,829	33,883	3,388	14,949	10,165	1,017
TOTAL	**273,298**	**120,844**	**14,733**	**123,208**	**55,961**	**7,204**

Note: Values are calculated using generic emission factors (refer **Appendix B**) and does not comprise of actual site specific measurements.

Figure 6 Representation of Major Controlled Particulate Emission Sources –Airly Mine







2.3 Ranking of Mining Activities and Identification of Top Four PM Sources

NSW EPA requirements for the assessment of particulate control measures are provided in **Appendix A**. This advice requires the top four controlled particulate emissions sources are assessed for the feasibility of further control measures being applied.

However, further advice from the EPA has indicated that these top four sources should represent a significant proportion of mine emissions. Within this report, the assessment of further control measures has been applied to all sources which cumulatively represent 95.3% of total site emissions (of TSP). These sources and emission totals are presented in **Table 14,** and cover the broad emission sources of wind erosion, emissions from roads, the use of bulldozers on coal and operation of the coal screen and secondary crusher. Potential control measures to be applied to these sources are discussed in detail in **Section 3**.

Table 14 Controlled Particulate Matter Sources Representing 95.3% of Airly Mine TSP Emissions

Emission Source	TSP Emissions (kg/year)	PM_{10} Emissions (kg/year)	$PM_{2.5}$ Emissions (kg/year)	Cumulative % Contribution to Total TSP Emissions
Coal Stockpile Wind Erosion	41,628	20,814	3,122	33.8
Dozer on Coal Stockpile	28,726	8,743	874	57.1
Emergency Stockpile Wind Erosion	22,706	11,353	1,703	75.5
Screening	11,959	8,969	897	85.2
Access Road	7,342	1,957	196	91.2
Torbane Road	1,998	532	53	92.8
Pit Top Exposed Area Wind Erosion	1,530	765	77	94.1
Secondary Crushing	1,495	598	60	95.3

Note: Values are calculated using generic emission factors (refer **Appendix B**) and does not comprise of actual site specific measurements.

3 POTENTIAL CONTROL MEASURES

2. Identify, quantify and justify best practice measures that could be used to minimise particle emissions

2.1 For each of the top four activities identified in step 1.3, identify the measures that could be implemented to reduce emissions, taking into consideration:

- *The findings of Katestone (June 2011) "NSW coal mining benchmarking study – international best practice measures to prevent and/or minimise emissions of particulate matter from coal mining",*
- *Any other relevant published information, and*
- *Any relevant industry experience from either Australia or overseas.*

2.2 For each of the top four activities identified in step 1.3, estimate the emissions of TSP, PM_{10} and $PM_{2.5}$ from each mining activity after applying the measures identified in step 2.1.

Current particulate matter controls being used at the mine must be clearly identified, quantified and justified. This means adding supporting information and evidence, including monitoring data, recorded keeping, management plans and/or operator training.

The emission reductions quoted within this Section are generic published control factors which do not take into account the specific nature of operations at Airly Mine. In the absence of costly site specific trials for each control measure being available, these generic factors are used to guide the selection of control measures which may be broadly appropriate for further investigation or application at the site.

Following an assessment of the feasibility of each measure (refer **Section 4**) some control measures are taken forward for an assessment of costs and benefits. Where a measure is identified as potentially providing particulate emissions reductions for a source at an acceptable cost, the implementation of the measure is committed to by Airly Mine, following site specific trials of the measure. These trials are essential and are proposed to:

1 Confirm current particulate emissions from the source in question; and,

2 Confirm the potential particulate emissions reductions following control measure implementation.

It is not considered to be appropriate to commit to widespread implementation of potentially costly and ineffective particulate control measures on the basis of non-site specific data.

Trials of each control measure will be implemented within 6 months of report submission, and a reassessment of the likely emission reductions afforded by each measure will be performed. Such reassessment will include field trials and comprehensive data collection and analysis.

Where measures are still identified as providing significant emission reductions at acceptable cost following these field trials, these will be implemented on a wider scale.

3.1 Haul Roads

Options for the control of dust emissions from unpaved haul roads fall into the following three categories:

- Vehicle restrictions that limit the speed, weight or number of vehicles on the road.
- Surface improvement by measures such as (a) paving or (b) adding gravel or slag to a dirt road.
- Surface treatment such as watering or treatment with chemical dust suppressants.

The applicability of the above control methods varies significantly due to the costs of installing and operating the various options, the timing of the implementation of the controls (for example at planning stage or applied retrospectively when the mine is operating) and the scale of the mining operation.

For example, vehicle restrictions that are considered at the mine planning phase might be relatively easy to apply, such as the replacement of a large number of small haul trucks with a smaller fleet of larger trucks, or other considerations such as upward facing vehicle exhausts. However, implementation of these control options retrospectively during mine operation would represent a significant capital expenditure. Vehicle speed restrictions may offer an effective control, but may pose a logistical or economic constraint if it restricts the transport of materials in the mine and may be difficult to manage and enforce.

Clearly, replacement of haul trucks with automated material handling systems, such as conveyors may offer a significant opportunity to reduce particulate emissions, if feasible.

The improvement of the road structure using non-sealed surfaces (such as gravelled surfaces) or substrata design (such as design to limit water penetration, pooling, camber and corners are easier to implement during the planning phases as they may require site layout considerations, such as the location of plant and processes to be altered. The use of non-sealed surfaces may require much greater frequency of maintenance, particularly during adverse weather conditions or heavily trafficked periods. Surface improvements may not be cost-effective with heavy haul vehicles that require high-grade engineered road structures to carry the load without disintegration.

Surface watering is a commonly applied control option, however the availability of water supplies may represent a significant constraint to its use, particularly during peak demand periods, such as high winds during prolonged dry periods. The use of chemical suppressants or surface binding agents offer enhanced dust control efficiency and may also reduce the volume of water required, or a reduction in the time required between watering. In some instances, watering after the application of chemical suppressants may reduce the efficacy of the overall dust control. Generally, chemical additives and suppressants offer an improved efficiency than water but not in all situations (e.g. temporary roads).

A summary of the potential control measures for minimising particulate emissions from haul roads, and their effectiveness, is provided in **Table 15** (Katestone, 2010).

Table 15 Best Practice Control Measures - Haul Roads

Control Type	Control Measure	Effectiveness
Vehicle Restrictions	Reduction from 75 km/hr to 50 km/hr	40-75
	Reduction from 65 km/hr to 30 km/hr	50-85
Surface Improvements	Pave the surface (currently implemented)	>90%
	Low silt aggregate	30%
	Oil and double chip surface	80%
Surface Treatments	Watering (standard procedure)	10-74%
	Watering Level 2 (>2 l/m²/hr)	75%
	Watering twice a day for industrial unpaved road	55%
	Hygroscopic salts[a]	Av. 45% over 14 days
		82% within 2 weeks
	Polymer and Tar/Bitumen emulsions	70% over 58 days

Notes: [a] Use of hygroscopic salts can also act to extend the required time between watering by 33% to 50% (USDHHS, 2012)
[b] Reductions achieved by the use of larger vehicles, conveyors and lower grader speeds have been calculated from the emission factors for these activities

SOURCE: Katestone (2010), Table 66

3.2 Wind Erosion

3.2.1 Coal Stockpiles

Stockpiles of coal provide a surface for the generation of wind-eroded material and the subsequent propagation of particulate matter emissions. In addition to stockpile dimensions, emissions generated by wind erosion from stockpiles are also dependent on the frequency of disturbance of the exposed surface. Over time the surface of an undisturbed stockpile will become depleted of erodible material and emissions of particulate matter will reduce. However, the nature of coal stockpiles is that they are frequently disturbed, causing fresh surface material to be exposed restoring the erosion potential (Katestone, 2011).

For existing stockpiles, the control measures identified in the literature to minimise particulate emissions include:

- Bypassing stockpiles to load directly into ROM bin or onto train
- Fencing, bunding or shelterbelts to reduce ambient wind speeds
- Watering to minimise lift-off with automatic control through continuous cycling and increased application based on meteorological conditions
- Chemical suppressants to bind loose fine surface material in response to adverse weather conditions
- Minimising residence time of coal in stockpiles
- Spillage clean-up
- Surface covering

Structures can be used to reduce emissions of particulate matter, such as earth walls (berms) or fences. Berms can act as a windbreak by preventing the erosive and drying effects of the wind. Berms can also reduce the amount of water and use of suppressants making it a cost-effective option in many cases. A study was conducted of the effectiveness of wind screens and determined that the most effective screens for reducing the wind speed had the following dimensions relative to the height of the stockpile (Katestone, 2011):

- Height: 1.25 times the height of the stockpile

- Width: 1.5 times the height of the stockpile
- Distance upwind: 2.0 times the height of the stockpile

Chemical binders and suppressants may be applied to the surface of stockpiles to enhance the cohesion of particles and reduce the potential for wind erosion. These binding agents are usually applied in solution and are sprayed onto the surface. Water sprays by themselves have been shown to offer in the region of 50% to 80% control efficiency. However, the effectiveness of spray additives is reduced by mechanical disturbance as it breaks the surface 'crust', which may be caused by stockpile working (i.e. the addition or removal of material), vehicle disturbance or the action of wild animals.

Wind breaks and screens offer an alternative to reduce wind erosion from stockpiled materials or areas with no vegetative cover. Recent studies have demonstrated a wide range of control efficiencies for screens and windbreaks, as summarised in Katestone 2011. Vegetative wind breaks are reported with control efficiency of 30% and wind screens and fences up to 80%. Studies regarding windbreak design and size have been shown to influence its effectiveness, particularly its relative height to the height of the stockpile, its distance downwind and its structural porosity (Katestone, 2011). Reducing the height of the stockpile may also offer a significant reduction in the wind erosion potential by reducing the wind speed over the stockpile surface.

The use of multiple controls, such as the use of chemical stabilisers and binders with wind breaks may offer enhanced dust control. Studies have reported a reduction in windblown dust emissions of up to 85% for up to 10 days of moderate to high wind speeds through the use of stabilisers and wind breaks (Katestone, 2011).

Similarly, stockpile size and orientation has been shown to affect the efficacy of wind breaks, with "smooth whaleback" profiles being more effective at reducing wind erosion than pointed stockpiles and orientation with the smallest face towards the prevailing wind offering increased protection from wind erosion. Studies suggest a control efficiency of 60% may be attributed to stockpile size, design and orientation.

A summary of the potential control measures for minimising particulate emissions from wind erosion from coal stockpiles, and their effectiveness, is provided in **Table 16** (Katestone, 2011).

Table 16 Best Practice Control Measures – Wind Erosion of Coal Stockpiles

Control Type	Control Measure	Effectiveness
Avoidance	Bypassing stockpiles	100% reduction in wind erosion for coal bypassing stockpiles
Surface stabilisation	Water spray (currently implemented)	50%
	Chemical wetting agents	80-99% 85% 90%
	Surface crusting agent	95%
	Carry over wetting from load in	80%
Enclosure	Silo with bag house	100% 95-99% 99%
	Cover storage pile with a tarp during high winds	99%
Wind speed reduction	Vegetative wind breaks (currently implemented)	30%
	Reduced pile height	30%
	Wind screens/wind fences	>80% 75-80%
	Pile shaping/orientation	<60%
	Erect 3-sided enclosure around storage piles	75%

SOURCE: Katestone (2011), Table 72

3.2.2 Exposed Areas

To control the generation and/or propagation of particulate emissions due to wind erosion, the following techniques are recommended, including those identified in Katestone, 2011:

- Paving – usually feasible for small areas in and around workshops
- Fencing, bunding or shelterbelts to reduce ambient wind speeds
- Adding gravel to the surface to reduce surface fines content and to reduce the surface wind speed
- Spillage clean up
- Watering
- Chemical suppressants

A summary of the potential control measures for minimising particulate emissions from wind erosion in exposed areas, and their effectiveness, is provided in **Table 17**, reproduced from Katestone (2011).

Table 17 Best Practice Control Measures – Wind Erosion of Exposed Areas

Control Type	Control Measure	Effectiveness
Surface stabilisation	Watering	50%
	Chemical suppressants	70% 84%
Wind speed reduction	Fencing, bunding or shelterbelts. Height should be greater than the height of the erodible surface	30% 70-80%

SOURCE: Katestone (2011), Table 71

3.3 Bulldozers on Coal

Katestone (2011) presents a comprehensive summary of an options appraisal conducted by Connell Hatch for the control of particulate emissions from bulldozers at the RG Tanna Coal Terminal. Options considered in the study included:

- Minimising travel speed and travel distance.
- Stabilising bulldozer travel routes and use of water or suppressants on travel routes.
- Manage coal moisture to ensure coal is sufficiently moist when working.
- Modify design of the bulldozer to minimise emissions.

Based upon the data available, the emission of particulate from bulldozer operation can only be quantified by hours of operation, and not the speed of the vehicles.

A summary of the potential control measures for minimising particulate emissions from bulldozers, and their effectiveness, is provided in **Table 18** (Katestone, 2011).

Table 18 Best Practice Control Measures – Bulldozers

Control Measure		Effectiveness
Bulldozer	Minimise travel speed and distance	Not quantified
	Keep travel routes and materials moist	50%

SOURCE: Katestone (2011), Table 76

3.4 Coal Screening and Secondary Crushing

Katestone (2011) does not provide emission reduction factors for coal processing operations. The reduction factor of 70% applied to the uncontrolled emission rate for screening and crushing of coal (**Section 2.2**) has been adopted from NPI (2011) and it is considered that enclosure of such operations is best practice.

Further control options for coal processing operations have not been considered further within this report, given that enclosure is considered to represent best practice control.

3.5 Quantification of Potential Particulate Management Measures

Table 19 presents the emission control factors assumed in this assessment for the potential particulate management measures identified.

Table 19 Control Factors Assumed for Potential Control Measures

Emission Source	Control Measure	Control Factor Assumed	Reference
Wind Erosion of Coal Stockpiles	Bypassing stockpiles	100%	Katestone (2011)
	Water spray (currently implemented on Coal Stockpile)	50%	Katestone (2011)
	Chemical wetting agents	80%	Katestone (2011)
	Surface crusting agent	95%	Katestone (2011)
	Silo with bag house	95%	Katestone (2011)
	Cover storage pile with a tarp during high winds	99%	Katestone (2011)
	Vegetative wind breaks (currently implemented on Coal Stockpile)	30%	Katestone (2011)
	Reduced pile height	30%	Katestone (2011)
	Wind screens/wind fences	75%	Katestone (2011)
	Pile shaping/orientation	60%	Katestone (2011)
	Erect 3-sided enclosure around storage piles	80%	Katestone (2011)
Wind Erosion of Exposed Areas	Watering	50%	Katestone (2011)
	Chemical suppressants	70%	Katestone (2011)
	Fencing, bunding, shelterbelts or in-pit dump. Height should be greater than the height of the erodible surface	30%	Katestone (2011)
Unpaved Roads	Pave the surface (currently implemented on Access Road)	90%	Katestone (2011)
	Low silt aggregate	30%	Katestone (2011)
	Oil and double chip surface	80%	Katestone (2011)
	Watering Level 2 (>2 l/m²/hr)	75%	Katestone (2011)
	Suppressants	84%	Katestone (2011)
	Hygroscopic salts	82%	Katestone (2011)
	Polymer and Tar / Bitumen emulsions	70%	Katestone (2011)
Bulldozers on Coal	Keep travel routes and materials moist	50%	Katestone (2011)

Table 20 to **Table 25** outline the anticipated emissions reductions should the reduction measures in **Table 19** be applied.

Table 20 Estimated Emissions – Wind Erosion of Coal Stockpile – Potential Controls

Emission Source	Control Option	Reduction Efficiency (%)	Reference	Emissions (Controlled)			Emissions (Controlled) plus Further Control		
				TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Wind Erosion of Coal Stockpile	Bypassing Stockpiles	100	Katestone (2011)	41,628	20,814	3,122	0	0	0
	Chemical Wetting Agents	80	Katestone (2011)				8,326	4,163	624
	Surface Crusting Agents	95	Katestone (2011)				2,081	1,041	156
	Silo with bag house	95	Katestone (2011)				2,081	1,041	156
	Cover storage pile with a tarp during high winds	99	Katestone (2011)				416	208	31
	Reduced pile height	30	Katestone (2011)				29,139	14,570	2,185
	Wind screens / wind fences	75	Katestone (2011)				10,407	5,203	781
	Pile shaping / orientation	60	Katestone (2011)				16,651	8,326	1,249
	Erect 3-sided enclosure around storage piles	80	Katestone (2011)				8,326	4,163	624

Table 21 Estimated Emissions – Dozer on Coal Stockpile – Potential Controls

Emission Source	Control Option	Reduction Efficiency (%)	Reference	Emissions (Controlled)			Emissions (Controlled) plus Further Control		
				TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Dozer on Coal Stockpile	Keep Travel Routes and Material Moist	50	Katestone (2011)	28,726	8,743	874	14,363	4,372	437

Table 22 Estimated Emissions - Wind Erosion of Emergency Coal Stockpile– Potential Controls

Emission Source	Control Option	Reduction Efficiency (%)	Reference	Emissions (Controlled)			Emissions (Controlled) plus Further Control		
				TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Wind Erosion of Emergency Coal Stockpile	Bypassing Stockpiles	100	Katestone (2011)	22,706	11,353	1,703	0	0	0
	Water Sprays	50	Katestone (2011)				11,353	5,676	851
	Chemical Wetting Agents	80	Katestone (2011)				4,541	2,271	341
	Surface Crusting Agents	95	Katestone (2011)				1,135	568	85
	Silo with bag house	95	Katestone (2011)				1,135	568	85
	Cover storage pile with a tarp during high winds	99	Katestone (2011)				227	114	17
	Vegetative wind breaks	30	Katestone (2011)				15,894	7,947	1,192
	Reduced pile height	30	Katestone (2011)				15,894	7,947	1,192
	Wind screens / wind fences	75	Katestone (2011)				5,676	2,838	426
	Pile shaping / orientation	60	Katestone (2011)				9,082	4,541	681
	Erect 3-sided enclosure around storage piles	80	Katestone (2011)				4,541	2,271	341

Table 23 Estimated Emissions – Access Road – Potential Controls

Emission Source	Control Option	Reduction Efficiency (%)	Reference	Emissions (Controlled)			Emissions (Controlled) plus Further Control		
				TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
	Watering Level 2 (>2 l/m²/hr)	80	Katestone (2011)	7,342	1,957	196	1,836	489	49

Note: Low Silt Aggregate, Oil and Double Chip Surface, Suppressants and Emulsions not considered suitable for a paved road

Table 24 Estimated Emissions – Torbane Road – Potential Controls

Emission Source	Control Option	Reduction Efficiency (%)	Reference	Emissions (Controlled)			Emissions (Controlled) plus Further Control		
				TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Torbane Road	Pave the surface	90	Katestone (2011)	1,530	765	77	153	77	8
	Low silt aggregate	30	Katestone (2011)				1,071	536	54
	Oil and double chip surface	80	Katestone (2011)				306	153	15
	Watering Level 2 (>2 l/m²/hr)	75	Katestone (2011)				383	191	19
	Suppressants	84	Katestone (2011)				245	122	12
	Hygroscopic salts	82	Katestone (2011)				275	138	14
	Lignosulphonates	77	Katestone (2011)				352	176	18
	Polymer emulsions	70	Katestone (2011)				459	230	23
	Tar and bitumen emulsions	70	Katestone (2011)				459	230	23

Table 25 Estimated Emissions - Wind Erosion of Pit Top Area – Potential Controls

Emission Source	Control Option	Reduction Efficiency (%)	Reference	Emissions (Controlled)			Emissions (Controlled) plus Further Control		
				TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Wind Erosion of Pit Top Area	Watering	50	Katestone (2011)	1,495	598	60	747	299	30
	Chemical suppressants	70	Katestone (2011)				448	179	18
	Fencing, bunding or shelterbelts	30	Katestone (2011)				1,046	419	42

A comparison of emissions following each control measure application against the original (with existing controls) estimated emissions of particulate are presented in **Figure 7** to **Figure 12**.

Figure 7 Potential Reductions in PM Emissions due to Additional Controls Wind Erosion from Coal Stockpile

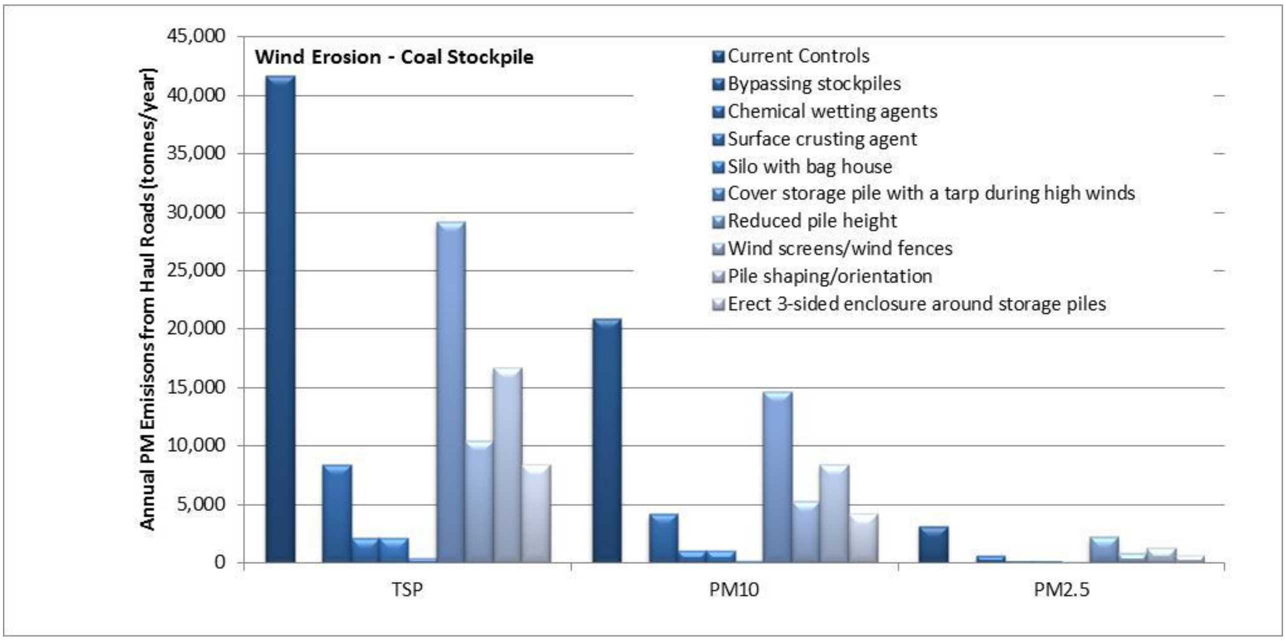


Figure 8 Potential Reductions in PM Emissions due to Additional Controls Dozer on Coal Stockpile

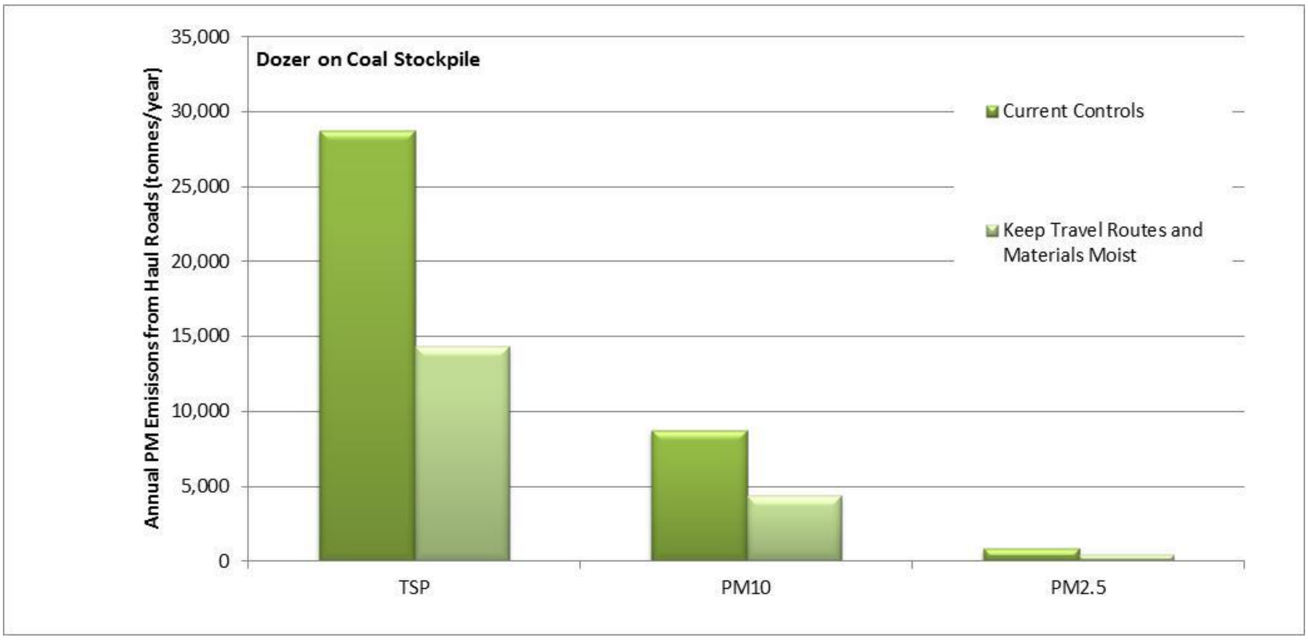


Figure 9 Potential Reductions in PM Emissions due to Additional Controls Wind Erosion from Emergency Coal Stockpile

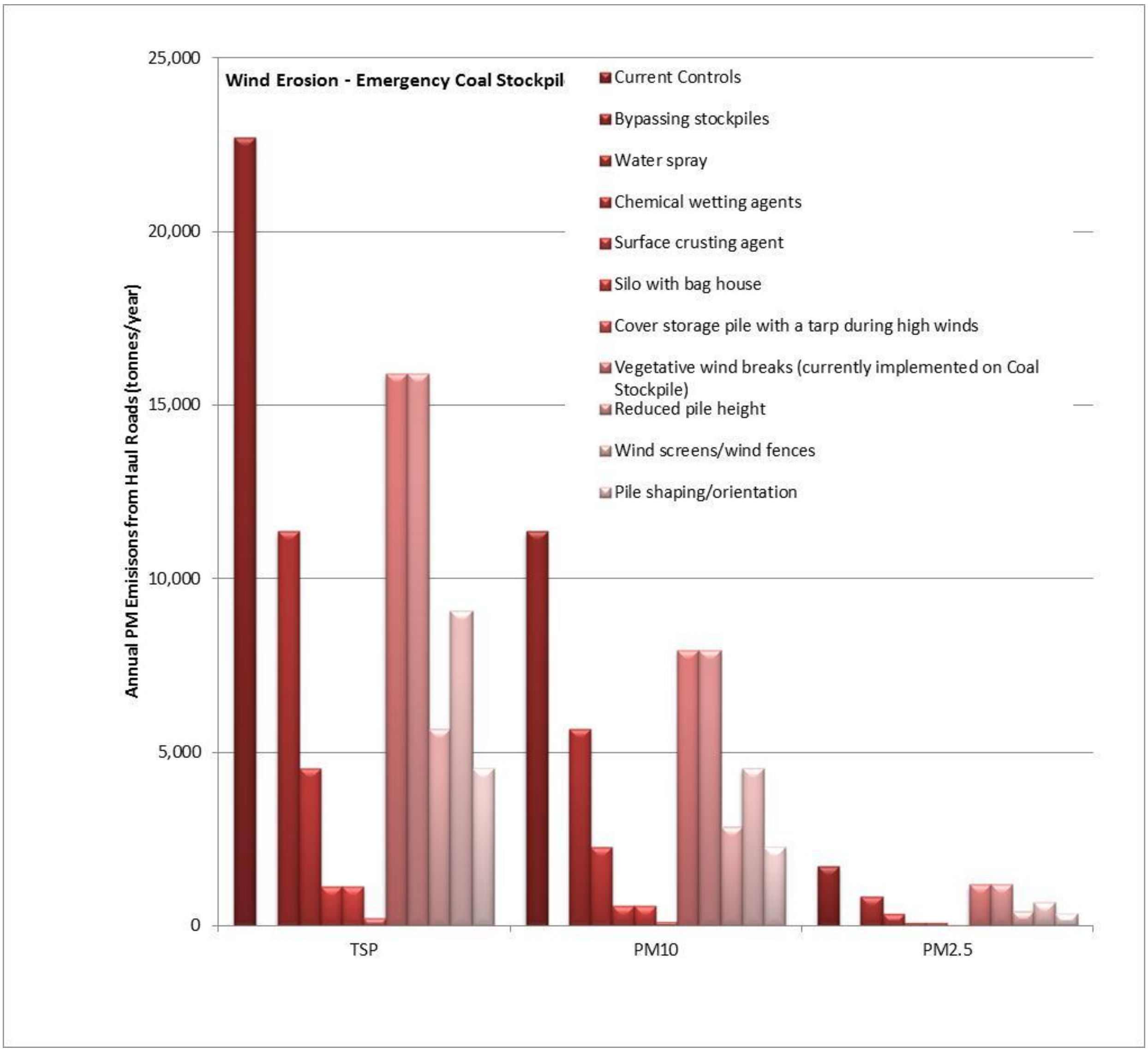


Figure 10 Potential Reductions in PM Emissions due to Additional Controls Access Road

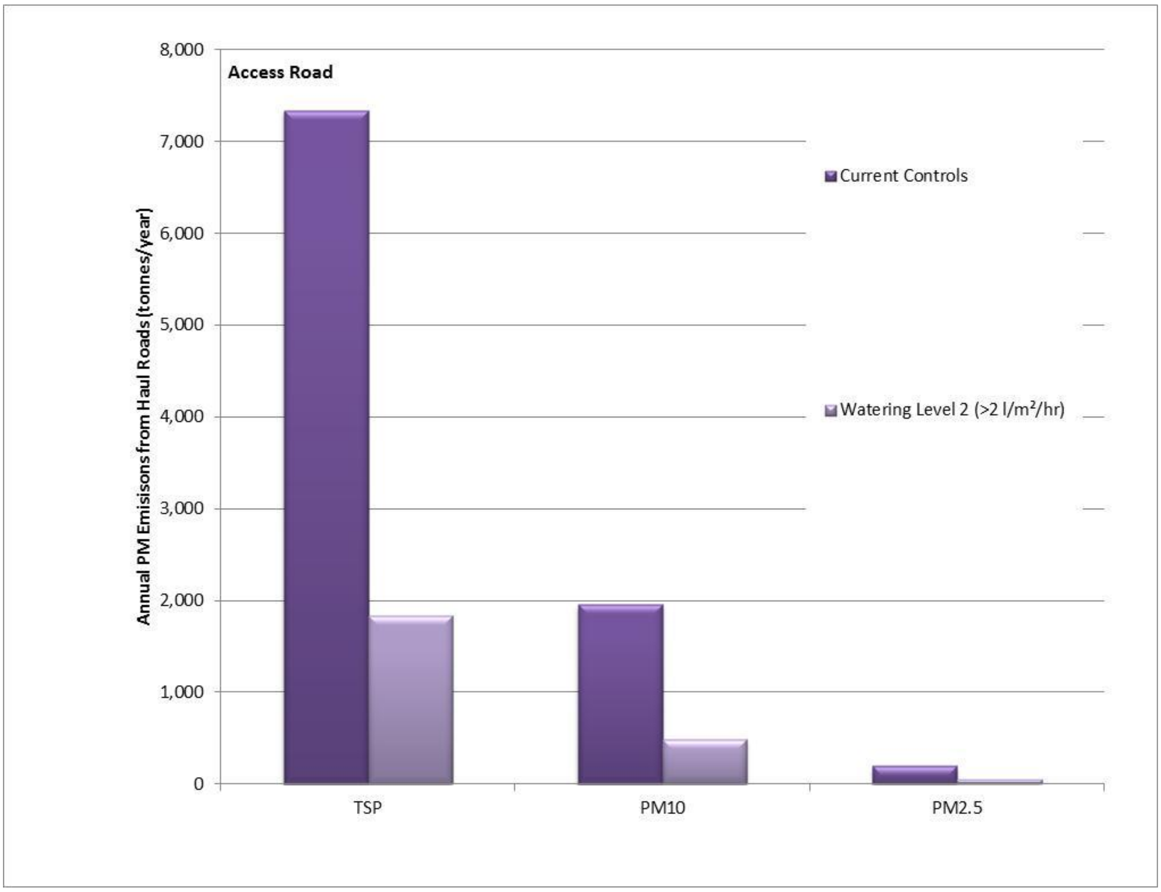


Figure 11 Potential Reductions in PM Emissions due to Additional Controls Torbane Road

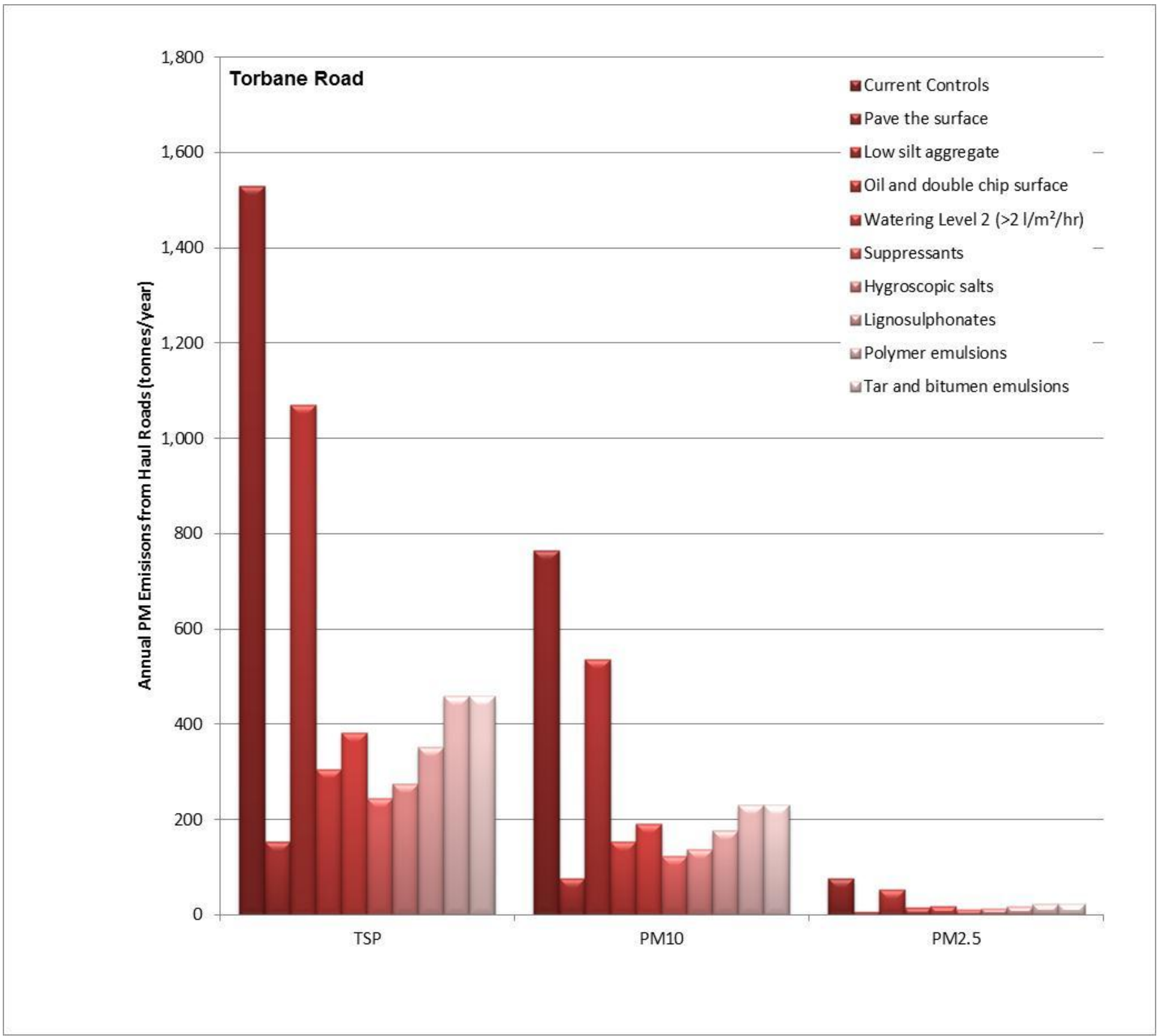
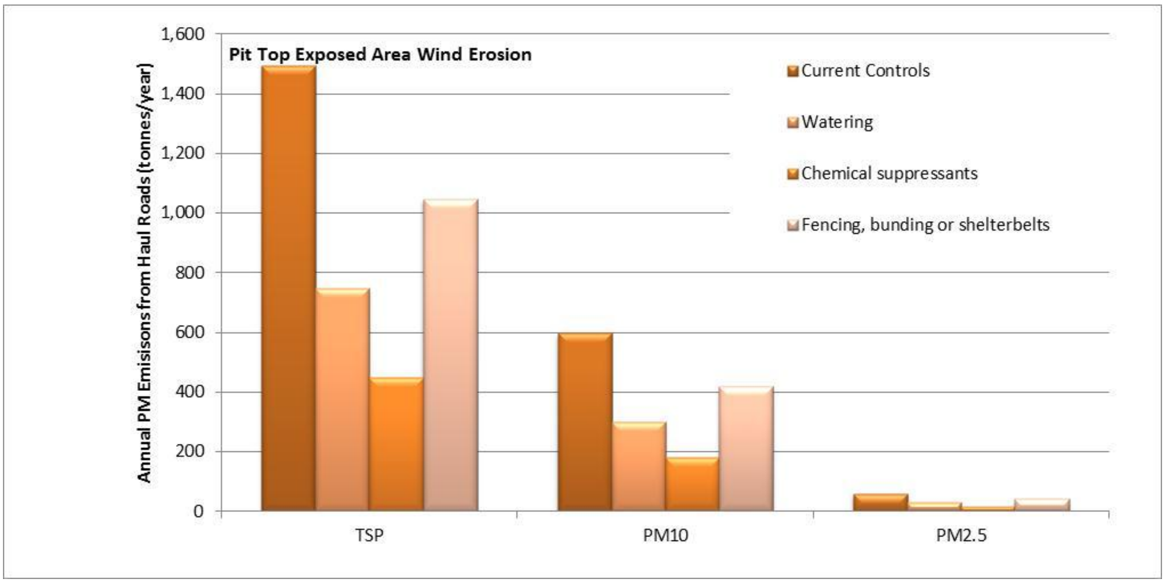


Figure 12 Potential Reductions in PM Emissions due to Additional Controls Pit Top Exposed Area Wind Erosion



4 EVALUATION OF ADDITIONAL CONTROL MEASURES

> ***3. Evaluate the practicability of implementing these best practice measures***
> *3.1 For each of the best practice measures identified in step 2.1, assess how practicable each one is to implement by taking into consideration:*
> - *implementation costs;*
> - *regulatory requirements;*
> - *environmental impacts;*
> - *safety implications; and,*
> - *compatibility with current processes and proposed future developments.*
>
> *3.2 Identify those best practice measures that will be implemented at the premises to reduce particle emissions.*

As required by EPA, the practicability of implementing each of the particulate control options identified in **Section 3** is to be assessed with due consideration given to:

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

The following sections examine the measures that may constrain the implementation of the particulate control measures outlined in **Table 19,** namely the regulatory requirements, environmental impacts, safety implications and compatibility with current processes and future development.

Each measure is provided a risk rating (**low**, **medium** or **high**) which identifies the constraints which may result in the implementation of the measure not being practical at Airly Mine. Where any of the four measures of practicability are rated as high, these measures are not taken forward for an assessment of cost implication and feasibility.

Section 4.1 examines the potential control measures identified for wind erosion of coal stockpiles, **Section 4.2** for wind erosion of exposed areas, **Section 4.3** for the operation of bulldozers on coal and **Section 4.4** for emissions from site roads.

4.1 Evaluation Findings – Wind Erosion of Coal Stockpiles

4.1.1 Practicality of Implementation

Table 26 provides a discussion of the feasibility of control measures for wind erosion of coal stockpiles (including emergency coal stockpile).

Table 26 Practicability of Implementing Control Measures on Wind Eroded Areas – Coal Stockpiles

Control Measure – Wind Erodible Areas	Regulatory Requirements RISK	Environmental Impacts RISK	Safety Implications RISK	Compatibility with Current Processes and Future Developments RISK	Conclusion of Evaluation
Bypassing stockpiles	RISK = LOW None	RISK = LOW Improvements in dust emissions would be realised	RISK = LOW None	RISK = HIGH Not compatible. Coal stockpiles are required for periods when coal cannot be accepted by trains.	✘ Not considered further in this assessment
Water Sprays (currently implemented at Coal Stockpile with water cart used on emergency stockpile as required)	RISK = LOW Ensure that run off is appropriately captured, filtered and discharged or recycled to on-site dams	RISK = LOW Ensure that run off is appropriately captured, filtered and discharged or recycled to on-site dams	RISK = MEDIUM Ensure electrical equipment is appropriately isolated. Ensure mists and sprays do not hinder mobile equipment operator vision	RISK = LOW Compatible	✘ Not considered further in this assessment – already implemented
Chemical wetting agents	RISK = LOW Ensure all chemicals are registered on-site with relevant MSDS at Stores	RISK = MEDIUM Ensure that application rate is appropriate to avoid run off into watercourses. Ensure application is performed during appropriate meteorological conditions to avoid wash/blow off onto other areas Based on the MSDS, a spill management program should be formulated.	RISK = MEDIUM Appropriate PPE required for water truck operative, and personnel involved in the mixing of suppressants with water (if required). If onsite storage required, appropriate signage required and emergency management plan required in event of spill/leakage	RISK = HIGH Not compatible for regularly disturbed areas. Application of wetting agents would need to be performed constantly	✘ Not considered further in this assessment
Surface crusting agents	RISK = LOW Ensure all chemicals are registered on-site with relevant MSDS at Stores	RISK = MEDIUM Ensure that application rate is appropriate to avoid run off into watercourses. Ensure application is performed during appropriate meteorological conditions to avoid wash/blow off onto other areas Based on the MSDS, a spill management program should be formulated.	RISK = MEDIUM Appropriate PPE required for water truck operative, and personnel involved in the mixing of crusting agents with water (if required). If onsite storage required, appropriate signage required and emergency management plan required in event of spill/leakage	RISK = HIGH Not compatible for regularly disturbed areas. Application of wetting agents would need to be performed constantly	✘ Not considered further in this assessment

Control Measure – Wind Erodible Areas	Regulatory Requirements RISK	Environmental Impacts RISK	Safety Implications RISK	Compatibility with Current Processes and Future Developments RISK	Conclusion of Evaluation
Enclosure (silo with bag house)	RISK = LOW None	RISK = LOW None	RISK = LOW None	RISK = HIGH Quantity of coal on stockpiles would make the installation of enclosure impractical	✘ Not considered further in this assessment
Cover storage pile with tarp during high winds	RISK = LOW None	RISK = LOW None	RISK = LOW None	RISK = HIGH Constant loading of coal stockpiles (24/7) would make the use of a tarp impractical	✘ Not considered further in this assessment
Vegetative wind break (currently implemented at Coal Stockpile)	RISK = LOW None	RISK = LOW None	RISK = LOW None	RISK = LOW Compatible	✘ Not considered further in this assessment – already implemented
Wind screens / fences	RISK = LOW None	RISK = LOW None	RISK = LOW None	RISK = HIGH Not compatible – the space required for the required fence height (1.25 times the height of the stockpile), width (1.5 times the width of the stockpile) and distance downwind (2 times the height of the stockpile) is not available at the site.	✘ Not considered further in this assessment
Erect 3-sided enclosure around storage piles	RISK = LOW None	RISK = LOW None	RISK = LOW None	RISK = HIGH Area of stockpiles too large to erect 3-siced enclosures. In addition, access to stockpile to be retained from all sides	✘ Not considered further in this assessment
Reduced pile height	RISK = LOW None	RISK = LOW None	RISK = LOW None	RISK = HIGH Not compatible due to limited coal storage area	✘ Not considered further in this assessment
Pile shaping / orientation	RISK = LOW None	RISK = LOW None	RISK = LOW None	RISK = HIGH Not compatible as stockpile shape limited by surrounding land uses.	✘ Not considered further in this assessment

No control measures for wind erosion from coal stockpiles have been identified as practicable for the Airly Mine and therefore no implementation costs have been assessed. It is noted that water sprays are used on the coal stockpile and a water truck is used on the emergency stockpile, both on an as-needs basis. Airly Mine propose to further investigate the conditions under which this watering should occur by performing a series of site specific coal tests, details of which are provided in **Section 5**.

4.2 Evaluation Findings – Wind Erosion of Exposed Areas

4.2.1 Practicality of Implementation

Table 27 provides a discussion of the feasibility of control measures for wind erosion of exposed areas.

Table 27 Practicability of Implementing Control Measures on Wind Eroded Areas – Exposed Areas

Control Measure – Wind Erodible Areas	Regulatory Requirements RISK	Environmental Impacts RISK	Safety Implications RISK	Compatibility with Current Processes and Future Developments RISK	Conclusion of Evaluation
Watering	RISK = LOW None	RISK = LOW Improvements in dust emissions would be realised	RISK = LOW None	RISK = LOW None	✓ Adopted potential measure **WEE1**
Chemical Suppressants	RISK = LOW Ensure that run off is appropriately captured, filtered and discharged or recycled to on-site dams	RISK = LOW Ensure that run off is appropriately captured, filtered and discharged or recycled to on-site dams	RISK = LOW None	RISK = LOW None	✓ Adopted potential measure **WEE2**
Fencing or Shelterbelts	RISK = LOW None	RISK = LOW Improvements in dust emissions would be realised	RISK = LOW None	RISK = LOW None	✓ Adopted potential measure **WEE3**

NB * Measures combined with identical control factors, activity rates and risks

4.2.2 Implementation Costs

As required by EPA, the cost implication of each potential particulate control measure has been assessed, taking into account (where applicable):

- Estimated capital expenditure;
- Labour costs;
- Material costs; and,
- Potential cost savings.

An estimation of the cost and net cost per tonne of TSP, PM_{10} and $PM_{2.5}$ suppressed is provided for each mitigation measure **APPENDIX C**.

4.3 Evaluation Findings – Bulldozers on Coal

4.3.1 Practicality of Implementation

Table 28 provides a discussion of the feasibility of control measures for bulldozers operating on coal.

Table 28 Practicability of Implementing Control Measures for Bulldozers Operating on Coal

Control Measure – Bulldozers	Regulatory Requirements RISK	Environmental Impacts RISK	Safety Implications RISK	Compatibility with Current Processes and Future Developments RISK	Conclusions of Evaluation
Keep travel routes and materials moist with water sprays	RISK = LOW Ensure that run off is appropriately captured, filtered and discharged or recycled to on-site dams	RISK = LOW Ensure that run off is appropriately captured, filtered and discharged or recycled to on-site dams Additional GHG emissions due to fuel consumption	RISK = MEDIUM Ensure road surface provides adequate traction for dozers to prevent slipping.	RISK = LOW Already implemented to some degree	✘ Not considered further in this assessment as water spraying already occurs on the coal stockpile

4.3.2 Implementation Costs

EPA require an assessment of the cost of each measure, although as no measures have been taken forward for further assessment, no cost benefit assessment of control measures for bulldozers operating on coal has been performed.

4.4 Evaluation Findings – Haul Roads

4.4.1 Practicality of Implementation

Table 29 provides a discussion of the feasibility of control measures for roads. Feasibility measures are provided considering all roads, as measures display commonality across the site.

Table 29 Practicability of Implementing Control Measures on Haul Roads

Control Measure – Haul Roads	Regulatory Requirements RISK	Environmental Impacts RISK	Safety Implications RISK	Compatibility with Current Processes and Future Developments RISK	Conclusions of Evaluation
Pave the surface (currently implemented for Access Road)	RISK = LOW Follow industry practice for the safe design of roads.	RISK = HIGH As part of mine development and rehabilitation, removal of the road will generate significant quantities of waste materials requiring disposal.	RISK = LOW Safety would likely be improved following paving as risk of accidents would be reduced. Speed restrictions would need to be closely monitored	RISK = LOW Compatible.	✘ Not considered further in this assessment
Low silt aggregate (Not applicable for Access Road as already paved)	RISK = LOW Follow industry practice for the safe design of roads.	RISK = MEDIUM As part of mine development and rehabilitation, removal of the road will generate significant quantities of waste materials requiring disposal or re-use.	RISK = MEDIUM Safety may be compromised following application of gravelling as risk of accidents may be increased as risk of skidding increases. Speed restrictions would need to be closely monitored to ensure this is not an issue	RISK = LOW Compatible	✓ Adopted potential measure **HR1**

Control Measure – Haul Roads	**Regulatory Requirements RISK**	**Environmental Impacts RISK**	**Safety Implications RISK**	**Compatibility with Current Processes and Future Developments RISK**	**Conclusions of Evaluation**
Oil and double chip surface (Not applicable for Access Road as already paved)	RISK = LOW Ensure all chemicals are registered on-site with relevant MSDS at Stores	RISK = HIGH Very little information or data is available to support this control option, and as such it is not considered likely to represent best practice.	RISK = MEDIUM Ensure road surface provides adequate traction for haul trucks to prevent skidding/slipping.	RISK = LOW Compatible	✘ Not considered further in this assessment
Watering Level 2 (>2 l/m²/hr)	RISK = LOW Ensure that run off is appropriately captured, filtered and discharged or recycled to on-site dams	RISK = LOW Ensure that run off is appropriately captured, filtered and discharged or recycled to on-site dams	RISK = MEDIUM Ensure road surface provides adequate traction for haul trucks to prevent skidding/slipping.	RISK = LOW Compatible	✓ Adopted potential measure **HR2**
Hygroscopic salts (Not applicable for Access Road as already paved)	RISK = LOW Ensure all chemicals are registered on-site with relevant MSDS at Stores	RISK = LOW Ensure that application rate is appropriate to avoid run off into watercourses. Ensure application is performed during appropriate meteorological conditions to avoid wash/blow off onto non-haul road areas Based on the MSDS, a spill management program should be formulated.	RISK = MEDIUM Ensure road surface provides adequate traction for haul trucks to prevent skidding/slipping. Ensure suitable storage and handling procedures are implemented to prevent harmful exposure to any chemicals in the suppressant product	RISK = LOW Compatible	✓ Adopted potential measure **HR3**
Polymer and Tar/Bitumen emulsions (Not applicable for Access Road as already paved)	RISK = LOW Ensure all chemicals are registered on-site with relevant MSDS at Stores	RISK = LOW Ensure that application rate is appropriate to avoid run off into watercourses. Ensure application is performed during appropriate meteorological conditions to avoid wash/blow off onto non-haul road areas Based on the MSDS, a spill management program should be formulated.	RISK = MEDIUM Ensure road surface provides adequate traction for haul trucks to prevent skidding/slipping. Ensure suitable storage and handling procedures are implemented to prevent harmful exposure to any chemicals in the suppressant product	RISK = LOW Compatible	✓ Adopted potential measure **HR4**

4.4.2 Implementation Costs

As required by EPA, the cost implication of each potential particulate control measure has been assessed, taking into account (where applicable):

- Estimated capital expenditure.
- Labour costs.
- Material costs.
- Potential cost savings.

An estimation of the cost and net cost per tonne of TSP, PM_{10} and $PM_{2.5}$ suppressed is provided for each mitigation measure **APPENDIX C**.

A summary of each measure is presented in **Table 30**.

Table 30 Summary of Control Options Evaluation

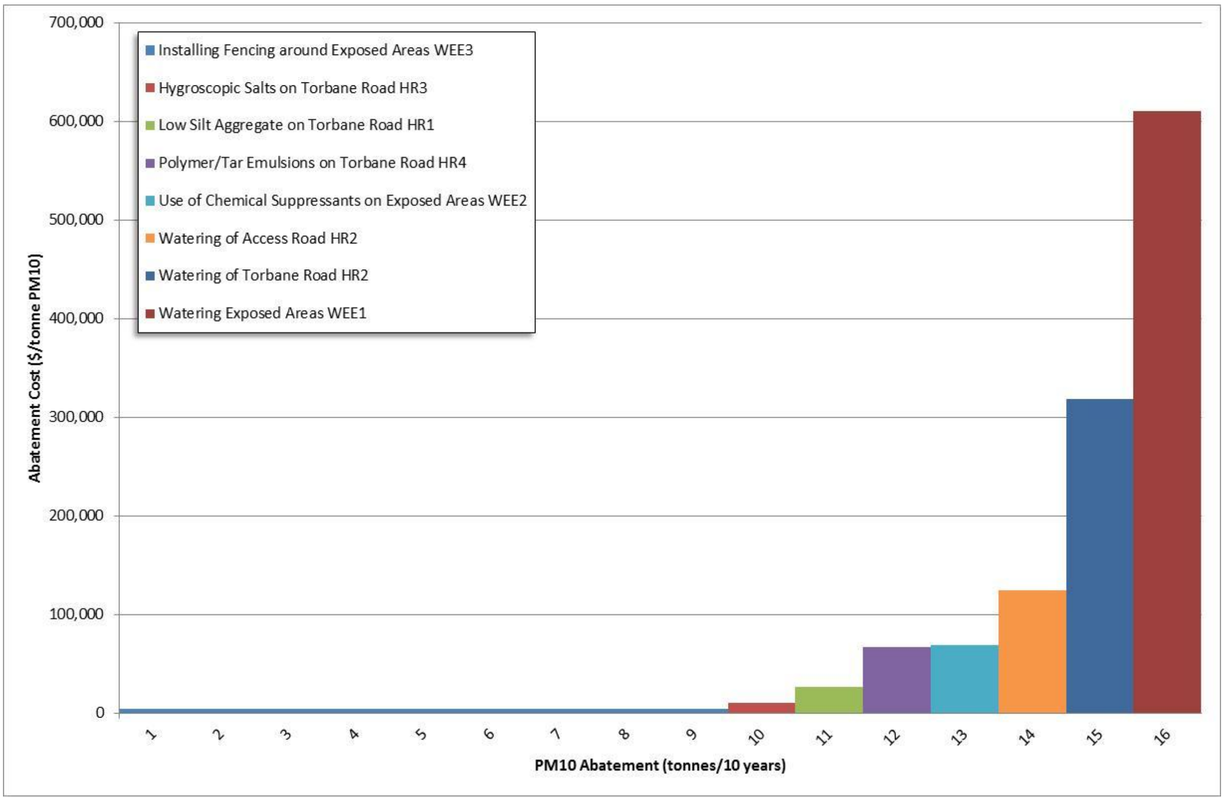
Emission Source	Control Measure		Cost/Benefit $/tonne PM_{10}	Regulatory Considerations	Environmental Impacts	Safety Implications	Site Compatibility
Exposed Areas	WEE1:	Watering	$610,427	Low	Low	Low	Low
	WEE2:	Chemical Suppressants	$68,827	Low	Low	Low	Low
	WEE3:	Fencing / Shelterbelts	$4,134	Low	Low	Low	Low
Roads	HR1:	Low Silt Aggregate	$26,144 (Torbane Road)	Low	Medium	Medium	Low
	HR2:	Watering (>2l/m^2/hour)	$124,359 (Access Road) $318,083 (Torbane Road)	Low	Low	Medium	Low
	HR3:	Hygroscopic Salts	$10,062 (Torbane Road)	Low	Low	Medium	Low
	HR4:	Polymer and Tar/Bitumen Emulsions	$67,262 (Torbane Road)	Low	Low	Medium	Low

4.5 Cost Curves

For each identified control measure evaluated as part of this process for the emission sources ranked as representing the top 95% of TSP emissions in **Table 14** a cost curve has been prepared to graphically display the relative effectiveness and relative cost of those controls. Displaying the collated data as a cost curve is a recognised industry-standard approach to visually identifying the preferential options.

The width of the each bar indicates the particulate mitigation afforded by each measure, with the height of each bar indicating the cost per unit of mitigation. Therefore, a wide and short bar indicates a measure that could potentially (and relatively) provide a greater level of particulate mitigation at a lower cost. These are the measures that should be prioritised for further investigation.

Figure 13 PM_{10} Abatement Cost Curve



4.6 Identification of Dust Control Measures for Airly Mine

The methodology followed above is consistent with the broad outline methodology proposed by NSW EPA, which is reproduced in **Appendix A**.

Through the adoption of this procedure, Airly Mine's emissions of particulate matter have been quantified with and without the range of existing control measures implemented on-site, and the top sources representing approximately 95% of calculated TSP emitting sources identified.

The particulate control measures that are already implemented at Airly are summarised in **Table 11**. It is noted that through the implementation of these controls, the monitoring undertaken around Airly demonstrates that the air quality criteria outlined in Project Approval conditions (refer to **Table 6**) are not exceeded. In this regard, it may be determined that the current controls implemented at Airly are adequate in controlling the impact of the mining operations and demonstrates compliance with the Project Approval and EPL conditions concerning the control of particulate emissions.

However, it is acknowledged that this process is designed to determine further controls which may assist in reducing particulate matter emissions from the Airly Mine as far as practicable. A range of additional control options for the processes operated at Airly has been investigated. All identified control options have been assessed to account for the risk associated with compliance with regulatory requirements, the potential environmental impacts, safety implications and their compatibility with current processes and future developments approved or anticipated at the Airly Mine. Through this initial screening, any options that were considered to be high risk for the above measures were discounted, resulting in a range of ten measures for which implementation costs were estimated.

The costings have been undertaken with reference to published and referenced data sources, experience or estimates from Airly and a range of assumptions. All assumptions have been provided for clarification and transparency.

The cost / benefit ratio of the control options are presented in *Airly Mine, Site Specific Particulate Matter Control Best Practice Assessment - Appendix C (Costs).* This analysis has identified the following control options as providing a potential to reduce the total emission of particulates from the site with costs of <$5,000 per tonne PM_{10} suppressed:

- Installation of fencing / wind breaks around exposed areas at the site.

Through the use of the above control options, it is estimated that approximately 2 tonnes of PM_{10} could be abated each year.

Airly Mine recognise the importance of reducing particulate matter emissions from the site. At the current time however, operations at the site are constantly changing due to the early stages of mining operations. This presents a number of challenges in the implementation of measures to control particulate emissions as the site constantly evolves and open areas are replaced with gravel and potentially hardstand areas as elements of the site come on line or locations changed or fixed. This makes the commitment to implementation of potentially costly, short term particulate control measures difficult to justify. Furthermore, the reduction of 2 tonnes of PM_{10} over a ten year period is not considered to represent a significant improvement in site emissions when compared to the calculated site emissions of 60 tonnes per year (refer **Table 12**).

At the current time, Airly Mine are not in a position to commit to any further particulate reduction measures. However, Airly Mine do commit to further improving current site dust suppression practices from the predicted major emission sources of the coal stockpile and emergency stockpile. Further details are provided in **Section 5**.

5 IMPLEMENTATION TIMEFRAME

4. Propose a timeframe for implementing all practicable best practice measures

4.1 For each of the best practice measures identified as being practicable in Step 3.2, provide a timeframe for their implementation.

As discussed in **Section 4.6**, a range of particulate control measures have been identified which are compatible with a range of considerations (regulatory, environmental, safety and site compatibility). A cost benefit analysis identified that the use of wind breaks around exposed areas at the site provided emissions reductions at the lowest cost (<$5K per tonne PM_{10} suppressed). However, given the early stages of mine development and the low level of particulate reduction afforded by this measure, it has not been committed to at this time.

Airly Mine currently implements a number of particulate management measures as outlined in **Table 11**. In the case of coal stockpiles (product coal and emergency coal stockpiles), these management measures are often implemented on an as-needs basis. Such measures include the use of water cannons and water carts to suppress dust emissions during hot, dry and windy conditions. In the interests of refining these management measures to ensure that particulate matter emissions are minimised with due regard to the conservation of water resources, Airly Mine will commit to performing a series of tests of coal to determine the propensity for dust generation through appropriate testing (e.g. Dust Extinction Moisture [DEM])[3]. This will allow an assessment of the likelihood of wind erosion more accurately than using generic emission factors. Site specific testing will also allow more targeted dust mitigation strategies to be designed (e.g. specific meteorological conditions under which water spraying is initiated) to minimise dust emissions from the site.

[3] DEM tests allow the moisture content at which the coal is deemed to emit no dust to be determined. Combined with wind tunnel dust-lift off tests and a number of moisture contents below the DEM, the wind speed at which erosion is initiated can be calculated and appropriate management measures employed at the mine site in conjunction with site meteorological data.

6 REFERENCES

- Countess Environmental (2006), WRAP Fugitive Dust Handbook.
- Katestone (2010), NSW Coal Mining Benchmarking Study - International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining.
- US Department of Health and Human Services (2012), Dust Control Handbook for Industrial Minerals Mining and Processing.
- USEPA (1995), AP 42, Fifth Edition, Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Technology Transfer Network - Clearinghouse for Inventories & Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, USA.
- USEPA (1998), AP 42, Chapter 11.9 Western Surface Coal Mining, Technology Transfer Network - Clearinghouse for Inventories & Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, USA
- USEPA (1982), AP 42, Chapter 11.24 Metallic Minerals Processing, Technology Transfer Network - Clearinghouse for Inventories & Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, USA
- USEPA (2006), AP 42, Chapter 13.2.2 Unpaved Roads, Technology Transfer Network - Clearinghouse for Inventories & Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, USA
- USEPA (2006), AP 42, Chapter 13.2.4 Aggregate Handling and Storage Piles, Technology Transfer Network - Clearinghouse for Inventories & Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, USA.
- USEPA (2006), AP 42, Chapter 13.2.5 Industrial Wind Erosion, Technology Transfer Network - Clearinghouse for Inventories & Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, USA.
- DCCEE (2011), National Pollutant Inventory Emission Estimation Technique Manual for Mining , Version 3, Australian Government Department of Sustainability, Environment, Water, Population and Communities.
- Airly Mine (2011), Annual Environmental Management Report

7 CLOSURE

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the manpower and resources devoted to it by agreement with the client. Information reported herein is based on the interpretation of data collected and has been accepted in good faith as being accurate and valid.

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COAL MINE PARTICULATE MATTER CONTROL BEST PRACTICE – SITE SPECIFIC DETERMINATION GUIDELINE

PURPOSE OF THIS GUIDELINE

The purpose of this guideline is to provide detail of the process to be followed in conducting a site specific determination of best practice measures to reduce emissions of particulate matter from coal mining activities.

This guideline also provides the required content and format of the report required for the Pollution Reduction Program "*Coal Mine Particulate Matter Best Practice - Assessment and Report*".

THE SITE SPECIFIC DETERMINATION PROCESS

In preparing the Report, the following steps must be followed, as a minimum:

5. ***Identify, quantify and justify existing measures that are being used to minimise particle emissions***
   5.1. Estimate baseline emissions of TSP, PM_{10} and $PM_{2.5}$ (tonne per year) from each mining activity. This estimate must:
      - utilise USEPA AP42 emission estimation techniques;
      - calculate uncontrolled emissions (with no particulate matter controls in place); and
      - calculate controlled emissions (with current particulate matter controls in place).

   (Note: These particulate matter controls must be clearly identified, quantified and justified with supporting information).

   5.2. Using the results of the controlled emissions estimates generated from Step 1.1, rank the mining activities according to the mass of TSP, PM_{10} and $PM_{2.5}$ emitted by each mining activity per year from highest to lowest.
   5.3. Identify the top four mining activities from Step 1.2 that contribute the highest emissions of TSP, PM_{10} and $PM_{2.5}$.

6. ***Identify, quantify and justify best practice measures that could be used to minimise particle emissions***
   6.1. For each of the top four activities identified in Step 1.3, identify the best practice measures that could be implemented to reduce emissions taking into consideration:
      - the findings of Katestone (2010), *NSW Coal Mining Benchmarking Study - International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining*, Katestone Environmental Pty Ltd, Terrace 5, 249 Coronation Drive, PO Box 2217, Milton 4064, Queensland, Australia. http://www.environment.nsw.gov.au/resources/air/KE1006953coalminebmpreport.pdf ;
      - any other relevant published information; and
      - any relevant industry experience from either Australia or overseas.

   6.2. For each of the top four activities identified in Step 1.3, estimate emissions of TSP, PM_{10} and $PM_{2.5}$ from each mining activity following the application of the best practice measures identified in Step 2.1.

7. ***Evaluate the practicability of implementing these best practice measures***
   7.1. For each of the best practice measures identified in Step 2.1, assess the practicability associated with their implementation, by taking into consideration:
      - implementation costs;
      - regulatory requirements;
      - environmental impacts;
      - safety implications; and
      - compatibility with current processes and proposed future developments.

   7.2. Identify those best practice measures that will be implemented at the premises to reduce particle emissions.
8. ***Propose a timeframe for implementing all practicable best practice measures***
   8.1. For each of the best practice measures identified as being practicable in Step 3.2, provide a timeframe for their implementation.

REPORT CONTENT

The report must clearly identify the methodologies utilised and all assumptions made.

The report must contain detailed information justifying and supporting all of the information used in each step of the process. For example, in calculating controlled emissions in Step 1, current particulate matter controls being used at the mine must be clearly identified, quantified and justified with supporting information and evidence including monitoring data, record keeping, management plans and/or operator training etc**.**

In evaluating practicability in Step 3, the licensee must document the following specific information:

- estimated capital, labour, materials and other costs for each best practice measure on an annual basis for a ten year period. This information must be set out in the format provided in Appendix A;
- The details of any restrictions on the implementation of each best practice measure due to an existing approval or licence;
- Quantification of any new or additional environmental impacts that may arise from the application of a particular best practice measure, such as increased noise or fresh water use;
- The details of safety impacts that may result from the application of a particular best practice measure;
- The details of any incompatibility with current operational practices on the premises; and
- The details of any incompatibility with future development proposals on the premises.

REPORT FORMAT

The report must be structured according to the process outlined above and submitted in both electronic format as .PDF format and hard copy format in triplicate. All emission estimates, costs and supporting calculations must be submitted in electronic format as .XLS format.

ABBREVIATIONS AND DEFINITIONS

USEPA AP42 Emission Estimation Techniques – all of the following:

- USEPA (1995), *AP 42, Fifth Edition, Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources*, Technology Transfer Network - Clearinghouse for Inventories & Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and

Standards, Research Triangle Park, NC 27711, USA.
http://www.epa.gov/ttn/chief/ap42/index.html ;
- USEPA (1998), *AP 42, Chapter 11.9 Western Surface Coal Mining*, Technology Transfer Network - Clearinghouse for Inventories & Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, USA. http://www.epa.gov/ttn/chief/ap42/ch11/final/c11s09.pdf ;
- USEPA (2006), *AP 42, Chapter 13.2.2 Unpaved Roads*, Technology Transfer Network - Clearinghouse for Inventories & Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, USA. http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s0202.pdf ;
- USEPA (2006), *AP 42, Chapter 13.2.4 Aggregate Handling and Storage Piles*, Technology Transfer Network - Clearinghouse for Inventories & Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, USA. http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s0204.pdf ; and
- USEPA (2006), *AP 42, Chapter 13.2.5 Industrial Wind Erosion*, Technology Transfer Network - Clearinghouse for Inventories & Emissions Factors, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, USA. http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s0205.pdf .

***PM_{10}* –** Particulate matter of 10 micrometres or less in diameter

$PM_{2.5}$ - Particulate matter of 2.5 micrometres or less in diameter

***Mining Activities* –** means:

- Wheel generated particulates on unpaved roads
- Wind erosion of 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
- Front-end loaders on overburden
- 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

TSP - Total Suspended Particulate Matter

Emission Factors

Bulldozing coal

The emission factors for bulldozing coal are taken from Table 11.9-2 of Chapter 11.9 of AP-42 (USEPA, 1998):

$$TSP\ (kg/hr) = \frac{35.6(s)^{1.2}}{(M)^{1.3}}$$

$$PM_{10}\ (kg/hr) = \left(\frac{8.44(s)^{1.5}}{(M)^{1.4}}\right) \times 0.75$$

$$PM_{2.5}\ (kg/hr) = \left(\frac{35.6(s)^{1.2}}{(M)^{1.3}}\right) \times 0.022$$

Where M is equal to the coal moisture content and s is equal to the coal silt content as provided in **Table 3**.

Front end loaders and excavators on coal and overburden

Specific emission factors for the operation of front end loaders and excavators on coal and overburden are not provided within AP-42. However, a default factor for TSP of 0.018 kg/t is provided in Table 11.9-4 of Chapter 11.9 of AP-42 (USEPA, 1998) for the activity of "truck loading by power shovel (batch drop)". The note provided with this figure however, encourages the user to make use of the predictive emission factor equations in Chapter 13 of AP-42 instead.

The quantity of particulate emissions (kg) generated by a batch drop process (per tonne) (e.g. a truck dumping to a storage pile, or loading out from a pile to a truck) may be estimated using the following expression:

$$EF\ (kg/t) = k \times 0.0016 \times \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

Where EF is the emission factor for TSP, PM_{10} or $PM_{2.5}$, k is the aerodynamic size multiplier (0.74 for TSP, 0.35 for PM_{10} and 0.053 for $PM_{2.5}$), U is the mean wind speed in m/s and M is the moisture content of coal and overburden (refer **Table 3**).

An average wind speed of 1.9 m/s has been adopted for the Airly Mine, based on onsite meteorological monitoring for calendar year 2011.

Material transfer of coal by conveyor

Specific emission factors for the transfer of material by conveyor at transfer points are not provided within AP-42. The Environment Australia Document "*National Pollutant Inventory for Mining (Version 3.0)*" (June, 2011) identifies that emissions of particulates at miscellaneous transfer points (including conveying) are estimated using the same emission factor as outlined in **Front end Loaders and excavators on coal** and this emission factor has been adopted within this report, using specific information for coal as outlined in **Table 3** of the main report.

Loading coal stockpiles

See **Front end Loaders and excavators on coal**.

Wind erosion of coal stockpiles and overburden/disturbed areas

The emission factors for wind erosion of coal stockpiles and overburden are taken from Table 11.9-2 of Chapter 11.9 of AP-42 (USEPA, 1998) as discussed in **Section 2.1.1**.

$$TSP\ (kg/ha/hr) = 1.8u$$

Where u is equal to the wind speed (m/s). Hourly wind speed data from the Airly Mine for 8,760 hours monitored during 2011 has been adopted.

Based on this data, an emission rate of TSP of 37,882 kg/ha/yr has been applied within this assessment. This equates to an average emission rate of 4 kg/ha/hr.

As discussed in Section **2.1**, the application of the AP-42 emission factor equation relating to industrial wind erosion of overburden (Chapter 13.2.5) yielded unrealistic emissions when the threshold friction velocity for overburden (and coal dust) was applied. Therefore the emission factor for coal stockpiles has been applied to all areas subject to wind erosion.

No emission factors for PM_{10} are provided for this emission source within Table 11.9-2 of Chapter 11.9 of AP-42. An assumption that 50% of the TSP is emitted as PM_{10} has been adopted for the purposes of this assessment. This is in line with the PM_{10}/TSP ratio quoted within the "*National Pollutant Inventory for Mining (Version 3.0)*" (June, 2011) for wind erosion sources.

Certain emission factors contained within the US EPA emission factor handbook AP-42 do not contain emission factors for $PM_{2.5}$ as often, little validated research has been undertaken to assess the fraction of PM_{10} which would be emitted as $PM_{2.5}$ from the wide range of sources involved.

Limited research has been conducted by the Midwest Research Institute (MRI) on behalf of the Western Regional Air Partnership (WRAP) with findings published within the document entitled *'Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors'* (MRI, 2006). This document provides seven proposed $PM_{2.5}$/PM_{10} ratios for fugitive dust source categories as presented in **Table 31**.

Table 31 Proposed $PM_{2.5}$ / PM_{10} Particle Size Ratios

Fugitive Dust Source	AP-42 Section	Proposed $PM_{2.5}$ / PM_{10} Ratio
Paved Roads	13.2.1	0.15
Unpaved Roads	13.2.2	0.1
Aggregate Handling and Storage Piles	13.2.4	0.1
Industrial Wind Erosion	13.2.5	0.15
Open Area Wind Erosion	-	0.15

The $PM_{2.5}$ / PM_{10} ratios presented in **Table 31** have been used within this report to calculate the emissions of $PM_{2.5}$ attributable to the activities occurring at Clarence Colliery, where specific $PM_{2.5}$ emission factors or scaling factors are not provided.

Coal crushing and screening

Emission factors for coal crushing are not provided specifically in AP-42 but are taken from AP-42 Chapter 11.24 Metallic Minerals Processing (1982). This approach is also taken within the National Pollutant Inventory for Mining (Version 3.0, June 2011).

Of relevance to this report are emission factors relating to primary coal crushing of high moisture (>4% by weight) coal and coal screening. Default emission factors for TSP and PM_{10} are provided for coal crushing as:

$$TSP\ (kg/t) = 0.01$$

$$PM_{10}\ (kg/t) = 0.004$$

And for screening as:

$$TSP\ (kg/t) = 0.08$$

$$PM_{10}\ (kg/t) = 0.06$$

Loading coal to trains

The emission factors for loading coal to trains are taken from Table 11.9-4 of Chapter 11.9 of AP-42 (USEPA, 1998):

$$TSP\ (kg/t) = 0.014$$

No PM_{10} or $PM_{2.5}$ emission factors are available for this source within AP-42, and as previously discussed, the PM_{10} emission factor is derived by applying a factor of 0.5 to the TSP emission factor whilst the emission factor for $PM_{2.5}$ is derived by applying the appropriate ratio of 0.1 (refer **Table 31**) to the PM_{10} emission factor. Resulting emission factors for PM_{10} and $PM_{2.5}$ are presented below.

$$PM_{10}\ (kg/t) = 0.007$$

$$PM_{2.5}\ (kg/t) = 0.0007$$

Loading coal to trucks

The emission factors for loading coal to trucks are taken from Table 11.9-2 of Chapter 11.9 of AP-42 (USEPA, 1998):

$$TSP\ (kg/t) = \frac{0.58}{(M)^{1.2}}$$

$$PM_{10}\ (kg/t) = \frac{0.0596}{(M)^{0.9}} \times 0.75$$

$$PM_{2.5}(kg/t) = \frac{0.58}{(M)^{1.2}} \times 0.019$$

Where M equals the material moisture content as provided in **Table 3**.

Bulldozing overburden

The emission factors for bulldozing overburden are taken from Table 11.9-2 of Chapter 11.9 of AP-42 (USEPA, 1998):

$$TSP\ (kg/hr) = \frac{2.6(s)^{1.2}}{(M)^{1.3}}$$

$$PM_{10}\ (kg/hr) = \left(\frac{0.45(s)^{1.5}}{(M)^{1.4}}\right) \times 0.75$$

$$PM_{2.5}\ (kg/hr) = \left(\frac{2.6(s)^{1.2}}{(M)^{1.3}}\right) \times 0.105$$

Where M is equal to the coal moisture content and s is equal to the coal silt content as provided in **Table 3**.

Loading and dumping of overburden

The emission factors for loading and dumping of overburden are taken from Table 11.9-4 of Chapter 11.9 of AP-42 (USEPA, 1998):

$$TSP\ (kg/t) = 0.001$$

No PM_{10} or $PM_{2.5}$ emission factors are available for this source within AP-42, and as previously discussed, the PM_{10} emission factor is derived by applying a factor of 0.5 to the TSP emission factor whilst the emission factor for $PM_{2.5}$ is derived by applying the appropriate ratio of 0.1 (refer **Table 31**) to the PM_{10} emission factor. Resulting emission factors for PM_{10} and $PM_{2.5}$ are presented below.

$$PM_{10}\ (kg/t) = 0.0005$$

$$PM_{2.5}\ (kg/t) = 0.00005$$

Wheel generated particulates on unpaved roads

The emission factors per vehicle kilometre travelled (VKT) for vehicles travelling on unpaved roads are taken from Chapter 13.2.2 of AP-42 (USEPA, 2006).

$$EF\ (kg/VKT) = k\ \times \left(\frac{s}{12}\right)^a \times \left(\frac{W}{3}\right)^b$$

Where EF is the emission factor for TSP, PM_{10} or $PM_{2.5}$, k is the aerodynamic size multiplier (4.9 for TSP, 1.5 for PM_{10} and 0.15 for $PM_{2.5}$), s is the silt content of the road (%) as taken from **Table 3** W is the average weight of vehicles travelling on the road (in tonnes) and a and b are empirical constants (for TSP, a = 0.7 and 0.9 for PM_{10} and $PM_{2.5}$, b = 0.45 for TSP, PM_{10} and $PM_{2.5}$). A conversion from lb/VKT to kg/VKT is also applied where 1 lb = 281.9 g).

Graders operating on unpaved roads

The emission factors for graders are taken from Table 11.9-2 of Chapter 11.9 of AP-42 (USEPA, 1998):

$$TSP\ (kg/VKT) = 0.0034 \times (S)^{2.5}$$

$$PM_{10}\ (kg/VKT) = 0.0056 \times (S)^{2.0} \times 0.6$$

$$PM_{2.5}\ (kg/VKT) = 0.0034 \times (S)^{2.5} \times 0.031$$

Where S is equal to the silt content of roads as provided in **Table 3**.

Centennial Coal

Centennial Coal Company Limited
P O Box 1000
Toronto NSW 2283
www.centennialcoal.com.au