Pacific Environment Limited

Consulting • Technologies • Monitoring • Toxicology

Report

ROCGLEN COAL MINE PRP U1: MONITORING RESULTS – WHEEL GENERATED DUST

WHITEHAVEN COAL MINING LIMITED

Job ID. 07487b

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CONTENTS

1 INTRODUCTION

Whitehaven Coal Mining Limited (WCMPL) holds Environmental Protection Licence (EPL) 12870 for the Rocglen Coal Mine (RCM). Condition U1 (*Particulate Matter Control Best Practice Implementation - Wheel Generated Dust)* requires that RCM must achieve and maintain a dust control efficiency of 80% or more on its haul roads.

To satisfy the requirements of the EPL, a Monitoring Plan was developed for condition U1 which outlined the proposed monitoring method to determine the site wide haul road control efficiency (**Pacific Environment, 2013a**).

This report provides results from the haul road dust control efficiency monitoring for Rocglen Coal Mine.

1.1 Licence Requirements

Condition U1.1 (*Particulate Matter Control Best Practice Implementation - Wheel Generated Dust)* requires that RCM must achieve and maintain a dust control efficiency of 80% or more on its haul roads. Control efficiency is calculated as:

$$CE = \frac{E_{uncontrolled} - E_{controlled}}{E_{uncontrolled}} \times 100$$

Where

E = measured emissions (mg/m^3).

Condition U1.2 requires that to assess compliance with U1.1, RCM must:

- Measure uncontrolled and controlled haul road emissions on at least 2 occasions using a mobile dust monitor.
- Continuously measure and record 'additional site data' including:
    - Vehicle kilometres travelled (VKT)
    - Meteorological conditions
    - Water use for dust suppression
- Undertake silt content and soil moisture sampling during sampling events.
- Determine if a site specific relationship can be derived between the measured control efficiency, additional site data, water use, meteorological data and silt content and moisture levels.

The measurement of controlled and uncontrolled haul road dust emissions must be undertaken under varying meteorological conditions, including at times when analysis of meteorological data indicated that elevate levels of dust are most likely at the Premises.

2 SAMPLING METHODOLOGY

2.1 Mobile Monitoring

PM_{10} emissions from haul roads were measured using the mobile system REX (Road Emissions eXpert). REX measures the concentration of PM_{10} generated from the test vehicle and so by comparing data collected from haul roads with and without controls, control efficiencies can be calculated.

The monitoring method is described in greater detail in ACARP Project C20023 (**Cox & Laing, in press**). All monitoring was conducted according to the internal Quality Management Plan for the use of REX (**Pacific Environment, 2013b**).

2.2 Sampling Approach

All active haul routes on the mine were sampled repeatedly over the sampling day. Within the full active circuit of the mine was an uncontrolled section of road, left at least 12 hours without controls (further details in **Section 2.3**).

2.3 Calculating Control Efficiency

Critical to the determination of haul road dust control efficiency is the definition of what constitutes an 'uncontrolled' section of haul road.

Seasonal changes in meteorology play a large role in the efficiency of controls applied to haul roads to manage wheel-generated dust. Conditions such as rainfall, high humidity, fog or damp are natural controls that reduce dust generated from an unsealed road. Conversely, higher ambient temperatures can cause increased evaporation, requiring more watering or suppressant to be used to meet a sufficient level of control. Road management, construction and maintenance also contribute to controlling dust.

For these reasons, it is not appropriate to calculate a control efficiency using baseline data that is heavily impacted by these seasonal conditions and management factors, where the control efficiency calculated does not have any bearing on the dust being generated (i.e. winter control efficiency being much lower than summer control efficiency). Therefore, the maximum uncontrolled data collected over all monitoring campaigns has been used to reflect an uncontrolled baseline and applied across the year to calculate the control efficiency.

For the purposes of determination of control efficiency, we define an uncontrolled haul road as:

> *"A section of at least 150 m of an active haul road where no water has been applied for at least 12 hours prior to monitoring and hasn't been treated with chemical suppressant. Less than 0.3 mm of precipitation has been recorded at the closest meteorological station in the preceding 12 hours and ambient conditions during monitoring do not act to suppress dust (rainfall, fog, mist, high humidity, low evaporation, low wind speeds)."*

3 RESULTS

In accordance with condition U1, two rounds of REX monitoring have been completed during February 2014 and June 2014. The results of the monitoring are shown in following sections:

- Dust control efficiency achieved on the sampling days (**Section 3.1**)
- Dust concentrations measured (**Section 3.2**)
- Additional site data, including meteorological conditions, operational factors and the results of silt and moisture sampling (**Section 3.3**)
- Site specific relationships between these data (**Section 3.4**)

3.1 Dust Control Efficiency

The average control efficiency achieved during the monitoring was calculated as 73 %. Average control efficiency achieved during each sampling campaign and the range by circuit is shown in **Table 3.1**.

Table 3.1: Summary of REX control efficiencies

Monitoring Round	Sampling Date	Number of circuits of the active mine	Average Control Efficiency	Range of Control Efficiency by circuit
1	5 February 2014	4	75 %	71 % - 78 %
2	25 June 2014	4	72 %	64 % - 78 %

The measured control efficiency of 72%-75% for the site is slightly less than the 80% required by the PRP. The reason for this is because the uncontrolled section of road was not representative of worst case road conditions (i.e. the uncontrolled section had an inherent level of existing control). The road section used to represent an uncontrolled road surface was reportedly left uncontrolled for 12 hours prior to sampling as required by the method but did not dry out as would typically be observed. The uncontrolled section of road was highly compacted and remained damp during the sampling, despite no controls being applied during the sampling day.

3.2 Dust Concentrations Measured

The average PM_{10} concentration measured during each sampling campaign is shown in **Table 3.2**. The controlled concentrations measured at Rocglen have been compared to concentrations measured at 10 other sites, shown in **Figure 3.1**. The controlled dust concentrations measured at Rocglen were comparable to other sites and lower than average. The plot presents the minimum, maximum, lower quartile, upper quartile and median of the data sets.

Although the control efficiency is lower at Rocglen than other sites, it is clear from **Figure 3.1** that the absolute dust emissions from controlled roads at Rocglen are lower than average.

Table 3.2: Summary of REX measured PM concentration

Monitoring Round	Sampling Date	Average controlled PM_{10} concentration (mg/m³)	Maximum average uncontrolled PM_{10} concentration (mg/m³)
1	5 February 2014	0.061	0.245
2	25 June 2014	0.069	

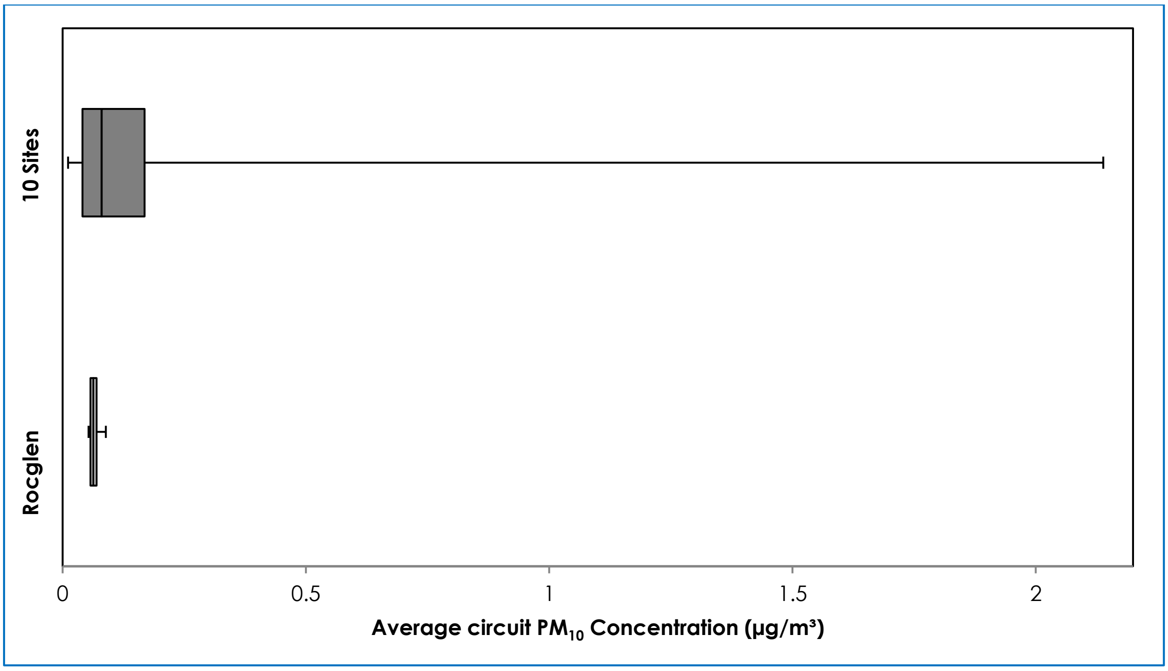

Figure 3.1: PM concentration measured at Rocglen compared to 10 other sites

The direct measurement of control efficiency, using REX, is clearly influenced by the uncontrolled section of road being damp and compacted, resulting in lower uncontrolled emissions and resulting in a lower calculated control efficiency using this method, despite the controlled emissions being comparable to other sites.

An alternative approach to determining control efficiency is therefore also presented, based on the US EPA AP-42 Section 13.2.2 Unpaved Roads. This methodology was proposed, along with mobile monitoring, in the Rocglen Best Practice Pollution Reduction Program report (**PAEHolmes, 2012**).

Figure 3.2 (sourced from **US EPA, 2006**) presents the relationship between the control efficiency due to watering and the moisture ratio. The moisture content "M" (shown on the x-axis) is calculated by dividing the surface moisture content of the watered road by the surface moisture content of the uncontrolled road. Based on surface moisture content of controlled and uncontrolled roads at Rocglen (refer to **Table 3.5**) a moisture ratio for each sampling event was determined. The February 2014 sampling moisture ratio calculated as 2.6 and the July 2014 moisture ratio was calculated as 6.1.

This equates to a control efficiency of approximately 80% in February 2014 and greater than 95% in July 2014, read from **Figure 3.2**.

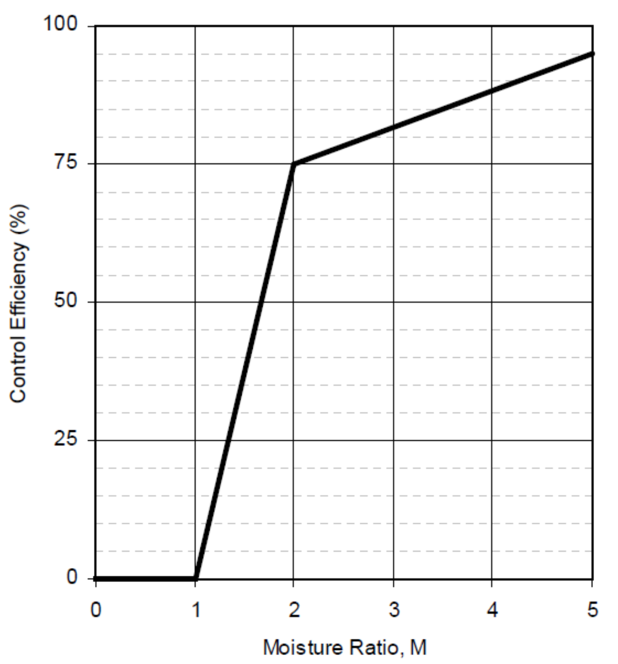

Figure 3.2: Watering control effectiveness for unsealed roads (US EPA, 2006)

3.3 Additional Site Data

A summary of the meteorological conditions, as recorded by the site meteorological station operating during the sampling day, for the day of each monitoring event is presented in **Table 3.3**. The average control efficiency achieved during each day has been included for comparison. The control efficiencies measured on each run correlate reasonably well with solar radiation. This relationship is illustrated in **Section 3.4**.

Table 3.3: Summary statistics for meteorological conditions

Parameter (units)	Round 1	Round 2
Average Wind Speed (m/s)	7.1 m/s	1.6 m/s
Average Temperature (°C)	22.9 °C	10.5 °C
Average Relative Humidity (%)	48.1 %	70.2 %
Average Solar Radiation (W/m²)	338 W/m²	129 W/m²
Total Rainfall (mm)	0.00 mm	0.00 mm

Four years of meteorological data (October 2009 – October 2013) from the Rocglen Coal Mine site meteorological station were analysed to determine the seasonal variation in meteorology at the site. **Figure 3.3** to **Figure 3.6** shows the following:

- Average monthly temperature compared to average temperature on sampling day (**Figure 3.3**)
- Average monthly humidity compared to average humidity on sampling days (**Figure 3.4**)
- Average monthly solar radiation compared to average solar radiation on sampling days (**Figure 3.5**)
- Total monthly rainfall by year (**Figure 3.6**)

The analysis shows that the sampling days where monitoring was completed are representative of changing seasonal conditions across the year. Rainfall data for December 2011 was sourced from nearby Canyon Met station due to a hardware fault.

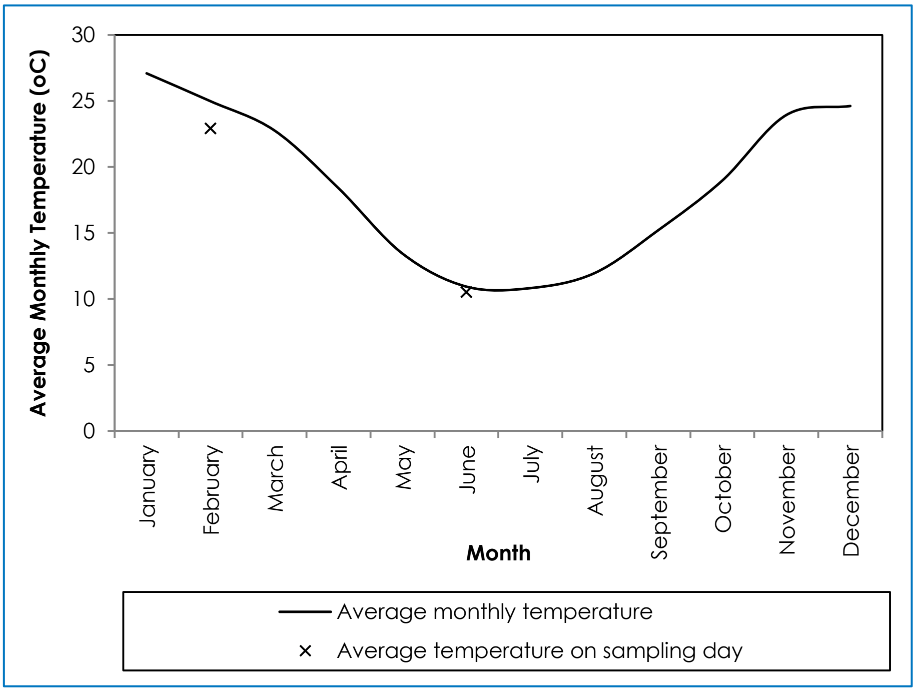

Figure 3.3: Average monthly temperature (°C) from October 2009 – October 2013 compared to average temperature on sampling day

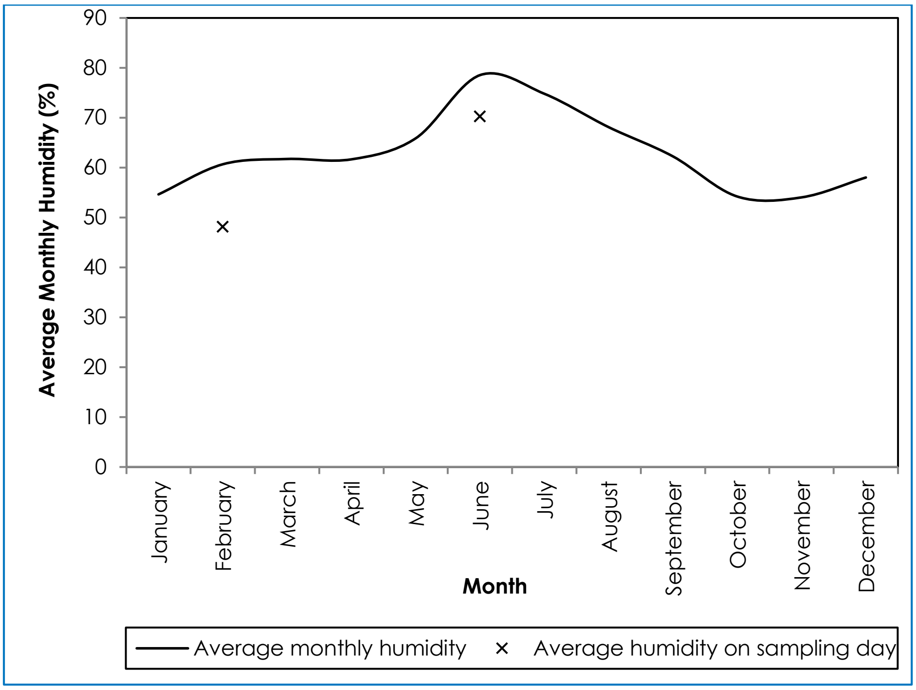

Figure 3.4: Average monthly humidity (%) from October 2009 – October 2013 compared to average humidity on sampling day

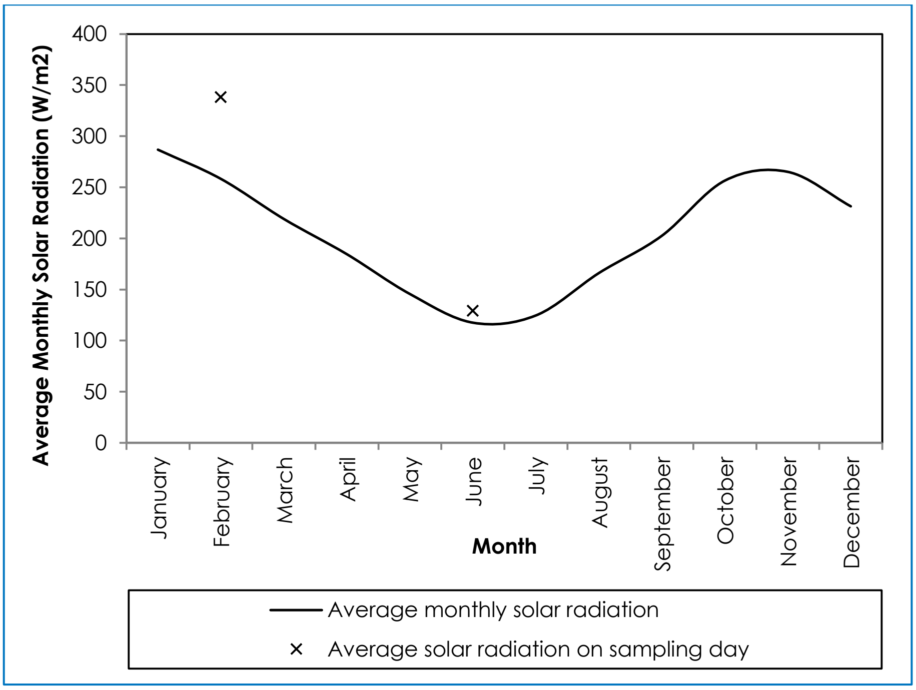

Figure 3.5: Average monthly solar radiation from October 2009 – October 2013 compared to average solar radiation on sampling day

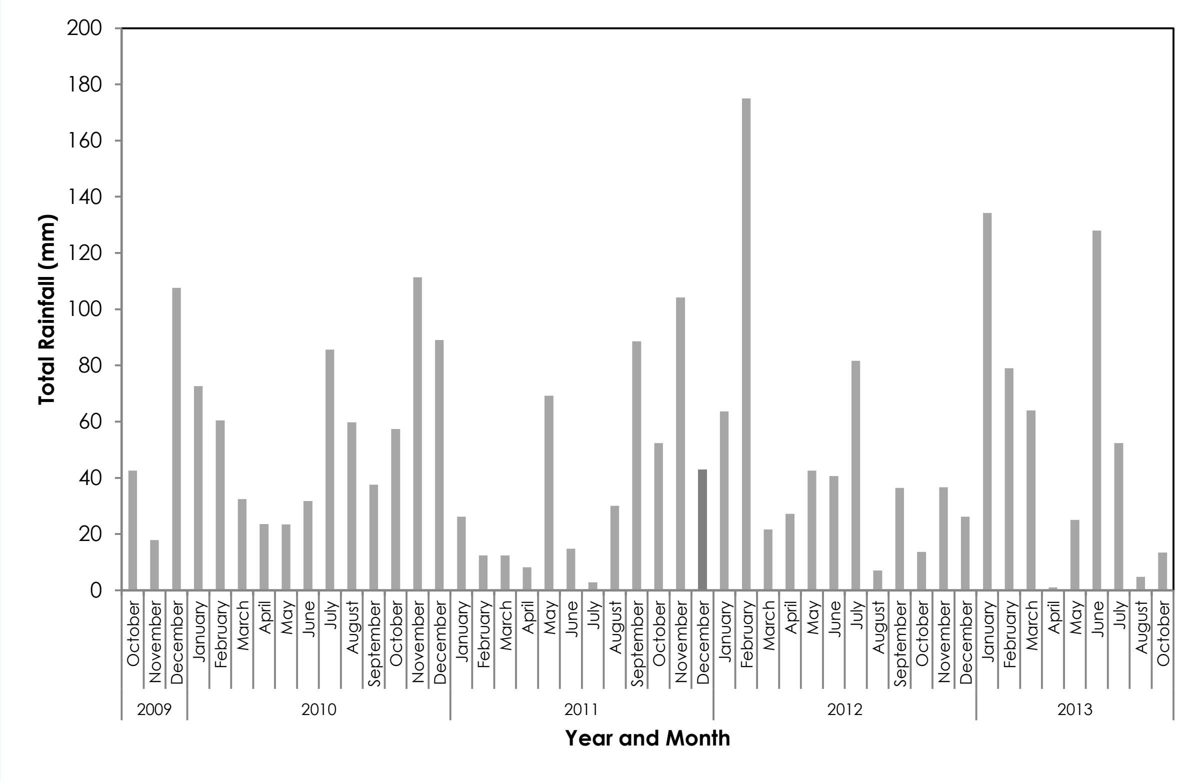

Figure 3.6: Total monthly rainfall (mm) from October 2009 – October 2013

In accordance with condition U1, additional operational data were collected for the periods of monitoring and are summarised in **Table 3.4**. The majority of operational parameters do not change between monitoring periods.

Table 3.4: Additional site data

Site Data	Monitoring Round 1	Monitoring Round 2
Vehicle movement routes	Pit to 550 dump and high dump, pit to ROM	Pit to high dump, pit to ROM
Loaded haul truck weight	CAT777F (3) 72 tonne empty, 91 tonne payload, CAT785 (3) 95 tonne empty, 151 tonne overburden load	CAT777F (3) 72 tonne empty, 91 tonne payload, CAT785 (3) 95 tonne empty, 151 tonne overburden load
Vehicle speed	Speed limit 60 km/h	Speed limit 60 km/h
Method of watering	Water	Water
Water application time	Not measured directly	Not measured directly
Water application volume	WAT866 (30,000L), WAT886 (10,000L)	WAT866 (30,000L), WAT876 (10,000L), WAT885 (13,000L)
Water application rate	Continuous or as required	Continuous or as required

Bulk sampling of the road surface was collected in accordance with the surface sampling methodology (**US EPA, 1993**). The samples were analysed at the laboratory for silt and moisture content, these reports are included in **Appendix A**.

Table 3.5: Results of silt and moisture sampling

Monitoring Round	Road Type	Control Level	Silt (%)	Moisture (%)
1	Permanent	Controlled	1.0	0.5
	Permanent	Uncontrolled	4.9	2.7
	Permanent	Controlled	1.9	13.8
2	Permanent	Uncontrolled	0.4	1.0
	Permanent	Controlled	1.0	9.5
	Temporary	Controlled	1.0	2.7

3.4 Site Specific Relationships

The strongest relationship between average control efficiency achieved on the sampling day and additional site specific data was with average solar radiation. This relationship is illustrated in **Figure 3.7**.

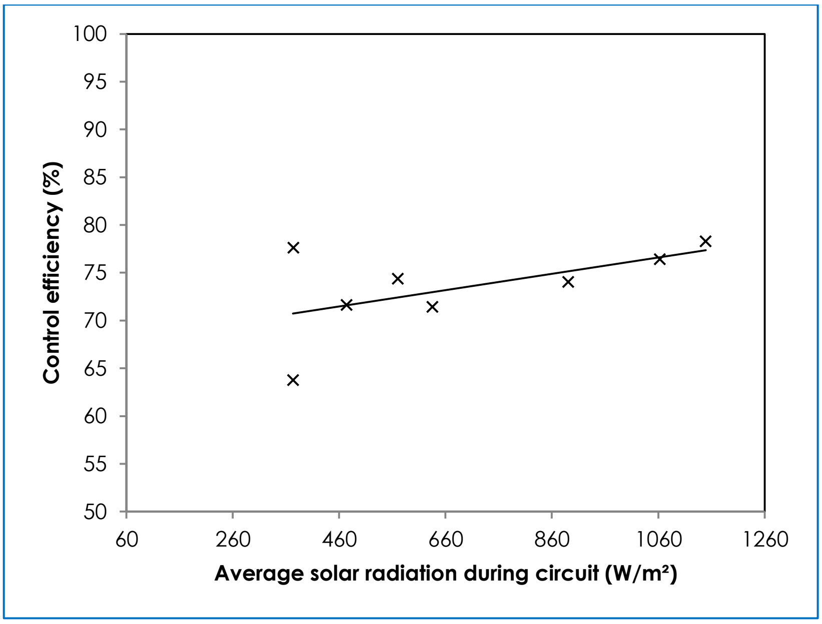

Figure 3.7: Average measured control efficiency (%) per circuit against solar radiation (W/m²)

4 CONCLUSION

Wheel-generated dust control efficiency was assessed at Rocglen Coal Mine on two occasions using a mobile dust monitoring system (REX). The dust control effectiveness was calculated as 75 % on 5 February 2014 and 72 % on 25 June 2014. When compared with other sites measured using the same method, the absolute dust emissions are comparable and on average lower, when compared to other sites using the same method. The direct measurement of control efficiency, using REX, is clearly influenced by the uncontrolled section of road being damp and compacted.

An alternative methodology for calculating control efficiencies using the moisture ratio demonstrated a control efficiency of 80 % for the February 2014 sampling and greater than 95 % in the June 2014 sampling.

This indicates that the level of control at Rocglen does not need to be increased; rather the lower control efficiency measured by REX is a result of moisture held in the uncontrolled road.

A number of factors contribute to dust generation from haul roads. The strongest relationship between control effectiveness and additional site data at Rocglen was shown with solar radiation. High temperatures, low humidity and high solar radiation are often shown to correlate well with the measured control efficiency and so should be used as a guide for managing haul road controls.

5 REFERENCES

Cox J and Laing G (in press). *Mobile Sampling of Dust Emissions from Unsealed Roads*. ACARP Project C20023. Stage 2 Final Report.

Pacific Environment (2013b). *Rocglen Coal Pollution Reduction Monitoring Plan – U1 Wheel Generated Dust*. Rocglen Coal Mine Pty Ltd, 25 July 2013.

Pacific Environment (2013b). *Quality Management Plan – Mobile Haul Road Monitoring*. 03 January 2013.

PAEHolmes (2012). Rocglen Coal Mine – Particulate Matter Control Best Practice Pollution Reduction Program. Whitehaven Coal Ltd, 29 June 2012.

US EPA (1993). *Procedures for Sampling Surface/Bulk Dust Loading*. Appendix C.1. AP-42.

US EPA (2006). *Section 13.2.2 Unpaved Roads.* AP-42.

Appendix A SILT AND MOISTURE SAMPLING RESULTS

A.1 FEBRUARY 2014 SILT AND MOISTURE SAMPLING

Job Number : L107254
Client : Pacific Environment Limited
Reference/Order : 7487b
Project : Rocglen

Page 1 of 1
plus Cover Page

Analyte		Lab No / Sample ID / DL	001	002	003
NQ968 - Moisture Determination of Bulk Samples					
Total Moisture (@ 105o C)	%	0.1	0.50	2.7	13.8
NQ899 - Size Analysis of Misc.Material					
+ 31.5 mm	%	0.1	nd	10.4	nd
-31.5 + 16.0 mm	%	0.1	6.4	6.8	0.8
-16.0 + 8.0 mm	%	0.1	35.6	4.4	13.0
-8.0 + 4.0 mm	%	0.1	25.2	6.4	15.2
-4.0 + 0.85 mm	%	0.1	21.0	22.3	36.6
-0.85 + 0.425 mm	%	0.1	4.7	16.3	16.5
-0.425 + 0.150 mm	%	0.1	4.4	21.3	12.7
-0.150 + 0.075 mm	%	0.1	1.7	7.2	3.3
-0.075 mm	%	0.1	1.0	4.9	1.9

DL = Detection Limit
LNR = Samples Listed not Received
-- = Not Applicable
nd = < DL
db = Dry basis

Sample Description Key (if req'd)

001	1. ROM RD CONTROLLED - HAUL RD
002	2. 3600 HAUL RD UNCONTROLLED - HAUL RD
003	3. 3600 DUMP RD CONTROLLED - HAUL RD

A.2 JULY 2014 SILT AND MOISTURE SAMPLING

ANDEL

Job Number : L108836
Client : Pacific Environment Limited
Reference/Order : 7487
Project : ROCGLEN

Page 1 of 1
plus Cover Page

Analyte		Lab No / Sample ID / DL	001	002	003
NQ968 - Moisture Determination of Bulk Samples					
Total Moisture (@ 105o C)	%	0.1	1.0	9.5	2.7
NQ899 - Size Analysis of Misc.Material					
+ 31.5 mm	%	0.1	nd	13.5	nd
-31.5 + 16.0 mm	%	0.1	nd	18.3	6.9
-16.0 + 8.0 mm	%	0.1	20.3	27.5	25.8
-8.0 + 4.0 mm	%	0.1	61.5	16.3	26.3
-4.0 + 0.85 mm	%	0.1	15.8	17.0	22.6
-0.85 + 0.425 mm	%	0.1	0.8	2.9	8.5
-0.425 + 0.150 mm	%	0.1	0.7	2.7	7.5
-0.150 + 0.075 mm	%	0.1	0.3	0.9	1.5
-0.075 mm	%	0.1	0.4	1.0	1.0

DL = Detection Limit
LNR = Samples Listed not Received
-- = Not Applicable
nd = < DL
db = Dry basis

Sample Description Key (if req'd)

001	1-COAL RD ROCGLEN
002	2-WEST DUMP ROCGLEN
003	3-DUMP RD ROCGLEN